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DOMESTIC WASTEWATER FACILITIES MANUAL

A Guide for the Design of Sewer Systems, Pump Stations, and Treatment Plants

*Please note, for clarification purposes, text in **red** are from the 10 State Standards and text in **blue** are changes by the Department.*

COMMONWEALTH OF PENNSYLVANIA
Department of Environmental Protection
For more information, visit DEP's website
at www.dep.pa.gov, Keyword: "wastewater."

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

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AUTHORITY: The Clean Streams Law (35 P.S. §§691.1-691.1001)
Title 25 Pa. Code Chapter 91.

POLICY: Pennsylvania's Domestic Wastewater Facilities Manual will be updated to improve and preserve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life and for recreation.

PURPOSE: Pennsylvania's design standards have not been updated since 1997. This document updates existing design standards and establishes design standards for new technologies for domestic wastewater treatment that had no design standards in 1997. These changes will improve the ability of the Department to be consistent in the permitting of domestic wastewater facilities statewide.

APPLICABILITY: This policy is applicable to persons designing and reviewing the designs of domestic wastewater facilities.

DISCLAIMER: The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these rules that weight or deference. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

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DEFINITIONS: Sewage Facilities. A system of sewage collection, conveyance, treatment and disposal which will prevent the discharge of untreated, adequately treated sewage or other wastes into waters of the Commonwealth or otherwise provide for the safe and sanitary treatment and disposal of sewage.

PREFACE

The Commonwealth of Pennsylvania provides for the regulation of wastewater disposal “to preserve and improve the purity of the waters of the Commonwealth for the protection of public health, animal and aquatic life, and for industrial consumption and recreation.”

These design standards should be used to help develop technically adequate permit applications for designs that are protective of the public health, safety, welfare and the environment. Technically adequate applications can be more quickly acted upon by the Department, under the DEP Permit Decision Guarantee Program.

Following Design Guidance does not guarantee adequate performance of the sewage facilities, but represents good engineering practices that reduce engineering and environmental risks and liabilities. Please note the following:

- i. This Guide does not relieve any permittee of its obligations to comply with all federal, interstate, state or local laws, ordinances, regulations, permits and/or other authorizations applicable to the sewage facilities. For example, if a treatment system does not perform as designed, the permittee might become subject to compliance action if effluent limits are exceeded or if permit conditions are not followed.
- ii. DEP will consider the licensed professional engineer whose seal is affixed to facility design documents to be fully responsible for the adequacy of all aspects of the facility design and compliance with the state standards and requirements. DEP approval or issuance of permit does not, in any way, relieve the design engineer of this responsibility.
- iii. The Design Engineer Report should identify deviation(s) from the Guidance, explain the technical rationale, and otherwise show the proposed design is adequately protective of the public health, safety, welfare and the environment.
- iv. Project-specific circumstances might require additional engineering and design justification to show that the proposal will adequately protect the public health, safety, welfare and the environment. For example, Antidegradation requirements for facilities located within High Quality or Exceptional Value watersheds might require additional engineering measures to ensure that the facilities do not cause degradation to the waters of the Commonwealth.

The design of wastewater facilities should not be limited by minimum requirements, but must meet the needs of the particular situation. It is not the purpose of this document to set forth data which can be used without due regard for the requirements of the particular project under design. The judgment of the skilled professional engineer is still required to apply these data. DEP will apply more stringent criteria when, in its judgment, their use is justified. With the foregoing qualifications definitely understood, DEP considers the items set forth in this manual as generally representative of good engineering practices.

This manual is based in part on the Recommended Standards for Wastewater Facilities, published by the Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. The Recommended Standards may be used for background information, or for supplementary

explanations where appropriate. However, in the event of discrepancies between the two documents, the standards in this document will govern.

New processes and variations of processes are proposed from time to time. Lack of description or criteria for a process does not suggest a process should not be used, but only that consideration by DEP will be on the basis of information submitted with a specific design. Section 9.3, entitled “Applications for New Processes” explains the requirements for experimental processes. Data on newly proven processes are usually meager, and final standards cannot be adopted immediately or included in a revised document. Tentative standards for such processes will be available as information is submitted and reviewed. DEP reserves the right to amend this document if and when necessary to incorporate such new processes. Any such amendments will be posted on DEP’s website and incorporated into the document at a later date.

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CHAPTER 1
GENERAL INFORMATION

1. ACTS OF THE GENERAL ASSEMBLY OF PENNSYLVANIA

The basis for requiring Part II permits for construction and operation of sewage collection and conveyance systems and sewage or industrial waste treatment facilities is contained in Pennsylvania's Clean Streams Law (the Act of June 22, 1937, P.L. 1987, No. 394, as amended) as follows:

Section 207. Approval of Plans, Designs and Relevant Data by the Department - (a) All plans, designs and relevant data for the construction of any new sewer system, or for the extension of any existing sewer system except as provided in section (b), by a person or municipality, or for the erection, construction, and location of any treatment works or intercepting sewers by a person or municipality, shall be submitted to the department for its approval before the same are constructed or erected or acquired. Any such construction or erection which has not been approved by the department by written permit, or any treatment works not operated or maintained in accordance with the rules and regulations of the department, is hereby also declared to be a nuisance and abatable as herein provided.

(b) Except as specifically provided by the rules and regulations of the department, plans, designs and relevant data for the construction of a sewer extension to collect no more than the volume of sewage from two hundred fifty single family dwelling units OR THEIR EQUIVALENT by a person or municipality shall not require a permit from the department if such sewer extension is located, constructed, connected and maintained in accordance with the rules and regulations of the department and is consistent with the approved official plan, required by Section 5 of the Act of January 24, 1966 (1965 P.L. 1535, No. 537), known as the "Pennsylvania Sewage Facilities Act," for the municipality in which the sewer extension is to be located, constructed, connected or maintained. However, all such sewer extensions remain subject to any conditions imposed by the department, the municipality, or any municipal authority whose interest may be affected by the sewer extension. Any such sewer extension which is located, constructed, connected or maintained contrary to the rules and regulations of the department, contrary to the terms and conditions of a permit, inconsistent with the approved official plan for the municipality or contrary to any conditions imposed by the department, municipality or municipal authority is also hereby declared to be a nuisance and abatable as provided herein."

As defined in the Act, "sewer extension" shall be construed to include new pipelines or conduits, and all other appurtenant constructions, devices and facilities except pumping stations and force mains added to an existing sewer system for the purpose of conveying sewage from individual structures or properties to the existing system.

Section 308. Approval of Plans, Designs, and Relevant Data by the Department

All plans, designs, and relevant data for the erection and construction of treatment works by any person or municipality for the treatment of industrial wastes shall be submitted to the Department for its approval before the works are

constructed or erected. Any such construction or erection which has not been approved by the Department by written permit, or any treatment works not maintained or operated in accordance with the rules and regulations of the Department, is hereby declared to be a nuisance.”

The basis for requiring Part II permits for discharge and disposal of sewage and industrial waste via land application is contained in Sections 202 and 307 of the Clean Streams Law.

Section 202. Sewage Discharges.—

No municipality or person shall discharge or permit the discharge of sewage in any manner, directly or indirectly, into the waters of this Commonwealth unless such discharge is authorized by the rules and regulations of the department or such person or municipality has first obtained a permit from the department. Such permit before being operative shall be recorded in the office of the recorder of deeds for the county wherein the outlet of said sewer system is located and in case the municipality or person fails or neglects to record such permit, the department shall cause a copy thereof to be so recorded, and shall collect the cost of recording from the municipality or person. No such permit shall be construed to permit any act otherwise forbidden by any decree, order, sentence or judgment of any court, or by the ordinances of any municipality, or by the rules and regulations of any water company supplying water to the public, or by laws relative to navigation. For the purposes of this section, a discharge of sewage into the waters of the Commonwealth shall include a discharge of sewage by a person or municipality into a sewer system or other facility owned, operated or maintained by another person or municipality and which then flows into the waters of the Commonwealth. A discharge of sewage without a permit or contrary to the terms and conditions of a permit or contrary to the rules and regulations of the department is hereby declared to be a nuisance.

Section 307. Industrial Waste Discharges.—

(a) No person or municipality shall discharge or permit the discharge of industrial wastes in any manner, directly or indirectly, into any of the waters of the Commonwealth unless such discharge is authorized by the rules and regulations of the department or such person or municipality has first obtained a permit from the department. For the purposes of this section, a discharge of industrial wastes into the waters of the Commonwealth shall include a discharge of industrial wastes by a person or municipality into a sewer system or other facility owned, operated or maintained by another person or municipality and which then flows into the waters of the Commonwealth.

(b) Public notice of every application for a permit or bond release under this section shall be given by notice published in a newspaper of general circulation, published in the locality where the permit is applied for, once a week for four weeks. The department shall prescribe such requirements regarding public notice and public hearings on permit applications and bond releases as it deems appropriate. For the purpose of these public hearings, the department shall have the authority and is hereby empowered to administer oaths, subpoena witnesses, or written or printed materials, compel the attendance of witnesses, or production of witnesses, or production of materials, and take evidence

including but not limited to inspections of the area proposed to be affected and other operations carried on by the applicant in the general vicinity. Any person having an interest which is or may be adversely affected by any action of the department under this section may proceed to lodge an appeal with the Environmental Hearing Board in the manner provided by law, and from the adjudication of said board such person may further appeal as provided in Title 2 of the Pennsylvania Consolidated Statutes (relating to administrative law and procedure). The Environmental Hearing Board, upon the request of any party, may in its discretion order the payment of costs and attorney's fees it determines to have been reasonably incurred by such party in proceedings pursuant to this act. In all cases involving surface coal mining as it is defined in section 3 of the act of May 31, 1945 (P.L.1198, No.418), known as the "Surface Mining Conservation and Reclamation Act," any person having an interest which is or may be adversely affected shall have the right to file written objections to the proposed permit application or bond release within thirty days after the last publication of the above notice. Such objections shall immediately be transmitted to the applicant by the department. If written objections are filed and an informal conference requested, the department shall then hold an informal conference in the locality of the surface mining operation. If an informal conference has been held, the department shall issue and furnish the applicant for a permit or bond release and persons who are parties to the administrative proceedings with the written finding of the department granting or denying the permit or bond release in whole or in part and stating the reasons therefor, within sixty days of said hearings. If there has been no informal conference, the department shall notify the applicant for a permit or bond release of its decision within sixty days of the date of filing the application. The applicant, operator, or any person having an interest which is or may be adversely affected by an action of the department to grant or deny a permit or to release or deny release of a bond and who participated in the informal hearing held pursuant to this subsection or filed written objections, may proceed to lodge an appeal with the Environmental Hearing Board in the manner provided by law and from the adjudication of said board such person may further appeal as provided by Title 2 of the Pennsylvania Consolidated Statutes.

(c) A discharge of industrial wastes without a permit or contrary to the terms and conditions of a permit or contrary to the rules and regulations of the department is hereby declared to be a nuisance.

The basis for requiring Part II permits for disposal of sewage or industrial waste via deep well injection, or for any other activity with potential to cause surface or groundwater pollution is contained in the Clean Streams law as follows:

Section 402. Potential Pollution

(a) whenever the Department finds that any activity, not otherwise requiring a permit under this act, including but not limited to the impounding, handling, storage, transportation, processing or disposing of materials or substances, creates a danger of pollution of the waters of the Commonwealth or that regulation of the activity is necessary to avoid such pollution, the Department may, by rule or regulation, require that such activity be conducted only pursuant to a permit issued by the Department or may otherwise establish the conditions

under which such activity shall be conducted, or the Department may issue an order to a person or municipality regulating a particular activity. Rules and regulations adopted by the Department pursuant to this section shall give the persons or municipalities affected a reasonable period of time to apply for and obtain any permits required by such rules and regulations.”

Copies of the Clean Streams Law, Act No. 394, approved June 22, 1937, P.L. 1987, as amended, may be obtained on the DEP website at www.dep.pa.gov, keyword “Clean Streams Law”.

2. DEPARTMENT OF ENVIRONMENTAL PROTECTION

2.1 Object

In reviewing reports and plans of proposed wastewater treatment, DEP has one dominant interest: the protection of the waters of the Commonwealth against pollution, under the provisions of the law.

Engineering reports and plans are, therefore, reviewed from the functional point of view to assure the suitability, adequacy, and operating reliability of the contemplated works to prevent stream pollution.

Matters of structural design, mechanical, electrical and other details are subjects of interest to DEP only to the extent that such items directly affect the functioning of the facilities and are necessary to make the project complete and ready for bidding.

Lack of description or criteria for a specific process does not suggest that it should not be used, but only that consideration by DEP will be on the basis of information submitted with the design.

2.2 Functions

In the exercise of its duties, DEP issues orders for the preparation of plans of treatment facilities and orders for the construction of such works.

Applications for permits are considered on the basis of the engineering facts presented and, accordingly, permits are issued or denied.

3. THE BUREAU OF CLEAN WATER

3.1 Functions

The Bureau of Clean Water examines and passes upon the technical aspects of all applications and plans for wastewater projects prior to issuance of a permit. The design engineer is responsible for all design computations and functioning of the proposed facilities.

3.2 Organization

Since the Clean Water permit program is decentralized, it is necessary that all negotiations concerning applications be handled through the Regional Office where the permit is being reviewed.

All applicants for permits contacting the Central Office shall be referred to the appropriate Regional Field Office. All discussions and consultations concerning an application must be initiated and carried out through the Regional Office. Applications and accompanying documents are not to be accepted in the Central Office, but in all cases referred to the Regional Field Office directly.

Regional Offices may at any time request the assistance of Central Office personnel during connection with the review of specific applications.

3.3 Regional offices

HEADQUARTERS	COUNTIES SUPERVISED
Southeast Regional Office Regional Clean Water Program Manager 2 East Main Street Norristown, PA 19401 Tel: (484) 250-5970	Bucks, Chester, Delaware, Montgomery, Philadelphia
Northeast Regional Office Regional Clean Water Program Manager 2 Public Square Wilkes-Barre, PA 18711-0790 Tel: (570) 826-2511	Luzerne, Monroe, Northampton, Pike, Schuylkill, Susquehanna, Wayne, Wyoming
Southcentral Regional Office Regional Clean Water Program Manager 909 Elmerton Avenue Harrisburg, PA 17110-8200 Tel: (717) 705-4707	Adams, Bedford, Berks, Blair Cumberland, Dauphin, Franklin, Lancaster, Lebanon, Mifflin, Perry, York
Northcentral Regional Office Regional Clean Water Program Manager 208 W. 3 rd Street, Suite 101 Williamsport, PA 17701 Tel: (717) 327-3636	Bradford, Cameron, Centre, Clearfield, Clinton, Columbia, Lycoming, Montour, Northumberland, Potter, Snyder, Sullivan, Tioga, Union
Southwest Regional Office Regional Clean Water Program Manager 400 Waterfront Drive Pittsburgh, PA 15222 Tel: (412) 442-4000	Allegheny, Armstrong, Beaver, Cambria, Fayette, Greene, Indiana, Somerset, Washington, Westmoreland
Northwest Regional Office Regional Clean Water Program Manager 230 Chestnut Street	Butler, Clarion, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, McKean, Mercer, Venango, Warren

Meadville, PA 16335-3481 Tel: (814) 332-6942	
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4. PERMITS

In order to preserve and improve the purity of the waters of the Commonwealth, the law requires that any municipality or person contemplating the construction of a new sanitary sewer or sewer system, the extension of an existing sanitary system, or the wastewater treatment works and related appurtenances shall, with the exception of certain sewer extensions, first obtain permit(s) from DEP. Refer to Section 1 (Act of the General Assembly of Pennsylvania) for sewer extension exempted from the permit requirement.

Issuance of Water Quality Protection permits occurs in two distinct phases as follows:

Part I (NPDES) Permits - represent authorization to “discharge pollutants” from “point Sources” to “navigable waters” (i.e., waters of the Commonwealth) under the National Pollutant Discharge Elimination System. The permit establishes effluent limits that the treatment plant must be designed to meet. NPDES permits are not required for discharges to groundwater, such as land application and groundwater injection, however, these discharges may require an injection well permit from EPA.

WQM Part II Permits - represent authorization to construct and operate sewage collection and conveyance systems, and sewage and industrial wastewater treatment facilities. Part II permits are also required for disposal of sewage and industrial waste via land application or underground injection. Part II permits are required for construction and operation of surface impoundments or any other activity which has potential to cause pollution of surface or groundwater.

Agencies of the Commonwealth planning the construction of sewerage facilities discharging to waters of the Commonwealth are required to file applications and to obtain permits, except that the filing and processing fees are not required.

Federal and other facilities requiring an NPDES Part I and Water Management Part II Permit are required to pay the appropriate fees as specified in Sections 9.1b and 9.1c, respectively.

Standard Operating Procedures

DEP establishes Standard Operating Procedures (SOPs) as a means to provide program-specific instructions to program staff in the review process of permit applications. Implementation of the standard operating procedures will ensure consistent procedures for reviewing permit applications across the department. The SOPs are available on the DEP website at:

<http://www.dep.pa.gov/Business/ProgramIntegration/DecisionGuarantee/Pages/StandardOperatingProcedures.aspx>

Permit Review Process and Permit Decision Guarantee

The Permit Review Process and Permit Decision Guarantee policy establishes a standardized review process and processing times for all DEP's permits. For the permits which Permit Decision Guarantee applies, DEP guarantees to provide permit decisions within the timeframes, provided applicants submit complete, technically adequate applications that address all applicable regulatory and statutory requirements in the first submission. Staff will follow a Department wide standard process for receiving, prioritizing, accepting, reviewing, denying and approving applications for permits or other authorizations. The Permit Review Process and Permit Decision Guarantee documents are available on the DEP website at:

<http://www.dep.pa.gov/Business/ProgramIntegration/DecisionGuarantee/Pages/default.aspx>

5. APPROVAL BY OTHER AGENCIES

5.1 Federal Government

Federal laws and regulations require that permission be obtained from proper federal authority (such as the Army Corps of Engineers) for any outfall or structure which discharges into or enters waters on which there is commercial navigation.

5.2 Pennsylvania Department of Labor and Industry

The Building Section of the Bureau of Occupational and Industrial Safety, Department of Labor and Industry, shall be contacted concerning approval of plans for compliance with

- (1) Building Energy Conservation Act (Act of 1980, P.L. 1203, No. 222) and
- (2) Fire and Panic Regulations of the Department of Labor and Industry.

5.3 Pennsylvania Public Utility Commission (PUC)

In cases where the applicant is subject to PUC regulations, a Certificate of Public Convenience from the PUC is required before a permit can be issued.

5.4 Delaware River Basin Commission

All applications for projects that are defined in the Delaware River Basin Commission's Rules and Regulations as having a substantial effect on the water resources (normally plants discharging greater than 50,000 gpd) of the Delaware River Basin will be submitted by DEP to the Commission for approval.

Issuance of a DEP permit in such a case will be withheld until the Commission notifies the DEP of its approval.

5.5 Approval must be obtained from the Department's Bureau of Air Quality for all features requiring air pollution control.

- 5.6 Approval must be obtained from the DEP’s Bureau of Waste Management for disposal of all solid residues by either land reclamation, agricultural utilization, or municipal waste landfill.
- 5.7 Other agencies who should be contacted, as necessary, are the Pennsylvania Council on the Arts, Pennsylvania Historical and Museum Commission, Pennsylvania State Police (Fire Marshall), Pennsylvania Department of Transportation, and local utilities.

6. FACILITIES OCCURRING IN MORE THAN ONE REGION

When the principal municipality served by a sewerage system making application is in one Region and the point(s) of discharge in another, the Region in which the principal municipality served is located shall handle the case unless other arrangements between field offices has been made.

In the Industrial Waste Program the “municipality served” concept does not apply. The Region in which the discharge is located shall be responsible for the case.

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7. SUMMARY OF PROCEDURES OBTAINING A PERMIT TO CONSTRUCT AND OPERATE DOMESTIC WASTEWATER TREATMENT FACILITIES

The person or municipality desiring to provide wastewater facilities must to engage the services of a licensed professional engineer (or registered surveyor, if applicable) skilled in designing wastewater facilities.

The engineer should make a survey of the situation and prepare a preliminary report and design. The design should conform to the standards set forth in this manual.

The engineer should request a pre-application conference with the regional clean water program staff for complex projects to ensure that the proper procedure for obtaining permits is followed and that the proposed design will conform to the requirements of the Department.

Based upon the results of the conference, the engineer may prepare a final report, and upon receiving effluent limits, may prepare final plans and specifications.

Permit applications should be submitted to the regional clean water program manager in accordance with instructions given under Chapter 9 of the manual.

Regional staff are responsible for processing and reviewing permit applications in a timely, consistent manner. The following principles apply when carrying out this responsibility:

1. Every applicant for a permit is entitled to prompt, efficient and courteous service, and a prompt answer regarding the action to be taken. In order for the regional office to properly process an application, certain deadlines must be set up in order to assure prompt service to applicants and to allow the staff sufficient time to complete its work on the application.
2. Before any application is accepted, it must be reviewed to determine whether it is accompanied by the required documentation (reports, plans, specifications, etc.) which is required by the regional office so that it can be properly processed.
3. Every application accompanied by proper documentation must be processed promptly even if the project does not meet Bureau requirements. However, appropriate and prescribed efforts shall be made to have sub>standard applications revised.
4. Whenever a review engineer recommends the issuance of a permit, this means that he or she is satisfied that the issuance of a permit, this means that he or she is satisfied that the project, as proposed in the application and accompanying documentation, complies with the requirements of the Clean Streams Law, other applicable laws, policies regulations, technical standards and requirements of the Department. If an application does not meet these requirements, and the applicant is unwilling within a specified time to correct his application accordingly, the permit must be denied or the application returned.
5. Applications which are faulty and do not meet all the requirements of applicable laws, regulations, policies and procedures, or technical standards may not be approved by including restrictive conditions in the permit. The only exceptions to this are applications which were submitted prior to a change in technical standards or regulations. Provisions

covering revised standards or regulations, or for experimental permits, may be included in the permit as special conditions where appropriate.

8. PRE-APPLICATION CONFERENCE

8.1 General

8.11 Pre-Application Conference

A pre-application conference is the foundation for improved understanding and communication between the potential applicant and the Department. The pre-application conference allows the Department, consultant and Applicant to discuss project details and seek clarification on applicable regulatory and statutory requirements. Upon request by the Applicant, the Department will schedule pre-application conferences when deemed to be necessary. Assistant Regional Directors will arrange these conferences in most cases and will also coordinate pre-application conferences for large scale, multi-permit projects. The Department will also include, as necessary, applicable partners (such as County Conservation Districts) in the pre-application conferences. For very large, high-priority economic development projects, the Regional Director will take the lead role in terms of coordinating meetings for the Department.

For the applicant and the applicant's consultant, the time invested in a pre-application conference pays dividends in the form of complete and technically adequate submissions, and shorter processing times resulting from a better understanding of the project and complicated matters prior to application submission. Further, these meetings are critical and highly recommended when large scale, multi-permitted facilities are involved and when a project spans multiple counties or regions or if federal permit coordination will be required.

The Department will seek as much information from the Applicant prior to the pre-application conference to ensure that all appropriate staff/programs are present and the outcome of the conference effectively outlines expectations and communicates next steps. This information may include but is not limited to detailed maps, plans and narrative, project location, project scope and project timeline.

Based on the Applicant's proposed project, the Department will provide an explanation of the number and type of permits required for the project; an explanation of the process and interrelationships of the various permits; discuss the need for or potential for public meetings or hearings; and, as possible, provide the applicant with the Permit Decision Guarantee timeframe. The Permit Decision Guarantee timeframe is contingent upon submission of a complete, technically adequate application addressing all applicable regulatory and statutory requirements. Additionally, the Department may recommend that the applicant seek public input prior to submitting an application.

The Pre-Application Checklist may be used by Department staff to guide discussions at the pre-application conference. Department staff may provide a Summary Letter following a pre-application conference to confirm discussions and when possible provide permit processing timeframes for the proposed project.

For projects that require multiple permits, the review for which will require significant Department time and resources, the Applicant will be requested to submit a proposed project schedule for review and concurrence by the Department. This schedule should outline in a timely and logical sequence, the expected submission dates and issuance dates for all permits needed for the overall project. It will be the responsibility of the Assistant Regional Director to coordinate the review of all permits necessary for the project.

8.12 Project Proposal

At a preliminary conference, the applicant's engineer is expected to set forth the wastewater problem and its proposed solution in such manner as to support the recommendations made and the conclusions reached.

8.13 Plans

Location maps, layout sketches and other illustrative material should be presented. A review of any of the items listed in this manual is in order, although at the time of the preliminary engineering conference many of these factors may not have been determined.

8.2 Preliminary Report

The regional water quality management staff may require the submission of a written preliminary report detailing the agreement reached or elaborating on any of the subjects discussed during the conference.

8.3 Scope of Engineering Advice

Advice given by the regional water quality management staff is advisory only and is not to be construed as representing official approval by the regional clean water program.

Favorable consideration of design data submitted at a preliminary conference or in a preliminary report, in no manner, waives the legal requirement for the submission of final plans and an engineer's report at the time a formal application for a permit is submitted, nor does it waive the right of the program to require modification of plans which do not conform to good engineering practice.

9. APPLICATIONS FOR WASTEWATER FACILITY PERMITS

9.1 Action by Applicant

- a. Act 537 (Sewage Facilities Act) Planning:

Act 537, enacted by the Pennsylvania Legislature in 1968, requires that every municipality in the state develop and maintain an up-to-date sewage facilities plan. The Act provides the requirements for these. Act 537 base plans are broad in scope and address existing sewerage needs as well as future growth and development needs.

The main purpose of a municipality's sewage facilities plan is to protect the health, safety and welfare of the citizens living in the municipality. All proposed wastewater facilities must demonstrate consistency with local wastewater facilities plans and conform to state laws. This is accomplished in part by the municipality updating its official sewage plan or by the municipality, owner, subdivider or agent of the proposed land development completing "Planning Modules for Land Development." The modules, including completion instructions, can be supplied by the Department. The municipality will act on the completed modules and submit them to the Department for review and subsequent approval or denial.

- b. National Pollutant Discharge Elimination System (NPDES) Part I Permit Giving Discharge Limitations:

Facilities which will discharge to waters of the Commonwealth will require an NPDES Part I Permit for authorization to discharge.

Application forms, application form instructions, fee amounts, and checklists may be obtained on the DEP website at www.dep.pa.gov, keyword NPDES.

- c. State Water Quality Management Part II Permit to Construct and Operate Sewerage Facilities.

All wastewater facilities, with the exception of certain sewer extensions, will require a Part II permit for authorization to construct and operate wastewater facilities. It is unlawful to begin construction work until the required permit(s) have been received from the Department. Refer to Section 1 of Part I (Act of the General Assembly of Pennsylvania) for sewer extensions exempted from the permit requirement.

To apply for a Part II Permit, the applicant must submit the documents listed below to the regional clean water program manager in whose region the project is located.

IF THE REQUIRED NUMBER OF COMPLETE AND CONSISTENT COPIES OF ALL DOCUMENTS ARE NOT SUBMITTED, THEN THE DOCUMENTS WILL BE RETURNED. The following documents must be submitted:

1. General Information Form (GIF).

2. Appropriate application fee, with check payable to the Commonwealth of Pennsylvania. This payment is required as a filing and processing fee as per the schedule below:

Sewer extensions (collectors only)	\$100.00
Sewer extensions with pumping station(s)	\$500.00
Pumping stations only	\$500.00
Sewer extensions with interceptor sewers	\$500.00
Sewer extensions with interceptor sewers & pumping station(s)	\$500.00
Interceptor sewer only	\$500.00
Wastewater treatment plant with or without sewers, etc.	\$500.00
Single residence wastewater treatment facility	\$25.00

In situations where the applicant is other than a federal, state, county or municipal agency, and when there is a stream "encroachment" or "water obstruction" associated with wastewater facilities, an additional application fee of \$50.00 should be submitted (this may be included in the same check for the Water Quality Management - Part II Permit application fee). The \$50 fee is not required for outfalls which are eligible for coverage under General Permit GP-4 (Intake and Outfall Structures) issued by the Bureau of Waterways Engineering and Wetlands on February 14, 1984 (e.g, 36 inches or less in diameter and not located on Exceptional Value or High Quality Stream).

NOTE: Projects requiring approval by the Delaware River Basin Commission and projects located in Allegheny, Bucks and Erie Counties require an additional set of permit applications and all supporting documentation.

3. Three (3) copies (original and 1 copy) of application, design module(s), and accompanying drawings and plans.
- a. Certification and proper signatures.
 - b. Engineer's professional seal on each plan sheet.
 - c. *Design Engineer's Report* with signature and seal on cover
 - i. The report should contain all the design factors/assumptions and pertinent calculations used in designing/sizing each of the proposed units or components thereof.
 - ii. When a treatment plant is involved, the report should also include information pertaining to expected effluent quality which the designer should be able to support.

- d. Properly notarized (original).
 - e. Technical specifications with engineer's seal and signature on cover
 - f. Additional copy for Delaware River Basin or Erie and Allegheny counties (if required).
4. Supplemental Information:
 - a. General Layout Diagram (unless design plans provide this information).
 - b. Sizes, Capacities and Dimensions Diagram (unless design plans provide this information).
 5. Design Modules.
 6. Topographic map with appropriate details.
 7. Act 14 Notification.
 - i. A copy of the applicant's correspondence notifying the municipality and the county in which the permitted activity will occur of the applicant's intentions and evidence that he received notification.
 - ii. Acceptable forms of evidence include certified mail receipt or written acknowledgement.
 8. Act 537 Approval (if required).
 9. Cultural Resources Notification
 10. Acts 67, 68 and 127 Notification (IW and Manure Storage Facilities only).
 11. Proof of Public Notification (IW and Manure Storage Facilities only)
 12. DRBC Notification (if required).
 13. Three copies of a soil erosion and sedimentation control plan to be implemented and maintained during and following any earthmoving activities associated with the sewerage project. If the county conservation district has approved a plan, please provide a copy of the approval.

- d. A Part II Permit application will not be accepted and a Part II Permit shall not be issued prior to the issuance of a Part I Permit if an NPDES Part I Permit is required.
- e. Application forms, application form instructions and checklists may be obtained on the DEP website,
<http://www.dep.pa.gov/Business/Water/CleanWater/WastewaterMgmt/Pages/NPDESWQM.aspx>.

9.2 Action by Regional Office

DEP will conduct a completeness and technical review of the permit, and will render a decision on the application in accordance with one of the following: the Standard Operating Procedure for Clean Water Program Water Quality Management Permits for Sewage Treatment Facilities, the Standard Operating Procedure for Clean Water Program Water Quality Management Permits for Sewage Collection Systems and Pump Stations, or the Standard Operating Procedure for Clean Water Program Water Quality Management General Permits for Sewers and Pump Stations, as appropriate.

9.3 Applications for New Processes

Wastewater treatment processes, which in principle and/or application are unconventional or new by virtue of the fact that no engineering data prepared by impartial professional engineers recognized as being highly skilled in the field of wastewater treatment are available from the full-scale operation at design capacity of a similar plant treating essentially the same type of waste, must be considered experimental.

9.31 Data Required on New Processes

If the results of full-scale studies of new processes are being submitted for consideration, under the provision of the above paragraph, such data shall conform to the following:

- a. The data shall be provided by a professional engineer skilled in the field of wastewater treatment and should be from continuous operation of a full-scale plant treating the type of wastes to be handled at design or simulated design loadings.
- b. Flow measurements should be noted and composite samples collected at least once a week during a continuous six-month operating period. The composite samples should be collected over a 24-hour period unless correlation of results from shorter test periods with those from 24-hour tests is demonstrated at the plant being tested. The following data should be reported:
 - i. Flow

For a 24-hour period

For a test period of other than 24-hour period

For a maximum significant period (e.g., eight-hour for schools or factory shifts)

Maximum rate of flow

Minimum rate of flow

- ii. Analyses of influent and effluent samples for the test period and, where applicable, for the maximum significant period, showing, at a minimum:

BOD

Suspended solids (total, volatile and fixed)

pH

Dissolved oxygen

Additional parameters may be needed depending on discharge requirements.

- iii. Where needed to give a complete picture, analyses of turbidity, pH, alkalinity, ammonia, nitrites, nitrates, total solids, chlorides and fecal coliforms.
- iv. The quantity and characteristics of any wastes other than domestic wastewater shall be given.
- v. All analyses are to be made in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater."
- vi. Notations of conditions which may create problems, such as excessive scum or foam, carry-through of large material in the effluent, floating solids on tanks, odors, sludge bulking, etc.
- vii. Method of disposal of sludge, daily quantity of sludge, percent solids (total, volatile and fixed) and sludge drying ability.
- viii. Operating provisions, such as quantity of air for activated sludge type processes.

- ix. Operating controls required such as limitations on suspended solids in aeration tanks; operational data needed, such as sludge index. (What factors of operation are required to operate plants successfully?)
 - x. Amount and quality of operation required (hours per day, whether operator is laborer, custodian, technician, chemist, or engineer).
 - xi. Any other data required by the Department.
- c. Data submitted other than above will be considered on its merits.

9.32 Experimental Permits

The risk incurred in experimentation with unconventional treatment methods must rest upon the proponent of the treatment method rather than the general public.

To qualify for a Part II Permit, a method or process must be proved by full-scale studies. Otherwise, an experimental permit may be issued, provided:

- a. Failure of the experiment will not result in serious pollution or hazard to the public health.
- b. Detailed plans are submitted showing how, in case of failure, the experimental plant or unit will be converted to a conventional installation.
- c. Financial resources are assured to make the conversion (funds placed in escrow or bond posted). The bond or certificate of deposit in the appropriate amount must be assigned to the Department to insure the availability of funds if it becomes necessary.
- d. Statewide not more than one experimental permit for the same process or method may be granted during the experimental period.
- e. The experimental permit will require that:
 - i. There be a limited experimental period not exceeding 18 months.
 - ii. The permittee must submit reports on operation during the experimental period as required by the Department.
 - a) The reports shall be prepared by a professional engineer who is skilled in the field of wastewater treatment and acceptable to the Department.
 - b) The data required will be generally in accordance with Section 9.31.

PRE-DRAFT

**CHAPTER 10
ENGINEERING REPORT****10. ENGINEERING (formerly 10)**

In conformity with the provisions of the Professional Engineers Registration Law, as amended (Act No. 367 of the General Assembly, approved May 23, 1945), DEP adopted the following requirements as contained in 25 Pa Code, Chapter 91 (available at www.pacode.com) of DEP's Rules and Regulations.

- a. An Engineer's Report, as well as plans and specifications, shall accompany the applications, clearly showing what is proposed and permitting the basis of design to be thoroughly understood and checked.
- b. Plans, reports and specifications shall be prepared by a licensed professional engineer authorized to practice in this Commonwealth.
- c. The front cover or flyleaf of each set of drawings and each copy of the report and specifications shall bear the imprint of the engineer's seal.
- d. All drawings submitted shall bear the imprint or legible facsimile of the engineer's seal.
- e. Reports, drawings and specifications for strip mines or for minor work not involving safety to life or health may be submitted, as approved by law, by a registered surveyor, and shall bear the imprint or facsimile of his seal.

Based on the above considerations, a professional engineer's seal will be required for all WQM permit applications.

11. DESIGN ENGINEER'S REPORT (formerly 11)

A Design Engineer's Report identifies and evaluates wastewater related problems; assembles basic information; presents criteria and assumptions; describes system reliability for each unit operation with the largest unit out of service; reviews organizational and staffing requirements; offers a conclusion and outlines time schedules and procedures to implement the project. The document includes sufficient detail to demonstrate that the proposed project meets applicable criteria.

The concept (including process description and sizing), factual data, and controlling assumptions and considerations for the wastewater facilities are presented for each process unit and for the whole system. These data form the continuing technical basis for the detailed design and preparation of construction plans and specifications. The report should specifically identify instances in which the design differs from the standards set forth in this manual, and provide adequate justification for such deviation.

Design Engineer's Reports are completed for projects involving new, expanded, upgraded, or rehabilitated wastewater treatment facilities and major collection, interceptor sewer, and pump station projects.

The Design Engineer's Report contains the following and any other pertinent information as required by the reviewing authority.

11.1 Existing Facility Review

Descriptions of existing system including condition and evaluation of problems needing correction.

11.2 Planning and Service Area

A description of the planning area and existing and potential future service areas are to be included.

11.3 Population Projection and Planning Period

Present and predicted population are to be based on a 20 year planning period. Phased construction of wastewater facilities should be considered in rapid growth areas. Sewers and other facilities with a design life in excess of 20 years should be designed for the extended period.

11.4 Hydraulic Capacity

11.41 General (formerly 43.4)

The wastewater received at the treatment plant is made up of domestic wastewater, industrial wastewater and the infiltration/inflow within the sewer system. Domestic wastewater consists of flow from residential, commercial, institutional and recreational establishments. Industrial wastewater includes any process or cooling water discharged to the sewer system. Inflow is stormwater that enters the sewer system directly, through sources including: storm drains, area drains, roof drains, sump pumps, manhole covers, etc, which is to be excluded from new construction. Infiltration is groundwater, including that caused by rainfall, that enters the sewer system through holes, gaps, or cracks in the collection and conveyance system or service laterals. Infiltration is to be minimized in new construction. See Section 11.44.

The hydraulic design of a treatment plant is a generalized term reflective of all of the above components, which indicates the flow conditions, up to which the facility will be capable of providing a predetermined level of treatment. The treatment plant is to be designed to accommodate the design flow conditions while meeting the NPDES and WQM permit requirements, and to prevent hydraulic overload conditions as defined in Title 25 of the Pennsylvania Code Chapter 94, www.pacode.com of DEP's Rules and Regulations.

The treatment plant/unit process design necessitates the use of a set of specific design flow parameters to accurately express the different design flow conditions which will occur due to:

- a. diurnal variations (e.g., morning flush),
- b. nondomestic source variations (e.g., industrial process flows, educational institutions),
- c. seasonal domestic variations (e.g., vacation homes and recreational facilities), and
- d. seasonal weather-induced variations (e.g., infiltration/inflow).

The individual unit process design standards contained in this manual describe the appropriate design flow parameters to be used in designing a particular unit.

11.42 Flow Definitions and Identification

The following flows for the design year are to be identified and used as a basis of design for sewers, lift stations, wastewater treatment plants, treatment units, and other wastewater handling facilities. Where any of the terms defined in this Paragraph are used in these design standards, the definition contained in this Paragraph applies.

a. Design Average Flow

The design average flow is the average of the daily volumes to be received for a continuous 12 month period expressed as a volume per unit time. However, the design average flow for facilities having critical seasonal high hydraulic loading periods (e.g., recreational areas, campuses, industrial facilities) are to be based on the average of the daily volumes to be received during the seasonal period.

b. Design Maximum Monthly Average Flow

The design maximum monthly average flow is the largest average of the daily volumes of flow to be received during a continuous 1 month period during a calendar year, expressed as a volume per unit time.

c. Design Maximum Day Flow

The design maximum day flow is the largest volume of flow to be received during a continuous 24 hour period expressed as a volume per unit time.

d. Design Peak Hourly Flow

The design peak hourly flow is the largest volume of flow to be received during a one hour period expressed as a volume per unit time.

e. Design Peak Instantaneous Flow

The design peak instantaneous flow is the instantaneous maximum flow

rate to be received.

f. Design Minimum Hourly Flow

The lowest flow rate received at the facility over a period of one hour.

11.43 Hydraulic Capacity for Wastewater Facilities to Serve Existing Collection Systems (formerly 43.41)

- a. When an existing treatment plant is expanded/upgraded, the existing flows are to be determined. As a minimum, the existing plant's past 5 years of data (if available) is to be reviewed, and the corresponding performance of various units and plant as a whole should be prepared for at least 3 years' representative data (exclude the data pertaining to abnormal rain or drought conditions).
- b. The hydraulic capacity design for the proposed plant expansion/upgrade should be based on the maximum monthly average flow derived from historical data, plus the additional projected maximum monthly average flow due to future flow contributions during the design period of the plant. The projected flow should include domestic wastewater flow, industrial wastewater flow and infiltration/inflow within the sewer system based on future conditions, and an evaluation and estimate of flows due to infiltration/inflow reduction activities conducted.
- c. When an existing sewer system is to be served by a new or modified treatment facility, the existing flows are to be determined. Flow monitoring of the sewer system should be conducted to obtain such information as maximum monthly average flow, peak hourly flow, minimum hourly flow, etc., necessary to design various treatment units utilizing the appropriate flow parameters as described in the manual or other design literature for each treatment unit.

11.44 Hydraulic Capacity for Wastewater Facilities to Serve New Collection Systems (formerly 43.41)

- a. For municipal systems and subdivisions of over 150 homes, the design average flow is to be based on 100 gallons per capita per day, with a 24-hour runoff period. The design average flow for plants serving less than 150 homes may be based on 75 gallons per capita per day, with a 16-hour runoff period. These flow figures include an allowance for infiltration.
- b. Any deviation from these values should be based on actual data for water consumption and projected or anticipated flow due to infiltration (during high groundwater conditions). The pipe manufacturer's recommendations and/or actual infiltration values obtained in the field with the use of a similar kind of pipe having similar field conditions may be used to

establish the projected flow due to infiltration.

- c. The design average flow for institutional and recreational establishments should be based on the design below:

For public schools: (formerly 43.51)

Toilet rooms only:	7 gpd/cap
For kitchen add	3 gpd/cap
For gym add	3 gpd/cap
Runoff Period	8 hours

For boarding schools: (formerly 43.51)

Flow	75 gpd/cap
Runoff Period	16 hours

For factories: (formerly 43.51)

Flow	35 gpd/cap
Runoff Period	Length of shift

Note: The facility is to be designed for largest shift.

For camps: (formerly 43.51)

Flow	60 gpd/cap
Runoff Period	16 hours

For hospitals and similar institutions: (formerly 53.51)

Flow	150-250 gpd/cap
Runoff Period	12-24 hours

- d. Design by Analogy (formerly 43.511)

- Data from similar municipalities or subdivisions may be utilized in the case of new systems; however, the designer must be able to clearly show to DEP the similarities between the existing municipalities or subdivisions (whose data are to be used) and the proposed facility.
- The designer should submit a narrative outlining the rationale for the data from similar municipalities or subdivisions.
- When reviewing and/or providing operational data as a representation of expected performance data for a treatment system, consideration shall be given to ensure the data is from a facility in a similar climate.

- e. Estimates of design wastewater flows for industrial/commercial dischargers must take into account the expected amounts of process wastewater, sanitary wastewater and cooling water which will be discharged into the sewerage system. Such information should be obtained directly from the owner/operator of the industrial/commercial establishment.
- f. These flow values are to be used in conjunction with a peaking factor from Figure 1 to cover normal infiltration for systems built with modern construction techniques. Refer to Section 31. However, an additional allowance should be made where conditions are unfavorable. Figure 1 is based on the following formula for dry weather flows:

$$\frac{Q_{peak}}{Q_{avg}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$$

where P is the population served, in thousands,
 Q_{peak} is the peak hourly flow,
 Q_{avg} is the design average flow.

11.45 Combined Sewer Interceptors

In addition to the above requirements, interceptors for combined sewers are to have capacity to receive a sufficient quantity of combined wastewater for transport to treatment facilities to ensure attainment of the appropriate water quality standards.

11.5 Organic Capacity

11.51 General (formerly 43.5)

The organic loading received at the treatment plant is made up of domestic loading and industrial loading. Domestic loading consists of loadings from residential, commercial, institutional, and recreational establishments and includes all loadings except from industries.

The design organic loading is the rated/permitted organic capacity of the treatment plant to provide a predetermined level of treatment. The treatment plant is to be designed to meet the NPDES as well as WQM permit requirements and to prevent organic overload conditions as defined under Chapter 94 of DEP's Rules and Regulations.

The shock effects of high concentrations and peak diurnal flows for short periods of time on the treatment process, particularly for small treatment plants, are to be considered.

Organic loading data is to be determined by influent flow-proportioned composite

samples which are representative of the waste stream. 24-hour composite samples are suggested as they provide the most representative data; however, 8 hour composite samples are the minimum required.

11.52 Organic Load Definitions and Identification

The following organic loads for the design year are to be identified and used as a basis for design of wastewater treatment facilities. Where any of the terms defined in this Paragraph are used in these design standards, the definition contained in this Paragraph applies.

a. Biochemical Oxygen Demand

The 5-day Biochemical Oxygen Demand (BOD₅) is defined as the amount of oxygen required to stabilize biodegradable organic matter under aerobic conditions within a five day period in accordance with Standard Methods for the Examination of Water and Wastewater. Total 5-day Biochemical Oxygen Demand (TBOD₅) is equivalent to BOD₅ and is sometimes used in order to differentiate carbonaceous plus nitrogenous oxygen demand from strictly carbonaceous oxygen demand.

The Carbonaceous 5-day Biochemical Oxygen Demand (CBOD₅) is defined as BOD₅ less the nitrogenous oxygen demand of the wastewater. See Standard Methods for the Examination of Water and Wastewater.

b. Design Average BOD₅ / Design Average Organic Load

The design average BOD₅ is generally the average of the organic load to be received for a continuous 12-month period for the design year expressed as weight per day. However, the design average BOD₅ for facilities having critical seasonal high loading periods (e.g., recreational areas, campuses industrial facilities) is to be based on the average organic load to be received during the seasonal period.

c. Design Maximum Month BOD₅ / Design Maximum Month Organic Load

The design maximum month BOD₅ is the largest amount of organic load to be received during a calendar month expressed as weight per day.

d. Design Maximum Day BOD₅ / Design Maximum Day Organic Load

The design maximum day BOD₅ is the largest amount of organic load to be received during a continuous 24-hour period expressed as weight per day. Equivalent to *organic design capacity* in Chapter 94, defined as the “highest daily” organic load.

e. Design Peak Hourly BOD₅ / Design Peak Hourly Organic Load

The design peak hourly BOD₅ is the largest amount of organic load to be received during a one hour period expressed as weight per day.

11.53 Organic Capacity of Wastewater Treatment Facilities to Serve Existing Collection Systems (formerly 43.52)

- a. Projections are to be made from actual waste load data to the extent possible.
- b. Projections are to be compared to those described in Paragraph 11.54 and an accounting made for significant variations from those values.
- c. The impact of industrial sources is to be documented. For projects with significant industrial contributions, evidence of adequate pretreatment strategies is to be included along with documentation that industries are aware of the pretreatment limitations and user costs associated with the project. Documentation of the individual industrial participation in the project plan including user charges is to be provided.
- d. Septage, supernatant, filtrate, leachate, and other recycle flows may contribute significant organic load and other materials which can cause operational problems and non-compliance with National Pollutant Discharge Elimination System (NPDES) permit limitations. If these flows are to be discharged to the wastewater treatment facility, consult the DEP and the Appendix A, Handling and Treatment of Septage at a Wastewater Treatment Plant.

11.54 Organic Capacity of Wastewater Treatment Facilities to Serve New Collection Systems (formerly 43.51)

- a. Domestic wastewater treatment design average BOD₅ is to be on the basis of at least 0.17 pounds of BOD₅ per capita per day and 0.20 pounds of suspended solids per capita per day, unless information is submitted to justify alternate designs. If nitrification is required, 0.036 pounds TKN per capita per day should be added.
- b. Where garbage grinders are commonly used in areas tributary to a domestic treatment plant, the design average BOD₅ basis should be increased to 0.22 pounds of BOD₅ per capita per day, and 0.25 pounds of suspended solids per capita per day. If nitrification is required, 0.046 pounds TKN per capita per day should be added.
- c. The design average BOD₅ for institutional and recreational establishments should be based on the design data below:

For public schools: (formerly 43.51)

Toilet rooms only: 0.04 lb/day/cap

For kitchen add 0.04 lb/day/cap
 For gym add 0.02 lb/day/cap

For boarding schools: (formerly 43.51)

BOD₅ 0.17 lb/day/cap

For factories: (formerly 43.51)

BOD₅ 0.085 lb/day/cap

For camps: (formerly 43.51)

BOD₅ 0.12 lb/day/cap

For hospitals and similar institutions: (formerly 43.51)

BOD₅ 0.17 lb/day/cap plus proper allowance for
 extra facilities

- d. Industrial contributions. Refer to Paragraph 11.53(c).
- e. Septage and Leachate. Refer to Paragraph 11.53(d).
- f. Data from similar municipalities may be utilized in the case of new systems. However, a thorough investigation that is adequately documented is to be provided to the reviewing authority to establish the reliability and applicability of such data.

11.6 Wastewater Treatment Facility Design Capacity

- a. The wastewater treatment facility hydraulic design capacity is the design maximum monthly average flow.
- b. The wastewater treatment facility organic design capacity is the design maximum month BOD₅.

11.7 Initial Alternative Development

The process of selection of wastewater treatment alternatives for detailed evaluation should be discussed. All wastewater management alternatives considered, including no action, and the basis for the engineering judgment for selection of the alternatives chosen for detailed evaluation, should be included.

11.8 Detailed Evaluation of Proposed Project

The following are to be included for the proposed project.

a. Sewer System Revisions

Proposed revisions to the existing sewer system including adequacy of portions not being changed by the project are to be evaluated.

b. Wet Weather Flows

Facilities to transport and treat wet weather flows in a manner that complies with federal, state and local regulations are to be provided.

c. Wet Weather Flow Equalization

If the ratio of design peak hourly flow to design average flow is 3:1 or more, flow equalization is to be considered. This may be accomplished by either building a wet weather retention basin and gradually returning the excess flow to the treatment plant during off-peak periods or by providing a plant large enough to handle all flows.

d. A High Flow Management Plan should be included for all existing facilities subject to wet weather peaking factors greater than 2.5.

e. Unit Sizing

Unit operation and unit process sizing and basis are to be provided.

f. Flow Diagram

A flow diagram of treatment facilities including all recycle flows is to be included.

g. Flexibility

Compliance with requirements of Paragraph 53.6 Arrangement of Units is to be assured.

h. Removal Efficiencies

Loadings to and removal efficiencies through each unit operation are to be provided in addition to total removal efficiency and effluent quality (both concentrations and mass).

i. Emergency Operation

Emergency operation requirements as outlined in Section 47 and Paragraph 56.1 are to be provided. Local regulatory agencies may have more stringent requirements.

j. Technology Not Included In These Standards

Paragraph 53.2 outlines procedures for introducing and obtaining approval to use technology not included in these standards. Proposals to use technology not included in these standards are to address the requirements of Paragraph 53.2.

A contingency plan, in the event that such new technology fails to meet the expected performance, may be required by the reviewing authority in the absence of three separate and representative full scale installations successfully using the same technology. Each representative full scale installation should have sufficient monitoring and appropriate testing results that demonstrate reliable and effective compliance with the design performance criteria and have been operated for not less than three years at or near design capacity without major failure of either the process or equipment.

k. Sludge

The solids disposal options considered and method selected are to be included. This is critical to completion of a successful project. Compliance with requirements of Chapter 80, Sludge Processing, Storage, and Disposal is to be assured.

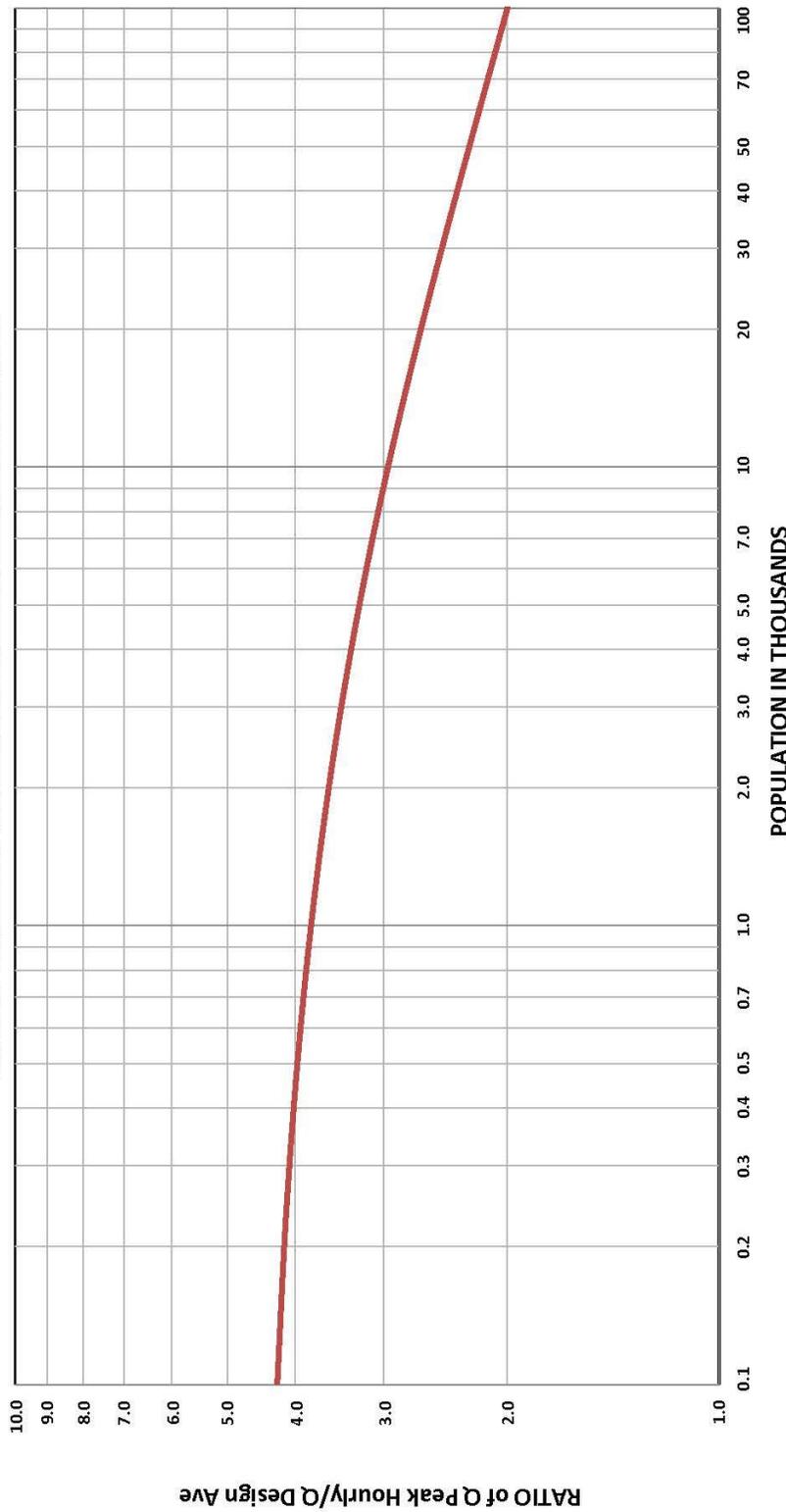
l. Treatment During Construction

A plan for the method and level of treatment (including sludge processing, storage and disposal) to be achieved during construction is to be developed and included in the Facility Plan submitted to the regulatory agency for review and approval. This approved treatment plan is to be implemented by inclusion in the plans and specifications to be bid for the project. Refer to Paragraph 20.15 and Section 21.

m. Operation and Maintenance

Portions of the project which involve complex operation or maintenance requirements are to be identified including laboratory requirements for operation, industrial sampling, and self-monitoring.

FIGURE 1
RATIO OF PEAK HOURLY FLOW TO DESIGN AVERAGE FLOW
 (WHERE INFILTRATION AND INFLOW ARE EXCLUDED IN ACCORDANCE WITH SECTION 31)



Q peak hourly: Maximum Rate of Wastewater Flow (Peak Hourly Flow)
 Q design ave: Design Average Daily Wastewater Flow

Source: $Q \text{ Peak Hourly} / Q \text{ Design Ave} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}}$ (P in thousands)

Fair, G. M., and Geyer, J. C., "Water Supply and Wastewater Disposal"
 1st Ed., John Wiley & Sons, Inc., New York (1954), p. 136

Figure 1 Ratio of Peak Hourly Flow to Design Average Flow

CHAPTER 20
ENGINEERING PLANS AND SPECIFICATIONS

20. PLANS AND SUPPORT DOCUMENTS (formerly 12)

Submissions to the reviewing authority are to include sealed plans, design criteria, the appropriate construction permit applications, review forms, and permit fee if required.

20.1 General (formerly 12.1)

20.11 Plan Title (formerly 12.1)

All plans for wastewater facilities are to bear a suitable title showing the name of the municipality, sewer district, or institution, and are to show the scale in feet, a graphical scale, the north point, date, and name and signature of the engineer with the certificate number and imprint or legible facsimile of the professional engineer's seal. A space should be provided for signature and/or approval stamp of the appropriate reviewing authority.

20.12 Plan Format (formerly 12.1)

The plans are to be clear and legible. They are to be drawn to a scale which will permit all necessary information to be plainly shown. The maximum plan size is to be no larger than 30 inches x 42 inches. Datum used should be indicated. Locations and logs of test borings, when made, are to be shown on the plans.

20.13 Plan Contents (formerly 12.1)

Detailed plans are to consist of plan views, elevations, sections and supplementary views which, together with the specifications and general layouts, provide the working information for the contract and construction of the facilities. They also are to include dimensions and relative elevations of structures, the location and outline form of equipment, location and size of piping, water levels, ground elevations, etc.

20.14 Design Criteria

Design criteria and calculations are to be included with all plans and specifications and a hydraulic profile is to be included for all wastewater treatment facilities. For sewer and lift station projects, information is to be submitted to verify adequate downstream sewer, pump station and treatment plant capacity.

20.15 Operation During Construction (formerly 15) (see also Paragraph 11.81)

- a. Specifications are to contain a program for keeping existing treatment plant units in operation during construction of plant additions/modifications.

- b. Should it be necessary to take plant units out of operation, a shut-down schedule **is to** be adhered to which will minimize pollution effects on the receiving stream.
- c. Where existing units are taken out of service during construction, provisions for alternative treatment are to be provided.
- d. The discharge must at all times meet the effluent limits regardless of any construction impacts.

20.2 Plans of Sewers (formerly 12.2)

20.21 General Plan (formerly 12.21)

A comprehensive plan of the existing and proposed sewers **is to** be submitted for projects involving new sewer systems or substantial additions to existing systems. The plan **is to** show the following:

20.211 Geographical Features (formerly 12.21a)

- a. Topography and Elevation

Existing or proposed streets and all streams or water surfaces **are to** be clearly shown. Contour lines at suitable intervals should be included.

- b. Streams (formerly 12.21b)

The direction of flow in all streams, and high and low water elevations of all water surfaces at sewer outlets and overflows **is to** be shown.

- c. Boundaries (formerly 12.21c)

The boundary lines of the municipality and/or the sewer district **or** area to be sewerred **are to** be shown.

20.212 Sewers (formerly 12.21d)

The plan **is to** show the location, size and direction of flow of all existing and proposed sanitary and combined sewers draining to the treatment facility.

20.22 Detailed Plans and Profiles (formerly 12.22)

Detailed plans and profiles are to be submitted. Profiles should have a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than

10 feet to the inch. **Plan views** should be drawn to a corresponding horizontal scale **and are to be shown on the same sheet**. Such plans and profiles **are to show**:

- a. Location of streets and sewers.
- b. Line of ground surface; size, material and type of pipe; length between manholes; invert and surface elevation at each manhole; and grade of sewer between each two adjacent manholes. All manholes **are to be** numbered on the plan and correspondingly numbered on the profiles.

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor **is to be** plotted on the profile of the sewer which is to serve the house in question. The engineer **are to** state that all sewers are sufficiently deep to serve adjacent basements, except when topographical considerations preclude service. The plans should note when the sewers are not deep enough to serve basements.

- c. Locations of all special features such as proposed finish grade to assure minimum cover, inverted siphons, concrete encasements, elevated sewers, etc.
- d. All known existing structures **and utilities**, both above and below ground, which might interfere with the proposed construction **or require isolation setback**, particularly water mains **and water supply structures (i.e., wells, clear wells, basins, etc.)**, gas mains, storm drains, **and telephone and power conduits**; and
- e. Special detailed drawings, made to scale to clearly show the nature of the design, **are to be** furnished to show the following particulars:
 1. All stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high or low water levels.
 2. Details of all special sewer joints and cross-sections.
 3. Details of all sewer appurtenances such as manholes, lampholes, inspection chambers, inverted siphons, regulators, tide gates and elevated sewers.

20.3 Plans of Wastewater Pumping Stations (formerly 12.3)

20.31 Location Plan (formerly 12.31)

A **location** plan **is to be** submitted for projects involving construction or revision of pumping stations. This plan **is to show** the following:

- a. The location and extent of the tributary area.

- b. Any municipal boundaries within the tributary area.
- c. The location of the pumping station and force main and pertinent elevations.

20.32 Detailed Plans (formerly 12.32)

Detailed plans are to be submitted showing the following, where applicable:

- a. A contour map of the property to be used.
- b. Existing pumping station.
- c. Proposed pumping station, including provisions for installation of future pumps or ejectors and location of appurtenances such as heaters, ventilators, electrical controls, etc.
- d. Elevation of high water at the site and maximum elevation of wastewater in the collection system upon occurrence of power failure.
- e. Subsurface information from the test borings and groundwater elevations.
- f. **Maximum hydraulic gradient in downstream gravity sewers when all installed pumps are in operation; and**
- g. Location and detail of pressure relief valves in force mains.

20.4 Plans of Wastewater Treatment Plants (formerly 12.4)

20.41 Location Plan (formerly 12.41)

- a. A plan is to be submitted showing the wastewater treatment plant in relation to the remainder of the system.
- b. A U.S. Geological Survey (USGS) topographic map (7.5-minute series is to be included to indicate its location with relation to streams and the point of discharge of treated effluent.

20.42 General Layout (formerly 12.42)

Layouts of the proposed wastewater treatment plant are to be submitted showing:

- a. Topography of the site.
- b. Size and location of plant structures - existing, proposed and abandoned.
- c. Schematic flow diagram showing the flow through various plant units and

showing utility systems serving the plant processes.

- d. Piping, including any arrangements for bypassing individual units. Materials handled and direction of flow through pipes are to be shown.
- e. Hydraulic profiles showing the flow of wastewater, supernatant liquor, recycle streams, and sludge.
- f. Test borings and groundwater elevations.

20.43 Detailed Plans (formerly 12.43)

Detailed plans are to show the following:

- a. Location, dimensions and elevations of all existing and proposed plant facilities.
- b. Elevations of high and low water level of the body of water to which the plant effluent is to be discharged.
- c. Type, size, pertinent features and manufacturer's rated capacity of all pumps, blowers, motors and other mechanical devices, unless included in the specifications.
- d. Minimum hourly, design average, and peak hourly hydraulic flow in profile;
- e. Adequate description of any features not otherwise covered by the specifications or engineer's report.
- f. Erosion and sedimentation control measures.

21. SPECIFICATIONS (formerly 13)

- a. Complete signed and sealed technical specifications are to be submitted for the construction of sewers, wastewater pumping stations, wastewater treatment plants, and all other appurtenances, and are to accompany the plans.
- b. The specifications accompanying construction drawings are to include, but not be limited to, specifications for the approved procedures for operation during construction in accordance with Paragraphs 11.8(1) and 20.15, and all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements as to the quality of materials, workmanship and fabrication of the project.
- c. The specifications are also to include:
 - 1. the type, size, strength, operating characteristics and ratings of equipment;
 - 2. allowable infiltration;

3. the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping and pipe joints;
4. electrical apparatus, wiring, **instrumentation and** meters;
5. laboratory fixtures and equipment;
6. operating tools;
7. construction materials;
8. special filter materials such as stone, sand, gravel or slag;
9. miscellaneous appurtenances;
10. chemicals when used;
11. instructions for testing materials and equipment as necessary to meet design standards;
12. **performance** tests for the completed facilities and component units;
13. the requirement for the plant to meet the effluent limits at all times regardless of any construction impacts; and
14. erosion and sedimentation control features where applicable.

It is suggested that performance tests be conducted at design load conditions wherever practical.

22. REVISIONS TO APPROVED PLANS (formerly 14)

- a. The facilities **are to** be constructed under supervision of a professional engineer in accordance with the approved reports, plans and specifications.
- b. Any deviations from approved plans or specifications **affecting capacity, flow, operation of units, or point of discharge are to be approved, in writing, before such changes are made. Plans or specifications** so revised should be submitted well in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval.
- c. Structural revisions or other minor changes not affecting capacities, flows or operations will be permitted during construction without approval.
- d. “Record Drawings” clearly showing such alterations **are to** be placed on file with DEP at the completion of the work.

23. BLASTING DURING CONSTRUCTION (formerly 16)

- a. If blasting is anticipated during construction of any portion of the wastewater facility project, the blasting must be done by a licensed professional in accordance with state regulations (Title 25 of the Pennsylvania Code, Chapter 211, www.pacode.com, of DEP’s Rules and Regulations).
- b. A permit must be secured from the Pennsylvania Fish Commission if blasting is to be done in or along a stream. In addition, the local waterways patrolmen must be notified when explosives are to be used.

24. OTHER APPROVALS

The Water Quality program reviews the permit application for compliance with the Clean Streams Law and the Clean Water Act, as appropriate. The issuance of a Water Quality Management permit does not relieve the permittee of the responsibility of securing all other permits or approvals that may be necessary. Such approvals include, but are not necessarily limited to, erosion and sedimentation control approval, DRBC approval, air quality approval, beneficial use of sewage sludge, etc.

CHAPTER 30 DESIGN OF SANITARY SEWER SYSTEMS

31. APPROVAL OF SEWERS (formerly 21)

- a. DEP will approve plans for new systems, or extensions to ~~systems~~ **new areas, or replacement sanitary sewers** only when designed as separate sanitary sewers, ~~in which~~ **where** rain water from roofs drains, streets, and other areas and groundwater from foundation drains **and sump pumps** are excluded.
- b. Any **modifications to existing** combined sewers **are to** provide for the complete interception of wastewater for treatment during dry weather and minimization of discharges of combined wastewater during wet weather.
- c. **Existing Overflows**
 1. **Overflows should be permitted only for combined sewer systems.**
 2. Overflows **are not to** be permitted at points where they will adversely affect the receiving stream or its uses.
 3. Where it is determined by DEP that an untreated overflow may adversely affect the receiving stream, treatment of the overflow may be required.
 4. Plans submitted to DEP shall certify the existence of all overflows from the sanitary sewers.

32. DESIGN FLOW AND DESIGN CAPACITY

32.1 Design Period (formerly 22)

Sewer systems should be designed to serve the projected future population (in conformance with Act 537 planning), within the present service area and other anticipated areas to be served in the future. An exception would be in considering parts of the systems that can be readily increased in capacity or where it may be more cost-effective to increase capacity at a later date. Consideration should be given to the maximum anticipated capacity required for non-residential users.

32.2 Design Factors (formerly 23)

- a. In designing sanitary sewers, the following factors should be considered:
 1. Maximum hourly quantity of domestic and other wastewater from residential and nonresidential users.
 2. Groundwater infiltration.
 3. Topography of area.

4. Location of wastewater treatment plant.
 5. Depth of excavation.
 6. Pumping requirements.
- b. The basis of design for all sewer projects is to accompany the plan documents.

32.3 Design Basis (formerly 24)

32.31 Laterals and sub-main sewers (formerly 24.11)

Laterals and sub-main sewers are to be designed to carry, when flowing full, a peak hourly flow of not less than 400 gallons per capita per day, exclusive of wastewater from nonresidential users.

32.32 Main, trunk interceptor and outfall sewers (formerly 24.12)

Main, trunk interceptor and outfall sewers are to be designed to carry, when flowing full, a peak hourly flow of not less than 250 gallons per capita per day, exclusive of wastewater from nonresidential users.

32.33 Interceptors carrying combined wastewater (formerly 24.13)

Interceptors carrying combined wastewater flow are to be designed to carry, as a minimum, 350 percent of the gauged or estimated peak hourly flow during dry weather conditions.

32.34 Alternate Method (formerly 24.2)

When deviations from the design standards in 32.31 – 32.33 are proposed, a brief description of the procedure used for sewer design is to be included, as well as the reason for the deviation.

33. DETAILS OF DESIGN AND CONSTRUCTION

33.1 Minimum Size (formerly 25.1)

33.11 General

Except as provided in Paragraph 33.12, no conventional public sewer carrying untreated wastewater should be less than 8 inches in diameter.

33.12 Exception

The use of 6-inch diameter sewers may be permitted when all of the following conditions are met:

- a. Topographical, geographical and/or practical conditions indicate that the sewer will not be extended;
- b. The flow to the proposed sewers generated within the natural tributary drainage area will not be augmented by flow generated outside of that area;
- c. The sewers have hydraulic capacity to convey the projected future **peak instantaneous** flows; and
- d. The agency responsible for maintaining the sewers must have equipment or be able to obtain immediate services to adequately clean and maintain the sewers.

33.2 Depth (formerly 25.2)

- a. **In general, sewers should be sufficiently deep to receive wastewater from basements and to prevent freezing.**
- b. Insulation **is to** be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

33.3 Buoyancy

Buoyancy of sewers is to be considered. Flotation of the pipe is to be prevented with appropriate construction where high groundwater conditions are anticipated.

33.4 Slope (formerly 25.3)

33.41 Slope Between Manholes (formerly 25.3)

Sewers **are to** be laid with uniform slope between manholes.

33.42 Recommended Minimum Slopes (formerly 25.3)

- a. All sewers **less than 48 inches are to** be so-designed and constructed to give mean velocities, when flowing full, of not less than **2.0** feet per second, based on Manning's formula using an "n" value of 0.013.
- b. The following are the minimum slopes which should be provided; however, slopes greater than these are desirable **for construction, to control sewer gases or to maintain self-cleansing velocities at all rates of flow within the design limits:**

Minimum Slope in

Nominal Sewer Size	Feet Per 100 Feet
6"	0.60
8"	0.40
10"	0.28
12"	0.22
14"	0.17
15"	0.15
16"	0.14
18"	0.12
21"	0.10
24"	0.08
27"	0.067
30"	0.058
33"	0.052
36"	0.046
39"	0.041
42"	0.037

- c. Sewers 48 inches or larger should be designed and constructed to give mean velocities, when flowing full, of not less than 3.0 feet per second, based on Manning's formula using an "n" value of 0.013.
- d. Use of other practical "n" values may be permitted by DEP if deemed justifiable on the basis of research or field data presented, provided that:
1. the values are based on long-term evaluation (≥ 20 years) of sewer performance. Use of lower values of n based on new sewers should not be considered in the long-term design of sewers, and
 2. data supporting the requested value of n is provided in the form of tables showing the values of the flow versus depth and velocity, and showing the calculated value of n.

33.43 Minimum Flow Depth (formerly 25.3)

- a. Under special conditions, if full and justifiable reasons are given, slopes slightly less than those specified when flowing full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for maximum monthly average flow.
- b. Whenever such decreased slopes are selected, the engineer must furnish with the report computations of the depths of flow in such pipes at minimum hourly, maximum monthly average and peak hourly rates of flow. If no data are available on the flows, the following may be used to estimate minimum hourly flow:

$$\frac{Q_{\min}}{Q_{\text{avg}}} = 0.2 \cdot P^{0.16}$$

Where P is the population served in thousands,
 Q_{min} is the minimum hourly flow,
 Q_{avg} is the design average flow.

- c. It is recognized that such decreased slopes may cause additional sewer maintenance expense. The operating authority of a sewer system considering decreased slopes is to furnish DEP written assurance that any additional sewer maintenance required by reduced slopes will be provided.

33.44 Minimization of Solids Deposition

- a. The pipe diameter and slope are to be selected to obtain the greatest practical velocities so as to minimize settling problems.
- b. Flatter slopes are not to be justified with oversize sewers.
- c. If the proposed slope is less than the minimum slope of the smallest pipe that can accommodate the design peak hourly flow, the actual depths and velocities at minimum, average, and design maximum day and peak hourly flow for each design section of the sewer are to be calculated by the design engineer and be included with the plans.

33.45 High Velocity Protection (formerly 25.6)

Where velocities greater than 15-10 feet per second are attained at peak instantaneous flow, special provisions as necessary are to be made to avoid scour and protect against displacement caused by erosion and shock.

33.46 Steep Slope Protection (formerly 25.31)

Sewers on 20 percent slope or greater are to be anchored securely with concrete anchors or equal. It will be the responsibility of the design engineer to prepare a detailed anchor design. The anchors are to be spaced as follows:

- a. Not over 36 feet center to center on grades of 20 percent up to 35 percent;
- b. Not over 24 feet center to center on grades of 35 percent up to 50 percent; and
- c. Not over 16 feet center to center on grades of 50 percent or greater.

33.5 Alignment (formerly 25.4)

- a. Sewers 24 inches or less in diameter are to be laid with straight alignment between manholes.

- b. The alignment **is to** be checked by either using a laser beam or lamping.
- c. On curved roadways where straight alignment would be difficult and expensive, curvilinear alignment may be considered for sewers larger than 24 inches.
 1. Only simple curves will be permitted.
 2. The radius of curvature **is to** be at least 100 feet.
 3. Manholes **are to** be installed at each end of the curved section.
 4. The distance between manholes should not exceed 250 feet; however, longer distances up to 400 feet may be approved on a larger size sewer, so long as the interior angle of the curve between manholes does not exceed 90 degrees.
 5. Compression or chemically welded joints **are to** be used.
 6. Joint deflection or pull **are to** **are not to** exceed the maximum permissible under American Society for Testing and Materials (ASTM) pipe or joint standards C-425, C-447 and C-361.
 7. Chemically welded pipe joint specifications D-2680 or equivalent **are to** apply.
 8. The specifications **are to** contain provisions for sewer cleaning equipment which will adequately maintain the flow capacity of the sewers and will prevent damage during the cleaning operation.
 9. **When curvilinear sewers are proposed, the recommended minimum slopes indicated in Paragraph 33.42 are to be increased accordingly to provide a minimum velocity of 2.0 feet per second (0.6 m/s) when flowing full.**

33.6 Changes in Pipe Size (formerly 25.5)

When a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method of securing these results is to place the 0.8 depth point of both sewers at the same elevations.

33.7 Materials (formerly 25.7)

- a. Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, such as: character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion and similar problems.
- b. Suitable couplings complying with ASTM specifications **are to** be used for joining dissimilar materials. The leakage limitations on these joints **are to** be in

accordance with Paragraph 33.9.

- c. All sewers are to be designed to prevent damage from superimposed live, dead, and frost-induced loads.
 - 1. Proper allowance for loads on the sewer are to be made because of soil and potential groundwater conditions, as well as the width and depth of the trench.
 - 2. Where necessary, special bedding, haunching and initial backfill, concrete cradle, or other special construction is to be used to withstand anticipated potential superimposed loading or loss of trench wall stability. See ASTM D-2321 or ASTM C-12 as appropriate.
- d. For new pipe materials for which ASTM standards have not been established, the design engineer is to provide complete pipe specifications and installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the specific detailed plans.

33.8 Installation (formerly 25.8)

33.81 Standards (formerly 25.81)

- a. Installation specifications are to contain appropriate requirements based on the criteria, standards and requirements established by the industry in its technical publications.
- b. Requirements are to be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to:
 - 1. damage the pipe or its joints,
 - 2. impede cleaning operations,
 - 3. impede future tapping,
 - 4. create excessive sidefill pressures or ovalation of the pipe, or
 - 5. seriously impair flow capacity.

33.82 Trenching (formerly 25.82)

- a. Trenching is to comply with appropriate Occupational Safety and Health Administration (OSHA) regulations.
- b. The width of the trench is to be ample to allow the pipe to be laid and joined properly and to allow the bedding and haunching to be placed and

compacted to adequately support the pipe.

- c. When wider trenches are needed, appropriate bedding class and pipe strength is to be used.
- d. In unsupported, unstable soil the size and stiffness of the pipe, stiffness of the embedment and in-situ soil and depth of cover are to be considered in determining the minimum trench width necessary to adequately support the pipe.
- e. The trench sides are to be kept as nearly vertical as possible.
- f. Ledge rock, boulders and large stones are to be removed to provide a minimum clearance of 4 inches below and on each side of all pipes.

33.83 Bedding, Haunching, and Initial Backfill (formerly 25.83)

- a. Bedding Classes A, B or C or crushed stone encasement as described in ASTM C-12 are to be used and carefully compacted for all rigid pipe, provided the proper strength pipe is used with the specified bedding to support the anticipated load.
 - 1. The anticipated load is to be based on the type soil encountered and potential ground water conditions.
 - 2. The same bedding material or other stone aggregate are to be used in the haunching and initial backfill zones such that a minimum cover of six inches above the pipe is provided.
- b. Bedding Classes I, II or III as described in ASTM D-2321 are to be used for all flexible pipes, provided the proper strength pipe is used with the specified bedding to support the anticipated load.
 - 1. The anticipated load is to be based on the type soil encountered and potential groundwater conditions.
 - 2. The embedment materials are to be carefully compacted for all flexible pipe.
 - 3. The same bedding material or other stone aggregate is to be used in the haunching and initial backfill zones such that a minimum cover of six inches above the pipe is provided.
- c. All water entering the excavations or other parts of the work is to be removed and handled in accordance with approved erosion and sedimentation control specifications and permits.
- d. No sanitary sewer is to be used for the disposal of trench water.

- e. Check dams are to be installed in the bedding and backfill of all new or replaced sewer lines to limit the drainage area subject to the French drain effect of gravel bedding. Major rehabilitation projects should also include check dams in the design.
 - 1. Dams are to consist of compacted clay bedding and backfill at least 3 feet thick to the top of the trench and cut into the walls of the trench 2 feet. Alternatively, compacted 33P mix or concrete encasement may be used, keyed into the trench walls.
 - 2. Dams are to be placed no more than 500 feet apart.
 - 3. The preferred location is upstream of each manhole.
 - 4. All stream crossings are to include check dams on both sides of the crossing.

33.84 Final Backfill (formerly 25.84)

- a. Suitable material removed from trench excavation, except where other material is specified, may be used in backfilling the remainder of the trench.
- b. Debris, frozen material, large clods or stones, organic matter or other unsuitable materials are not to be used as backfill within 2 feet of the top of the pipe.
- c. **Final** backfill is to be placed in such a manner as not to disturb the alignment of the pipe.

33.85 Deflection Test (formerly 25.85)

- a. Deflection tests are to be performed on all flexible pipe. Deflection tests for composite pipes, such as truss pipe, are to be performed if the design engineer deems it necessary.
- b. The deflection test is to be run not less than 30 days after final backfill has been placed.
- c. The rigid ball or mandrel used for the deflection test is to have a diameter not less than 95 percent of the base inside diameter or average inside diameter of the pipe, depending on which is specified in the ASTM Specification, including the appendix, to which the pipe is manufactured.
- d. The pipe is to be measured in compliance with ASTM D-2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings.

- e. The test is to be performed without mechanical pulling devices.
- d. No pipe is to exceed a deflection of 5 percent of the inside diameter. If deflection exceeds 5 percent, the pipe is to be excavated. Replacement or correction is to be accomplished in accordance with the requirements in the approved specifications.

33.9 Joints and Leakage Tests (formerly 25.9)

33.91 Joints (formerly 25.91)

- a. The installation of joints and the materials used are to be included in the specifications.
- b. Sewer joints are to be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

33.92 Service Connections

- a. Service connections to the sewer main are to be water tight and are not to protrude into the sewer.
- b. If a saddle type connection is used, it is to be a device designed to join with the types of pipe which are to be connected.
- c. All materials used to make service connections are to be compatible with each other and with the pipe materials to be joined and are to be corrosion proof.

33.93 Leakage Tests (formerly 25.92)

- a. Leakage tests are to be specified. This may include appropriate water or low pressure air testing.
- b. The testing methods selected are to take into consideration the range in groundwater elevations during the test and anticipated during the design life of the sewer.

33.94 Water (Hydrostatic) Test (formerly 25.92)

- a. The leakage exfiltration or infiltration is not to exceed 100 gallons per inch of pipe diameter per mile per day for any section of the system.
- b. An exfiltration or infiltration test is to be performed with a minimum positive head of 2 feet.

33.95 Air test (formerly 25.92)

The air test is to conform, as a minimum, to the test procedure described in ASTM C-828 for clay pipe, and ASTM F-1417 for plastic pipe. For other materials, test procedures are to be approved by DEP.

34. MANHOLES (formerly 26)

34.1 Location (formerly 26.1)

- a. Manholes are to be installed:
 1. at the end of each line;
 2. at all changes in grade, size, or alignment;
 3. at all intersections; and
 4. at distances not greater than 400 feet for sewers 15 inches or less and 500 feet for sewers 18 inches to 30 inches. Distances up to 600 feet may be approved in larger lines where adequate modern cleaning equipment for such spacing is provided.
- b. Cleanouts may be used only for special conditions and are not to be substituted for manholes nor installed at the end of laterals greater than 150 feet in length.
- c. The location of manholes in streams should be avoided.

34.2 Drop Type (formerly 26.2)

- a. A drop pipe should be provided for the sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solids deposition.
- b. Drop manholes should be constructed as an outside drop connection. Inside drop connections (when necessary) are to be secured to the interior wall of the manhole and provide access for cleaning.
- c. Due to the unequal earth pressure that would result from the backfilling operation in the vicinity of the manhole and to support the drop pipe, the entire outside drop connection is to be encased in concrete.

34.3 Diameter (formerly 26.3)

- a. The minimum diameter of manholes is to be 48 inches. Larger diameters are required for manholes with inside drops, and may be necessary for manholes with large diameter sewers or multiple pipes connecting at the manhole.
- b. A minimum access diameter of 24 inches is to be provided.

34.4 Flow Channel (formerly 26.4)

- a. The flow channel **straight** through a manhole should be made to conform **as closely as possible** in shape and slope to that of the **connecting** sewers.
- b. The channel walls should be formed or shaped to the full height of the crown of the outlet sewer in such a manner as to not obstruct maintenance, inspection, or flow in the sewers.
- c. When curved flow channels are specified in manholes, including branch inlets, the minimum slopes indicated in Paragraph 33.42 should be increased to maintain acceptable velocities.

34.5 Bench

- a. A bench **is to** be provided on each side of any manhole channel when the pipe diameter(s) are less than the manhole diameter.
- b. The bench should be sloped no less than ½ inch per foot (4 percent).
- c. No lateral sewer, service connection, or drop manhole pipe **is to** discharge onto the surface of the bench.

34.6 Watertightness (formerly 26.5)

- a. Solid watertight manhole covers are to be used whenever the manhole tops may be flooded by street runoff or high water. **Locked manhole covers may be desirable in isolated easement locations or where vandalism may be a problem.**
- b. Manholes **are to** be of the pre-cast concrete, fiberglass, polyvinyl chloride (PVC), or poured-in-place concrete type.
- c. Manholes **are to** be waterproofed on the exterior.
- d. **Manhole lift holes and grade adjustment rings are to be sealed with non-shrinking mortar or other material approved by DEP.**
- e. Inlet and outlet pipes **are to** be joined to the manhole with a gasketed, flexible, watertight connection or any watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

34.7 Manhole **Inspection and Testing** (formerly 26.6)

The specifications **are to** include a requirement for manhole inspection and testing for **watertightness or damage prior to placing into service**. These tests may include water, air or vacuum testing.

- a. In the water test, exfiltration **is not to** exceed a rate of 0.019 gallons per day per

inch of manhole diameter per vertical foot of manhole during a continuous 4-hour test period.

- b. Air testing, if specified, is to conform to the test procedures described in ASTM C-1244.
- c. Vacuum testing is to be in accordance with the testing equipment manufacturer's written instructions and the test results compared to the manufacturer's published vacuum test tables.

34.8 Corrosion Protection For Manholes

Where corrosive conditions due to septicity or other causes are anticipated, corrosion protection on the interior of the manholes is to be provided.

34.9 Electrical (formerly 26.7)

- a. Electrical equipment installed or used in manholes is to conform to the provisions of Paragraph 42.25.
- b. Electrical equipment is not to be located where it could be submerged under water or sewage.

34.10 Venting (formerly 26.8)

Gravity sewers must be adequately vented through holes in manhole covers when infiltration/inflow is not a problem, or through other provisions.

35. SEWERS IN RELATION TO STREAMS (formerly 27)

35.1 Location of Sewers in Streams (formerly 27.1)

35.11 Cover Depth

- a. The top of all sewers entering or crossing streams are to be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements are to be met:
 - 1. One foot of cover where the sewer is located in rock;
 - 2. Three feet of cover in other material. In major streams, more than 3 feet of cover may be required; and
 - 3. In paved stream channels, the top of the sewer line should be placed below the bottom of the channel pavement.
- b. Less cover may be approved only if the proposed sewer crossing will not interfere with future modifications to the stream channel. Justification for

requesting less cover is to be provided in the application.

35.12 Horizontal Location (formerly 27.1)

Sewers located along streams are to be located outside of the stream bed and at a sufficient distance to provide for future possible stream widening and to prevent pollution by siltation during construction.

35.13 Structures (formerly 27.1)

The sewer outfalls, headwalls, manholes, gate boxes, or other structures are to be located so they do not interfere with the free discharge of flood flows of the stream.

35.14 Alignment (formerly 27.2)

- a. Sewers crossing streams should be designed to cross the stream as nearly perpendicular to the stream flow as possible and are to be free from change in grade.
- b. Sewer systems are to be designed to minimize the number of stream crossings.

35.2 Construction (formerly 27.2)

35.21 Materials

- a. Sewers entering or crossing streams are to be constructed of cast or ductile iron pipe with mechanical joints or concrete encasement around other types of pipes so that they will remain watertight and free from changes in alignment or grade.
- b. Material used to backfill the trench are to be stone, coarse aggregate, washed gravel, or other materials which will not readily erode, cause siltation, damage the pipe during placement, or corrode the pipe.

35.22 Siltation and Erosion Control (formerly 27.2 and 27.3)

- a. Construction methods that will minimize siltation and erosion are to be employed.
- b. The design engineer is to include in the project specifications the method(s) to be employed in the construction of sewers in or near streams. Such methods are to provide adequate control of siltation and erosion by limiting unnecessary excavation, disturbing or uprooting trees and vegetation, dumping of soil or debris, or pumping silt-laden water into the stream.

- c. Specifications are to require that cleanup, grading, seeding, planting and/or restoration of all work areas is to begin immediately.
- d. Exposed areas are not to remain unprotected for more than seven days.

35.23 Alternative Construction Methods

When the alignment of a sewer crosses a stream, consideration is to be given to trenchless construction technologies as an alternative to open trench construction. Such designs may be approved by the reviewing authority on a case by case basis under the provisions of Paragraph 53.2.

36. INVERTED SIPHONS (formerly 27.4)

- a. Inverted siphons should have two or more barrels, with a minimum pipe size of 6 inches.
- b. Siphons are to be provided with necessary appurtenances for maintenance, convenient flushing and cleaning equipment.
- c. Sufficient head is to be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second at maximum monthly average flows conveyed by the sewers.
- d. The ~~manholes~~ inlet and discharge structures are to have adequate clearance for cleaning equipment, inspection, and flushing.
- e. The inlet and outlet details are to be arranged so that the normal flow is diverted to one barrel, so that either barrel may be cut out of service for cleaning.
- f. The vertical alignment should permit cleaning and maintenance.

37. AERIAL CROSSINGS (formerly 27.5)

- a. Support is to be provided for all joints in pipes utilized for aerial crossings. The supports are to be designed to prevent frost heave, overturning and settlement.
- b. Precautions against freezing, such as insulation and increased slope, are to be provided.
- c. Expansion joints are to be provided between above-ground and below-ground sewers.
- d. Where buried sewers change to aerial sewers, special construction techniques are to be used to minimize frost heaving.
- e. For aerial stream crossings, the impact of flood waters and debris are to be considered. The bottom of the pipe should be placed no lower than the elevation of the 50-year flood.
- f. Ductile iron pipe with mechanical joints is recommended.

38. PROTECTION OF WATER SUPPLIES (formerly 28)

38.1 Water Supply Interconnections (formerly 28.1)

- a. There **is to** be no physical connection between a public or private water supply system and a sewer, or appurtenance thereto, which would permit the passage of any sewage or polluted water into the potable water supply.
- b. No water pipe **is to** pass through or come in contact with any part of a sewer manhole.

38.2 Relation to Waterworks Structures (formerly 28.2)

- a. When sewers are proposed in the vicinity of any water supply facilities, requirements in DEP's *Public Water Supply Manual*, available on DEP's website, Keyword: "DEP Drinking Water Publications" should be used to confirm acceptable isolation distances.
- b. **All existing waterworks units, such as basins, wells, or other treatment units, within 200 feet of the proposed sewer are to be shown on the engineering plans.**
- c. In general, sanitary sewers should be located at least 100 feet from public water supply sources and 50 feet from private water supply sources unless the sanitary lines are encased in concrete or constructed of ductile iron pipe with mechanical joints or equivalent.
- d. **Soil conditions in the vicinity of the proposed sewer within 200 feet of waterworks units are to be determined and shown on the engineering plans.**

38.3 Relation to Water Mains (formerly 28.3)**38.31 Horizontal Separation (formerly 28.31)**

- a. Sewers should be laid at least 10 feet, horizontally, from any existing or proposed water mains. **The distance is to be measured edge to edge.**
- b. **For gravity sewers where it is not practical to maintain a 10 foot separation, the DEP may allow deviation on a case-by-case basis, if supported by data from the design engineer. Such deviation may allow installation of the gravity sewer closer to a water main, provided that:**
 1. **the water main** is laid in a separate trench; or if
 2. it is laid in the same trench, with the water main located at one side of a bench of undisturbed earth; and if
 3. in either case the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

38.32 Vertical Separation

- a. Whenever sewers must cross under water mains, the sewer **is to** be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main.
 1. This vertical separation is to be maintained for the portion of the water main located within 10 feet horizontally of any sewer or drain it crosses.
 2. The 10 feet is to be measured as a perpendicular distance from the drain or sewer line to the water line.
- b. When the elevation of the sewer cannot be varied to meet the above requirements, the water main **is to** be relocated to provide this separation, for a distance of 10 feet extending on each side of the sewer.
- c. Where possible, one full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
- d. Where possible, sewers crossing water mains **are to** be constructed so that the sewer joints will be equidistant and as far as possible from the water main joints.
- e. The water main should be constructed of slip-on or mechanical-joint cast-iron pipe, ductile iron, galvanized steel or protected steel pipe having mechanical joints and the sewer constructed of mechanical-joint cast-iron pipe for any portion within 10 feet of the water main.
- f. Both services **are to** be pressure tested to assure watertightness prior to backfilling.
- g. Where less than an 18 inch vertical separation exists between the water and sewer line, the sewer line may be concrete encased 10 feet on either side of the water main.
- h. Where a water main crosses under a sewer, adequate structural support **is to** be provided for the sewer to prevent damage to the water main.

39. ALTERNATIVE SEWER SYSTEMS (formerly 29)

As an alternative to a conventional gravity sewer system, the use of such systems as small diameter, variable grade, vacuum, pressure sewers and STEP (septic tank effluent pumping) systems may be considered in designing the wastewater conveyance systems. The selection of conveyance systems should be based on both monetary and nonmonetary (e.g., environmental, social, institutional) considerations. This section includes design guidelines/standards for a pressure sewer system. Proposals received for the use of any other alternative conveyance systems will be reviewed on their merits on a case-by-case basis. In general, DEP will use the

consultant's analysis and recommendations, manufacturer's literature, experience with similar facilities and good engineering practice in reviewing such proposals.

39.1 Pressure Sewer System (formerly 29.1)

39.11 Application (formerly 29.1)

The pressure sewer system may be considered as an alternative to a conventional gravity collection system in situations where the use of gravity sewers is not feasible and/or cost effective. It is expected that a pressure sewer system would generally be used in small subsystems or areas. This system may be used under conditions such as the following:

- a. Where the topography makes it difficult for the potential users to be served by a gravity collection system.
- b. Where groundwater conditions make it difficult to construct and maintain a gravity collection system.
- c. Where excessive rock excavation makes the gravity collection system impractical.

39.12 Design Criteria (formerly 29.12)

The following considerations **are to** be used for the design of a pressure sewer system, including the grinder pump units or centrifugal pump units where solids do not present a problem.

- a. Collection System
 1. No pressure sewer less than 1¼ inches inside diameter **is to** be provided. The required size **is to** be determined to maintain low frictional losses in the system and a minimum scouring velocity of 2 feet per second at all points in the system.
 2. Special care **is to** be exercised in the hydraulic design of a pressure sewer system which is proposed to serve ultimately more houses than those expected to be served initially.
 3. The determination of flow in the pressure sewer system **is to** be made on the basis of the maximum probable number of grinder or centrifugal pump units that would be expected to run simultaneously or some other accepted method of computing the peak sewage flow rate in the system.
 4. The pressure sewer system **is to** be laid out in a branched or tree configuration to avoid flow-splitting at branches which cannot be accurately predicted.

5. The pressure sewer piping **is to** be installed in a depth sufficient to protect against freezing and damage from vehicular traffic.
 6. Although any suitable pipe material can be used, plastic pipe such as PVC SDR-26 or equivalent are considered suitable.
 7. **When the Hazen-Williams formula is used, the value for "C" is to be 100 for unlined iron or steel pipe for design. For other smooth pipe materials such as PVC, polyethylene, lined ductile iron, etc., a higher "C" value, not to exceed 120, may be allowed for design.**
 8. Cleanout connections **are to** be provided at distances not to exceed capacity of available cleaning equipment (approximately 500-600 feet).
 9. Appropriate valves for bypass pumping of the wastewater between cleanouts, necessary during the repair of the pressure sewer piping, **are to** be provided.
 10. Flushing cleanouts should be provided at the upstream end of every major branch.
 11. Pressure and vacuum release valves **are to** be employed at appropriate locations.
 12. Pressure sewers should be constructed on a gradually ascending slope to minimize air binding.
 13. The pressure sewer main **is to** be color taped or coded to distinguish between sanitary sewer and water main, and the direction of flow should be indicated on all pressure sewers inside the buildings.
 14. Current requirements for protection of water supplies, as outlined in Section 38, **are to** be followed.
 15. Pressure sewer system operating pressures in general **are not to** exceed a range of 40 to 60 psig for any appreciable period of time.
 16. Thorough pressure testing of all lines, fittings, etc. **are to** be made prior to start-up.
 17. Details of construction **are to** be clearly stated in the drawings and/or specifications.
- b. Grinder Pump Units

1. The minimum net storage capacity of the grinder pump unit **are to** be approximately 50 gallons. The grinder pump tank should be able to accommodate normal peak flows and emergency storage during a short power failure.
2. If grinder pump units are replacing an existing onlot system, the existing system should be retained for holding wastewater during an extensive power failure. An emergency overflow should be provided from the grinder pump tank to the emergency holding tank.
3. The grinder pump **is to** have the characteristics which will continue to produce flows of at least 8 gallons per minute (gpm) under all conditions.
4. Check and shut-off valves **are to** be employed to isolate the grinder pump unit from the house service line and the pressure laterals.
5. Appropriate high water and overflow detection devices such as visual and/or audio alarm **are to** be provided.
6. The grinder pump control panel **is to** contain a separate control circuit and breaker for the alarms.
7. Provisions **are to** be made to ensure that the grinder pump operates under power load fluctuations and contains integral protection against back siphonage and over pressure.
8. The grinder pump unit **is to** be capable of reducing any material in the wastewater which enters the grinder unit to such size that the material will pass through the pump unit and pressure sewer without plugging or clogging.
9. No screens or other devices requiring regular maintenance **are to** be used to prevent trashy material from entering the grinder pump.
10. At least one stand-by grinder pump unit for each 50 units or fraction thereof **is to** be provided for emergency replacement.
11. If the grinder pump unit is installed outside the residence, provisions must be made for access, as well as protection, from weather and vandalism. Inside installations **are to** be quiet and free from electrical and/or health hazards. All installations **are to** be certified by nationally recognized independent testing laboratories, such as the Underwriter's Laboratories, Inc. and the National Sanitation Foundation (NSF).
12. The grinder pump unit must be capable of being removed without

dewatering the collection tank.

- c. Centrifugal Pump Units
 1. As an alternative to using the grinder pump unit, a centrifugal pump may be used in conjunction with an existing septic tank or other pump tank. Specifically designed centrifugal pumps with cutters may be used in lieu of a grinder pump for pumping raw wastewater.
 2. All conditions applicable to the grinder pump unit as stated in Paragraph 39.12b, which can be utilized with the centrifugal pump unit, **are to** be considered.

39.13 Operation, Maintenance and Service (formerly 29.13)

- a. Grinder pump units must be serviceable and replaceable under wet conditions without electric hazard to the repair personnel.
- b. Provisions should be made to avoid interruption of sewer service due to mechanical or power failure.
- c. Ownership and responsibilities for repair and maintenance of the pressure sewers and grinder pump units **are to** be clearly defined and established prior to the approval of any installation.
- d. The pressure sewer system **is to** be owned, maintained and operated by a municipal or other governmental body or private company.
- e. The grinder or centrifugal pump unit may be owned and operated by a private concern or individual. However, the pump unit should be maintained through a maintenance agreement, by the owner of the pressure sewer system.
- f. Private ownership and maintenance will be accepted as a viable alternative. The party maintaining the units **is to** have full repair service capability on short notice.

39.2 Other Sewer Systems

Prior to the use of other alternative sewer systems, the project should be discussed with DEP, so that a set of design criteria may be proposed **by the applicant** and agreed to **by DEP** prior to the commencement of design.

CHAPTER 40
WASTEWATER PUMPING STATIONS

41. GENERAL (formerly 31)

41.1 Flooding (formerly 31.1)

- a. Wastewater pumping station structures and electrical and mechanical equipment **are to** be protected from physical damage by the 100-year flood.
- b. Wastewater pumping stations should remain fully operational and accessible during the 25-year flood.
- c. Applicable regulations of state and federal agencies regarding flood plain obstructions **are to** be followed.

41.2 Accessibility and Security (formerly 31.2)

- a. The pumping stations **are to** be readily accessible by maintenance vehicles during all weather conditions.
- b. It is recommended that pump station areas be fenced and that **access** hatches to pump stations be locked, especially for those pump stations located in remote areas.
- c. The facility should be located off the traffic way of streets and alleys.

41.3 Grit Protection of Pumps (formerly 31.3)

- a. The installation of screens, comminutors, and grit removal shall be considered. Refer to Sections 61, 62, and 63 for design requirements.
- b. Where it is necessary to pump wastewater prior to grit and gross solids removal, the design of the wet well and pump station piping **are to** receive special consideration to avoid operational problems from the accumulation of grit and clogging due to gross solids.

41.4 Safety

- a. Adequate provision **are to** be made to effectively protect maintenance personnel from hazards.
- b. Equipment for confined space entry in accordance with OSHA and regulatory agency requirements **is to** be provided for all wastewater pumping stations. Also refer to Section 57.

41.5 Operation During Construction (formerly 31.4)

When an existing pumping station is to be modified, the specifications are to include provisions for adequate pumping capacity during the construction period.

42. DESIGN OF WET AND DRY WELL PUMP STATIONS (formerly 32)

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

42.1 Structures (formerly 32.1)

42.11 Separation (formerly 32.11)

- a. Dry wells, including their superstructure, are to be completely separated from the wet well.
- b. Common walls are to be gas tight.
- c. A dehumidifier is recommended for moisture control.

42.12 Equipment Removal (formerly 32.12)

- a. Provisions are to be made to facilitate removing pumps, motors, and other mechanical and electrical equipment.
- b. Individual pump and motor removal are not to interfere with the continued operation of remaining pumps.

42.13 Access and Safety Landings

42.131 Access (formerly 32.13)

- a. Suitable and safe means of access for persons wearing self-contained breathing apparatus are to be provided for both dry and wet wells.
- b. If the access is greater than 4-feet deep, stairs are to be provided in accordance with the requirements of Subparagraph 42.232.
- c. Access to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance are to conform to Paragraph 61.13. Also refer to Section 57.

42.232 Safety Landings (formerly 32.13)

- a. For built-in-place pump stations, a stairway with rest landings should be provided at vertical intervals not to exceed 12 feet.
- b. For factory-built pump stations over 15 feet deep, a rigidly fixed landing should be provided at vertical intervals not to exceed

10 feet.

- b. Where a landing is used, a **suitable and** rigidly fixed barrier should be provided to prevent an individual from falling past the intermediate landing to a lower level.
- c. A manlift or elevator may be used in lieu of landings in a factory-built station, provided emergency access is included in the design.

42.14 Construction Materials (formerly 32.14)

- a. Due consideration **is to** be given to the selection of materials because of the presence of hydrogen sulfide and other corrosive gases, greases, oils and other constituents frequently present in wastewater. **This is particularly important in the selection of metals and paints.**
- b. **Contact between dissimilar metals should be avoided or other provisions made to minimize galvanic action.**

42.15 Buoyancy (formerly 32.15)

Where high groundwater conditions are anticipated, buoyancy of the wastewater pumping station structures **are to** be considered and, if necessary, adequate provisions **are to** be made for their protection.

42.2 Pumps (formerly 32.2)

42.21 Multiple Units (formerly 32.21)

- a. **Multiple** pumps **are to** be provided. A minimum of three pumps should be provided for stations designed to handle maximum monthly average flows of greater than 1 million gallons per day (MGD).
- b. Where only two units are provided, they **are to** be of the same capacity. Each **is to** be capable of handling peak **hourly** flows.
- c. Where three or more units are provided, they should be designed to fit actual flow conditions and must be of such capacity that with any one unit out of service, the remaining units will have capacity to handle peak **hourly** flows.
- d. **All pumps should be tested by the manufacturer. These tests should include a hydrostatic test and an operating test.**

42.22 Protection Against Clogging (formerly 32.22)

- a. Pumps handling sanitary or combined wastewater **are to** be preceded by one or more screening devices such as a manually cleaned bar screen,

mechanically cleaned bar screen, comminutor, or coarse bar rack to protect the pumps from clogging or damage. Refer to Sections 61 and 62 for design criteria.

- b. Where the size of the installation warrants, mechanically cleaned and/or duplicate bar racks are to be provided. Refer to Section 61.
- c. Where a manually and/or mechanically cleaned bar screen is used, refer to Paragraph 61.121 for appropriate bar spacing.
- d. Where a manually cleaned bar screen or coarse bar rack is provided, convenient facilities must be provided for handling screenings.
- e. Where a bar rack is provided, a mechanical hoist is also to be provided.

42.23 Pump Openings (formerly 32.23)

Except where grinder pumps are used, pumps handling raw wastewater are to be capable of passing spheres of at least 3 inches in diameter, and pump suction and discharge piping are to be at least 4 inches in diameter.

42.24 Priming (formerly 32.24)

The pump is to be placed so that under normal operating conditions, it will operate under a positive suction head, except as specified in Section 43 for suction lift pump stations.

42.25 Electrical Equipment (formerly 32.25)

- a. Electrical systems and components in wet wells (e.g., motors, lights, cables, conduits, switchboxes, control circuits, etc.) or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, are to comply with the National Electrical Code requirements for Class I, Division 1, Group D, locations. In addition, equipment located in the wet well is to be suitable for use under corrosive conditions.
- b. Each flexible cable is to be provided with a water-tight seal and separate strain relief.
- c. A fused disconnect switch located above ground is to be provided for all pumping stations. When such equipment is exposed to weather, it is to meet the requirements of weather proof equipment of NEMA 3R or 4, at a minimum.
- d. Electrical systems and components in dry well are to comply with the National Electrical Code requirements for Class I, Division 1, Group D locations, if the structural configuration or piping arrangement could lead

to a situation where hazardous concentrations of flammable gases or vapors “could reasonably be present.”

- e. **Lightning and surge protection systems should be considered.**
- f. A 110 volt power receptacle to facilitate maintenance should be provided inside the control panel for lift stations that have control panels outdoors.
- g. Ground fault interruption protection **is to** be provided for all outdoor outlets.

42.26 Intake (formerly 32.26)

- a. Each pump should have an individual intake.
- b. Wet well design should be such as to avoid turbulence near the intake and to prevent vortex formation.
- c. Intake piping should be as straight and short as possible.

42.27 Dry Well Dewatering (formerly 32.27)

- a. A sump pump equipped with dual check valves **is to** be provided in the dry wells to remove leakage or drainage with the discharge above the high water level of the wet well.
- b. Water ejectors connected to a potable water supply will not be approved.
- c. All floor and walkway surfaces should have an adequate slope to a point of drainage.
- d. Pump seal water **is to** be piped **or channeled directly** to the sump.
- e. **The sump pump is to be sized to remove the maximum pump seal water discharge that could occur in the event of a pump seal failure. Refer to Section 46.**

42.28 Pumping Rates (formerly 32.28)

- a. The pumps and controls of main pumping stations, and especially pumping stations operated as part of the treatment facility, should be selected to operate at varying delivery rates. Such pump stations should be designed to deliver as uniform flow as practicable in order to minimize hydraulic surges.
- b. **The station design capacity is to be based on the peak hourly flow determined in accordance with Paragraph 11.4 and should be adequate to maintain a minimum velocity of 2 feet per second in the force main. Refer**

to Paragraph 49.1.

42.29 Quick Disconnect Provisions (formerly 32.29)

Quick disconnect provisions should be considered in wet well type pumping stations for ease in replacing pumps.

42.3 Controls (formerly 32.3)

42.31 Type (formerly 32.31)

- a. Control systems are to be of the air bubbler type, the encapsulated float type, the sonic detector type or the flow measuring type.
 1. Bubbler type level monitoring systems are to include dual air compressors.
 2. Float tube control systems on existing stations being upgraded may be approved, provided that related electrical equipment complies with the National Electrical Code requirements for Class I, Division 1, Group D locations.
- b. Provision is to be made to automatically alternate the pumps in use.
- c. Suction lift stations should be designed to alternate pumps daily instead of each pumping cycle to extend the life of the priming equipment.

42.32 Location (formerly 32.32)

- a. The control system is to be located away from the turbulence of incoming flow and pump suction.
- b. Float tubes in dry wells are to extend high enough to prevent overflow.

42.4 Valves (formerly 32.4)

42.41 Suction Line

Suitable shut-off valves are to be placed on the suction line of dry pit pumps.

42.42 Discharge Line

- a. Suitable shut-off and check valves are to be placed on the discharge line of each pump (except on screw pumps).
- b. The check valve is to be located between the shut-off valve and the pump.
- c. Check valves are to be suitable for the material being handled and are to

be placed on the horizontal portion of discharge piping.

- d. Check valves **are not to** be placed on the vertical portion of discharge piping except that check valves may be approved on vertical risers when plans and specifications require a specific valve which is designed and is advertised by the manufacturer as suitable for raw wastewater on a vertical riser (e.g., ball check valves).
- e. Valves **are to** be capable of withstanding normal pressure and water hammer. Motorized slow closing plug valves are acceptable.
- f. All shut-off and check valves **are to** be operable from the floor level and accessible for maintenance.
- g. Outside levers are recommended on swing check valves.
- h. Where limited pump backspin will not damage the pump and low discharge head conditions exist, short individual force mains for each pump may be considered in lieu of discharge valves.
- i. Valves **are not to** be located in the wet well.

42.5 Wet Wells (formerly 32.5)

42.51 Divided Wells (formerly 32.51)

Consideration should be given to dividing the wet well into multiple sections, properly interconnected, to facilitate repairs and cleaning.

42.52 Size (formerly 32.52)

- a. The wet well size and control setting **are to** be appropriate to avoid heat buildup in the pump motor due to frequent starting and to avoid septic conditions due to excessive detention time.
- b. The effective capacity (e.g., capacity between working levels) of the wet well **is to** generally provide a holding period not to exceed 10 minutes for the maximum monthly average flow.
- c. Where tributary flow distance is short, a holding period not to exceed 30 minutes for the maximum monthly average flow should be considered.

42.53 Floor Slope (formerly 32.53)

- a. The wet well floor **is to** have a minimum slope of one horizontal to one vertical (1:1) to the hopper bottom.
- b. The horizontal area of the hopper bottom **is not to** be greater than

necessary for proper installation and functioning of the inlet.

42.54 Air Displacement

Covered wet wells are to have provisions for air displacement to the atmosphere, such as an inverted "J" tube or other means.

42.6 Ventilation (formerly 32.6)

42.61 General

- a. Ventilation is to be provided for all pump stations.
- b. Where the dry well is below the ground surface, mechanical ventilation is required.
- c. If screens or mechanical equipment requiring maintenance or inspection are located in the wet well, permanently installed ventilation is required.
- d. There is to be no interconnection between the wet well and dry well ventilation systems.

42.62 Air Inlets and Outlets

- a. In dry wells over 15 feet deep, multiple inlets and outlets are desirable.
- b. Dampers should not be used on exhaust or fresh air ducts.
- c. Fine screens or other obstructions in air ducts should be avoided to prevent clogging.

42.63 Electrical Controls

- a. Switches for operation of ventilation equipment should be marked and located conveniently.
- b. All intermittently operated ventilating equipment is to be interconnected with the respective pit lighting system.
- c. Consideration should be given for the use of automatic controls where intermittent operation is used.
- d. The manual lighting ventilation switch is to override the automatic controls.
- e. For a two speed ventilation system with automatic switch over where gas detection equipment is installed, consideration should be given to increasing the ventilation rate automatically in response to the detection of

hazardous concentrations of gases or vapors.

42.64 Fans, Heating, and Dehumidification

- a. The fan wheel should be fabricated from non-sparking material.
- b. Automatic heating and/or dehumidification equipment **is to** be provided in all dry wells.
- c. The electrical equipment and components **are to** meet the requirements in Paragraph 42.25

42.65 Wet Wells (formerly 32.61)

- a. Ventilation may be either continuous or intermittent.
- b. Ventilation, if continuous, **is to** provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour.
- c. Air **is to** be forced into the wet well by mechanical means rather than exhausted from the wet well.
- d. The air change requirements **are to be based on 100 percent fresh air.**
- e. Portable ventilation equipment **is to be provided for use at submersible pump stations and wet wells with no permanently installed ventilation equipment.**

42.66 Dry Wells (formerly 32.62)

- a. Ventilation may be either continuous or intermittent.
- b. Ventilation, if continuous, **is to** provide at least six complete air changes per hour; if intermittent, at least 30 complete air changes per hour.
- c. A system of two speed ventilation with an initial ventilation rate of 30 changes per hour for 10 minutes and automatic switch over to 6 changes per hour may be used to conserve heat.
- d. The air change requirements **are to be based on 100 percent fresh air.**

42.7 Flow Measurement (formerly 32.7)

- a. Suitable devices for measuring wastewater flow **are to** be considered at all pumping stations.
- b. Indicating, totalizing, and recording flow measurement **are to be provided at pumping stations with a 70 gpm or greater design peak hourly flow, determined in**

accordance with Paragraph 11.4, and at pumping stations with variable frequency drives or screw pumps.

- c. Elapsed time meters, used in conjunction with annual pumping rate tests, may be acceptable for pump stations with constant output pumps and a design peak hourly flow ~~up to~~ of less than 70 gpm, provided sufficient metering is configured to measure the duration of individual and simultaneous pump operation.

42.8 Water Supply (formerly 32.8)

- a. There ~~is to~~ be no physical connection between any potable water supply and a wastewater pumping station which, under any conditions, might cause contamination of the potable water supply.
- b. If a potable water supply is brought to the station, it should comply with conditions stipulated under Paragraph 56.2.

43. SUCTION LIFT PUMP STATIONS (formerly 33)

Suction lift pumps ~~are to~~ meet the applicable requirements under Sections 41 and 42.

43.1 Pump Priming and Lift Requirements

43.11 General (formerly 33)

- a. Suction-lift pumps ~~are to~~ be of the self-priming or vacuum-priming type.
- b. Suction-lift pump stations using dynamic suction lifts exceeding the limits outlined in the following sections may be approved upon submission of:
 - 1. factory certification of pump performance, and
 - 2. detailed calculations indicating satisfactory performance under the proposed operating conditions.
- c. Detailed calculations supporting subparagraph b. ~~are to include:~~
 - 1. static suction-lift as measured from "lead pump off" elevation to center line of pump suction,
 - 2. friction and other hydraulic losses of the suction piping,
 - 3. vapor pressure of the liquid,
 - 4. altitude correction,
 - 5. required net positive suction head, and a

6. safety factor of at least 6 feet.

43.12 Self-Priming Pumps (formerly 33.1)

- a. Self-priming pumps are to be capable of rapid priming and re-priming at the “lead pump on” elevation.
- b. Self-priming and re-priming are to be accomplished automatically under design operating conditions.
- c. Suction piping should not exceed the size of the pump suction and is not to exceed 25 feet in total length.
- d. Priming lift at the “lead pump on” elevation is to include a safety factor of at least 4 feet from the maximum allowable priming lift for the specific equipment at design operating conditions.
- e. The combined total of dynamic suction lift at the “pump off” elevation and required net positive suction head at design operating conditions is not to exceed 22 feet.

43.13 Vacuum Priming Pumps (formerly 33.2)

- a. Vacuum priming pump stations are to be equipped with dual vacuum pumps capable of automatically and completely removing air from the suction lift pump.
- b. The vacuum pumps are to be adequately protected from damage due to wastewater.
- c. The combined total of dynamic suction lift at the “pump off” elevation and required net positive suction head at design operating conditions is not to exceed 22 feet.

43.2 Equipment, Wet Well Access, and Valve Location (formerly 33)

- a. The pump equipment compartment is to be above grade or offset.
- b. The pump equipment compartment is to be effectively isolated from the wet well to prevent a hazardous and corrosive sewer atmosphere from entering the equipment compartment.
- c. Wet well access is not to be through the equipment compartment.
- d. Wet well access is to be at least 24 inches in diameter.
- e. Gasketed replacement plates are to be provided to cover the opening to the wet well for pump units removed for servicing.

- f. Valves are not to be located in the wet well.

44. SUBMERSIBLE PUMP STATIONS - SPECIAL CONSIDERATIONS (formerly 34)

Submersible pump stations are to meet the applicable requirements under Sections 41 and 42, except as modified in this Section.

44.1 Construction (formerly 34.1)

- a. Submersible pumps and motors are to:
 - 1. be designed specifically for raw wastewater use, including totally submerged operation during a portion of each pumping cycle, and
 - 2. meet the requirements of the National Electrical Code for such units.
- b. An effective method to detect shaft seal failure should be provided.

44.2 Pump Removal (formerly 34.2)

Submersible pumps are to be readily removable and replaceable without personnel entering or dewatering the wet well or disconnecting any piping in the wet well.

44.3 Electrical (formerly 34.3)

44.31 Power Supply and Control Circuitry (formerly 34.3.a)

- a. Electrical supply, control and alarm circuits are to be designed to provide strain relief and to allow disconnection from outside the wet well.
- b. Terminals and connectors are to be protected from corrosion by location outside of the wet well or through use of water-tight seals. If located outside, weatherproof equipment is to be used.

44.32 Controls (formerly 34.3.b)

- a. The motor control center is to be:
 - 1. located outside the wet well,
 - 2. readily accessible, and
 - 3. protected by a conduit seal or other appropriate measures meeting the requirements of the National Electrical Code, to prevent the atmosphere of the wet well from gaining access to the control center.

- b. The seal is to be located so that the motor can be removed and electrically disconnected without disturbing the seal.
- c. When such equipment is exposed to weather, it is to meet the requirements of weatherproof equipment NEMA 3R or 4, at a minimum.
- d. The pump motor is to meet the requirements of the National Electrical Code for Class I, Division 1, Group D locations.

44.33 Power Cord (formerly 34.3.d and e)

- a. Pump motor power cords are to be designed for flexibility and serviceability under conditions of extra hard usage and are to meet the requirements of the National Electrical Code standards for flexible cords in wastewater pump stations.
- b. Ground fault interruption protection are to be used to de-energize the circuit in the event of any failure in the electrical integrity of the cable.
- c. Power cord terminal fittings are to be provided with strain relief appurtenances and are to be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, are to be provided with strain relief appurtenances, and are to be designed to facilitate field connection.

44.4 Valves (formerly 34.4)

- a. Valves required under Paragraph 42.4 are to be located in a separate valve chamber.
- b. Provisions are to be made to remove or drain accumulated water from the valve chamber.
- c. The valve chamber may be dewatered to the wet well through a drain line with a gas and water tight valve.
- d. Check valves that are integral to the pump need not be located in a separate valve chamber provided that the valve can be removed from the wet well in accordance with Paragraph 44.2.
- e. Access is to be provided in accordance with Paragraph 42.131.

44.5 Operation (formerly 34.5)

Submersible pumps are to be capable of unsubmerged operation without damage or reduction of service capability, or positive provisions (e.g., backup controls) are to be made to assure submergence.

45. SCREW PUMP STATIONS - SPECIAL CONSIDERATIONS

Screw pumps are to meet the applicable requirements of Sections 41 and 42.

45.1 Covers

Covers or other means of excluding direct sunlight are to be provided as necessary to eliminate adverse effects caused by temperature changes.

45.2 Pump Wells

A positive means of isolating individual screw pump wells is to be provided.

45.3 Bearings

Submerged bearings are to be lubricated by an automated system without pump well dewatering.

46. ALARM SYSTEMS (formerly 35)

- a. Alarm systems with a backup power source are to be provided for pumping stations.
- b. The alarm is to be activated in cases of power failure, dry well sump and wet well high water levels, pump failure, use of the lag pump, unauthorized entry, or any other cause of pump station malfunction.
- c. Pumping station alarms should transmit and identify alarm conditions to a municipal facility that is manned 24 hours a day. If such a facility is not available, the alarm is to be transmitted to municipal offices during normal working hours and to the home of the person(s) in responsible charge of the pump station during off-duty hours.
- d. Audio-visual alarm systems with a self-contained power source may be acceptable in some cases in lieu of a transmitting system outlined above, depending upon location, station holding capacity and inspection frequency.

47. EMERGENCY OPERATION (formerly 36)**47.1 Objective**

The objective of emergency operation is to prevent the discharge of raw or partially treated wastewater to any waters and to protect public health by preventing back-up of wastewater and subsequent discharge to basements, streets, and other public and private property.

47.2 Emergency Pumping Capability

- a. Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity.

- b. Emergency pumping capability is to be accomplished by connection of the station to at least two independent utility substations, by provision of portable or in-place internal combustion engine equipment to generate electrical or mechanical energy, or by the provision of portable pumping equipment.
- c. Emergency pumping is to comply with the conditions stipulated in Paragraph 56.1.
- d. Emergency standby systems are to have sufficient capacity to start up and maintain the total rated running capacity of the station.
- e. Regardless of the type of emergency standby system provided, a portable pump connection to the force main with rapid connection capabilities and appropriate valves are to be provided outside the dry well and wet well.

47.3 Emergency High Level Overflows (formerly 36)

- a. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions, consideration should be given to providing a controlled, high-level wet well overflow to supplement alarm systems and emergency pumping capability in order to prevent backup of wastewater into basements, or other discharges that could cause severe adverse impacts on public interests, including public health and property damage.
- b. Where a high level overflow is utilized, consideration is to also be given to the installation of storage/detention tanks or basins, which are to drain back to the station wet well.
- c. All structures capable of bypassing are to be controlled by a lockable, manually operated valve.
- d. Where such overflows are considered, the regulatory agency is to be contacted for the necessary treatment or storage requirements.
- e. Outfall structures are to be in accordance with Section 55.

47.4 Overflow Prevention Methods (formerly 36.1)

A satisfactory method is to be provided to prevent or minimize overflows. The following methods should be evaluated on an individual basis. The choice should be based on least cost and least operation problems of the methods providing an acceptable degree of reliability.

47.41 Storage Capacity (formerly 36.11)

- a. Storage capacity, including trunk sewers for retention of wet weather flows, should be evaluated.

- b. Storage basins must be designed to drain back into the wet well or collection system after the flow recedes.

47.42 In-Place or Portable Pump (formerly 36.12)

An in-place or portable pump driven by an internal combustion engine meeting the requirements of Paragraph 47.5 below, capable of pumping from the wet well to the discharge side of the station, should be considered.

47.43 Independent Public Utility Sources (formerly 36.13)

Independent public utility sources or engine-driven generating equipment meeting the requirements of Paragraph 47.4 below should be considered.

47.5 Equipment Requirements (formerly 36.2)

47.51 General (formerly 36.21)

The following general requirements **are to** apply to all internal combustion engines used to drive auxiliary pumps, service pumps through special drives or electrical generating equipment.

47.511 Engine Protection (formerly 36.211)

- a. The engine must be protected from operating conditions that would result in damage to equipment.
- b. Unless continuous manual supervision is planned, protective equipment **is to** be capable of shutting down the engine, activating an alarm as provided in **Section 46**.
- c. Protective equipment **is to** monitor for conditions of low oil pressure and overheating, except oil pressure monitoring will not be required for engines with splash lubrication.

47.512 Size (formerly 36.212)

The engine **is to** have adequate rated power to start and continuously operate all connected loads.

47.513 Fuel Type (formerly 36.213)

- a. Reliability and ease of starting, especially during cold weather conditions, should be considered in the selection of the type of fuel.
- b. **Where public utility gas is selected, consideration is to be given to**

a generator design that may be operated with an alternate fuel supply system in accordance with National Electric Code (701.11, 2008 Edition.)

47.514 Underground Fuel Storage

Underground fuel storage and piping facilities are to be constructed in accordance with applicable state, provincial, and federal regulations.

47.515 Engine Ventilation (formerly 36.214)

The engine is to be located above grade and is to be provided with adequate ventilation of fuel vapors and exhaust gases.

47.516 Routine Start-up (formerly 36.215)

All emergency equipment is to be provided with instructions indicating the need for regular starting and running of such units at full loads.

47.517 Protection of Equipment (formerly 36.216)

Emergency equipment is to be protected from damage at the restoration of regular electrical power.

47.518 Air Quality

Regulations of state, provincial and federal agencies regarding air quality are to be considered.

47.519 Silencer

Noise control should be considered.

47.52 Engine-Driven Pumping Equipment (formerly 36.22)

Where permanently installed or portable engine-driven pumps are used, the following requirements, in addition to general requirements, are to apply.

47.521 Pumping Capacity (formerly 36.221)

- a. Engine driven pumps are to meet the design pumping requirements unless storage capacity is available for flows in excess of pump capacity.
- b. Pumps are to be designed for anticipated operating conditions, including suction lift, if applicable.

47.522 Operation (formerly 36.222)

- a. The engine and pump **are to** be equipped to provide automatic start-up and operation of pumping equipment unless manual start-up and operation is justified. Provisions **are to** also be made for manual start-up.
- b. Where manual start-up and operation is justified, storage capacity and alarm system must meet the requirements of Section **46 and Paragraph 47.423**

47.523 Portable Pumping Equipment (formerly 36.223)

- a. Where part or all of the engine-driven pumping equipment is portable, sufficient storage capacity with alarm system **is to** be provided to allow time for detection of pump station failure and transportation and hook up of the portable equipment.
- b. A riser from the force main with quick connect coupling and appropriate valving **is to** be provided to hook up portable pumps.

47.53 Engine-Driven Generating Equipment (formerly 36.23)

Where permanently installed or portable engine-driven generating equipment is used, the following requirements, in addition to general requirements, **are to** apply.

47.531 Generating Capacity (formerly 36.231)

- a. Generating unit size **is to** be adequate to provide power for pump motor starting current and for lighting, ventilation, and other auxiliary equipment necessary for safety and proper operation of the lift station.
- b. The operation of only one pump during periods of auxiliary power supply must be justified. Such a justification may be made on the basis of anticipated **peak hourly flows** relative to single pump capacity, anticipated length of power outage and storage capacity.
- c. Special sequencing controls **are to** be provided to start pump motors unless the generating equipment has the capacity to start all pumps simultaneously with auxiliary equipment operating.

47.532 Operation (formerly 36.232)

- a. Provisions **are to** be made for automatic and manual start-up and load transfer **unless only manual start-up and operation is justified**.
- b. The generator must be protected from operating conditions that

would result in damage to equipment.

- c. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load.
- d. Where manual start-up and transfer is justified, storage capacity and the alarm system must meet the requirements in Section 46 and Paragraph 47.433.

47.533 Portable Generating Equipment (formerly 36.233)

- a. Where portable generating equipment or manual transfer is provided, sufficient storage capacity, with an alarm system, is to be provided to allow time for detection of pump station failure and transportation and connection of generating equipment.
- b. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

47.54 Independent Utility Substations

Where independent substations are used for emergency power, each separate substation and its associated distribution lines are to be capable of starting and operating the pump station at its rated capacity.

48. INSTRUCTIONS AND EQUIPMENT (formerly 37)

Wastewater pumping stations and portable equipment should be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools and such spare parts as may be necessary.

49. FORCE MAINS (formerly 38)

49.1 Velocity and Diameter (formerly 38.1 and 38.7)

- a. At maximum monthly average flow, a velocity of at least 2 feet per second is to be maintained.
- b. A maximum velocity of 8 feet per second is recommended to avoid high head loss and protect valves.
- c. No public force main is to be less than 4 inches in diameter, except where grinding facilities are used.

49.2 Air and Vacuum Relief Valve (formerly 38.2)

- a. Air relief valves are to be placed at high points in the force main to prevent air

locking.

- b. Vacuum relief valves may be necessary to relieve negative pressure on force mains. The force main configuration and head conditions should be evaluated as to the need for and placement of vacuum relief valves.

49.3 Termination (formerly 38.3)

- a. Force mains should enter the receiving manhole with a smooth flow transition to the gravity sewer system at a point not more than 1 foot above the flow line.
- b. Corrosion protection for the receiving manhole is to be provided in accordance with Paragraph 34.8.

49.4 Pipe and Design Pressure (formerly 38.4)

- a. Pipe and joints are to be equal to water main strength materials suitable for design conditions.
- b. The force main, reaction blocking and station piping are to be designed to withstand water hammer pressures and associated cyclic reversal stresses that are expected with the cycling of wastewater pump stations.
- c. The use of surge valves, surge tanks or other suitable means to protect the force main against severe pressure changes are to be evaluated.

49.5 Special Construction (formerly 38.5)

Force main construction near streams or water works structures and at water main crossings is to meet applicable requirements of Sections 36, 37, and 38.

49.6 Design Friction Losses (formerly 38.6)

49.61 Friction Coefficient

Friction losses through force mains are to be based on the Hazen-Williams formula or other acceptable method.

When the Hazen-Williams formula is used, the value for "C" are to be 100 for unlined iron or steel pipe for design. For other smooth pipe materials such as PVC, polyethylene, lined ductile iron, etc., a higher "C" value, not to exceed 120, may be allowed for design.

49.62 Maximum Power Requirements

- a. When initially installed, force mains will have a significantly higher "C" factor. The effect of the higher "C" factor should be considered when calculating maximum power requirements and duty cycle time to prevent

damage to the motor.

- b. The effects of higher discharge rates on selected pumps and downstream facilities should be considered.

49.7 Separation from Water Mains (formerly 38.8)

- a. There is to be at least a 10-foot horizontal separation between water mains and sanitary sewer force mains.
- b. Force mains crossing water mains are to be laid to provide a minimum vertical distance of 18 inches between the outside of the force main and the outside of the water main. This is to be the case where the water main is either above or below the force main.
- c. At crossings, if possible, one full length of water pipe are to be located so both joints will be as far from the force main as possible.
- d. Special structural support for the water main and force main may be required.

49.8 Identification and Leakage Testing (formerly 38.9)

- a. Where force mains are constructed of material which might cause the force main to be confused with potable water mains, the force main should be appropriately identified.
- b. Leakage tests, including testing methods and leakage limits, are to be specified in contract documents.

49.9 Maintenance Considerations

- a. Isolation valves should be considered where force mains connect into a common force main.
- b. Cleanouts at low points and chambers for pig launching and catching should be considered for any force main to facilitate maintenance.

49.10 Cover

Force mains are to be covered with sufficient earth or other insulation to prevent freezing.

CHAPTER 50
WASTEWATER TREATMENT FACILITIES

51. GENERAL (formerly 41)

51.1 Design Information (formerly 41.1)

- a. The engineer should confer with DEP before proceeding with the design of detailed plans for wastewater treatment plants. A preliminary meeting with DEP is strongly recommended if the design standards in this manual are NOT being followed, or if a variance is being requested.
- b. Plants should be designed to serve about 20-years' projected population from the initiation of design.
- c. Deferred construction of those units which can be easily increased in capacity is a consideration to minimize the initial construction costs; however,
 1. any units for which construction is being deferred should be specifically identified.
 2. any units downstream of the deferred unit which may be affected by such deferral should be identified. Deferral of construction may require the upsizing of such downstream units. For example, deferral of the construction of an equalization basin should be considered in the design of disinfection equipment or final clarifiers, which are based on peak hourly flows.

51.2 Plant Location (formerly 41.2)

- a. In general, to avoid local objections, a wastewater treatment plant site should be as far as practicable from any present built-up area or any area which will probably be built up within a reasonable future period. It is recommended that the treatment plant be at least 250 feet from an occupied dwelling or recreational area.
- b. The direction of prevailing winds should be considered when selecting the plant site.
- c. If a critical location must be used, special consideration must be given to the design and type of plant provided.
- d. Space should be provided to allow for plant expansion in the event of a population expansion or requirement for additional treatment.
- e. Compatibility of treatment process with the present and planned future land use, including noise, potential odors, air quality, and anticipated sludge processing and disposal techniques should be considered.
- f. Where a site must be used which is critical with respect to these items,

appropriate measures are to be taken to minimize adverse impacts.

- g. Local soil characteristics, geology, hydrology and topography should be considered.

51.3 Flood Protection (formerly 41.3)

- a. The treatment plant structures, electrical and mechanical equipment are to be protected from physical damage by the 100-year flood.
- b. The treatment plant should remain fully operational and accessible during the 25-year flood. This applies to new construction and to existing facilities undergoing major modification.
- c. Flood plain regulations of federal, state, and local agencies are to be considered.

51.4 Climate Protection (formerly 41.4)

- a. At treatment plants designed to be operated during the winter months, a walk-in housing with heaters shall be provided for equipment such as blowers, chlorinators, chemical feeders and controls which may be adversely affected by low temperatures.
- b. Special design consideration shall also be given to treatment units which, based on practical operating experience, will operationally be adversely affected by cold weather.

51.5 Reliability

In order to provide for reliability, DEP recommends redundancy of treatment units and equipment at maximum monthly average flow. Otherwise, either flow equalization capacity and/or High Flow Management Plan (see NPDES NMS standard permit conditions) should be required to address operations under MMA and peak flows to prevent SSOs.

52. QUALITY OF EFFLUENT (formerly 42)

The required degree of wastewater treatment is to be based on the effluent requirements and water quality standards established by DEP, including discharge permit requirements, and pretreatment requirements for land treatment and reuse applications.

53. DESIGN (formerly 43)

53.1 Type of Treatment (formerly 43.1)

- a. Items to be considered in selection of the appropriate type of treatment are presented in Chapter 10.

- b. The plant design is to provide the necessary flexibility to perform satisfactorily within the expected range of waste characteristics and volumes.

53.2 Required Engineering Data for New Process and Application Evaluation (formerly 43.2)

The policy of the DEP is to encourage rather than obstruct the development of any methods or equipment for treatment of wastewater. The lack of inclusion in these standards of some types of wastewater treatment processes or equipment should not be construed as precluding their use. DEP may approve other types of wastewater treatment processes and equipment under the condition that the operational reliability and effectiveness of the process or device have been demonstrated with one or more suitably-sized prototype units operating at their design load conditions, to the extent required.

To determine that such new processes and equipment or applications have a reasonable and substantial chance of success, DEP may require the following:

- a. Monitoring observations, including test results and engineering evaluations, demonstrating the efficiency of such processes.
- b. Detailed description of the test methods.
- c. Testing, including appropriately-composited samples, under various ranges of strength and flow rates (including diurnal variations) and waste temperatures over a sufficient length of time to demonstrate performance under the range of climatic and other conditions which may be encountered in the area of the proposed installations.
- d. Other appropriate information.

DEP may require that appropriate testing be conducted and evaluations be made under the supervision of a competent process engineer other than those employed by the manufacturer, patent holder or developer.

53.3 Industrial Wastes (formerly 43.3)

Wherever applicable, information on the expected physical, chemical and biological characteristics of industrial wastewater should be obtained in order to determine its treatability characteristics and acceptability for discharge into the sewerage system (e.g., to determine what pretreatment requirements may be appropriate). It may be necessary to conduct a pilot plant study of the treatability of the wastewater to establish appropriate design parameters.

53.4 Hydraulic Design (formerly 43.4)

53.41 Critical Flow Conditions

- a. Flow conditions critical to the design of the treatment plant are described

in Chapter 10.

- b. Initial low flow conditions are to be evaluated in the design to minimize operational problems with freezing, septicity, flow measurements and solids dropout.
- c. The design peak hourly flow is to be used to evaluate the effect of hydraulic peaks on unit processes, pumping, piping, settling tanks, etc.

53.42 Treatment Plant Design Capacity

- a. The treatment plant design capacity is to be as described in Chapter 10.
- b. The plant design flow selected is to meet the appropriate effluent and water quality standards that are set forth in the discharge permit.
- c. The design of treatment units that are not subject to peak hourly flow requirements are to be based on the maximum monthly average flow, unless specifically stated otherwise.
- d. For plants subject to high wet weather flows or overflow detention pumpback flows, the design maximum day flows that the plant is to treat on a sustained basis should be specified.

53.43 Flow Equalization

- a. Facilities for the equalization of flows and organic shock load are to be considered at all plants which are critically affected by surge loadings in order to provide flexibility in plant operation and facilitate optimal plant performance.
- b. The sizing of the flow equalization facilities should be based on data obtained herein and from Chapter 10.

53.5 Organic Design

- a. Organic loadings for wastewater treatment plant design are to be based on the information given in Chapter 10.
- b. The effects of septage flow which may be accepted at the plant are to be given consideration and appropriate facilities are to be included in the design. Refer to the Appendix A.
- c. The shock effects of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants and batch processes, are to be considered.

53.6 Conduits (formerly 43.6)

- a. All piping and channels should be designed to carry the peak instantaneous flows.
- b. The incoming sewer should be designed for unrestricted flow.
- c. Bottom corners of the channels must be filleted.
- d. Conduits **are to** be designed to avoid creation of pockets and corners where solids can accumulate.
- e. Suitable gates **or valves** should be placed in channels to seal off unused sections which might accumulate solids.
- f. The use of shear gates, stop gates or stop planks is permitted where they can be used in place of gate valves or sluice gates.
- g. Corrosion resistant materials **are to** be used for these control gates.
- h. All piping and channels **are to** be accessible for cleaning out settled solids.

53.7 Arrangement of Units (formerly 43.7)

- a. All treatment units and their components should be arranged for greatest operation and maintenance convenience, flexibility, continuity of **optimum** effluent quality and for facilitation of the installation of future units.
- b. **Where duplicate units are provided, a central collection and distribution point including proportional flow splitting is to be provided for the wastewater flow before each unit operation. Exceptions to this central collection and distribution point requirement may be made on a case-by-case basis when the design incorporates more than one unit process in the same physical structure.**
- c. Cold weather operation should also be considered when arranging the treatment units and their component parts to utilize, where feasible, solar radiant heat and natural protection from wind and weather.

53.8 Flow Division Control (formerly 43.8)

- a. Flow division control facilities **are to** be provided as necessary to ensure organic and hydraulic loading control to plant process units and **are to** be designed for easy operator access for change, observation and maintenance.
- b. The use of **upflow division** boxes equipped with adjustable sharp-crested weirs or similar devices is recommended.
- c. The use of valves for flow splitting is not **acceptable**.
- d. Appropriate flow measurement **facilities are to** be incorporated in the flow

division control design.

54. PLANT DETAILS (formerly 44)

54.1 Installation of Mechanical Equipment (formerly 44.1)

The specifications should be written to ensure that the installation and initial operation of major items of mechanical equipment will be inspected and approved by a representative of the manufacturer.

54.2 Removal from Service (formerly 44.2)

54.2.1 General

- a. Properly located and arranged structures and piping are to be provided so that each unit of the plant can be removed from service independently.
- b. The design is to facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and ensure rapid process recovery upon return to normal operational mode.
- c. Removal of units from service may be accomplished through the use of duplicate or multiple treatment units in any stage if the design peak instantaneous flow can be handled hydraulically with the largest unit out of service.
- d. Removal of units from service should be accomplished by treatment unit redundancy at maximum monthly average flow, so that treatment efficiency may be retained with one unit out of service.
- e. Process piping should be designed to prevent the circumvention any unit processes.
- f. The actuation of all bypasses unit removals from service is to require manual action by operating personnel.

54.2.2 Unit Bypass During Construction (formerly 44.2.1)

Final plan documents are to include temporary bypass requirements as deemed necessary by DEP to avoid unacceptable temporary water quality degradation.

54.3 Unit Dewatering, Flotation Protection, and Plugging (formerly 44.3)

- a. Means such as drains or sumps are to be provided to completely dewater each unit to an appropriate point in the process.
- b. Due consideration is to be given to the possible need for hydrostatic pressure relief devices to prevent flotation of structures.

- c. Pipes subject to clogging **are to** be provided with means for mechanical cleaning or flushing.

54.4 Construction Materials (formerly 44.4)

- a. Due consideration should be given to the selection of materials which are to be used in a wastewater treatment plant because of the possible presence of hydrogen sulfide and other corrosive gases, greases, oils and similar constituents frequently present in the wastewater. This is particularly important in the selection of metals and paints.
- b. Contact between dissimilar metals should be avoided to minimize galvanic action.

54.5 Painting (formerly 44.5)

- a. The use of paints containing lead or mercury should be avoided.
- b. In order to facilitate identification of piping, particularly in the large plants, it is suggested that the different lines be color-coded. The following color scheme is recommended for standardization:

Raw sludge line – brown with black bands
 Sludge recirculation suction line – brown with yellow bands
 Sludge draw-off line – brown with orange bands
 Sludge recirculation discharge line – brown
 Digested sludge line – black
 Sludge gas line – red
 Natural gas line – red with black bands
 Nonpotable water line – purple
 Potable water line – blue
 Chlorine line – yellow
 Sulfur Dioxide – light green with yellow bands
 Wastewater line – gray
 Compressed air line – Dark green
 Water lines for heating digesters or buildings – blue with a 6-inch red band spaced 30 inches apart
 Fuel oil/diesel – red
 Plumbing drains and vents – black
 Alum or coagulant – orange
 Ferric Chloride – orange
 Polymer – orange with green band

The contents and direction of flow **are to** be stenciled on the piping in a contrasting color.

- c. The color coding and stenciling **are to** apply for the entire length of the piping.

Note: It should be recognized that other organizations, such as ASTM, may have color and marking schemes that differ from the standards contained in this manual. In the event of conflicts, this design standards contained in this manual are to be used.

54.6 Operating Equipment (formerly 44.6)

- a. A complete set of tools, accessories and spare parts necessary for the plant operator's use is to be provided.
- b. Readily accessible storage space and work bench facilities are to be provided, and consideration should be given to provisions of a garage area for large equipment storage, maintenance and repair.

54.7 Erosion Control During Construction (formerly 44.7)

Effective site erosion control is to be provided during construction. A soil erosion and sedimentation control plan is to be included in the construction documents.

54.8 Grading and Landscaping (formerly 44.8)

- a. Upon completion of the plant, the ground should be graded and sodded or seeded.
- b. All-weather walkways should be provided for access to all units.
- c. Where possible, steep slopes should be avoided to prevent erosion.
- d. Surface water is not to be permitted to drain into any unit. Particular care is to be taken to protect trickling filter beds, sludge beds and intermittent sand filters from stormwater runoff.
- e. Provisions should be made for landscaping, particularly when a plant must be located near residential areas.

54.9 Influent sampling

Influent sampling is to be provided as required in the NPDES permit.

55. PLANT OUTFALLS (formerly 45)

55.1 Discharge Impact Control (formerly 45.1)

The outfall sewer is to be designed to discharge to the receiving stream in a manner which will ensure adequate dispersion and prevent nuisance conditions. The outfall and/or headwall and stream crossings associated with the sewerage applications are permitted under the WQM permit. Consideration should be given to the following:

- a. Preference for free fall or submerged discharge at the site selected.

- b. Utilization of cascade aeration of effluent discharge to increase dissolved oxygen.
- c. Limited or complete across-stream dispersion, as needed, to protect aquatic life movement and growth in the immediate reaches of the receiving stream.
- d. Headwalls may be used where adequate dispersion is obtained without carrying the outfall into the stream.
- e. **Construction Requirements of Paragraph 35.2 are to be used where** an outfall is extended into the stream.

55.2 Protection and Maintenance (formerly 45.2)

- a. The outfall sewer **is to** be so constructed and protected against the effects of flood water, tide, ice or other hazards as to reasonably ensure its structural stability and freedom from blockage.
- b. A manhole should be provided at the shore end of all gravity sewers extending into the receiving waters.
- c. Hazards to navigation **are to** be considered in designing outfall sewers.

55.3 Sampling Provisions (formerly 45.3)

- a. All outfalls **are to** be designed so that a sample of the effluent can be obtained at a point after the final treatment process and before discharge to or mixing with the receiving waters.
- b. **A sampling point also should be located immediately prior to disinfection.**

56. ESSENTIAL FACILITIES (formerly 46)

56.1 Emergency Power Facilities (formerly 46.1)

56.11 General

All plants **are to** be provided with an alternate source of electric power or pumping capability to allow continuity of operation during power failures. **Refer to Paragraph 47.4 for design details.** Methods of providing alternate sources include:

- a. The connection of at least two separate and independent public utility sources such as substations **able to supply power without interruption.** A power line from each substation will be required, unless documentation is received and approved by DEP, verifying that duplicate lines are not necessary to minimize water quality violations.
- b. Portable or in-place internal combustion engine equipment which will

generate electrical or mechanical energy; and

- c. Portable pumping equipment when only emergency pumping is required. For more specific information refer to Section 47 - Emergency Operation for pumping stations.

56.12 Power for Aeration (formerly 46.11)

- a. Standby generating capacity normally is not required for aeration equipment used in the activated sludge process. In cases where a history of long-term (4 hours or more) power outages **or reduced voltage** have occurred, auxiliary power for minimum aeration of the activated sludge will be required.
- b. Full power generating capacity and/or other special waste treatment facilities may be required by DEP for waste discharges to certain critical stream segments. Examples of critical stream segments are ones where there are discharges above: (a) a bathing beach, (b) a public water supply source and/or (c) other similar situations.

56.13 Power for Disinfection (formerly 46.12)

- a. Continuous disinfection **is to** be provided during all power outages.
- b. **Continuous dechlorination is required for systems that dechlorinate.**

56.14 Power for Data Loggers

- a. Computers configured to log data **are to** be supplied with an uninterruptable power supply (UPS).
- b. Each UPS **is to** monitor its own battery condition and issue alarms on low battery.
- c. UPSs configured to supply computers **are to** cause the computer to save all open files and data logging files, without overwriting existing files, at the time of primary power failure and again when a low battery condition occurs.

56.2 Water Supply (formerly 46.2)

56.21 General (formerly 46.21)

- a. An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant.
- b. No piping or other connections **are to** exist in any part of the treatment plant which, under any conditions, might cause the contamination of a

potable water supply.

- c. The chemical quality should be checked for suitability for its intended uses such as for heat exchangers, chlorinators, etc.

56.22 Direct Connections (formerly 46.22)

Potable water from a municipal or separate supply may be used directly at points above grade for the following hot and cold supplies:

- a. Lavatory
- b. Water closet
- c. Laboratory sink (with vacuum breaker)
- d. Shower
- e. Drinking fountain
- f. Eye wash fountain
- g. Safety shower

Hot water for any of the above units **is not to** be taken directly from a boiler used for supplying hot water to a sludge heat exchanger or digester heating coils.

56.23 Indirect Connections (formerly 46.23)

- a. Where a potable water supply is to be used for any purpose in a plant other than those listed in Paragraph 56.22, a break tank, pressure pump and pressure tank **are to** be provided. Water **is to** be discharged to the break tank through an air gap at least 6 inches above the maximum flood line or the spill line of the tank, whichever is higher.
- b. A sign **is to** be permanently posted at every hose bib, faucet, hydrant or sill cock located on the water system beyond the break tank to indicate that the water is not safe for drinking.

56.24 Separate Potable Water Supply (formerly 46.24)

- a. Where it is not possible to provide potable water from a public water supply, a separate well may be provided.
- b. Location and construction of the well should comply with requirements of the state and local regulations.
- c. Requirements governing the use of the supply are those contained in **Paragraphs 56.22 and 56.23**

56.25 Separate Non-Potable Water Supply (formerly 46.25)

Where a separate non-potable water supply is to be provided, a break tank will not be necessary, but all system outlets **are to** be posted with a permanent sign

indicating the water is not safe for drinking.

56.3 Sanitary Facilities (formerly 46.3)

Toilets, showers, lavatories and lockers **are to** be provided in sufficient numbers and at convenient locations to serve the expected plant personnel. Such facilities may not be necessary at plants where a part-time operator is employed.

56.4 Floor Slopes (formerly 46.5)

Floor surfaces **are to** be sloped adequately to a point of drainage.

56.5 Stairways (formerly 46.6)

- a. Stairways **are to** be installed in lieu of ladders for access to units requiring **routine** inspection and maintenance, such as digesters, trickling filters, aeration tanks, clarifiers, tertiary filters, etc.
- b. **Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided.**
- c. Stairways should be installed with consideration to facilitate carrying samples, tools, etc. All risers in a stairway should be of equal height.
- d. **Stairways are to have slopes between 30 and 40 degrees from the horizontal to facilitate carrying samples, tools, etc.**
- e. **Each tread and riser are to be of uniform dimension in each flight.**
- f. **Minimum tread run is not to be less than 9 inches.**
- g. **The sum of the tread run and riser is not to be less than 17 inches nor more than 18 inches.**
- h. **A stairway is not to have more than a 12-foot continuous rise without a platform.**

56.6 Flow Measurement (formerly 46.7)

56.61 Location

Flow measurement facilities **are to** be provided to measure the following flows:

- a. **Plant influent and effluent flows. If influent flow is significantly different from effluent flow, both are to be measured. This applies to installations such as lagoons, sequencing batch reactors, and plants with excess flow storage or flow equalization;**
- b. **Excess flow treatment facility discharges;**

- c. Other flows required to be monitored under the provisions of the discharge permit; and
- d. Other flows such as return activated sludge, waste activated sludge, recirculation, supernatant and filtrate return flows and recycle required for plant operational control.

56.62 Facilities

- a. Flow measurement facilities are to be provided at all plants.
- b. Indicating, totalizing, and recording flow measurement devices are to be provided for all plants with maximum monthly average flow of ~~0.1~~ 0.05 MGD or greater.
- c. Flow measurement facilities for lagoon systems are not to be less than elapsed time meters used in conjunction with pumping rate tests or are to be calibrated weirs.
- d. All flow measurement equipment are to be sized to function effectively over the full range of flows expected and are to be protected against freezing.
- e. See Paragraph 42. 5 for the requirements concerning electrical systems and components located in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present.

56.63 Hydraulic Conditions

- a. Flow measurement equipment including approach and discharge conduit configuration and critical control elevations is to be designed to ensure that the required hydraulic conditions necessary for accurate measurement are provided.
- b. Turbulence, eddy currents, air entrainment or any other aspect that upsets the normal hydraulic conditions that are necessary for accurate flow measurement are to be avoided.

56.7 Sampling Equipment

- a. Flow proportional effluent composite sampling equipment is to be provided at all mechanical plants with a design average flow of ~~0.1~~ 0.05 MGD or greater and at other facilities where it is necessary to meet discharge permit monitoring requirements.
- b. Composite sampling equipment is to be provided as needed for influent sampling and for monitoring plant operations. The influent sampling point is to be located

prior to any process return flows, and after any return flows or hauled-in waste acceptance locations.

- c. Refer to Paragraph 42.25 for the requirements concerning electrical systems and components located in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present. This Paragraph is to be considered in the design and location of influent composite sampling equipment.

56.8 Septage and Holding Tank Waste (formerly 46.8)

- a. Facilities should be provided at municipal treatment plants for the acceptance and safe and sanitary handling of liquid organic waste material such as septic and/or holding tank pumpings delivered to the site by tank truck or other similar means.
- b. Such facilities should be designed to discharge the waste into the treatment plant during off-peak flow hours at a rate which does not adversely affect the operation of the treatment units and the efficiency of the treatment plant.

57. SAFETY (formerly 47)

57.1 General

Adequate provision is to be made to effectively protect plant personnel and visitors from hazards. The following are to be provided to fulfill the particular needs of each plant:

- a. Enclosure of the plant site with a fence and signs designed to discourage the entrance of unauthorized persons and animals.
- b. Hand rails with toe-boards where appropriate and guards around tanks, trenches, pits, stairwells, and other hazardous structures where the top of the wall is less than 42 inches above the surrounding ground level;
- c. Gratings over appropriate areas of treatment units where access for maintenance is required;
- d. First aid equipment.
- e. “No Smoking” signs in hazardous areas.
- f. Protective clothing and equipment as needed such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, hearing protectors, etc.
- g. Portable blowers and sufficient hose.
- h. Portable lighting equipment complying with the National Electrical Code requirements;

- i. Gas detectors listed and labeled for use in Class I, Division 1, Group D locations;
- j. Appropriately placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manhole, hazardous chemical storage areas, flammable fuel storage areas, high noise areas, etc.
- k. Adequate ventilation in pump station areas in accordance with Paragraph 42.6;
- l. Provisions for local lockout on stop motor controls.
- m. Provisions for confined space entry and laboratory safety in accordance with OSHA and regulatory agency requirements; and
- n. Adequate vector control.
- o. Provisions for a handicapped person to gain access to laboratory, administrative and other buildings.

57.2 Hazardous Chemical Handling (formerly 47.1)

Underground storage facilities for chemicals such as alum or ferric chloride or fuels are to be constructed in accordance with the Environmental Protection Agency (EPA) regulations and the State Storage Tank and Spill Prevention Act (Act 32) for underground storage tanks for both fuels and hazardous materials.

57.21 Containment Materials (formerly 47.11)

The materials utilized for storage, piping, valves, pumping, metering, splash guards, etc. are to be specially selected considering the physical and chemical characteristics of each hazardous or corrosive chemical.

57.22 Secondary Containment (formerly 47.12)

- a. Chemical storage areas are to be enclosed in dikes or curbs which will contain the stored volume until it can be safely transferred to alternate storage or released to the wastewater at controlled rates which will not damage facilities, inhibit the treatment processes or contribute to the stream pollution.
- b. Secondary containment areas are not to be designed with a bottom drain.
- c. Liquid polymer should be similarly contained to reduce areas with slippery floors, especially to protect travelways. Non-slip floor surfaces are desirable in polymer-handling areas.

57.23 Liquefied Gas Chemicals

- a. Areas intended for storage and handling of chlorine and sulfur dioxide and other hazardous gases are to be properly designed and isolated.
- b. Gas detection kits, alarms, controls, safety devices, and emergency repair kits are to be provided.

57.24 Splash Guards (formerly 47.14)

- a. All pumps or feeders for hazardous or corrosive chemicals are to have guards which will effectively prevent spray of chemicals into space occupied by personnel.
- b. The splash guards are in addition to guards to prevent injury from moving or rotating machinery parts.

57.25 Piping Labeling, Coupling Guards, Location (formerly 47.15)

- a. All piping containing or transporting corrosive or hazardous chemicals are to be identified with labels every 10 feet and with at least two labels in each room, closet or pipe channel. Color coding may also be used, but is not an adequate substitute for labeling.
- b. All connections (flanged or other type), except adjacent to storage or feeder areas, are to have guards which will direct any leakage away from space occupied by personnel.
- c. Pipes containing hazardous or corrosive chemicals should not be located above shoulder level except where continuous drip collection trays and coupling guards will eliminate chemical spray or dripping onto personnel.

57.26 Protective Clothing and Equipment (formerly 47.16)

The following items of protective clothing or equipment are to be available and utilized for all operations or procedures where their use will minimize injury hazard to personnel:

- a. Self-contained breathing apparatus recommended for protection against chlorine.
- b. Chemical workers' goggles or other suitable goggles. (Safety glasses are insufficient.)
- c. Face masks or shields for use over goggles.
- d. Dust masks to protect the lungs in dry chemical areas;
- e. Rubber gloves.

- f. Rubber aprons with leg straps.
- g. Rubber boots. (Leather and wool clothing should be avoided near caustics.)
- h. Safety harness and line.

57.27 Warning System and Signs (formerly 47.17)

- a. Facilities **are to** be provided for automatic shutdown of pumps and sounding of alarms when failure occurs in a pressurized chemical discharge line.
- b. Warning signs requiring use of goggles **are to** be located near chemical unloading stations, pumps and other points of frequent hazard.

57.28 Dust Collection (formerly 47.18)

Dust collection equipment **is to** be provided to protect personnel from dusts injurious to the lungs or skin and to prevent polymer dust from settling on walkways. The latter is to minimize slick floors which result when a polymer-covered floor becomes wet.

57.29 Eye Wash Fountains and Safety Showers (formerly 47.13)

- a. Eye wash fountains and safety showers utilizing potable water **are to** be provided in the laboratory and on each floor level or work location involving hazardous or corrosive chemical storage, mixing (or slaking), pumping, metering or transportation unloading.
- b. **Eye wash fountains and safety showers** are to be as close as practicable to possible chemical exposure sites and are to be fully **operable** during all weather conditions.
- c. Eye wash fountains **are to** be supplied with water of moderate temperature (~~50~~**75**[°]-90°F), separate from the hot water supply, suitable to provide 15 to 30 minutes of continuous washing of the eyes.
- d. The emergency showers **are to** be capable of discharging 30-50 gpm of water at moderate temperature at pressures of ~~20~~ **30** to 50 psig.

57.3 Hazardous Chemical Container Identification (formerly 47.19)

- a. The identification and hazard warning data included on shipping containers, when received, **are to** appear on all containers (regardless of size or type) used to store, carry or use as a hazardous substance.
- b. Wastewater and sludge sample containers should be adequately labeled. Below is

a suitable label for a wastewater sample:

RAW WASTEWATER

Sample point no. _____
Contains Harmful Bacteria.
May contain hazardous or toxic material.
Do not drink or swallow.
Avoid contact with openings or breaks in the skin.

58. LABORATORY (formerly 46.4)

58.1 General

- i. All treatment plants are to include a laboratory for making the necessary analytical determinations and operating control tests, except for plants utilizing only processes not requiring laboratory testing for plant control where satisfactory off-site laboratory provisions are made to meet the permit monitoring requirements. For plants where a fully equipped laboratory is not required, the requirements for utilities, fume hoods, etc., may be reduced.
- ii. The laboratory is to have sufficient size, bench space, equipment, and supplies to perform all self-monitoring analytical work required by discharge permits, and to perform the process control tests necessary for good management of each treatment process included in the design.
- iii. The facilities and supplies necessary to perform analytical work to support industrial waste control programs will normally be included in the same laboratory.
- iv. The laboratory arrangement should be sufficiently flexible to allow future expansion should more analytical work be needed.
- v. Laboratory instrumentation and size should reflect treatment plant size, staffing requirements, process complexity, and applicable certification requirements.
- vi. Experience and training of plant operators should be assessed when determining treatment plant laboratory needs.
- vii. Treatment plant laboratory needs may be divided into the following three general categories:
 - I. Plants performing only basic operational testing accredited by role; this typically includes pH, temperature, dissolved oxygen, and total chlorine residual;
 - II. Plants performing more complex operational and permit laboratory tests including biochemical oxygen demand, suspended solids, and bacterial

analysis, and;

III. Plants performing more complex operational, permit, industrial pretreatment, and multiple plant laboratory testing.

viii. Expected minimum laboratory needs for these three plant classifications are outlined in this Section. However, in specific cases, laboratory needs may have to be modified or increased due to industrial monitoring needs or special process control requirements.

58.2 Category I: Plants performing only basic operational testing

58.21 Location and Space

A floor area up to 150 square feet at the treatment site should be adequate. If considering off-site sample analysis, the facility is to consider the requirement that all Class I parameters, as described above, be analyzed within 15 minutes of sample collection.

58.22 Design and Materials

The facility is to provide for electricity, water, heat, sufficient storage space, a sink, and a bench top. The lab components need not be of industrial grade materials. Laboratory equipment and glassware are to be of types recommended by Standard Methods for the Examination of Water and Wastewater and the reviewing authority.

58.3 Category II: Plants performing more complex operational and permit laboratory tests including biochemical oxygen demand, suspended solids, and bacterial analysis

58.31 Location and Space

- a. The laboratory size should be based on providing adequate room for the equipment to be used. In general, the laboratories for this category of plant should provide a minimum of approximately 300 square feet of floor space.
- b. Adequate bench space for each analyst is to be provided.
- c. The laboratory should be located at the treatment site on ground level.
- d. It is to be isolated from vibrating, noisy, or high-temperature machinery or equipment which might have adverse effects on the performance of laboratory staff or instruments.

58.32 Floors

Floor surfaces should be fire resistant and highly resistant to acids, alkalies,

solvents, and salts.

58.33 Cabinets and Bench Tops

- a. Laboratories in this category usually perform both discharge permit testing and operational control monitoring utilizing "acids" and "bases" in small quantities, such that laboratory grade metal cabinets and shelves are not mandatory. The cabinets and shelves selected may be of wood or other durable materials.
- b. Bench tops should be of acid resistant laboratory grade materials for protection of the underlying cabinets.
- c. Glass doors on wall-hung cabinets are recommended.
- d. One or more cupboard style base cabinets should be provided.
- e. Cabinets with drawers should be provided with rubber bumpers and stops to prevent accidental removal.
- f. Cabinets for Category II laboratories are not required to have gas, air, vacuum, and electrical service fixtures.
- g. Built-in shelves should be adjustable.

58.34 Fume Hoods, Sinks, and Ventilation

58.341 Fume Hoods

- a. Fume hoods are to be provided for laboratories where required analytical work results in the production of noxious fumes.
- b. Air intake should be balanced against all exhaust ventilation to maintain an overall positive pressure relative to atmospheric in the laboratory.

58.342 Sinks

A laboratory grade sink and drain trap are to be provided.

58.343 Ventilation

Laboratories should be air conditioned. In addition, separate exhaust ventilation should be provided.

58.35 Balance and Table

- a. An analytical balance of the automated digital readout, single pan 0.1

milligram sensitivity type is to be provided.

- b. A heavy special-design balance table which will minimize vibration of the balance is recommended. This table is to be located as far as possible from windows, doors, or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

58.36 Equipment, Supplies, and Reagents

- a. The laboratory is to be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements. If any required analytical testing produces malodorous or noxious fumes, the engineer should verify that the in-house analysis is more cost-effective than use of an independent off-site laboratory.
- b. Discharge permit, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs.
- c. Composite samplers may be required to satisfy permit sampling requirements.
- d. References such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A. Analytical Procedures Manual should be consulted prior to specifying equipment items.

58.37 Utilities

58.371 Power Supply

Consideration should be given to providing line voltage regulation for the power supplied to laboratories using delicate instruments.

58.372 Laboratory Water

Reagent water of a purity suitable for analytical requirements is to be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening the feed water to the still.

58.38 Safety

58.381 Equipment

Laboratories are to provide, as a minimum, the following: first aid equipment; protective clothing (including goggles, gloves, lab aprons, etc.); and a fire extinguisher.

58.382 Eyewash Fountains and Safety Showers

Eyewash fountains and safety showers complying with Paragraph 57.29 should be provided.

58.4 Category III: Plants performing more complex operational, permit, industrial pretreatment and multiple plant laboratory testing**58.41. Location and Space**

- a. The laboratory should be located at the treatment site on ground level, with environmental control as an important consideration.
- b. It is to be isolated from vibrating, noisy, or high temperature machinery or equipment which might have adverse effects on the performance of laboratory staff or instruments.
- c. The laboratory facility needs for Category III plants should be described in the Engineering Report or Facility Plan.
- d. The laboratory floor space and facility layout should be based on an evaluation of the complexity, volume, and variety of sample analyses expected during the design life of the plant including testing for process control, industrial pretreatment control, user charge monitoring, and discharge permit monitoring requirements.
- e. Consideration is to be given to the necessity to provide separate (and possibly isolated) areas for some special laboratory equipment, glassware, and chemical storage.
- f. The analytical and sample storage areas should be isolated from all potential sources of contamination.
- g. It is recommended that the organic chemical facilities be isolated from other facilities.
- h. Adequate security is to be provided for sample storage areas.
- i. Provisions for the proper storage and disposal of chemical wastes are to be made.
- j. At large plants, office and administrative space needs should be considered.
- k. For less complicated laboratory needs bench-top working surface should occupy at least 35 percent of the total laboratory floor space. Additional floor and bench space should be provided to facilitate the performance of analysis of industrial wastes, as required by the discharge permit and the

utility's industrial waste pretreatment program.

- l. Ceiling height should be adequate to allow for the installation of wall mounted water stills, deionizers, distillation racks, hoods, and other equipment with extended height requirements.

58.42 Floors and Doors

58.421 Floors

- a. Floor surfaces should be fire resistant and highly resistant to acids, alkalis, solvents, and salts.
- b. Floor surfaces should be a single color for ease of locating dropped items. The structural floor is to be concrete with no basement.

58.422 Doors

- a. Two exit doors should be located to permit straight egress from the laboratory, preferably at least one to outside the building.
- b. Doors should have a minimum width of 36 inches and are to open in the direction of exit traffic.
- c. Panic hardware should be used.
- d. They should have large glass windows for easy visibility of approaching or departing personnel.
- e. Automatic door closers should be installed; swinging doors should not be used.
- f. Flush hardware should be provided on doors if cart traffic is anticipated.
- g. Kick plates are also recommended.

58.43 Cabinets and Bench Tops

58.431 Cabinets

- a. Wall-hung cabinets are recommended for dust-free storage of instruments and glassware. Units with sliding glass doors are recommended.
- b. A reasonable proportion of cupboard style base cabinets and drawer units should be provided.

- c. All cabinet shelving should be acid resistant and adjustable.
- d. Drawers should slide out so that entire contents are easily visible. They should be provided with rubber bumpers and stops to prevent accidental removal.
- e. Drawers should be supported on ball bearings or nylon rollers which pull easily in adjustable steel channels.
- f. All metal drawer fronts should be double-wall construction.
- g. The laboratory furniture **is to** be supplied with adequate water, gas, air, and vacuum service fixtures; traps, strainers, plugs, and tailpieces, and electrical service fixtures.

58.432 Bench Tops

- a. Bench tops should be constructed of materials resistant to attacks from normally used laboratory reagents.
- b. Generally, bench-top height should be 36 inches. However, areas to be used exclusively for sit-down type operations should be 30 inches high and include kneehole space.
- c. One-inch overhangs and drip grooves should be provided to keep liquid spills from running along the face of the cabinet.
- d. Tops should be furnished in large sections, 1¼ inches thick. They should be field joined into a continuous surface with acid, alkali, and solvent-resistant cements which are at least as strong as the material of which the top is made.

58.44 Hoods

58.441 General

- a. Fume hoods to promote safety **are to** be provided for laboratories where required analytical work results in the production of noxious fumes.
- b. Canopy hoods over heat-releasing equipment **are to** be provided.

58.442 Fume Hoods

- a. Location
 - i. Fume hoods should be located where air disturbance at the face of the hood is minimal. Air disturbance may be created

by persons walking past the hood; by heating, ventilating, or air-conditioning systems; by drafts from opening or closing a door; etc.

- ii. Safety factors should be considered in locating a hood. If a hood is situated near a doorway, a secondary means of egress is to be provided.
- iii. Bench surfaces should be available next to the hood so that chemicals need not be carried long distances.

b. Design and Materials

- i. The selection, design, and materials of construction of fume hoods and their appropriate safety alarms are to be made by considering the variety of analytical work to be performed. The characteristics of the fumes, chemicals, gases, or vapors that will or may be released by the activities therein should be considered. Special design and construction is necessary if perchloric acid use is anticipated.
- ii. Consideration should be given to providing more than one fume hood to minimize potential hazardous conditions throughout the laboratory.
- iii. Air intake should be balanced against all exhaust ventilation to maintain an overall positive pressure relative to atmospheric in the laboratory.
- iv. Fume hoods are not appropriate for operation of heat-releasing equipment that does not contribute to hazards, unless they are provided in addition to those needed to perform hazardous tasks.

c. Fixtures

- i. One sink should be provided inside each fume hood. A cup sink is usually adequate.
- ii. All switches, electrical outlets, and utility and baffle adjustment handles should be located outside the hood. Light fixtures should be explosion-proof.

d. Exhaust

- i. Twenty-four hour continuous exhaust capability should be provided.

- ii. Exhaust fans should be explosion-proof.
- iii. Exhaust velocities should be checked when fume hoods are installed.

58.443 Canopy Hoods

- a. Canopy hoods should be installed over the bench-top areas where hot plate, steam bath, or other heating equipment or heat-releasing instruments are used.
- b. The canopy should be constructed of heat and corrosion resistant material.

58.45 Sinks, Ventilation, and Lighting

58.451 Sinks

- a. The laboratory should have a minimum of two sinks (not including cup sinks). At least one of them should be a double-well sink with drainboards.
- b. A sink dedicated to hand washing should be provided.
- c. Additional sinks should be provided in separate work areas as needed, and identified for the use intended.
- d. Sinks and traps should be made of epoxy resin or plastic materials highly resistant to acids, alkalies, solvents, and salts, and should be abrasion and heat resistant, non-absorbent, and lightweight.
- e. Traps should be made of glass, plastic, or lead when appropriate and easily accessible for cleaning.
- f. Waste openings should be located toward the back so that a standing overflow will not interfere.
- g. All water fixtures on which hoses may be used should be provided with reduced zone pressure backflow preventers to prevent contamination of water lines.

58.452 Ventilation

- a. Laboratories should be separately air conditioned, with external air supply for one hundred percent make-up volume.
- b. In addition, separate exhaust ventilation should be provided.

- c. Ventilation outlet locations should be remote from ventilation inlets.
- d. Consideration should be given to providing dehumidifiers.
- e. Air intake should be balanced against all supply air that is exhausted to maintain an overall positive pressure in the laboratory relative to atmospheric and other pressurized areas of the building which could be the source of airborne contaminants.

58.453 Lighting

- a. Good lighting, free from shadows, is to be provided for reading dials, meniscuses, etc., throughout the laboratory.
- b. Consideration is to be given to the effects of radio frequency interference when selecting luminary ballasts for laboratories using delicate instruments.

58.46 Balance and Table

- a. An analytical balance of the automatic, digital readout, single pan, 0.1 milligram sensitivity type is to be provided.
- b. A heavy special-design balance table which will minimize vibration of the balance is to be provided.
- c. The table is to be located as far as practical from windows, doors, or other sources of drafts or air movements, so as to minimize undesirable impacts from these sources upon the balance.

58.47 Microscope

A binocular or trinocular microscope with a 20 watt halogen light source, phase contrast condenser, mechanical stage, 10x, 40x and 100x phase contrast objectives, wastewater reticule eyepiece and centering telescope is recommended for process control at activated sludge plants.

58.48 Equipment, Supplies, and Reagents

- a. The laboratory is to be provided with all of the equipment, supplies, and reagents that are needed to carry out all of the facility's analytical testing requirements.
- b. Discharge permit, process control, and industrial waste monitoring requirements should be considered when specifying equipment needs.
- c. Composite samplers may be required to satisfy permit sampling

requirements.

- d. References such as Standard Methods for the Examination of Water and Wastewater and the U.S.E.P.A. Analytical Procedures Manual should be consulted prior to specifying equipment items.

58.49 Utilities and Services

58.491 Power Supply

Consideration should be given to providing line voltage regulation for power supplied to laboratories using delicate instruments.

58.492 Laboratory Water

Reagent water of a purity suitable for analytical requirements is to be supplied to the laboratory. In general, reagent water prepared using an all glass distillation system is adequate. However, some analyses require deionization of the distilled water. Consideration should be given to softening and/or deionizing the feed water to the still.

58.493 Gas and Vacuum

- a. Natural or LP gas should be supplied to the laboratory. Digester gas should not be used.
- b. An adequately-sized line source of vacuum with outlets available throughout the laboratory should be provided.

58.5 Safety

58.501 Equipment

Laboratories are to provide, as a minimum, the following:

- a. first aid equipment;
- b. protective clothing and equipment (such as goggles, safety glasses, full face shields, gloves, etc.);
- c. fire extinguishers;
- d. chemical spill kits;
- e. "No Smoking" signs in hazardous areas; and
- f. appropriately placed warning signs for slippery areas, non-potable water fixtures, hazardous chemical storage areas, flammable fuel storage areas, etc.

58.502 Eyewash Fountains and Safety Showers

Eyewash fountains and safety showers complying with Paragraph 57.29

should be provided.

59. CHEMICALS AND CHEMICAL HANDLING (V)

59.1 General (V.A)

59.11 Plans and Specifications (V.A.1)

Plans and specifications are to be submitted for review and approval, and are to include:

- a. Descriptions of feed equipment, including maximum and minimum feed ranges.
- b. Location of feeders, piping layout and points of application.
- c. Storage and handling facilities.
- d. Specifications for chemicals to be used.
- e. Operating and control procedures including proposed application rates.
- f. Descriptions of testing equipment and procedures.

59.12 Chemical Application (V.A.2)

Chemicals are to be applied to the water at such points and by such means as to:

- a. Ensure maximum efficiency of treatment.
- b. Provide maximum safety to operators.
- c. Ensure satisfactory mixing of the chemicals with the water.
- d. Provide maximum flexibility of operation through various points of application, when appropriate.
- e. Prevent backflow or back-siphonage between multiple points of feed through common manifolds.

59.2 Facilities Design (V.B)

59.21 Design and Capacity (V.B.1)

The design of chemical feed equipment is to be such that:

- a. Feeders will be able to supply, at all times, the necessary amounts of chemicals at an accurate rate, throughout the range of feed, considering

- initial and ultimate treatment plant capacity.
- b. Equipment surfaces and any appurtenances which contact chemicals are resistant to the aggressiveness of the chemical.
 - c. Corrosive chemicals are introduced in such a manner as to minimize potential for corrosion.
 - d. Chemicals that are incompatible are not fed, stored or handled together.
 - e. All chemicals are conducted from the feeder to the point of application in separate conduits.
 - f. Chemical feeders are as near as practical to the feed point.
 - g. Chemical feeders and pumps operate within the feed range recommended by the manufacturer.
 - h. Chemicals may be fed by gravity where practical.

59.22 Number of Feeders (V.B.2)

- a. Where chemical feed is necessary for the protection of the supply, such as chlorination, coagulation or other essential processes:
 - 1. A minimum of two feeders are to be provided.
 - 2. The standby unit or a combination of units of sufficient capacity should be available to replace the largest unit during shutdowns.
 - 3. Where a booster pump is required, duplicate equipment and, when necessary, standby power is to be provided.
 - 4. The standby power is to be capable of taking over with minimal delay in the event of a power outage in order to keep booster pumps in service.
- b. A separate feeder is to be used for each chemical applied.
- c. Spare parts are to be available for all feeders to replace parts which are subject to wear and damage.

59.23 Control (V.B.3)

- a. Feeders may be manually or automatically controlled, with automatic controls being designed to allow override by manual control.
- b. Automatic chemical dose or residual analyzers should provide:

1. Alarms for critical values.
 2. Recording charts, or a digital readout with computerized data recorder.
- c. Chemical feed rates are to be proportional to the rate of flow, especially where the water flow rate is not constant.
- d. A means to measure water flow must be provided in order to determine chemical feed rates.
- e. A method of ensuring complete mixing of treatment chemicals with the treatment plant influent water is to be provided. Mixing gradients for various treatment chemicals are to be as follows:
1. Coagulation with low molecular weight polymer: $200 - 400 \text{ sec}^{-1}$
 2. Coagulation without polymer: $300 - 1,000 \text{ sec}^{-1}$
 3. Disinfection: $500 - 1,000 \text{ sec}^{-1}$
- f. Provisions are to be made for measuring the quantities of chemicals used.
- g. Weighing scales:
1. Are to be provided for weighing cylinders at all plants utilizing chlorine gas; for larger plants, the indicating and recording type are desirable.
 2. Should be provided for volumetric dry chemical feeders.
 3. Should be accurate to measure increments of 0.5 percent of load.

59.24 Chemical Feed Systems

59.241 Dry Chemical Feed Systems (V.B.4)

Dry chemical feed systems are to:

- a. Completely enclose stored dry chemicals to prevent emission of dust to the operating room.
- b. Dry chemical storage silos and hoppers are to be designed to prevent chemical bridging and uncontrolled discharge.
- c. Hopper sidewall angle should be at least 60 degrees from the horizontal.

- d. Measure chemicals volumetrically or gravimetrically.
 1. Volumetric dry feeders

When dosing accuracy is a significant consideration, a rotating table design with a circular groove and adjustable knife height should be used. A vibrating bin with a screw-type conveyor should not be used when dosing accuracy is a significant consideration.
 2. Gravimetric dry feeders

Where ease of operation and accurate dosing are essential, gravimetric feeders should be used.
- e. Provide adequate solution water and agitation of the chemical in the solution pot.
 1. When inorganic chemicals are used, the solubility of the chemical at lowest water temperature at the maximum dosage rate should determine the size and water supply rate for a solution tank for a continuous dissolving system.
 2. For dry polymers, the aging tank following the wetting tank and preceding the feed tank are to be sized to provide a 30-minute to 1-hour detention time.

59.242 Positive Displacement Solution Pumps (V.B.5)

- a. Positive displacement type solution feed pumps should be used to feed liquid chemicals, but are not to be used to feed chemical slurries.
- b. Pumps must be capable of operating at the required maximum rate against the maximum head conditions found at the point of injection.

59.243 Liquid Chemical Feed Systems (V.B.6)

- a. Liquid chemical feeders are to be such that chemical solutions cannot be siphoned or overfed into the water supply by ensuring discharge at a point of positive pressure, or other suitable means or combinations as necessary.
- b. A metering pump equipped with a calibration chamber is to be used in a liquid feeding system.

- c. Chemical metering pumps should be equipped with a pulsation dampener (when pulsation-type pump is used), back pressure valve, pressure relief valve and a pressure waterline to flush chemicals from the metering pump.
- d. The pressure increase across the pump should be at least 10 to 20 psi.

59.25 Chemical Feed Equipment Location (V.B.8)

Chemical feed equipment is to:

- a. Be located in a separate room to reduce hazards and dust problems.
- b. Be conveniently located near points of application to minimize length of feed lines.
- c. Be provided with protective curbing so that chemicals from equipment failure, spillage or accidental drainage will not enter the water in conduits, treatment or storage basins.
- d. Be readily accessible for servicing, repair and observation of operation.

59.26 Service Water Supply (V.B.9)

- a. In-plant water used for dissolving dry chemicals, diluting liquid chemicals or operating chemical feeders are to be:
 - 1. Only from a safe, approved source.
 - 2. Protected from contamination by appropriate means.
 - 3. Ample in supply and adequate in pressure.
 - 4. Provided with means for measurement when preparing specific solution concentrations by dilution.
 - 5. Properly treated for hardness when necessary.
 - 6. Obtained from a location sufficiently downstream of any chemical feed point to ensure adequate mixing.
- b. The service water is to comply with Paragraph 26.2.

59.27 Tanks

59.271 Solution Tanks (V.B.10)

- a. A means which is consistent with the nature of the chemical solution is to be provided in a solution tank to maintain a uniform strength of solution.
- b. Continuous agitation is to be provided to maintain slurries in suspension.
- b. Two solution tanks of adequate volume may be required for a chemical to ensure continuity of supply in servicing a solution tank.
- c. A means is to be provided to measure the solution level in the tank.
- d. Chemical solutions are to be kept covered. Large tanks with access openings are to have such openings curbed and fitted with overhanging covers.
- e. Subsurface locations for solution tanks are to:
 - 1. Be free from sources of possible contamination.
 - 2. Ensure positive drainage for groundwater, accumulated water, chemical spills and overflows.
- f. Overflow pipes, when provided, are to:
 - 1. Be turned downward, with the end screened.
 - 2. Have a freefall discharge.
 - 3. Be located where noticeable.
- g. Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.
- h. Each tank is to be provided with a valved drain, protected against backflow.
- i. Solution tanks are to be located and protective curbing provided so that chemicals from equipment failure, spillage or accidental drainage are not to enter the water in conduits, treatment or storage basins.

59.272 Day Tanks (V.B.11)

- a. Day tanks are to be provided where bulk storage of liquid chemical is provided.

- b. Day tanks are to meet all of the requirements of Paragraph V.B.10. (Solution Tanks – previous page)
- c. Day tanks should hold no more than a 30-hour supply.
- d. Day tanks are to be scale-mounted, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank attached to a float may be used.
- e. The ratio of the area of the tank to its height must be such that gauge rod unit readings are meaningful in relation to the total amount of chemical fed during a day.
- e. Hand pumps may be provided for transfer from a carboy or drum. A tip rack is to be used to permit withdrawal into a bucket from a spigot. Where motor-driven transfer pumps are provided, a liquid level limit switch and an overflow from the day tank must be provided.
- f. A means which is consistent with the nature of the chemical solution is to be provided to maintain uniform strength of solution in a day tank. Continuous agitation is to be provided to maintain chemical slurries in suspension.
- g. Tanks are to be properly labeled to designate the chemical contained.

59.28 Feed Lines (V.B.12)

- a. Feed lines are to be designed consistent with scale-forming or solids-depositing properties of the water, chemical, solution or mixtures conveyed.
- b. Duplicate feed lines should be considered where blockages are likely.
- c. Feed lines should be as short as possible and:
 - 1. Made of durable, corrosion-resistant material.
 - 2. Easily accessible throughout the entire length.
 - 3. Protected against freezing.
 - 4. Readily cleanable.

- d. Feed lines should slope upward from the chemical source to the feeder when conveying gases.
- e. Feed lines should be color coded (See Paragraph 54.5).

Table 59.1**Chemical Storage and Handling Materials**

Chemical	Acceptable	Nonacceptable
Calcium Hydroxide	Carbon Steel PVC 304 Stainless	Alumina Ceramic
Sodium Hydroxide 50% (Potassium Hydroxide)	Carbon Steel PVC 304 Stainless	Alumina Ceramic Viton
Sodium Carbonate	304 Stainless Hastelloy C Alumina Ceramic PVC	Carbon Steel
Sodium Bicarbonate	304 Stainless Hastelloy C Alumina Ceramic PVC	Carbon Steel
Sodium Silicate	304 Stainless Hastelloy C Alumina Ceramic PVC	Carbon Steel
Phosphoric Acid	Hastelloy C Alumina Ceramic PVC Kynar	Carbon Steel 304 and 316 Stainless Hypalon
Calcium Hypochlorite	Glass Rubber Stoneware Wood	All metals
Sodium Hypochlorite	Ceramics Glass Plastic Rubber	All metals

59.3 Chemicals (V.C)

- a. The handling, storage and use of chemicals requires careful attention. Consideration is to be given to methods of handling shipping containers, especially those containing compressed gases, oxidants and corrosive materials.

- b. Height of ceilings for overhead hoists and floors of sufficient construction for ease in the handling of mechanical equipment should be provided.
- c. Storage and use areas are to be properly ventilated so as to minimize possible accidental reaction of chemicals involved based on their characteristics.

59.31 Quality (V.C.1)

- a. Chemical containers are to be fully labeled to include:
 - 1. Chemical name, purity and concentration.
 - 2. Supplier's name and address.
 - 3. Precautions in handling.
- b. Provisions should be made to assay the chemicals delivered where the quality is in doubt.
- c. Chemicals having a distinguishing color may be used, providing the coloring material is not toxic in concentrations used and will not impart odor or color to the water.

59.32. Storage (V.C.2)

- a. Space should be provided for:
 - 1. A separate storage area for each chemical.
 - 2. At least 30 days of chemical supply.
 - 3. Convenient and efficient handling of chemicals.
 - 4. Dry storage conditions.
- b. Storage tanks and pipelines for liquid chemicals are to be specific to the chemicals and not for alternates.
- c. Offloading areas must be clearly labeled to prevent accidental cross-contamination.
- c. Chemicals are to be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved storage unit.
- d. Liquid chemical storage tanks must:
 - 1. Have a liquid level indicator.

2. Have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows. A common receiving basin may be provided for each group of compatible chemicals that provides sufficient containment volume to prevent accidental discharge in the event of failure of the largest tank.
- e. Solution storage or day tanks supplying feeders directly should have sufficient capacity for 1 day of operation.
- f. Acid storage tanks should be vented to the outside atmosphere but not through vents in common day tanks.
- g. Chemical storage areas are not to have drains that lead directly to the environment nor directly to the treatment process.

59.33 Housing (V.C.3)

In addition to the following general equipment requirements, facilities for housing specific chemicals are to be designed in accordance with the applicable requirements of Paragraphs 59.4 (Operator Safety) and 59.5 (Specific Chemicals)

- a. Structures, rooms and areas accommodating chemical feed equipment are to provide convenient access for:
 1. Servicing and repair.
 2. Observation of operation.
- b. Floor surfaces are to be smooth and impervious, slip-proof and well drained.
- c. Open basins, tanks and conduits are to be protected from chemical spills or accidental drainage.

59.34 Handling (V.C.4)

- a. Carts, elevators and other appropriate means are to be provided for lifting chemical containers to minimize excessive lifting by operators.
- b. Provisions are to be made for disposing of empty bags, drums or barrels by an approved procedure which will minimize exposure to dusts.
- c. Provisions must be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers, in such ways as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of:
 1. Vacuum pneumatic equipment or closed conveyor systems.

2. Facilities for emptying shipping containers in special enclosures.
3. Exhaust fans and dust filters which put the hoppers or bins under negative pressure.
- d. Provisions are to be made for measuring quantities of chemicals used to prepare feed solutions.

59.4 Operator Safety (V.D)

In addition to the following requirements, the WEF Manual MOP 1 - *Safety Health and Security in Wastewater Systems*, should be used as a guide for operator safety.

59.41 Ventilation (V.D.1)

Special provisions are to be made for ventilation of chemical feed and storage rooms. Exhaust systems must:

- a. Not exhaust into fresh air intakes.
- b. Not exhaust contaminants into areas where they may represent a hazard to employees.
- c. Not draw contaminants through employee work areas.
- d. Be in operation continually when needed.

59.42 Respiratory Protection Equipment (V.D.2)

- a. Respiratory protection equipment, meeting the requirements of NIOSH and MSHA are to be available where gases are handled, and are to be stored at a convenient location, but not inside any room where the gas is used or stored.
- b. The units are to use compressed air, have at least 30-minute capacity, and be compatible with or exactly the same as units used by the fire department responsible for the plant.

59.43 Protective Equipment (V.D.3)

- a. At least 1 pair of rubber gloves, a dust respirator of a type certified by NIOSH or MSHA for toxic dusts, an apron or other protective clothing, and goggles or face mask are to be provided for each operator.
- b. A deluge shower and/or eye washing device should be installed where strong acids or alkalis are used or stored.

- b. A water holding tank that will allow water to come to room temperature must be installed in the water line feeding the deluge shower and eye washing device. Other methods of water tempering will be considered on an individual basis.
- c. Other protective equipment should be provided as necessary.

59.44 Chlorine Leak Detection (V.D.4)

- a. A bottle of ammonium hydroxide, 56 percent ammonia solution, is to be available for chlorine leak detection.
- b. Where 150 lb. cylinders, ton containers, tank cars and stationary storage tanks are used, a leak repair kit as approved by the Chlorine Institute, Inc. are to be provided.
- c. Continuous chlorine leak detection equipment is recommended.
- d. Where a leak detector is provided, it is to be equipped with both an audible alarm and a warning light.
- e. Masks and equipment should be tested at least annually.

59.45 Hazard Communication

All employers with hazardous chemicals in their workplaces must have labels and safety data sheets for their exposed workers, and train them to handle the chemicals appropriate, as required by OSHA's Hazard Communication Standard (29 CFR 1910.1200(g)).

59.5 Specific Chemicals (V.E)

59.51 Acids and Caustics (V.E.1)

- a. Acids are to be kept in closed corrosion-resistant shipping containers or storage units.
- b. Acids and caustics are not to be handled in open vessels, but should be pumped in undiluted form from original containers through a suitable hose to the point of treatment or to a covered day tank.
- c. Systems designed to add strong acids or caustics are to include a flow sensor or other secondary mechanism to provide redundant controls that will ensure the acid or caustic will not be pumped into the system when there is inadequate water flow to provide dilution.

59.52 Activated Carbon (V.E.2)

- a. Activated carbon is a potentially combustible material requiring isolated storage.
- b. Storage facilities should be fire proof and equipped with explosion-proof electrical outlets, lights and motors in areas of dry handling.
- c. Bags of powdered carbon should be stacked in rows with aisles between in such a manner that each bag is accessible for removal in case of fire.

59.53 Chlorine (Also see Section 102) (V.E.3)

While neither explosive nor flammable in its elemental form, chlorine is capable of supporting combustion of other substances. Therefore, chlorine must be stored away from other compressed gases, organic matter or other flammable material.

a. Calcium Hypochlorite

The storage of calcium hypochlorite is a major safety consideration. It should never be stored where it is subject to heating or allowed to contact any organic material of an easily oxidized nature. The decomposition of calcium hypochlorite is exothermic, and will proceed rapidly if any part of the material is heated to 350°F.

b. Liquid Chlorine

Liquid chlorine is a skin irritant and can cause severe injury resembling burns to body tissue. Since the liquid form vaporizes to gas rapidly at atmospheric temperature and pressure, the procedures for using liquid chlorine are to be the same as for gas chlorine.

c. Gas Chlorine

1. Chlorine gas feed and storage is to be enclosed and separated from other operating areas. The chlorine room is to be:
 - i. Provided with a clear, gas-tight, shatter-resistant inspection window installed in an interior wall to permit the chlorination system to be viewed without entering the room.
 - ii. Constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed.
 - iii. Provided with doors equipped with panic hardware, ensuring ready means of exit. Doors opening outward to the building exterior are recommended.
2. Full and empty cylinders of chlorine gas should be:

- i. Isolated from operating areas.
 - ii. Restrained in position to prevent upset.
 - iii. Stored in rooms separate from ammonia storage.
 - iv. Stored in areas not in direct sunlight or exposed to excessive heat.
3. Where chlorine gas is used, the room is to be constructed to provide the following:
- i. Each room is to have a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied; where this is not appropriate due to the size of the room, a lesser rate may be considered.
 - ii. The ventilating fan is to take suction near the floor as far as practical from the door and air inlet, with the point of discharge so located as not to contaminate air inlets to any rooms, buildings or other areas where people may gather.
 - iii. Air inlets should be through louvers near the ceiling.
 - iv. Louvers for air intake and exhaust are to facilitate airtight closure.
 - v. Separate switches for the fan and lights are to be located at each entrance to the chlorine room and at the inspection window.
 - vi. Outside switches are to be protected from vandalism.
 - vii. A signal light indicating fan operation is to be provided at each entrance when the fan can be controlled from more than one point.
 - viii. Vents from feeders and storage are to discharge to the outside atmosphere, above grade.
 - ix. The room location should be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.
 - x. Floor drains are discouraged. Where provided, the floor drains are to discharge to the outside of the building and are not to be connected to other internal or external drainage

systems.

4. Chlorinator rooms should be heated to 60°F and be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment.
5. Pressurized feed lines are not to carry chlorine gas beyond the chlorinator room.

59.54. Sodium Chlorite (V.E.4)

Sodium chlorite is a strong oxidizing agent which can be ignited by friction, heat, shock or contamination with organic matter. Provisions are to be made for proper storage and handling the sodium chlorite to eliminate any danger of explosion.

59.55. Sodium Hypochlorite (V.E.5)

- a. Sodium hypochlorite storage and handling procedures should be arranged to minimize the slow natural decomposition process either by contamination or by exposure to more extreme storage conditions.
- b. Feed rates should be regularly adjusted to compensate for progressive loss in chlorine content.
- c. Storage
 1. Sodium hypochlorite is to be stored in the original shipping containers or in sodium hypochlorite compatible containers.
 2. Storage containers or tanks are to be sited out of the sunlight in a cool area and are to be vented to the outside of the building.
 3. Wherever reasonably feasible, stored hypochlorite is to be pumped undiluted to the point of addition. Where dilution is unavoidable, deionized or softened water should be used.
 4. Storage areas, tanks and pipe work are to be designed to avoid the possibility of uncontrolled discharges and a sufficient amount of appropriately selected spill absorbent is to be stored on-site.
 5. Reusable hypochlorite storage containers are to be reserved for use with hypochlorite only and are not to be rinsed out or otherwise exposed to internal contamination.
- d. Feeders
 1. Positive displacement pumps with hypochlorite compatible

materials for wetted surfaces are to be used.

2. To avoid air-locking in smaller installations, small diameter suction lines are to be used with foot valves and degassing pump heads.
3. Flooded suction is to be used, with pipe work arranged to ease escape of gas bubbles.
4. Calibration tubes or mass flow monitors which allow for direct physical checking of actual feed rates are to be provided.
5. Injectors are to be made removable for regular cleaning where hard water is to be treated.

**CHAPTER 60
PRELIMINARY TREATMENT**

61. SCREENING DEVICES (formerly 51)

In order to protect the plant from reduced efficiency and/or physical damage, all plants are to be equipped with one or more of the screening devices such as manually cleaned bar screen, mechanically cleaned bar screen, comminutor or coarse bar racks. Selection of a particular device will be governed by its intended purpose and the circumstances as detailed in this chapter. Provisions for odor control should be investigated and provided whenever a potential problem may develop.

61.1 Coarse Screens (formerly 51.1)**61.11 Specific Provisions (formerly 51.11)**

- a. A manually cleaned bar screen is to be required as the sole screening device or as an emergency bypass to the mechanically cleaned bar screen or comminutor.
- b. Screening devices and screening storage areas are to be protected from freezing.

61.12 Design and Installation (formerly 51.13)**61.121 Bar Spacing (formerly 51.131)**

- a. Clear openings between bars for manually cleaned screens should be no less than 1 inch. Clear openings for mechanically cleaned screens may be smaller.
- b. Maximum clear opening should be no greater than 1¾ inches.

61.122 Slope (formerly 51.132)

- a. Manually cleaned screens should be placed on a slope of 30 to 45 degrees to the horizontal.
- b. Mechanically cleaned screens should be placed on a slope of 45 to 90 degrees from the horizontal.

61.123 Velocities (formerly 51.133)

- a. At maximum monthly average flow, approach velocities should be no less than 1.25 feet per second to prevent settling.
- b. At peak instantaneous flow conditions, approach velocities should be no greater than 3.0 feet per second to prevent forcing material through the openings.

61.124 Channels (formerly 51.134)

- a. Dual channels **are to** be provided and equipped with the necessary gates to isolate flow from any screening unit.
- b. Provisions **are to** also be made to facilitate dewatering each unit.
- c. The channel preceding and following the screen **is to** be shaped to eliminate stranding and settling of solids.

61.125 Invert (formerly 51.135)

The screen channel invert should be 3 to 6 inches below the invert of the incoming sewer.

61.126 Flow Distribution (formerly 51.136)

Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

61.127 Backwater Effect on Flow Metering

- a. Flow measurement devices should be selected for reliability and accuracy.
- b. The effect of changes in backwater elevation due to intermittent cleaning of screens should be considered in locations of flow measurement equipment.

61.128 Auxiliary Screens (formerly 51.17)

Where a single mechanically cleaned screen is used, an auxiliary manually cleaned screen **is to** be provided. Where two or more mechanically cleaned screens are used, the design **is to** provide for taking any unit out of service without sacrificing the capability to handle the peak instantaneous flow.

61.129 Screenings Removal and Disposal (formerly 51.137)

- a. A convenient and adequate means for removing screenings **is to** be provided. Hoisting or lifting equipment may be necessary depending on the depth of pit and amount of screenings or equipment to be lifted.
- b. Facilities must be provided for handling, storage **and disposal** of screenings **in a manner acceptable to DEP**. Separate grinding of screenings and return to the wastewater flow is unacceptable.
- c. Manually cleaned screening facilities should include an accessible

platform from which the operator may rake screenings easily and safely.

- d. If screenings are not removed for disposal upon collection, facilities are to be provided with a receptacle for screenings at the point where they are collected.
- e. Suitable drainage facilities **are to** be provided both for the platform and for storage areas.

61.13 Access and Ventilation (formerly 51.14)

- a. Screens located in pits more than 4 feet deep **are to** be provided with stairway access. Access ladders are acceptable for pits less than 4 feet deep, in lieu of stairways.
- b. Screening devices installed in a building where other equipment or offices are located **are to** be isolated from the rest of the building, be provided with separate outside entrances and be provided with separate and independent fresh air supply.
- c. Fresh air **is to** be forced into enclosed screening device areas or in open pits more than 4 feet deep.
- d. Dampers should not be used on exhaust or fresh air ducts, and fine screens or other obstructions should be avoided to prevent clogging.
- e. Where continuous ventilation is required, at least 12 complete air changes per hour **are to** be provided.
- f. Where continuous ventilation would cause excessive heat loss, intermittent ventilation of at least 30 complete air changes per hour **are to** be provided when **personnel** enter the area. **The air change requirements are to be based on 100 percent fresh air.**
- g. Switches for operation of ventilation equipment should be marked and located conveniently.
- h. All intermittently operated ventilation equipment **is to** be interconnected with the respective pit lighting system.
- i. The fan wheel should be fabricated from nonsparking material.
- j. **Explosion proof gas detectors are to be provided in accordance with Section 57.**

61.14 Safety and Shields (formerly 51.15)

61.141 Railings and Gratings (formerly 51.151)

- a. Channels for manually cleaned screens **are to** be protected by guard railings and deck gratings, with adequate provisions for removal or opening to facilitate raking.
- b. Channels for mechanically cleaned screens **are to** be protected by guard railings and deck gratings, with adequate provisions for access to facilitate maintenance and repair.

61.142 Mechanical Devices (formerly 51.152)

- a. Mechanically cleaned screens **are to** have adequate removable enclosures to protect personnel against accidental contact with moving parts and to prevent dripping in multi-level installations.
- b. A positive means of locking out each mechanical device **and temporary access for use during maintenance is to** be provided.

61.143 Drainage

Floor design and drainage **are to be provided to prevent slippery areas.**

61.144 Lighting

Suitable lighting **is to be provided in all work and access areas. Refer to Paragraph 61.152.**

61.15 Electrical Equipment and Control Systems (formerly 51.16)

61.151 Timing Devices (formerly 51.161)

All mechanical units which are operated by timing devices **are to** be provided with auxiliary controls which will set the cleaning mechanism in operation at a pre-set high water elevation. If the cleaning mechanism fails to lower the high water, a warning should be signaled.

61.152 Electrical Equipment, Fixtures and Controls (formerly 51.162)

Electrical **equipment**, fixtures and controls in screening areas where hazardous gases may accumulate **are to** meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

61.153 Manual Override (formerly 51.163)

Automatic controls **are to** be supplemented by a manual override.

61.2 Fine Screens (formerly 51.2)

61.21 General (formerly 51.21)

1. Fine screens as discussed here have openings of approximately 1/16 inch. The amount of material removed by fine screens is dependent on the wastestream being treated and screen opening size.
2. Fine screens should not be considered equivalent to primary sedimentation but may be used in lieu of primary sedimentation where subsequent treatment units are designed on the basis of anticipated screen performance.
3. Selection of screen capacity should consider flow restriction due to retained solids, gummy materials, frequency of cleaning and extent of cleaning.
4. Where fine screens are used, additional provision for removal of floatable oils and greases is to be considered.

61.22 Design (formerly 51.22)

- a. Tests should be conducted to determine BOD₅ and suspended solids removal efficiencies at the peak hydraulic and peak organic loadings. Pilot testing for an extended time is preferred.
- b. A minimum of two fine screens are to be provided, with each unit being capable of independent operation.
- c. Capacity is to be provided to treat peak design instantaneous flows with one unit out of service.
- d. Fine screens are to be:
 1. preceded by a coarse bar screening device,
 2. protected from freezing, and
 3. located to facilitate maintenance.
- e. Comminuting devices are not to be used ahead of fine screens.

61.23 Electrical Equipment, Fixtures and Controls (formerly 51.23)

Electrical equipment, fixtures and controls and screening areas where hazardous gases may accumulate are to meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

61.24 Servicing (formerly 51.24)

- a. Hosing equipment is to be provided to facilitate cleaning.

- b. Provisions are to be made for isolating or removing units from location for servicing.

62. COMMINUTORS (formerly 52)

62.1 Specific Provisions

- a. Comminutors and/or mechanically cleaned bar screens are to be used in plants that do not have primary sedimentation.
- b. Comminutors may be used in lieu of screening devices to protect equipment where stringy substance accumulation on downstream equipment will not be a substantial problem.
- c. Consideration should be given to providing protection for comminutors by coarse bar racks, especially when the flow is received from a combined sewer system.
- d. Provisions for access, ventilation, shields, and safety are to be in accordance with Paragraphs 61.13, 61.14, and 61.15.

62.2 Location

- a. The same requirements apply as for bar screens. Refer to Section 61 of this chapter.
- b. If all the flow to the plant is received from grinder pumps, a comminutor is not needed.

62.3 Design Considerations (formerly 52.3)

62.31 Location (formerly 52.31)

- a. Comminutors should be located downstream of any grit removal equipment and be protected by a coarse screening device.
- b. Comminutors not preceded by grit removal equipment are to be protected by a 6-inch deep gravel trap.

62.32 Size (formerly 52.32)

Comminutor capacity is to be adequate to handle peak instantaneous flow.

62.33 Installation (formerly 52.33)

- a. A bypass channel with a screening device is to be provided. The use of the bypass channel should be automatic at depths of flow exceeding the design capacity of the comminutor or in case of comminutor failure.
- b. Gates are to be provided in accordance with Paragraphs 61.124 and

61.128.

62.34 Servicing (formerly 52.34)

Provisions **are to** be made to facilitate servicing units in place and removing units from location for servicing.

62.35 Electrical Controls and Motors (formerly 52.35)

Electrical equipment in comminutor chambers where hazardous gases may accumulate **is to** meet the requirements of the National Electric Code for Class I, Division 1, Group D locations. Motors in areas not governed by this requirement **are to** be protected against accidental submergence.

62.36 Railings and Gratings (formerly 52.36)

Comminutors and bypass channels **are to** be protected by guard railings and deck gratings with adequate provisions for access to facilitate maintenance and repairs.

63. GRIT REMOVAL FACILITIES (formerly 53)

63.1 Specific Provisions (formerly 53.1)

- a. Grit removal facilities should be provided for all wastewater treatment plants and are **required necessary** for plants receiving wastewater from combined sewers or from sewer systems receiving substantial amounts of grit.
- b. If a plant serving a separate sewer system is designed without grit facilities, **the design is to include provision for future installation.**
- c. Consideration **is to** be given to possible damaging effects on pumps, comminutors, other preceding equipment and the need for additional storage capacity in treatment units where grit is likely to accumulate.

63.2 Location (formerly 53.2)

63.21 General (formerly 53.21)

- a. Grit removal facilities should be located ahead of pumps and comminuting devices.
- b. Coarse bar racks should be placed ahead of grit removal facilities.

63.22 Housed Facilities (formerly 53.22)

63.221 Ventilation (formerly 53.221)

Refer to Paragraph 61.13. Fresh air **is to** be introduced continuously at a rate of 12 air changes per hour, or intermittently at a rate of 30 air changes

per hour. Odor control devices may also be warranted.

63.222 Access (formerly 53.222)

Adequate stairway access to above or below grade facilities **is to be** provided.

63.223 Electrical (formerly 53.223)

- a. All electrical fixtures and controls in enclosed grit removal area where hazardous gases may accumulate **are to meet** the requirements of the National Electric Code for Class I, Division 1, Group D locations.
- b. **Explosion proof gas detectors are to be provided in accordance with Section 57.**

63.224 Lighting (formerly 53.224)

Adequate lighting with explosion protection **is to be** provided to operate and maintain equipment.

63.23 Outside Facilities (formerly 53.23)

Grit removal facilities located outside **are to be** protected from freezing.

63.3 Type and Number of Units (formerly 53.3)

- a. Plants treating wastes from combined sewers should have at least two mechanically cleaned grit removal units with provisions for bypassing.
- b. A single manually cleaned or mechanically cleaned grit chamber with bypass is acceptable for wastewater treatment plants **with a design maximum monthly average flow of less than 50,000** serving separate sanitary sewer systems.
- c. Facilities for larger plants serving separate sanitary sewers should have at least one mechanically cleaned unit with a bypass.
- d. **Facilities other than channel-type are to be provided with adequate and flexible controls for velocity and/or air supply devices and with grit collection and removal equipment.**
- e. **Aerated grit chambers should have air rates adjustable in the range of 3 to 8 cubic feet per minute per foot of tank length.**
- f. **Detention time in the tank should be in the range of 3 to 5 minutes at design peak hourly flows.**
- g. **Vortex-type grit chambers may also be considered.**

63.4 Design Considerations (formerly 53.4)

63.41 General (formerly 53.41)

The design effectiveness of a grit removal system **is to** be commensurate with the requirements of the subsequent process units.

63.42 Inlet (formerly 53.42)

Inlet turbulence **is to** be minimized in channel-type units.

63.43 Velocity and Detention (formerly 53.43)

- a. Channel-type chambers **are to** be designed to control velocities during normal variations in flow as close as possible to 1 foot per second.
- b. The detention period **is to** be based on the size of particle to be removed.
- c. All **aerated** grit removal facilities should be provided with adequate automatic control devices to regulate detention time, agitation or air supply.

63.44 Grit Washing (formerly 53.44)

The need for grit washing should be determined by the method of **grit handling and** final grit disposal.

63.45 Dewatering (formerly 53.45)

- a. Provisions **are to** be made for isolating and dewatering each unit.
- b. **The design is to provide for complete draining and cleaning by means of a sloped bottom equipped with a drain sump.**

63.46 Water (formerly 53.46)

An adequate supply of water under pressure **is to** be provided for cleanup.

63.47 Grit Handling (formerly 53.47)

- a. Grit removal facilities located in deep pits should be provided with mechanical equipment for hoisting or transporting grit to ground level.
- b. Impervious nonslip working surfaces with adequate drainage **is to** be provided for grit handling areas.
- c. Grit transporting facilities **are to** be provided with protection against freezing and loss of material.

63.48 Aeration (formerly 53.48)

An aerated grit removal facility should be considered. This facility must have a metered and adjustable air supply.

64. PRE-AERATION (formerly 54)

Pre-aeration of wastewater to reduce septicity may be required in special cases, and should be located downstream of grit removal facilities.

64.1 Location

Pre-aeration facilities should be located downstream of grit removal facilities.

64.2 Forced or Induced Draft Aeration

Devices are to be designed to:

- a. Include a blower with a weatherproof motor in a tight housing and screened enclosure.
- b. Ensure adequate counter current of air through the enclosed aerator column.
- c. Exhaust air directly to the outside atmosphere.
- d. Include a downturned and 24-mesh screened air outlet and inlet.
- e. Be such that sections of the aerator can be easily reached or removed for maintenance of the interior.
- f. Provide loading at a rate of 1 to 5 gpm for each square foot of total tray area.
- g. Ensure that the water outlet is adequately sealed to prevent unwarranted loss of air.
- h. Discharge through a series of five or more trays with separation of trays not less than 6 inches or as approved by DEP.
- i. Provide distribution of water uniformly over the top tray.
- j. Be of durable material resistant to the aggressiveness of water and dissolved gases.

64.3 Pressure Aeration

Pressure aeration devices are to be designed to:

- a. Give thorough mixing of compressed air with water being treated.

- b. Provide screened and filtered air, free of obnoxious fumes, dust, dirt and other contaminants.

64.4 Other Methods of Aeration

Other methods of aeration may be used if applicable to the treatment needs. Such methods include, but are not restricted to, spraying, diffused air, cascades and mechanical aeration. The treatment process must be designed to meet the particular needs of the water to be treated and are subject to the approval of DEP.

64.5 Ventilation

Ventilation is to be provided to prevent the accumulation of released gases in the building that houses the treatment facilities.

64.6 Bypass

A bypass should be provided for all pre-aeration units.

65. COAGULATION

Coagulation is to be taken to mean a process using coagulant chemicals and mixing by which colloidal and suspended material are destabilized and agglomerated into settleable or filterable flocs, or both.

65.1 Flash Mixing

- a. The detention period should not be more than 30 seconds with mixing equipment capable of imparting a minimum velocity gradient (G) of at least 750 fps/ft.
- b. The design engineer should determine the appropriate G value and detention time through experimentation.
- c. Static mixers may be used where the flow is relatively constant and will be high enough to maintain the necessary turbulence for complete chemical reactions.

65.2 Location

The rapid mix and flocculation basin are to be as close together as possible.

66. FLOCCULATION

Flocculation is a process to enhance agglomeration or collection of smaller floc particles into larger, more easily settleable or filterable particles through gentle stirring by hydraulic or mechanical means.

66.1 Basin Design

- a. Inlet and outlet designs are to minimize short-circuiting and destruction of floc.
- b. Series compartments are recommended to further minimize short-circuiting and to provide decreasing mixing energy with time.
- c. Basins should be designed so that individual basins may be isolated without disrupting plant operation.
- d. A drain and/or pumps are to be provided to facilitate dewatering and sludge removal.
- e. Coagulation and flocculation units should be designed so that their removal from service will not interfere with normal operation of the remainder of the plant.

66.2 Detention

- a. For particulate removal, the flocculation period should be 20 to 30 minutes at maximum monthly average flow with consideration to using tapered (i.e., diminishing velocity gradient) flocculation.
- b. If flocculation is being used ahead of primary settling tanks for the purpose of obtaining increased reduction in BOD, the detention period should be at least 45 minutes at maximum monthly average flow.
- c. The design of flocculation units are to be based upon the value of GT (mean velocity gradient in seconds times the detention time in seconds) which is ordinarily in the range of 30,000 to 150,000.
- d. The engineer should establish the value of GT through experimentation.

66.3 Equipment

- a. Agitators should be driven by variable speed drives with the peripheral speed of paddles ranging from 0.5 to 3.0 feet per second.
- b. External, non-submerged drive equipment is preferred.

66.4 Piping

- a. In order to prevent destruction of the floc, flocculation and sedimentation basins are to be as close together as possible.
- b. The velocity of flocculated water through pipes or conduits to settling basins are not to be less than 0.5 nor greater than 1.5 feet per second.
- c. Allowances must be made to minimize turbulence at bends and changes in direction.

66.5 Other Designs

- a. Baffling may be used to provide for flocculation in small plants only after consultation with DEP.
- b. The design should be such that the necessary GT values will be maintained over the expected variations in flow.

67. FLOW EQUALIZATION (formerly 55)

67.1 General (formerly 55.1)

- a. Use of flow equalization to reduce the variations in hydraulic and organic loadings **is to** be considered at all wastewater treatment plants.
- b. When a significant portion of the plant's flow will be from high peak flow sources (such as restaurants, schools, nursing homes and commercial laundry), flow equalization facilities **are to** be provided.

67.2 Location (formerly 55.2)

Equalization basins should be located downstream of pretreatment facilities such as bar screens, comminutors and grit chambers.

67.3 Type (formerly 55.3)

- a. Flow equalization can be provided by using separate equalization basins or on-line treatment units such as aeration tanks.
- b. Equalization basins may be designed as either in-line or side-line units.
- c. Unused treatment units, such as sedimentation or aeration tanks, may be utilized as on-line equalization basins during the early period of design life.

67.4 Size (formerly 55.4)

- a. Equalization basin capacity should be sufficient to effectively reduce expected flow and load variations.
- b. The determination of equalization volume should be based on the wastewater flow hydrograph during wet weather conditions.
- c. The design should consider the flow requirements for specific unit operations or equipment.

67.5 Design (formerly 55.5)

65.51 Mixing (formerly 55.51)

- a. Aeration or mechanical equipment **is to** be provided to maintain adequate

mixing.

- b. Corner fillets and hopper bottoms with draw-offs **are to** be provided to alleviate the accumulation of sludge and grit.

67.52 Aeration (formerly 55.52)

- a. Aeration equipment **is to** be sufficient to maintain a minimum of 1 mg/L of dissolved oxygen in the mixed equalization basin contents at all times.
- b. Air supply rates based on standard air (standard air is defined as air at a temperature of 68°F, a pressure of 14.7 psia, and a relative humidity of 36 percent) should be a minimum of 1.25 cfm/1,000 gallons of storage capacity.
- c. The air supply should be isolated from other treatment plant aeration requirements to facilitate process aeration control.
- d. Standard process aeration equipment may be utilized as a source of standby aeration.

67.53 Controls (formerly 55.53)

- a. Inlets and outlets for all equalization basin compartments **are to** be equipped with accessible external valves, stop plates, weirs or other devices to permit flow control and the removal of an individual unit from service.
- b. Facilities **are to** be provided to measure and indicate liquid levels and flow rates.

67.6 Electrical (formerly 55.6)

All electrical work in housed equalization basins, **where hazardous concentrations of flammable gases or vapors may accumulate**, **is to** meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.

67.7 Access (formerly 55.7)

Suitable access **is to** be provided to facilitate cleaning and the maintenance of equipment.

CHAPTER 70
SETTLING

71. GENERAL (formerly 61)

71.1 Number of Units (formerly 61.1)

- a. Multiple settling units capable of independent operation are desirable and are to be provided in all plants where maximum monthly average flow exceeds 100,000 gpd.
- b. Plants not having multiple units are to include other provisions to assure continuity of treatment.

71.2 Arrangement (formerly 61.2)

Settling tanks are to be arranged such that the criteria in Paragraphs 53.6 and 72.7 can be met.

71.3 Flow Distribution (formerly 61.3)

Effective flow splitting devices and control appurtenances (i.e., gates, splitter boxes, etc.) are to be provided to permit proper proportioning of flow and solids loading to each settling unit, throughout the expected range of flows. Refer to Paragraph 53.7.

71.4 Tank Configuration (formerly 61.4)

Consideration should be given to the probable flow pattern, the selection of tank size and shape, and inlet and outlet type and location.

72. DESIGN CONSIDERATIONS (formerly 62)

72.1 Dimensions (formerly 62.1)

The minimum length of flow from inlet to outlet should be 10 feet unless special provisions such as baffles are made to prevent short-circuiting.

The vertical side water depths are to be designed to provide an adequate separation zone between the sludge blanket and the overflow weirs. The minimum side water depths are to be as follows:

Type of Settling Tank	Minimum Side Water Depth, ft
Primary	10
Secondary tank following activated sludge process*	12

Type of Settling Tank	Minimum Side Water Depth, ft
Secondary tank following attached growth biological reactor*	10

* Greater side water depths are recommended for secondary clarifiers in excess of 4,000 square feet surface area [equivalent to 70 feet diameter]. Side water depths less than 12 feet may be permitted for package plants with a design average flow less than 25,000 gallons per day, if justified based on successful operating experience.

72.2 Surface Overflow Rates (formerly 62.2)

72.21 Primary Settling Tanks (formerly 62.21)

Primary settling tank sizing should reflect the degree of solids removal needed and the need to avoid septic conditions during low flow periods. Sizing is to be calculated for both the maximum monthly average and design peak hourly flow conditions, and the larger surface area determined is to be used. The following surface overflow rates should not be exceeded in the design:

Type of Primary Settling Tank	Surface Overflow Rates at: ¹	
	Max Month Average Flow gpd/ft ²	Design Peak Hourly Flow gpd/ft ²
Tanks not receiving waste activated sludge ²	1,000	2,000
Tanks receiving waste activated sludge	1,000	1,200

¹ Surface overflow rates are to be calculated with all flows received at the settling tanks. Primary settling of normal domestic wastewater can be expected to remove approximately one-third of the influent BOD when operating at an overflow rate of 1,000 gallons per day/square foot.

² Anticipated BOD and TSS removal should be determined by laboratory tests and should consider the characteristics of the wastes. Significant reduction in BOD/and TSS removal efficiency will result when the peak hourly overflow rate exceeds 1,500 gallons per day/square foot.

72.22 Intermediate Settling Tanks (formerly 62.22)

Surface overflow rates for intermediate settling tanks following units of fixed film reactor processes are not to exceed 1,200 gpd per square foot based on peak hourly flow. Higher surface settling rates to 1,500 gallons per day per square foot based on the design peak hourly flow may be permitted if such rates are shown to

have no adverse effects on subsequent treatment units.

72.23 Final Settling Tanks (formerly 62.23)

Settling tests should be conducted wherever a pilot study of biological treatment is warranted by unusual waste characteristics or treatment requirements. Testing is to be done where proposed loadings go beyond the limits set forth in this section.

72.231 Attached Growth Biological Reactors

Surface overflow rates for settling tanks following trickling filters or rotating biological contactors are not to exceed 1,200 gpd per square foot based on design peak hourly flow.

72.232 Activated Sludge

To perform properly while producing a concentrated return flow, activated sludge settling tanks must be designed to meet thickening as well as solids separation requirements. Since the rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks is quite high in activated sludge processes, surface overflow rate and weir overflow rate should be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence and occasional poor sludge settleability. Settling tanks in activated sludge systems must be designed not only for surface overflow rates, but also for solids loading rates. The following parameters should be utilized in the design of intermediate and/or final settling tanks for various activated sludge processes. In applying surface overflow and solids loading values from this table, sizing is to be calculated for both surface overflow and solids loading using peak and average conditions, and the larger surface area determined is to be used.¹ Consideration should be given to flow equalization.

Type of Process	Surface Overflow Rate (gpd/sq. ft.) ¹		Solids Loadings ³	
	Average	Peak ²	Average	Peak ⁴
Conventional Activated Sludge Step Aeration Complete Mix Contact Stabilization	800	1,200 ⁵	40	50
Extended Aeration, Single Stage Nitrification	500	1,000	30	50
Nitrification Stage of Separate Stage Nitrification	500	800	30	50
Carbonaceous Stage of Separate Stage Nitrification	900	1,200	45	50

Activated Sludge with Chemical Addition for Phosphorus Removal ⁶	500	900		50
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- ¹ The area upstream of the inlet baffle should not be used in calculating the surface overflow rate and, furthermore, only maximum monthly average flow (i.e., excluding the return flow) should be used.
- ² Design peak hourly flow.
- ³ Based on mixed liquor flow - (i.e., wastewater and return sludge flow).
- ⁴ The clarifier peak solids loading rate is to be calculated based on the design peak hourly flow rate plus the design maximum return sludge rate requirement and the design MLSS under aeration.
- ⁵ Plants needing to meet 20 mg/L suspended solids should reduce the surface overflow rate to 1,000 gallons per day per square foot.
- ⁶ When phosphorus removal to a concentration of less than 1.0 mg/L is required.

72.3 Inlet Structures (formerly 62.3)

- a. Inlets and baffling should be designed to dissipate the inlet velocity, to distribute the flow equally both horizontally and vertically and to prevent short-circuiting.
- b. Provision of flocculation zones is to be considered for secondary settling tanks.
- c. Channels should be designed to maintain a velocity of at least 1 foot per second at one-half the maximum monthly average flow.
- d. Corner pockets and dead ends are to be eliminated and corner fillets or channeling used where necessary.
- e. Provisions are to be made for elimination or removal of floating materials that may accumulate in inlet structures.

72.4 Weirs (formerly 63)

72.41 General (formerly 63.1)

Overflow weirs are to be readily adjustable over the life of the structure to correct for differential settlement of the tank.

72.42 Location (formerly 63.2)

- a. Overflow weirs are to be located to optimize actual hydraulic detention time and minimize short-circuiting.
- b. Peripheral weirs are to be placed at least 1 foot from the wall.

72.43 Design Rates (formerly 63.3)

- a. Weir loadings are not to exceed:

Average Plant Capacity	Loading Rate at Maximum Monthly Average Flow* gpd/lin ft	Loading Rate at Design Peak Hourly Flow gpd/lin ft
≤ 1 MGD	10,000	20,000
> 1 MGD	15,000	30,000

*Excluding recycle flows

- b. Weir lengths should be calculated for both the maximum monthly average flow and design peak hourly flow, and the longer length should be used.
- c. If pumping is required, the pumps are to be operated as continuously as possible. Also, weir loadings should be related to pump delivery rates to avoid short circuiting.

72.44 Weir Troughs (formerly 63.4)

Weir troughs are to be designed to prevent submergence at peak instantaneous flow and to maintain a velocity of at least 1 foot per second at one-half the maximum monthly average flow.

72.5 Submerged Surfaces (formerly 63.5)

- a. The tops of troughs, beams and similar submerged construction elements are to have a minimum slope of one horizontal to 1.4 vertical (1:1.4).
- b. The underside of such elements should have a slope of one horizontal to one vertical (1:1) to prevent the accumulation of scum and solids.

72.6 Unit Dewatering (formerly 62.4)

Unit dewatering features are to conform to the provisions outlined in Paragraph 54.3.

72.7 Freeboard (formerly 62.7)

- a. Walls of settling tanks are to extend at least 6 inches above the surrounding ground surface and are to provide not less than 12 inches of freeboard.
- b. Where walls of settling tanks are more than 4 feet above the surrounding ground surface, consideration should be given to providing a walkway for safe access to clean the weirs and weir troughs.
- c. Additional freeboard or the use of wind screens is recommended where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

72.8 Removal from Service (formerly 62.5)

- a. Design **is to** provide for independent removal of each settling tank unit for maintenance and repair so as to minimize deterioration of effluent quality and ensure rapid process recovery upon return to normal operational mode.
- b. The **piping** design should provide for redistribution of the plant flow to the remaining units.

72.9 Anti-flotation Devices (formerly 62.6)

Adequate systems, such as hydrostatic pressure relief valves, tension piles, or foundation slab projections **are to** be incorporated in the design to prevent flotation of dewatered tanks.

73. SLUDGE AND SCUM REMOVAL (formerly 64)

73.1 Scum Removal (formerly 64.1)

- a. **Full surface mechanical** scum collection and removal facilities, including baffling, **are to** be provided for all settling tanks.
- b. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling and disposal **is to** be recognized in design.
- c. Provisions may be made **to remove scum from the wastewater treatment process and direct it to either a scum concentrator or to the sludge treatment process.**
- d. **Other special provisions for scum disposal may be necessary.**

73.2 Sludge Removal (formerly 64.2)

- a. **Mechanical** sludge collection and withdrawal facilities **are to** be designed as to assure rapid removal of the sludge.
- b. Suction withdrawal should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand and is encouraged for those plants designed for carbonaceous oxygen demand reduction, especially **for activated sludge clarifiers over 60 feet in diameter.**
- c. Each settling tank **is to** have its own sludge withdrawal lines to ensure adequate control of sludge wasting rate for each tank.

73.21 Sludge Hopper (formerly 64.3)

- a. The minimum slope of the side walls **is to** be one horizontal to 1.7 vertical (1:1.7).
- b. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal.

- c. Hopper bottoms **are to** have a maximum dimension of 2 feet.
- d. Extra depth sludge hoppers for sludge thickening are not acceptable.

73.22 Cross-Collectors (formerly 64.4)

Cross-collectors serving one or more settling tanks may be useful in place of multiple sludge hoppers.

73.23 Sludge Removal Pipeline (formerly 64.5)

- a. Each **sludge** hopper **is to** have an individually-valved sludge withdrawal line at least 6 inches in diameter.
- b. The static head available for withdrawal of sludge **is to** be 30 inches or greater as necessary to maintain a 3 feet per second velocity in the withdrawal pipe.
- c. Clearance between the end of the withdrawal line and the hopper walls **are to** be sufficient to prevent bridging of the sludge.
- d. Adequate provisions **are to** be made for rodding or backflushing individual pipe runs.
- e. **Provisions are to be made to allow for visual confirmation of return sludge.**
- f. Piping **is also to** be provided to return sludge for further processing.

73.24 Sludge Removal Control (formerly 64.6)

- a. Separate settling tank sludge lines may drain to a common sludge well.
- b. Sludge wells equipped with telescoping valves or other appropriate equipment **are to** be provided for viewing, sampling and controlling the rate of sludge withdrawal.
- c. The use of easily maintained sight glass and sampling valves may be appropriate.
- d. A means of measuring the sludge removal rate **is to** be provided.
- e. Air lift sludge removal will not be approved for removal of primary sludges.
- f. Sludge pump motor control system **are to** include time clocks and valve activators for regulating the duration and sequencing of sludge removal.

73.3 Return Sludge Equipment (formerly 64.7)

73.31 Return Sludge Rate (formerly 64.71)

- a. The minimum permissible return sludge rate of withdrawal from the final settling tank is a function of the concentration of suspended solids in the mixed liquor entering the settling tank, the sludge volume index of these solids, and the length of time these solids are retained in the settling tank. Since undue retention of solids in the final settling tanks may be deleterious to both the aeration and sedimentation phases of the activated sludge process, the rate of sludge return expressed as a percentage of the maximum monthly average flow of wastewater should generally be variable between the limits set forth as follows:

Type of Process	% Max Month Avg Flow	
	Minimum	Maximum
Standard Rate, Step Aeration Complete Mix	15	100
Contact Stabilization	50	150
Extended Aeration Oxidation Ditches Single Stage Nitrification	50	150
Carbonaceous Stage of Separate Stage Nitrification	15	100
Nitrification Stage of Separate Stage Nitrification	50	200

- b. The rate of sludge return is to be varied by means of variable speed motors, drives or timers (at small plants) to pump sludge at the above rates.
- c. All designs are to provide for flexibility in operation and should provide for operation in various process modes, if feasible.

73.32 Return Sludge Pumps (formerly 64.72)

- a. If motor driven return sludge pumps are used, the maximum return sludge capacity is to be obtained with the largest pump out of service.
- b. A positive head should be provided on pump suction.
- c. Pumps should have at least 3-inch suction and discharge openings.
- d. If air lifts or geyser pumps are used for returning sludge from each settling tank hopper, no standby unit will be required, provided that:
 - i. the design of the air lifts is be such that they are amenable to rapid

- and easy cleaning,
- ii. suitable standby equipment for returning sludge is be available, and
- iii. a blower is dedicated to the pumps.
- e. **Air lifts should be at least 3 inches in diameter.**
- f. Provisions **are to** be made to prevent large objects from entering and plugging air lifts and return sludge piping.
- g. For low flow facilities or facilities operating at less than design flow, consideration is to be made regarding the use of a return sludge pump capable of operating at a reduced flow rate.

73.33 Return Sludge Piping (formerly 64.73)

- a. Discharge piping **should be at least 4 inches in diameter and** should be designed to maintain a velocity of not less than 2 feet per second when return sludge facilities are operating at normal return sludge rates.
- b. Suitable devices for observing, sampling and controlling return activated sludge flow from each settling tank hopper **are to** be provided, **as outlined in Paragraph 73.24.**

73.34 Waste Sludge Facilities (formerly 64.74)

- a. Waste sludge control facilities should have a capacity of at least 25 percent of the average rate of wastewater flow and function satisfactorily at rates of ½ percent of average wastewater flow or a minimum of 10 gallons per minute, whichever is larger.
- b. Means for observing, measuring, sampling and controlling waste activated sludge flow **is to** be provided.
- c. Waste sludge may be discharged to the primary settling tank, sludge digestion tank, **sludge thickening or dewatering processes, storage tank,** or any practical combination of these units.

73.4 Measuring Devices (formerly 64.8)

- a. Devices should be installed in all plants for indicating flow rates of raw wastewater or primary effluent, return sludge and air to each tank unit.
- b. Measuring devices in plants designed for wastewater flows of 100,000 gpd or more, as a maximum monthly average, should totalize and record, as well as indicate flows.

- c. Where the design provides for all return sludge to be mixed with the raw wastewater (or primary effluent) at one location, the mixed liquor flow rate to each aeration unit should be measured.

74. PROTECTIVE AND SERVICE FACILITIES (formerly 65)

74.1 Operator Protection (formerly 65.1)

All settling tanks **are to** be equipped to enhance safety for operators. Such features **are to** appropriately include machinery covers, life lines, stairways, walkways, hand rails and slip resistant surfaces.

74.2 Mechanical Maintenance Access (formerly 65.2)

The design **is to** provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanism, baffles, weirs, inlet stilling baffle areas, and effluent channels.

74.3 Electrical **Equipment, Fixtures and Controls** (formerly 65.3)

- a. Electrical **equipment, fixtures and controls** in enclosed settling basins **and scum tanks, where hazardous concentrations of flammable gases or vapors may accumulate, are to** meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.
- b. The fixtures and controls **are to** be located so as to provide convenient and safe access for operation and maintenance. Adequate area lighting **is to** be provided.

CHAPTER 80
SLUDGE PROCESSING, STORAGE AND DISPOSAL

81. GENERAL (formerly 71)

Facilities for sludge processing/storage are to be provided at all wastewater treatment facilities.

Handling equipment is to be capable of processing sludge to a form suitable for ultimate disposal unless provisions acceptable to the regulatory agency are made for processing the sludge at an alternate location.

DEP should be contacted if sludge unit processes not described in this Chapter are being considered or are necessary to meet state, provincial, or federal sludge disposal requirements.

82. PROCESS SELECTION (formerly 71)

The selection of sludge handling unit processes should be based, at a minimum, upon the following considerations:

- a. Local land use;
- b. System energy requirements;
- c. Cost effectiveness of sludge thickening and dewatering;
- d. Equipment complexity and staffing requirements;
- e. Adverse effects of heavy metals and other sludge components upon the unit processes;
- f. Sludge digestion or stabilization requirements, including appropriate pathogen and vector attraction reduction;
- g. Side stream or return flow treatment requirements (e.g., digester or sludge storage facilities supernatant, dewatering unit filtrate, wet oxidation return flows);
- h. Sludge storage requirements;
- i. Methods of ultimate disposal; and
- j. Back-up techniques of sludge handling and disposal.

83. SLUDGE THICKENING (formerly 73)**83.1 General Considerations (formerly 73.1)**

- a. Sludge thickeners to reduce the volume of sludge should be considered.
- b. The design of thickeners (gravity, dissolved air flotation, centrifuge and others)

should consider the following:

1. the type and concentration of sludge,
 2. the sludge stabilization processes,
 3. **storage requirements,**
 4. the method of ultimate sludge disposal,
 5. chemical needs, and
 6. the cost and ease of operation.
- c. **The use of gravity thickening tanks for unstabilized sludges is not recommended because of problems due to septicity unless provisions are made for adequate control of process operational problems and odors at the gravity thickener and any following unit processes.**
- d. Particular attention should be given to the pumping and piping of the concentrated sludge and possible onset of anaerobic conditions.
- e. Sludge should be thickened to at least 5 percent solids by weight prior to transmission to digesters.

83.2 Gravity Thickening (formerly 73.2)

- a. Both solids and hydraulic surface loading must be considered when designing gravity thickeners.
- b. A hydraulic loading of 400 to 800 gpd/sq. ft. is recommended.
- c. A solids loading of 5 to 12 pounds/day/sq. ft. is recommended for thickeners.
- d. Thickener covers to prevent odor problems **are to** be considered when use of lower hydraulic rates than described here is proposed.

83.3 Air Flotation (formerly 73.3)

- a. The use of air flotation is limited primarily to thickening of sludges prior to dewatering. Air flotation thickening is best applied to thickening waste activated sludge, and it is possible to thicken the sludge to 6 percent solids.
- b. A solids loading of 20 pounds/day/sq. ft. without the application of polyelectrolyte and 40 pounds/day/sq. ft. with the application of polyelectrolyte is recommended in the design of air flotation thickening units.
- c. The hydraulic loading should not exceed 0.8 gpm/sq. ft.

83.4 Prototype Studies

Process selection and unit process design parameters should be based on prototype studies. The reviewing authority will require such studies where the sizing of other plant

units is dependent on thickener performance. Refer to Paragraph 53.2 for any new process determination.

84. ANAEROBIC SLUDGE DIGESTION (formerly 74)

84.1 General

84.11 Multiple Units (formerly 74.1)

- a. Multiple tanks or alternate methods of sludge processing are to be provided for continued plant operations.
- b. Facilities for sludge storage and supernatant separation in an additional unit may be required, depending on raw sludge concentration and disposal methods for sludge and supernatant.

84.12 Depth (formerly 74.2)

If process design provides for supernatant withdrawal, the proportion of depth to diameter should allow for the formation of a reasonable depth of supernatant liquor. A minimum side water depth of 20 feet is recommended.

84.13 Maintenance Provisions (formerly 74.3)

To facilitate emptying, cleaning and maintenance, the following features are desirable:

84.131 Slope (formerly 74.31)

- a. The tank bottom is to slope to drain toward the withdrawal pipe.
- b. Where the sludge is to be removed by gravity alone, the tank bottom should have a slope of four horizontal to one vertical (4:1).
- c. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of twelve horizontal to one vertical (12:1) or greater is recommended.

84.132 Access Manholes (formerly 74.32)

- a. At least two 36-inch diameter access manholes should be provided in the top of the tank in addition to the gas dome.
- b. There should be stairways to reach the access manholes.
- c. A separate sidewall manhole that is large enough to permit the use of mechanical equipment to facilitate removal of grit and sand should be provided.

- d. The side wall access manhole should be low enough to facilitate heavy equipment handling and may be buried in the earthen bank insulation.

84.133 Safety (formerly 74.33)

- a. Nonsparking tools, safety lights, rubber-soled shoes, safety harnesses, gas detectors for flammable and toxic gases, gas masks and at least two self-contained breathing units **as described in Paragraph 102.56**, are to be provided for emergency use.
- b. Refer to other safety items as appropriate in Section 57.

84.14 Toxic Materials

If the anaerobic digestion process is proposed, the basis of design is to be supported by wastewater analyses to determine the presence of undesirable materials, such as high concentrations of sulfates or inhibitory concentrations of heavy metals.

84.2 Sludge Inlets, Outlets, Recirculation and High Level Overflow (formerly 74.4)

84.21 Multiple Inlets and Draw-Offs (formerly 74.41)

Multiple sludge inlets and draw-offs and, where used, multiple recirculation suction and discharge points to facilitate flexible operation and effective mixing of the digester contents are to be provided unless adequate mixing facilities are provided within the digester.

84.22 Inlet Configurations (formerly 74.42)

One inlet should discharge above the liquid level and be located at approximately the center of the tank to assist in scum breakup. The second inlet should be opposite to the suction line at approximately the 2/3 diameter point across the digester.

84.23 Inlet Discharge Location (formerly 74.42)

Raw sludge inlet discharge points should be so located as to minimize short circuiting to the digested sludge or supernatant draw-offs.

84.24 Sludge Withdrawal (formerly 74.43)

- a. Sludge withdrawal to disposal should be from the bottom of the tank.
- b. The bottom withdrawal pipe should be interconnected with the necessary valving to the recirculation piping to increase operational flexibility when

mixing the tank contents.

84.25 Emergency Overflow (formerly 74.44)

- a. An unvalved vented overflow **is to** be provided to prevent damage to the digestion tank and cover in case of accidental overflowing.
- b. This emergency overflow **is to** be piped to an appropriate **point and at an appropriate rate** in the treatment process or sidestream treatment facilities to minimize the impact on process units.

84.3 Tank Capacity (formerly 74.5)

84.31 Rational Design (formerly 74.51)

- a. The total digestion tank capacity should be determined by rational calculations based upon such factors as
 1. volume of sludge added (including allowance for chemical treatment for P),
 2. percent solids and character,
 3. the temperature to be maintained in the digesters,
 4. the degree or extent of mixing to be obtained,
 5. the degree of volatile solids reduction required;
 6. **the solids retention time at peak loadings; and**
 7. **the method of sludge disposal.**
- b. The capacity should consider appropriate allowances for gas, scum, supernatant and digested sludge storage.
- c. Secondary digesters **of two-stage series digestion systems** which are utilized for digested sludge storage and concentration **are not to** be credited in the calculations for volumes required for sludge digestion.
- d. Calculations **are to** be submitted to justify the basis of design.

84.32 Standard Design (formerly 74.52)

When such calculations are not submitted to justify the design based on the above factors, the minimum digestion tank capacity is to be as outlined below. These requirements assume that the raw sludge is derived from ordinary domestic wastewater, a digestion temperature is to be maintained in the range of 85°F to 95°F, 40 to 50 percent volatile matter in the digested sludge, and that the digested sludge will be removed frequently from the process. (See also Paragraphs 84.11 and 89.11.)

84.321 Completely-Mixed Systems (formerly 74.522)

- a. Completely-mixed primary systems **are to** provide for intimate and effective mixing to prevent stratification and to measure homogeneity of digester content.
- b. The system may be loaded at a rate up to **80** pounds of volatile solids per 1,000 cubic feet in volume per day in the active digestion units.
- c. At least 15 days of solids retention time **are to** be provided.
- d. When grit removal facilities are not provided, the reduction of digester volume due to grit accumulation should be considered.

84.322 Moderately-Mixed Systems (formerly 74.523)

- a. For primary digestion systems where mixing is accomplished only by circulating sludge through an external heat exchanger, the system may be loaded at a rate up to **40** pounds of volatile solids per 1,000 cubic feet of volume per day in active digestion units. **This loading may be modified upward or downward depending upon the degree of mixing provided.**
- b. At least 30 days of solids retention time should be provided.

84.323 Multi-stage Systems (formerly 74.53)

- a. For digestion systems utilizing two stages (primary and secondary units), the first stage (primary) may be either completely mixed or moderately mixed **and loaded in accordance with Paragraphs 84.321 or 84.322.**
- b. The second stage (secondary) is to be designed for sludge storage, concentration and gas collection and **are not to** be credited in the calculations for volumes required for sludge digestion.

84.324 Digester Mixing (formerly 74.521)

- a. Facilities for mixing the digester contents **are to** be provided where required for proper digestion by reason of loading rates or other features of the system.
- b. Where sludge recirculation pumps are used for mixing, they **are to** be provided in accordance with appropriate requirements of **Paragraph 87.1.**

84.4 Gas Collection, Piping and Appurtenances (formerly 74.6)

84.41 General (formerly 74.61)

- a. All portions of the gas system, including the space above the tank, liquor, storage facilities and piping, **are to** be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under positive pressure.
- b. All enclosed areas where any gas leakage might occur **are to** be adequately ventilated.

84.42 Safety Equipment (formerly 74.62)

- a. All necessary safety facilities **are to** be included where gas is produced.
- b. Pressure and vacuum relief valves and flame traps, together with automatic safety shutoff valves, **are to** be provided and protected from freezing.
- c. Water seal equipment **is not to** be installed.
- d. Safety equipment and gas compressors should be housed in a separate room with an exterior entrance.

84.43 Gas Piping and Condensate (formerly 74.63)

- a. Gas piping **is to** have a minimum diameter of 4 inches. A smaller diameter pipe at the gas **production** meter is acceptable.
- b. Gas piping **is to** slope to condensation traps at low points.
- c. The use of float-controlled condensation traps is not permitted.
- d. Condensation traps **are to** be protected from freezing.
- e. **Tightly fitted self-closing doors should be provided at connecting passageways and tunnels that connect digestion facilities to other facilities to minimize the spread of gas.**
- f. **Piping galleries are to be ventilated in accordance with Paragraph 84.47.**

84.44 Gas Utilization Equipment (formerly 74.64)

- a. Gas-burning boilers, engines, etc. **are to** be located in separate, well-ventilated rooms not connected to the digester gallery. **Such rooms would not ordinarily be classified as a hazardous location if isolated from the digestion gallery.**
- b. Gas lines to these units **are to** be provided with suitable flame traps.

84.45 Electrical Equipment, Fixtures, and Controls (formerly 74.65)

Electrical equipment, fixtures and controls in enclosed places and adjacent to anaerobic digestion appurtenances, where hazardous gases may accumulate are to comply with the National Electrical Code for Class I, Division 1, Group D locations.

84.46 Waste Gas (formerly 74.66)**84.461 Location**

- a. Waste gas burners are to be readily accessible and should be located at least 50 feet away from any plant structure.
- b. Waste gas burners are to be of sufficient height and so located to prevent injury to personnel due to wind or downdraft conditions.

84.462 Pilot Light

- a. All waste gas burners are to be equipped with automatic ignition, such as a pilot light or a device using a photoelectric cell sensor.
- b. Consideration should be given to the use of natural or propane gas to ensure reliability of the pilot light.

84.463 Gas Piping Slope

Gas piping is to be sloped at a minimum of 2 percent up to the waste gas burner with a condensation trap provided in a location not subject to freezing.

84.47 Ventilation (formerly 74.67)

- a. Any underground enclosures connecting with digestion tanks or containing sludge or gas piping or equipment are to be provided with forced ventilation in accordance with Paragraphs 42.61 through 42.64 and 42.66.
- b. The piping gallery for digesters should not be connected to other passages.
- c. The ventilation rate for Class I, Division 2, Group D locations including enclosed areas without a gas tight partition from the digestion tank or areas containing gas compressors, sediment traps, drip traps, gas scrubbers, or pressure regulating and control valves, if continuous, is to be at least 12 complete air changes per hour.

84.48 Meter (formerly 74.68)

- a. A gas meter with bypass **is to** be provided to meter total gas production for each active digestion unit. Total gas production for two-stage digestion systems operated in series may be measured by a single gas meter with proper interconnected gas piping.
- b. Where multiple primary digestion units are utilized with a single secondary digestion unit, a gas meter **is to** be provided for each primary digestion unit. The secondary digestion unit may be interconnected with the gas measurement unit of one of the primary units. Interconnected gas piping **is to** be properly valved with gas tight gate valves to allow measurement of gas production from either digestion unit and maintenance of either digestion unit.
- c. Gas meters may be of the orifice plate, turbine or vortex type. Positive displacement meters should not be utilized.
- d. The meter must be specifically designed for contact with corrosive and dirty gases.

84.5 Digester Heating (formerly 74.7)

84.51 Insulation (formerly 74.71)

Wherever possible, digestion tanks should be constructed above groundwater level and should be suitably insulated (with earth embankment or by other means) to minimize heat loss.

84.52 Heating Facilities (formerly 74.72)

Sludge may be heated by circulating it through external heaters or by heating units located inside the digestion tank. **Refer to Paragraph 84.522.**

84.521 External Heating

- a. Piping **is to** be designed to provide for the preheating of feed sludge before introduction into the digesters.
- b. Provisions **are to** be made in the layout of the piping and valving to facilitate heat exchanger tube removal and cleaning of the lines.
- c. **Heat exchanger sludge piping should be sized for peak heat transfer requirements.**
- d. **Heat exchangers should have a heating capacity of 130 percent of the calculated peak heating requirement to account for the occurrence of sludge tube fouling.**

84.522 Other Heating Methods

- a. Hot water heating coils affixed to the walls of the digester or other types of internal heating equipment that require emptying the digester contents for repair are not to be used.
- b. Other systems and devices have been developed recently to provide both mixing and heating of anaerobic digester contents. These systems will be reviewed on their own merits. Operating data detailing their reliability, operation, and maintenance characteristics will be required. Refer to Paragraph 53.2.

84.53 Heating Capacity (formerly 74.73)

84.531 Capacity

- a. Sufficient heating capacity is to be provided to consistently maintain the design sludge temperature, considering insulation provisions and ambient cold weather conditions.
- b. Where digestion tank gas is used for other purposes, an auxiliary fuel may be required.
- c. The design operating temperature should be in the range of 85°F to 100°F where optimum mesophilic digestion is required.

84.532 Standby Requirements

The provision of standby heating capacity or the use of multiple units sized to provide the heating requirements is to be considered, unless acceptable alternative means of handling raw sludge are provided for the extended period that a digestion process outage is experienced due to heat loss.

84.54 Hot Water Internal Heating Controls (formerly 74.74)

84.541 Mixing Valves (formerly 74.741)

A suitable automatic mixing valve is to be provided to temper the boiler water with return water so that the inlet water to the heat removable heat jacket or coil in the digester can be held at a temperature of 140°F or less. Manual control should also be provided by suitable bypass valves.

84.542 Boiler Controls (formerly 74.742)

The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180°F to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, low gas pressure, or excessive boiler water

temperature or pressure.

84.543 Boiler Water Pumps (formerly 74.743)

- a. Boiler water pumps **are to** be sealed and sized to meet the operating conditions of temperature, operating head and flow rate.
- b. Duplicate units **are to** be provided.

84.544 Thermometers (formerly 74.744)

Thermometers **are to** be provided to show inlet and outlet temperatures of the sludge, hot water feed, hot water return and boiler water.

84.545 Water Supply (formerly 74.745)

The chemical quality should be checked for suitability for boiler use and possible addition of water conditioning chemical. **Refer to Paragraph 56.23 for required break tank for indirect water supply connections.**

84.55 External Heater **Operating Controls (formerly 74.75)**

All controls necessary to ensure effective and safe operation are required. Provision for duplicate units in critical elements should be considered.

84.6 Supernatant Withdrawal (formerly 74.8)

Where supernatant separation is to be used to concentrate sludge in the digester units and increase digester solids retention time, the design **is to** provide for ease of operation and positive control of supernatant quality.

84.61 Piping Size (formerly 74.81)

Supernatant piping should not be less than 6 inches in diameter.

84.62 Withdrawal Arrangements (formerly 74.82)

84.621 Withdrawal Levels (formerly 74.821)

- a. **Supernatant withdrawal** piping should be arranged so that withdrawal can be made from three or more levels in the digester.
- b. An unvalved vented overflow **is to** be provided.
- c. The emergency overflow **is to** be piped to an appropriate point **and at an appropriate rate** in the treatment process or side stream treatment units to minimize the impact on process units.

84.622 Withdrawal Selection (formerly 74.822)

On fixed cover tanks, the supernatant withdrawal level should be selected by means of interchangeable extensions at the discharge end of the piping.

84.623 Supernatant Selector (formerly 74.823)

- a. A fixed screen supernatant selector or similar type device is to be limited for use in an unmixed secondary digester unit.
- b. If such a supernatant selector is provided, provisions are to be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe.
- c. High pressure backwash facilities are to be provided utilizing non-potable utility water.

84.63 Sampling (formerly 74.83)

- a. Provision should be made for sampling at each supernatant draw-off level.
- b. Sampling pipes should be at least 1½ inches in diameter, equipped with a quick opening valve, and should terminate at a suitably-sized sampling sink or basin.
- c. High pressure backwash facilities for the sampling pipe should be provided utilizing non-potable utility water.

84.64 Supernatant Disposal (formerly 74.84)

- a. Supernatant return and disposal facilities should be designed to alleviate adverse hydraulic and organic effects on plant operations.
- b. If nutrient removal (e.g., phosphorus, ammonia nitrogen) must be accomplished at a plant, a separate supernatant side stream treatment system should be provided.

84.7 Anaerobic Digestion Sludge Production

- a. For calculating design sludge handling and disposal needs, sludge production values from a two-stage anaerobic digestion process are to be based on a maximum solids concentration of 5 percent without additional thickening.
- b. The solids production values on a dry weight basis are to be based on the following for the listed processes:

Primary plus waste activated sludge – at least 0.12 lb/P.E./day.

Primary plus fixed film sludge – at least 0.09 lb/P.E./day.

85. AEROBIC SLUDGE DIGESTION. (formerly 75)

85.1 General (formerly 75.1)

An aerobic sludge digestion system is to include provisions for effective air mixing, digestion, supernatant separation, sludge concentration, and any necessary sludge storage. These provisions may be accomplished by separate tanks or processes or in the digestion tanks.

85.2 Number of Units (formerly 75.11)

- a. Multiple digestion units capable of independent operation are desirable and are to be provided in all plants where the design maximum monthly average flow exceeds ~~400,000~~ 50,000 gallons per day.
- b. All plants not having multiple units are to provide alternate sludge handling and disposal methods.

85.3 Tank Capacity (formerly 75.11)

The determination of tank capacities are to be based on rational calculations including such factors as quantity of sludge produced, sludge characteristics, time of aeration and sludge temperature.

85.31 Volatile Solids Loading (formerly 75.11)

It is recommended that the volatile suspended solids loading not exceed 100 pounds per 1,000 cubic feet of volume per day in the digestion units. Lower loading rates between 25 to 100 pounds/1,000 cubic feet/day may be necessary depending on temperature, type of sludge and other factors.

85.32 Solids Retention Time (formerly 75.11)

Required minimum solids retention time for stabilization of biological sludges vary depending on temperature and type of sludge. Normally, a minimum of 15 days retention should be provided for waste activated sludge and 20 days for combination of primary and waste activated sludge, or primary sludge alone.

85.33 Effect of Temperature on Volume

- a. The volumes in Paragraphs 85.31 and 85.32 are based on digester temperatures of 59°F. Where sludge temperature is lower than 59°F, additional detention time should be considered.
- b. Aerobic digesters should be covered to minimize heat loss for colder

temperature applications.

- c. Additional volume or supplemental heat may be required if the land application disposal method is used in order to meet the applicable U.S. EPA requirements. Refer to Paragraph 85.9 for necessary sludge storage.

85.4 Mixing (formerly 75.2)

Aerobic digesters are to be provided with mixing equipment which can maintain solids in suspension and which ensure complete mixing of the digester content. Refer to Paragraph 85.5.

85.5 Air Requirements (formerly 75.2)

- a. Sufficient air is to be provided to keep the solids in suspension and maintain DO between 1 and 2 mg/L.
- b. For minimum mixing and oxygen requirements, an air supply of 30 cfm per 1,000 cubic feet of tank volume is to be provided with the largest blower out of service.
- c. If diffusers are used, the nonclog type is recommended, and they should be designed to permit continuity of service.
- d. If mechanical aerators are utilized, a minimum of 1 horsepower per 1,000 cubic feet should be provided.
- e. A minimum of two aerators per tank are to be provided to permit continuity of service.
- f. Use of mechanical aerators is discouraged where freezing temperatures will cause ice build-up on the aerator and support structures.

85.6 Supernatant Separation and Scum and Grease Removal

85.61 Supernatant Separation (formerly 75.4)

- a. Facilities are to be provided for effective separation or decanting of supernatant. Separate facilities are recommended; however, supernatant separation may be accomplished in the digestion tank if additional volume is provided per Paragraph 85.3.
- b. The supernatant drawoff unit is to be designed to prevent recycle of scum and grease back to plant process units.
- c. Provision should be made to withdraw supernatant from multiple levels of the supernatant withdrawal zone.

85.62 Scum and Grease Removal (formerly 75.4)

Facilities are to be provided for the effective collection of scum and grease from the aerobic digester for final disposal, to prevent its recycle back to the plant process, and to prevent long term accumulation and potential discharge in the effluent.

85.7 High Level Emergency Overflow (formerly 75.5)

- a. An unvalved high level overflow and any necessary piping are to be provided to return digester overflow back to the head of the plant or to the aeration process in case of accidental overfilling.
- b. Design considerations related to the digester overflow are to include:
 1. waste sludge rate and duration during the period the plant is unattended,
 2. potential effects on plant process units,
 3. discharge location of the emergency overflow, and
 4. potential discharge of suspended solids in the plant effluent.

85.8 Aerobic Digestion Sludge Production

- a. For calculating design sludge handling and disposal needs, sludge production values from aerobic digesters are to be based on a maximum solids concentration of 2 percent without additional thickening.
- b. The solids production values on a dry weight basis are to be based on the following for the listed processes:

Primary plus waste activated sludge - at least 0.16 lb/P.E./day.

Primary plus fixed film sludge - at least 0.12 lb/P.E./day.

85.9 Digested Sludge Storage Volume**85.91 Sludge Storage Volume (formerly 75.6)**

- a. Sludge storage is to be provided in accordance with Section 89 to accommodate daily sludge production volumes and as an operational buffer for unit outage and adverse weather conditions.
- b. Designs are not to utilize increased sludge age in the activated sludge system as a means of storage.

85.92 Liquid Sludge Storage

Liquid sludge storage facilities are to be based on the following values unless digested sludge thickening facilities are utilized (refer to Section 83) to provide

solids concentrations of greater than 2 percent.

Sludge Source	Volume/Population
	ft ³ /P.E./day
Waste activated sludge -- no primary settling, primary plus waste activated sludge, and extended aeration activated sludge	0.13
Waste activated sludge exclusive of primary sludge	0.06
Primary plus attached growth biological reactor sludge	0.10

85.10 Autothermal Thermophilic Aerobic Digestion

- a. Thermophilic digestion temperature should be maintained between 122°F and 158°F.
- b. Systems may be either single or multiple stage.
- c. The sludge should be thickened prior to treatment in the digestion tanks.
- d. The digestion tanks should be suitably insulated to minimize heat loss.

86. HIGH pH STABILIZATION

86.1 General

Alkaline material may be added to liquid primary or secondary sludges for sludge stabilization in lieu of digestion facilities; to supplement existing digestion facilities; or for interim sludge handling. There is no direct reduction of organic matter or sludge solids with the high pH stabilization process. There is an increase in the mass of dry sludge solids. Without supplemental dewatering, additional volumes of sludge will be generated. The design is to account for the increased sludge quantities for storage, handling, transportation, and disposal methods and associated costs.

86.2 Operational Criteria

- a. Sufficient alkaline material is to be added to liquid sludge in order to produce a homogeneous mixture with a minimum pH of 12 after two hours of vigorous mixing.
- b. Facilities for adding supplemental alkaline material are to be provided to maintain the pH of the sludge during interim sludge storage periods.

86.3 Odor Control and Ventilation

- a. Odor control facilities are to be provided for sludge mixing and treated sludge storage tanks when located within ½ mile of residential or commercial areas.
- b. DEP should be contacted for design and air pollution control objectives to be met for various types of air scrubber units.
- c. Ventilation is to be provided for indoor sludge mixing, storage or processing facilities in accordance with Paragraph 42.65.

86.4 Mixing Tanks and Equipment

86.41 Tanks

- a. Mixing tanks may be designed to operate as either a batch or continuous flow process.
- b. A minimum of two tanks are to be provided.
- c. The tanks are to provide a minimum of two hours contact time in each tank. The following items are to also be considered in determining the number and size of tanks:
 - (1) peak sludge flow rates;
 - (2) storage between batches;
 - (3) dewatering or thickening performed in tanks;
 - (4) repeating sludge treatment due to pH decay of stored sludge;
 - (5) sludge thickening prior to sludge treatment; and
 - (6) type of mixing device used and its associated maintenance or repair requirements.

86.42 Equipment

- a. Mixing equipment is to be designed to:
 1. provide vigorous agitation within the mixing tank,
 2. maintain solids in suspension, and
 3. provide for a homogeneous mixture of the sludge solids and alkaline material.
- b. Mixing may be accomplished either by diffused air or mechanical mixers.

- c. If diffused aeration is used:
 - 1. an air supply of 30 cfm/1000 ft³ of mixing tank volume is to be provided with the largest blower out of service.
 - 2. if diffusers are used, the nonclog type should be provided, and they should be designed to permit continuity of service.
- d. If mechanical mixers are used:
 - 1. the impellers are to be designed to minimize fouling with debris in the sludge and
 - 2. consideration is to be made to provide continuity of service during freezing weather conditions.

86.5 Chemical Feed and Storage Equipment

86.51 General

- a. Alkaline material is caustic in nature and can cause eye and tissue injury. Equipment for handling or storing alkaline material is to be designed for adequate operator safety. Refer to Section 57 for proper safety precautions.
- b. Storage, slaking, and feed equipment should be sealed as airtight as practical to prevent contact of alkaline material with atmospheric carbon dioxide and water vapor and to prevent the escape of dust material.
- c. All equipment and associated transfer lines or piping are to be accessible for cleaning.

86.52 Feed and Slaking Equipment

- 1. The design of the feeding equipment is to be determined by the treatment plant size, type of alkaline material used, slaking required, and operator requirements.
- 2. Equipment may be either of batch or automated type.
- 3. Automated feeders may be of the volumetric or gravimetric type depending on accuracy, reliability, and maintenance requirements.
- 4. Manually operated batch slaking of quicklime (CaO) should be avoided unless adequate protective clothing and equipment are provided.
- 5. At small plants, hydrated lime [Ca(OH)₂] should be used instead of quicklime due to safety and labor-saving reasons.

6. Feed and slaking equipment are to be sized to handle a minimum of 150% of the peak sludge flow rate including sludge that may need to be retreated due to pH decay.
7. Duplicate units are to be provided.

86.53 Chemical Storage Facilities

- a. Alkaline materials may be delivered either in bag or bulk form depending upon the amount of material used.
- b. Material delivered in bags is to be stored indoors and elevated above floor level.
- c. Bags should be of the multi-wall moisture-proof type.
- d. Dry bulk storage containers are to be as airtight as practical and are to contain a mechanical agitation mechanism.
- e. Storage facilities are to be sized to provide a minimum of a 30-day supply.

86.6 Sludge Storage

Refer to Section 89 for general design considerations for sludge storage facilities. The design is to incorporate the following considerations for the storage of high pH stabilized sludge:

86.61 Liquid Sludge

- a. Liquid high pH stabilized sludge is not to be stored in a lagoon. Such sludge is to be stored in a tank or vessel equipped with rapid sludge withdrawal mechanisms for sludge disposal or retreatment.
- b. Provisions are to be made for adding alkaline material in the storage tank.
- c. Mixing equipment in accordance with Paragraph 86.42 above is to be provided in all storage tanks.

86.62 Dewatered Sludge

- a. On-site storage of dewatered high pH stabilized sludge should be limited to 30 days.
- b. Provisions for rapid retreatment or disposal of dewatered sludge stored on-site are to be made in case of sludge pH decay.

86.63 Off-Site Storage

There is to be no off-site storage of high pH stabilized sludge unless specifically allowed by the regulatory agency.

86.7 Disposal

- a. Immediate sludge disposal methods and options are recommended to be utilized in order to reduce the sludge inventory on the treatment plant site and the amount of sludge that may need to be retreated to prevent odors if sludge pH decay occurs.
- b. If the land application disposal option is utilized for high pH stabilized sludge, said sludge should be incorporated into the soil during the same day of delivery to the site.

87. SLUDGE PUMPS AND PIPING (formerly 76)

87.1 Sludge Pumps (formerly 76.1)

87.11 Capacity (formerly 76.11)

- a. Pump capacities should be adequate but not excessive.
- b. Provision for varying pump capacity is desirable.
- c. A rational basis of design is to be provided with the plan documents.

87.12 Duplicate Units (formerly 76.12)

Duplicate units are to be provided at all installations.

87.13 Type (formerly 76.13)

- a. Plunger pumps, screw feed pumps, recessed impeller type centrifugal pumps, progressive cavity pumps or other types of pumps with demonstrated solids handling capability are to be provided for handling raw sludge.
- b. Where centrifugal pumps are used, a parallel positive displacement pump should be provided as an alternate to pumping heavy sludge concentrations, such as primary or thickened sludges, that may exceed the pumping head of a centrifugal pump.

87.14 Minimum Head (formerly 76.14)

- a. A minimum positive head of 24 inches is to be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps.

- b. Maximum suction lifts should not exceed 10 feet for positive displacement pumps.

87.15 Sampling Facilities (formerly 76.15)

- a. Unless sludge sampling facilities are otherwise provided, quick closing sampling valves **are to** be installed at the sludge pumps.
- b. The size of the valve and piping should be at least 1½ inches and should terminate at a suitably sized sampling sink or floor drain.
- c. Provision should be made for sampling at various levels in the mixing zone.

87.2 Sludge Piping (formerly 76.2)

87.21 Size and Head (formerly 76.21)

- a. **Digested** sludge withdrawal piping should have a minimum diameter of 8 inches for gravity withdrawal and 6 inches for pump suction and discharge lines.
- b. Where withdrawal is by gravity, the available head on the discharge pipe should be adequate to provide at least 4 feet per second velocity.
- c. **Undigested sludge withdrawal piping is to be sized in accordance with Paragraph 73.23.**

87.22 Slope and Flushing Requirements (formerly 76.22)

- a. Gravity piping should be laid on uniform grade and alignment.
- b. The slope of gravity discharge piping should not be less than 3 percent **for primary sludges and all sludges thickened to greater than 2 percent solids.**
- c. **Slope on gravity discharge piping should not be less than 2 percent for aerobically digested sludge or waste activated sludge with less than 2 percent solids.**
- d. **Cleanouts are to be provided for all gravity sludge piping.**
- e. Provisions should be made for cleaning, draining and flushing discharge lines.
- f. All sludge pipes **are to** be suitably located and adequately protected to prevent freezing.

87.23 Supports (formerly 76.23)

Special consideration should be given to the corrosion resistance and continuing stability of supporting systems located inside the digestion tank.

88. SLUDGE DEWATERING (formerly 77)

88.1 General

- a. On-site sludge dewatering facilities are to be provided for all plants, although the following requirements may be reduced with on-site liquid sludge storage facilities or approved off-site sludge disposal.
- b. For calculating design sludge handling and disposal needs for sludge stabilization processes other than described in Paragraphs 84.7 for anaerobic digestion and 85.8 for aerobic digestion, a rational basis of design for sludge production values is to be developed and provided to the reviewing authority for approval on a case-by-case basis.

88.2 Sludge Drying Beds (formerly 77.1)

88.21 General (formerly 77.11)

Sludge drying beds may be used as a sole means, or in combination with other dewatering systems, to dewater digested sludge from either the anaerobic or aerobic process. Various types of drying beds such as sand, wedge-wire, vacuum assisted and sand-reed may be used.

Adequate provision are to be made for sludge dewatering and/or sludge disposal facilities for those periods of time during which outside drying of sludge on beds is hindered by weather.

88.22 Area (formerly 77.12)

- a. Sludge drying bed area is to be calculated using a rational basis considering such factors as:
 1. the climatic conditions,
 2. the character and volume of sludge to be dewatered,
 3. the digester volume and other wet sludge storage facilities,
 4. degree of sludge thickening provided after digestion,
 5. the maximum drawing depth of sludge which can be removed from the digester or other sludge storage facilities without causing process or structural problems,

6. the time required on the bed to produce a removable cake and
 7. **capacities** of **auxiliary** sludge dewatering facilities.
- b. For design purposes, a **maximum** depth of 8 to 12 inches of wet sludge should be utilized.
 - c. In the absence of rational design, the size of the sand drying bed may be estimated on the basis of
 1. 1.0 to 1.5 sq. ft./capita for primary digested sludge,
 2. 1.25 to 1.75 sq. ft./capita for primary and humus digested sludge, and
 3. 1.75 to 2.5 sq. ft./capita for primary and activated digested sludge, when drying beds is the primary method of dewatering.
 - d. The drying bed area based on 1 sq. ft./capita may be used when it is to be used as a backup dewatering unit.
 - e. Sand drying beds may be reduced in size by 25 percent when covered.

88.23 Percolation Type **Bed Components** (formerly 77.13)

88.231 **Gravel** (formerly 77.131a)

- a. The lower course of gravel around the underdrains should be properly graded, should be at least 12 inches in depth
- b. The gravel course should extend at least 6 inches above the top of the underdrains.
- c. The gravel course should be placed in two or more layers.
- d. The top layer of at least 3 inches should consist of gravel $\frac{1}{8}$ to $\frac{1}{4}$ inch in size.

88.232 **Sand** (formerly 77.131b)

- a. The top course should consist of at least 9 to 12 inches of clean, hard, and washed coarse sand.
- b. The effective size of the sand should be in the range of 0.8 mm to 1.5 mm
- c. The uniformity coefficient of the sand should be less than 5.0.

- d. The finished sand surface should be level.

88.233 Underdrains (formerly 77.132)

- a. Underdrains should be at least 4 inches in diameter and laid with open joints. Perforated pipe may also be used.
- b. Underdrains should be spaced not more than 20 feet apart and sloped at a minimum of 1 percent.
- c. Lateral tiles should be spaced at 8 to 10 feet.
- d. Underdrains should discharge back to the treatment process.
- e. Various pipe materials may be selected provided the material is corrosion resistant.
- f. Underdrains are to be appropriately bedded to ensure that they are not damaged by sludge removal equipment.

88.234 Additional Dewatering Provisions

Consideration is to be given to provide a means of decanting the supernatant of sludge placed on the sludge drying beds. More effective decanting of supernatant may be accomplished with polymer treatment of sludge.

88.235 Seal

- a. Beds are to be sealed such that seepage loss through the seal is as low as practicably possible.
- b. Seals consisting of soils, bentonite, or synthetic liners may be considered, provided the permeability, durability, and integrity of the proposed material can be satisfactorily demonstrated for anticipated conditions.
- c. Results of a testing program which substantiates the adequacy of the proposed seal shall be incorporated into and/or accompany the engineering report.
- d. Standard ASTM International procedures or acceptable similar methods shall be used for all tests.
- e. To achieve an adequate seal in beds using soil, bentonite, or other seal materials, the hydraulic conductivity (k) in centimeters per second specified for the seal shall not exceed the value derived from the following expression, where L equals the thickness of the

seal in centimeters.

$$k = 2.6 \times 10^{-9}L$$

The "k" obtained by the above expression corresponds to a percolation rate of pond water of less than 500 gallons per day per acre at a water depth of 6 feet and a liner thickness of 1 foot, using the Darcy's law equation.

- f. For a seal consisting of a synthetic liner, seepage loss through the liner shall not exceed the quantity equivalent to seepage loss through an adequate soil seal.

88.25 Walls (formerly 77.14)

- a. Walls should extend 18 inches above and at least 9 inches below the surface of the sludge drying bed.
- b. Outer walls are to be water tight down to the bottom of the bed and extend at least 4 inches above the outside grade elevation to prevent soil from washing into the beds.

88.26 Sludge Removal (formerly 77.15)

- a. A minimum of two beds should be provided.
- b. Each bed should be constructed so as to be readily and completely accessible to mechanical cleaning equipment.
- c. Concrete runways spaced to accommodate mechanical equipment should be provided.
- d. Special attention should be given to assure adequate access to the areas adjacent to the sidewalls.
- e. Entrance ramps down to the level of the sand bed should be provided.
- f. The ramps should be high enough to eliminate the need for an entrance end wall for the sludge bed.

88.27 Sludge Influent (formerly 77.16)

- a. The sludge pipe to the drying beds should terminate at least 12 inches above the surface and be so arranged that it will drain.
- b. Concrete splash slabs should be provided at sludge discharge points.

88.28 Drainage Disposal (formerly 77.17)

Drainage from beds is to be returned to the raw or settled wastewater.

88.29 Protective Enclosure (formerly 77.18)

A protective enclosure is to be provided if winter operation is required.

88.3 Mechanical Dewatering Facilities (formerly 77.2)

88.31 General (formerly 77.21)

- a. Provision is to be made to maintain sufficient continuity of service so that sludge may be dewatered without accumulating beyond storage capacity.
- b. Before determining the required number of dewatering units, consideration is to be given to other sludge disposal methods (e.g., liquid sludge disposal, drying beds) to be utilized and the available storage capacity.
- c. The number of vacuum filters, centrifuges, filter presses, belt filters, or other mechanical dewatering facilities, or combinations thereof, should be sufficient to dewater the sludge produced with the largest unit out of service.
- d. If standby dewatering facilities are not available, adequate storage facilities equivalent to a 3-month sludge production or other means of sludge disposal are to be provided.
- e. Documentation must be submitted justifying the basis of design of a mechanical dewatering facility.

88.32 Water Supply Protection

Provisions for water supply to mechanical dewatering facilities are to be in accordance with Paragraph 56.23.

88.33 Auxiliary Facilities for Vacuum Filters

- a. Back-up vacuum and filtrate pumps are to be provided.
- b. It is permissible to have uninstalled back-up vacuum and filtrate pumps for every three or less vacuum filters, provided that the installed units can easily be removed and replaced.
- c. At least one filter media replacement unit is to be provided.

88.34 Ventilation (formerly 77.22)

- a. Adequate facilities are to be provided for ventilation of the dewatering

area in accordance with Paragraph 42.65.

- b. The exhaust air should be properly conditioned to avoid odor nuisance.

88.35 Chemical Handling Enclosures (formerly 77.23)

1. Dry chemical mixing facilities should be completely enclosed to prevent the escape of dust.
2. Chemical handling equipment should be automated to eliminate the manual lifting requirement. Refer to Section 57.
3. Polymers and other chemicals are to be handled and stored as per manufacturer's instructions.

88.4 Drainage and Filtrate Disposal (formerly 77.24)

- a. Drainage from sludge drying beds or filtrate from other dewatering units is to be returned to the wastewater treatment process at appropriate points and rates.
- b. Sampling equipment is to be provided as needed to monitor drainage and filtrate waste streams. (See also Paragraphs 56.7 and 84.64.)

88.5 Other Dewatering Facilities

If other methods of sludge dewatering are proposed, a detailed description of the process and design data is to accompany the plans. Refer to Paragraph 53.2 for any new process determinations.

88.6 Quantity Measurement (formerly 77.26)

A means of measuring the quantity of sludge processed should be provided.

89. SLUDGE STORAGE AND DISPOSAL (formerly 78)

89.1 Sludge Storage (formerly 78.1)

89.11 General

- a. Sludge storage facilities should be provided at all treatment plants. The storage facilities may consist of a combination of drying beds, additional volume in sludge stabilization units, separate tanks, pad areas, or other methods approved by DEP for the storage of either liquid or dried sludge.
- b. Storage facilities are to be determined based on the available sludge disposal options and may be on- or off-site. Refer to Paragraphs 88.2 and 89.2 for drying bed and lagoon design criteria, respectively.

1. Those proposals involving on-site domestic wastewater sludge storage facilities are reviewed and approved under the WQM permit, and a separate permit from the Bureau of Waste Management is not be required. The applicant are to submit the appropriate calculations justifying the number of days of storage required based on the sludge handling or disposal options at the facility. Drainage and/or leachate collection from the storage pads is to be piped to a treatment facility for treatment.
 2. Proposals involving the off-site sludge storage facilities are to be reviewed and permitted by the Bureau of Waste Management. The applicant is to contact the Bureau of Waste Management for the requirements for an off-site sludge storage facility.
- c. The design is to provide for odor control in sludge storage tanks and sludge lagoons including aeration, covering, or other appropriate means.

89.12 Volume

- a. Rational calculations justifying the number of days of storage to be provided are to be submitted and are to be based on the total sludge handling and disposal system. Refer to Paragraphs 84.7 and 85.8 for anaerobically and aerobically digested sludge production values. Sludge production values for other stabilization processes should be justified in the basis of design.
- b. If the land application method of sludge disposal is the only means of disposal utilized at a treatment plant, storage is to be provided based on the following considerations, at a minimum:
 1. Inclement weather effects on access to the application land;
 2. Temperatures including frozen ground and stored sludge cake conditions;
 3. Haul road restrictions including spring thawing conditions;
 4. Area seasonal rainfall patterns;
 5. Cropping practices on available land;
 6. Potential for increased sludge volumes from industrial sources during the design life of the plant;
 7. Available area for expanding sludge storage; and
 8. Appropriate pathogen reduction and vector attraction reduction requirements.

- c. A minimum range of 120 to 180 days storage should be provided for the design life of the plant unless a different period is approved DEP. Refer to Paragraph 89.33 for other sludge land application considerations.

89.2 Sludge Storage Lagoons

89.21 General

- a. Sludge storage lagoons may be permitted only upon proof that the character of the digested sludge and the design mode of operation are such that offensive odors will not result.
- b. Where sludge lagoons are permitted, adequate provisions are to be made for other acceptable sludge handling methods in the event of upset or failure of the sludge digestion process.

89.22 Location

Sludge lagoons are to be located as far as practicable from inhabited areas or areas likely to be inhabited during the lifetime of the structures.

89.23 Seal

- a. Adequate provisions are to be made to seal the sludge lagoon bottoms and embankments in accordance with the requirements of Paragraph 93.422 to prevent leaching into adjacent soils or ground water.
- b. The seal is to be protected to prevent damage from sludge removal activities.
- c. Groundwater monitoring may be required by DEP in accordance with Paragraph 93.65.

89.24 Access

Provisions are to be made for pumping or heavy equipment access for sludge removal from the sludge lagoon on a routine basis.

89.25 Supernatant Disposal

- a. Lagoon supernatant is to be returned to the wastewater treatment process at appropriate points and rates.
- b. Sampling equipment is to be provided as needed to monitor supernatant waste streams. (See also Paragraphs 56.7 and 84.64.)

89.3 Sludge Disposal (formerly 78.2)

89.31 General

- a. All domestic wastewater sludge disposal proposals are reviewed and permitted by the Bureau of Waste Management. The applicant shall is to contact the Bureau of Waste Management for appropriate sludge disposal requirements.
- b.
- c. Drainage facilities for sludge vehicle transfer stations are to be provided to allow any spillage or washdown material to be collected and returned to the wastewater treatment plant or sludge storage facility.

89.32 Sanitary Landfilling

Sludge and sludge residues may be disposed of in approved sanitary landfills under the terms and conditions of DEP.

89.33 Land Application

- a. Sludge may be utilized as a soil conditioner for agricultural, horticultural, or reclamation purposes. Important design considerations include, but are not necessarily limited to:
 1. sludge stabilization process,
 2. appropriate pathogen and vector attraction reduction,
 3. sludge characteristics including the presence of inorganic and organic chemicals,
 4. application site characteristics (soils, groundwater elevations, setback distance requirements, etc.),
 5. local topography and hydrology,
 6. cropping practices,
 7. spreading and incorporation techniques,
 8. population density and odor control, and
 9. local groundwater quality and usage.
- b. Sludge mixing equipment or other provisions to assist in the monitoring of land applied sludge should be considered in the design of sludge handling and storage facilities.
- c. Due to inclement weather and cropping practices, alternative sludge disposal options are recommended to ensure the sludge is properly managed.
- d. Sludge should not be applied to land which is used for growing food crops to be eaten raw, such as leafed vegetables and root crops.

89.34 Sludge Lagoons for Disposal

Sludge lagoons should not be used for ultimate disposal of sludge due to odor potential, area and volume required, and possible long term problems from groundwater contamination.

89.35 Other Disposal Methods

If other methods of sludge disposal are proposed, a detailed description of the technique and design data is to accompany the plans. Refer to Paragraph 53.2 for any new process determinations.

DRAFT

**CHAPTER 90
BIOLOGICAL TREATMENT**

91. TRICKLING FILTERS (formerly 81)

91.1 General (formerly 81.1)

- a. Trickling filters may be used for treatment of wastewater amenable to treatment by aerobic biological processes.
- b. Trickling filters **are to** be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.
- c. Trickling filters **are to** be designed to meet the discharge requirements for the receiving waters as established by the NPDES permit or to properly condition the wastewater for subsequent treatment processes.
- d. Multi-stage filters may be considered, if needed, to meet more stringent effluent standards.

91.2 Number of Units

- a. Consideration should be given to dividing the required volume into two or more units at all plants.
- b. For plants designed to receive maximum monthly average flow of 50,000 gpd or more, the total volume is to be divided among two or more units capable of independent operation to meet applicable effluent limitations and reliability guidelines.

91.3 Hydraulics (formerly 81.2)

91.31 Distribution (formerly 81.21)

91.311 Uniformity (formerly 81.211)

- a. The wastewater may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform distribution to the surface area.
- b. At maximum monthly average flow, the deviation from a calculated uniformly distributed volume per square foot of the filter surface **is not to** exceed plus or minus 10 percent at any point.
- c. All hydraulic factors involving proper distribution of wastewater on the filters **are to** be carefully calculated. **Such calculations are to be submitted to DEP.**

- d. Reverse reaction nozzles, hydraulic brakes or motor-driven distributor arms are to be provided for rotary distributors to ensure that the maximum speed recommended by the distributor manufacturer is not exceeded and to attain the desired media dosing rate.

91.312 Head Requirements (formerly 81.212)

- a. For reaction type distributors, a minimum head of 24 inches between low water level in siphon chamber and center of arms is required.
- b. Similar allowance in design is to be provided for added pumping head requirements where pumping to the reaction type distributor is used.

91.313 Clearance (formerly 81.213)

A minimum clearance of 6 12 inches between media and distributor arms is to be provided. Greater clearance is essential where icing may occur.

91.32 Dosing (formerly 81.22)

- a. Wastewater may be applied to the filters by siphons, pumps or by gravity discharge from preceding treatment units when suitable flow characteristics have been developed.
- b. Application of the wastewater is to be practically continuous.
- c. The piping system is to be designed to permit recirculation.

91.33 Piping System (formerly 81.23)

The piping system, including dosing equipment, distributor and distributor effluent underdrains, are to be designed to provide capacity for the peak hourly flow rate, including recirculation required under Paragraph 91.65.

91.4 Media (formerly 81.4)

91.41 Quality (formerly 81.41)

- a. The media may be crushed rock, slag or manufactured material.
- b. The media is to be durable, resistant to spalling or flaking and relatively insoluble in wastewater.
- c. The top 18 inches are to have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent, as prescribed by ASCE

Manual of Engineering Practice, Number 13.

- d. The balance is to pass a 10-cycle test using the same criteria.
- e. Slag media **is to** be free from iron or other leachable material that will adversely affect the process or effluent quality.
- f. Manufactured media **is to** be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalis, organic compounds, and fungus and biological attack.
- g. Media **is to** be structurally capable of supporting a person’s weight, or a suitable access walkway **is to** be provided to allow for distributor maintenance.

91.42 Depth (formerly 81.42)

- a. Trickling filter media **is to** have a minimum depth of 6 feet above the underdrains.
- b. Rock and/or slag filter media depths **are not to** exceed 10 feet, and manufactured filter media depths **are not to** exceed the recommendations of the manufacturer.
- c. Forced ventilation should be considered in accordance with **Paragraph 91.53**.

91.43 Size, Grading and Handling of Media (formerly 81.43)

91.431 Rock, Slag and Similar Media (formerly 81.431)

- a. Rock, slag and similar media **are not to** contain more than 5 percent by weight of pieces whose longest dimension is three times the least dimension.
- b. **Media is to** be free from thin elongated and flat pieces, dust, clay, sand, or fine material, and conform to the following size and grading when mechanically graded over vibrating screen with square openings:

Passing 4½-inch screen - 100 percent by weight
 Retained on 3-inch screen - 95-100 percent by weight
 Passing 2-inch screen - 0 - 2 percent by weight
 Passing 1-inch screen - 0 - 1 percent by weight

91.432 Manufactured Media (formerly 81.432)

Media suitability will be evaluated on the basis of experience with

installations handling similar wastes and loadings. To ensure sufficient void clearances, media with specific surface areas of no more than 30 square feet per cubic foot is acceptable for filters employed for carbonaceous reduction and 45 square feet per cubic foot for second stage ammonia reduction.

91.433 Handling and Placing of Media (formerly 81.44)

- a. Material delivered to the filter site **is to** be stored on wooden planks or other approved clean, hard-surfaced areas.
- b. All material **is to** be rehandled at the filter site and no material **is to** be dumped directly into the filter.
- c. Crushed rock, slag and similar media **are to** be washed and rescreened or forked at the filter site to remove all fines.
- d. Such material **is to** be placed by hand to a depth of 12 inches above the tile underdrains and the remainder of material may be placed by means of belt conveyors or equally effective methods approved by the engineer.
- e. All material **is to** be carefully placed so as not to damage the underdrains.
- f. Manufactured media **is to** be handled and placed as approved by the engineer.
- g. Trucks, tractors or other heavy equipment **are not to** be driven over the filter during or after construction.

91.5 Underdrainage System (formerly 81.5)

91.51 Arrangement (formerly 81.51)

- a. Underdrains with semi-circular inverts or equivalent should be provided and the underdrainage system **are to** cover the entire floor of the filter.
- b. Inlet openings into the underdrains **are to** have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

91.52 Hydraulic Capacity (formerly 81.52)

- a. The underdrains **are to** have a minimum slope of 1 percent.
- b. Effluent channels **are to** be designed to produce a minimum velocity of 2 feet per second at average daily rate of application to the filter, **including recirculated flows.**

91.53 Ventilation (formerly 81.53)

- a. The underdrainage system, effluent channels and effluent pipe **are to** be designed to permit free passage of air.
- b. The design should consider installation of vent stacks on the filter periphery for additional ventilation.
- c. The size of drains, channels and pipes should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak **instantaneous flow**, including proposed or possible future recirculated flows.
- d. Forced ventilation should be provided for covered trickling filters to ensure adequate oxygen for process requirements.
- e. Windows or simple louvered mechanisms so arranged to ensure air distribution throughout the enclosure **are to** be provided.
- f. The design of the ventilation facilities **are to** provide for operator control of air flow in accordance with outside seasonal temperature.
- g. Design computations showing the adequacy of air flow to satisfy process oxygen requirements **are to** be submitted.

91.54 Flushing (formerly 81.54)

- a. Provision should be made for flushing the underdrains unless high rate recirculation is utilized.
- b. In small rock and slag filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes.
- c. Inspection facilities should be provided.

91.6 Special Features (formerly 81.6)**91.61 Flooding (formerly 81.61)**

Appropriate valves, sluice gates or other structures **are to** be provided to enable flooding of rock or slag media filters for filter fly control.

91.62 Freeboard (formerly 81.62)

- a. A freeboard of 4 feet or more should be provided for tall manufactured media filters to contain windblown spray.

- b. Provide at least 6 foot headroom for maintenance of the distributor on covered filters.

91.63 Maintenance (formerly 81.63)

All distribution devices, underdrains, channels and pipes are to be installed so that they may be properly maintained, flushed or drained.

91.64 Winter Protection (formerly 81.64)

Adequate protection, such as covers in severe climate or wind breaks in moderate climates, is to be provided to maintain operation and treatment efficiencies when climatic conditions are expected to result in problems due to cold temperatures.

91.65 Recirculation (formerly 81.65)

- a. The piping system is to be designed for recirculation as required to achieve the design efficiency.
- b. The recirculation rate is to be variable and subject to plant operator control between the range of one-half to four times the maximum monthly average flow.
- c. A minimum of two recirculation pumps are to be provided.

91.66 Recirculation Measurement (formerly 81.66)

- a. Devices are to be provided to permit measurement of the recirculation rate. Elapsed time meters and pump head recording devices are acceptable for facilities treating less than 1 MGD.
- b. The design of the recirculation facilities is to provide for both continuity of service and the range of recirculation ratios.
- c. Reduced recirculation rates for periods of brief pump outages may be acceptable depending on water quality requirements.

91.67 Ventilation Ports

The underdrainage ventilation ports are to be designed to ensure that the interior flow will be retained inside the trickling filter.

91.7 Rotary Distributor Seals (formerly 81.7)

- a. Mercury seals are not to be permitted.
- b. Ease of seal replacement is to be considered in the design to ensure continuity of operation.

91.8 Unit Sizing (formerly 81.3)

- a. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when sufficient amounts of industrial wastes are present.
- b. Trickling filter design is to consider design maximum day organic load conditions including the oxygen demands due to recycle flows (i.e., sludge dewatering filtrate, anaerobic digester supernatant, etc.) resulting from high concentrations of BOD₅ and TKN associated with such flows.
- c. The volume of media determined from either pilot plant studies or the use of acceptable design equations is to be based on the design maximum day BOD₅ loading rate rather than the design average BOD₅ rate. Refer to Paragraph 11.52.

91.9 Multi-Stage Filters (formerly 81.8)

The foregoing standards also apply to all multi-stage filters.

92. ACTIVATED SLUDGE (formerly 82)**92.1 General (formerly 82.1)****92.11 Applicability (formerly 82.11)****92.111 Biodegradable Wastes (formerly 82.111)**

- a. The activated sludge process and its various modifications may be used where wastewater to be treated is amenable to the aerobic biological treatment process.
- b. Effects of any industrial wastes and toxics present in the wastewater should be evaluated before selecting the activated sludge process. See Appendix B – Inhibitory Chemicals.

92.112 Operational Requirement (formerly 82.112)

The activated sludge process requires close attention and competent operating supervision, including routine laboratory testing for monitoring and process control. These requirements are to be considered when proposing this type of treatment.

92.113 Energy Requirements (formerly 82.113)

- a. The activated sludge process requires major energy usage to meet aeration demands.

- b. Energy costs and potential mandatory emergency public power reduction events in relation to critical water quality conditions must be carefully evaluated.
- c. Capability of energy usage phasedown while still maintaining process viability, both under normal and emergency energy availability conditions, must be included in the activated sludge design.

92.12 Specific Process Selection (formerly 82.12)

- a. The activated sludge process and its several modifications may be employed to accomplish varied degrees of removal of suspended solids and reduction of carbonaceous and/or nitrogenous oxygen demand.
- b. Choice of the process most applicable will be influenced by:
 - 1. the degree and consistency of treatment required,
 - 2. type of waste to be treated,
 - 3. proposed plant size,
 - 4. anticipated degree of operation and maintenance, and
 - 5. operating and capital costs.
- c. All designs are to provide for flexibility in operation.
- d. All designs are to facilitate easy conversion to various operation modes.

92.13 Winter Protection (formerly 82.13)

In severe climates, protection against freezing is to be provided to ensure continuity of operation and performance. Insulation of tanks by earthen banks should be considered.

92.2 Pretreatment (formerly 82.2)

- a. Where primary settling tanks are not used, effective removal or exclusion of grit, debris, excessive oil or grease, and screening of solids is to be accomplished prior to the activated sludge process. Screening devices with clear openings of ¼ inch or less are to be provided.
- b. Where primary settling is used, provision is to be made for discharging raw wastewater directly to the aeration tanks to facilitate plant start-up and operation during the initial stages of the plant's design life.

92.3 Aeration (formerly 82.3)

92.31 Capacities and Permissible Loadings (formerly 82.31)

- a. The size of the aeration tank for any particular adaptation of the process is to be determined by full-scale experience, pilot plant studies, or rational calculations based mainly on solids retention time, food to microorganism ratio and mixed liquor suspended solids levels. Other factors such as size of treatment plant, diurnal load variations and degree of treatment required are to also be considered. In addition, temperature, alkalinity, pH and reactor dissolved oxygen are to be considered when designing for nitrification.
- b. Calculations should be submitted to justify the basis for design of aeration tank capacity.
- c. For facilities designed to accommodate future growth, provisions are to be made for ensuring appropriate aeration tank size for current loadings.
- d. Calculations using process design values differing substantially from those in the accompanying table should reference actual operating plants.
- e. Mixed liquor suspended solids levels greater than 5,000 mg/L may be allowed provided that adequate data is submitted that shows the aeration and clarification system is capable of supporting such levels.
- f. When process design calculations are not submitted, the aeration tank capacities and permissible loadings for the several adaptations of the processes shown in the following table are to be used. These values apply to plants receiving peak to average diurnal load ratios of design peak hourly BOD₅ to design average BOD₅ ranging from about 2:1 to 4:1. Thus, the utilization of flow equalization facilities to reduce the diurnal organic load may be considered by DEP as justification to approve organic loading rates that exceed those specified in the table.

PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS

(Note: For Proper Use of This Table, See Paragraph 92.31)

Process	Mode of Aeration	Minimum Aeration Retention Period - Hours (based on maximum monthly average flow)	Maximum Aeration Tank Organic Loading - lb. BOD ₅ /1000 cu.ft./day ⁵	F/M Ratio lb. BOD ₅ /lb. MLVSS/day	MLSS mg/liter
Conventional Step Aeration Complete Mix	Air System	6	40	0.2 – 0.5	1,000 – 3,000
	Pure Oxygen System	2	160	0.3 – 1.0	3,000 – 5,000
Contact Stabilization	Air System	5 ¹	60	0.2 – 0.6	1,000 – 3,000
Single Stage Nitrification ²	Air System	12	20	0.08 – 0.16	2,000 – 5,000
	Pure Oxygen System	4	60	0.10 – 0.20	3,000 – 5,000
Extended Aeration and Oxidation Ditches	Air System	24	15	0.05 – 0.1	3,000 – 5,000
Carbonaceous Stage of Separate Stage Nitrification	Air System	4	70	0.3 – 0.8	1,000 – 2,500
	Pure Oxygen System	1.5	250	0.5 – 1.0	3,000 – 5,000
Nitrification Stage of Separate Stage Nitrification	Air System	6	10 ³	0.05 – 0.20 ⁴	1,000 – 3,000
	Pure Oxygen System	2	25 ³	0.08 – 0.20 ⁴	3,000 – 5,000

¹ Total aeration capacity, includes both contact and reaeration capacities. Normally the contact zone equals 30 to 35 percent of the total aeration capacity.

² Not recommended if wastewater temperatures are expected to fall below 10°C.

³ Lb. NH₃-N/1000 cu. ft./day

⁴ Lb. NH₃-N/lb. MLVSS/day

⁵ Based on the maximum daily BOD₅ load to the aeration tank.

Note: In designing nitrogen reduction systems with biological processes, provisions are to be made for providing 10 mg/L of alkalinity per 1 mg/L of nitrogen reduced.

92.32 Arrangement of Aeration Tanks (formerly 82.32)**92.321 General Tank Configuration (formerly 82.321)**

a. Dimensions

1. The dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank are to be such as to maintain effective mixing and utilization of air.
2. Ordinarily, liquid depths should not be less than 10 feet or more than 30 feet except in special design cases such as oxidation ditch design.
3. **Horizontally mixed aeration tanks are to have a depth of not less than 5.5 feet.**

b. Short-Circuiting

For very small tanks or tanks with special configuration, the shape of the tank, the location of the influent and sludge return and the installation of aeration equipment should provide for positive control to prevent of short-circuiting of the wastewater through the tank.

92.322 Number of Units (formerly 82.322)

- c. Consideration should be given to dividing the required aeration tank volume into two or more units at all plants.
- d. For plants designed to receive maximum monthly average flow of 50,000 gpd or more, the total aeration tank volume is to be divided among two or more units capable of independent operation to meet applicable effluent limitations and reliability guidelines.

92.323 Inlets and Outlets (formerly 82.323)

a. Controls

1. Inlets and outlets for each aeration tank unit are to be suitably equipped with valves, gates, stop plates, weirs or other devices that allow for flow control to any unit and to maintain a reasonably constant liquid level.
2. **The effluent weir for a horizontally mixed aeration tank system is to be easily adjustable by mechanical means and**

is to be sized based on the design peak instantaneous flow plus the maximum return sludge flow. Refer to Paragraph 73.31.

3. The hydraulic properties of the system are to be designed to permit the peak instantaneous flow, including the maximum sludge return flow, to be carried with any single aeration tank unit out of service.

b. Conduits

1. Channels and pipes carrying liquids with solids in suspension are to be designed to maintain self-cleansing velocities or are to be agitated to keep such solids in suspension at all rates of flow within the design limits.
2. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

92.324 Freeboard (formerly 82.324)

- a. All aeration tanks should have a freeboard of not less than 18 inches.
- b. Where a mechanical surface aerator is used, the freeboard should be not less than 3 feet to protect against windblown spray freezing on walkways.

92.325 Froth Spray (formerly 82.325)

- a. Use of a froth spray system to cut down the foam in the aeration tank should be considered.
- b. The froth spray pump(s) should preferably be located in the chlorine contact tank to prevent clogging of nozzles.
- c. The froth spray lines in the aeration tank should point perpendicular to the flow.

92.326 Oxidation Ditches (formerly 82.326)

a. Depth

1. The maximum liquid depth in the ditch is to be 12 feet for vertical sidewalls and 6 feet for sloping sidewalls.

2. Large ditches should have at least two bottom drains for ease of emptying and cleaning.
3. For ditches greater than 6 feet deep, consideration should be given to placing baffles within 15 feet downstream of aerators to provide proper mixing of the entire depth of the channel.

b. Inlet/Outlet

1. The raw wastewater inlet and return sludge flow **are to be** located immediately upstream from the first brush (rotor).
2. The outlet or overflow weir device **is to be** located between the last brush and the inlet of each ditch.

c. Brushes

1. Rotors or brushes are used to provide surface aeration for oxygen transfer and to keep the contents of the ditch mixed and moving.
2. A velocity of the liquid in the ditch must be maintained at 1.0 to 1.5 feet per second to prevent the settling of solids.
3. There **are to be** a minimum of two brushes per ditch for oxygen control and for continued operation should a brush have a mechanical breakdown.
4. With one brush out of service, adequate aeration and velocity **are to be** maintained by the remaining brushes through the sizing of the brushes and controlling the submergence.
5. Consideration should be given regarding the use of a variable speed motor controller to optimize process performance and minimize electrical consumption.
6. Consideration should be given in the colder areas to cover both the brush and motor drive units to prevent an ice buildup problem at the two ends of the brush shaft.

d. Weirs

Each ditch **is to** have an easily adjustable effluent control weir to

vary the brush depth submergence in order to vary the amount of oxygen transfer.

- e. Clarifiers following ditches should have both mechanical sludge scrapers and scum skimmers with baffle to prevent solids/scum carryover due to no primary clarifiers. They should also have a positive means of sludge return to the ditch or wasting, along with a means of sludge return measurement.
- f. The entire ditch **is to** be lined with an impervious material to prevent erosion and scouring by the liquid velocity in the ditch.
- g. Provisions **are to** be made to prevent surface runoff from entering the ditch.

92.33 Aeration Equipment (formerly 82.33)

92.331 General (formerly 82.331)

- a. Oxygen requirements generally depend on maximum diurnal organic loading, degree of treatment and level of suspended solids concentration to be maintained in the aeration tank mixed liquor.
- b. Aeration equipment **is to** be capable of maintaining a minimum of 2.0 mg/L of DO in the mixed liquor at all times and providing thorough mixing of the mixed liquor.
- c. In the absence of experimentally determined values, the design oxygen requirements for all activated sludge processes **are to** be 1.1 lbs. oxygen/lb. **peak hourly** BOD₅ applied to the aeration tanks, with the exception of the extended aeration process, for which the value **are to** be 1.5 lbs. oxygen/lb. **peak hourly** BOD₅ to include endogenous respiration requirements.
- d. In the case of nitrification, the oxygen requirement for oxidizing ammonia must be added to the above requirement for carbonaceous BOD₅ removal and endogenous respiration requirements. The nitrogenous oxygen demand **is to** be taken as 4.6 times the **diurnal peak hourly TKN** ammonia content of the influent to the aeration tank.
- e. The oxygen demands due to recycle flows (heat treatment supernatant, filtrate from dewatering operations, elutriates, etc.) must be considered due to the high concentrations of BOD₅ and ammonia associated with such flows.

- f. Careful consideration should be given to maximizing oxygen utilization per unit power input. Unless flow equalization is provided, the aeration system should be designed to match the diurnal organic load variation while economizing on power input. Refer to Paragraph 92.31.
- g. Consideration should be given regarding the use of a variable speed motor controller to optimize process performance and minimize electrical consumption.

92.332 Diffused Air Systems (formerly 82.332)

The design of the diffused air system is to be performed by either of the two methods described below in (a) or (b) and augmented as required by considerations of items (c) through (h).

- a. Having determined the oxygen requirements per Paragraph 92.331, air requirements for a diffused air system are to be determined by use of any of the well-known equations incorporating such factors as:
 - 1. Tank depth;
 - 2. Alpha factor of wastewater;
 - 3. Beta factor of wastewater;
 - 4. Certified aeration device oxygen transfer efficiency;
 - 5. Minimum aeration tank dissolved oxygen concentration;
 - 6. Critical wastewater temperature; and
 - 7. Altitude of plant.

In the absence of experimentally determined alpha and beta factors, wastewater transfer efficiency is to be assumed to be **not greater than 50 percent** of clean water oxygen transfer efficiency for plants treating primarily (90 percent or greater) domestic wastewater. Treatment plants where the waste contains higher percentages of industrial wastes are to use a correspondingly lower percentage of clean water efficiency and are to have calculations submitted to justify such a percentage. The design transfer efficiency should be included in the specifications.

- b. Minimum air requirements for all activated sludge processes (excluding nitrogenous oxygen demand) except extended aeration (assuming equipment capable of transmitting to the mixed liquor the amount of oxygen required in Paragraph 92.331) is to be considered to be 1,500 cu. ft. per pound of peak hourly BOD₅ aeration tank loading at standard conditions of pressure, temperature and humidity. For the extended aeration process, the

value is to be 2,050 cu. ft. per pound of peak hourly BOD₅ aeration tank loading at standard conditions of pressure, temperature and humidity. These requirements include mixing but do not include oxygen demand for nitrification. Refer to Paragraph 92.331.

- c. The air required for channels, air lifts, aerobic digesters or other air-use demand is to be added to the air requirements calculated above.
- d. The specified capacity of blowers or air compressors, particularly centrifugal blowers, should take into account that the air intake temperature may reach 115°F or higher, and the pressure may be less than normal. The specified capacity of the motor drive should also take into account that the intake air may be -20°F or less and may require oversizing of the motor or a means of reducing the rate of air delivery to prevent overheating or damage to the motor.
- e. All blowers and electrical controls are to be located in a building or a heated, walk-in enclosure.
- f. The blowers are to be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand with the single largest unit out of service.
- g. The design is to provide for varying the volume of air delivered in proportion to the load demand of the plant.
- h. The use of timers to conserve energy is acceptable, provided necessary minimum DO level is maintained in the aeration tank.
- i. Aeration equipment is to be easily adjustable in increments and are to maintain solids in suspension within these limits. Step type proportioning is acceptable.
- j. Diffuser systems are to be capable of providing for the diurnal peak oxygen demand or 200 percent of the design average day oxygen demand, whichever is larger.
- k. The air diffusion piping and diffuser system are to be capable of delivering normal air requirements with minimal friction losses.
- l. Air piping systems should be designed such that total air loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 psi at normal operating conditions.
- m. The spacing of diffusers should be in accordance with the oxygen

requirements through the length of the channel or tank, and should be designed to facilitate adjustment of their spacing without major revision to air header piping.

- n. Diffusers should be located 1 to 2 feet from the bottom of the tank when operating.
- o. All plants employing less than four independent aeration tanks **are to** be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tank. However, use of fixed diffusers may be approved on a case-by-case basis if it is demonstrated that the built-in design and/or operational flexibility can keep the facility in compliance when one of the tanks is out-of-service or not in operation due to maintenance.
- p. Individual assembly units of diffusers **are to** be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff.
- q. Diffusers in any single assembly **are to** have substantially uniform pressure loss.
- r. Air filters **are to** be provided in numbers, arrangements and capacities to furnish at all times an air supply sufficiently free from dust to prevent damage to blowers and clogging of the diffuser system used.

92.333 Mechanical Aeration Systems (formerly 82.333)

- a. Oxygen Transfer Performance
 - 1. The mechanism and drive unit **are to** be designed for the expected conditions in the aeration tank in terms of the power performance. Certified on-line testing **is to** verify mechanical aerator performance based on similar geometrical tank design. Refer to applicable **provisions of Paragraph 92.332**.
 - 2. In the absence of specific design information, the oxygen requirements **are to** be calculated using a transfer rate not to exceed 2 lbs. of oxygen per horsepower per hour in clean water at standard conditions.
 - 3. Design transfer efficiency **is to** be included in the specifications.

b. Design Requirements

A mechanical aeration system is to accomplish the following:

- (1) Maintain a minimum of 2.0 mg/L of dissolved oxygen in the mixed liquor at all times throughout the tank or basin.
- (2) Maintain all biological solids in suspension (for a horizontally mixed aeration tank system an average velocity of 1 foot per second is to be maintained).
- (3) Meet maximum oxygen demand and maintain process performance with the largest unit out of service.
- (4) Provide for varying the amount of oxygen transferred in proportion to the load demand on the activated sludge process.
- (5) Provide that motors, gear housing, bearings, grease fittings, etc. be easily accessible and protected from inundation and spray as necessary for proper functioning of the unit.

c. Winter Protection

Where extended cold weather conditions occur, the aerator mechanism and associated structure are to be protected from freezing due to splashing and spray. Due to high heat loss, subsequent treatment units are to be protected from freezing.

92.4 Biological Nutrient Removal

Biological Nutrient Removal (BNR) processes may be approved at the discretion of the reviewing authority on a case-by-case basis under the provisions of Paragraph 53.2. Many proprietary BNR systems are available and vendors should be consulted for design details. The design is to meet the applicable requirements under Chapters 50, 70 and 90, except as modified in this Paragraph.

All BNR designs are to provide for flexibility in operation and should provide for operation in various modes, if feasible. Vital components for internal mixed liquor recycle and mechanical mixing systems are to meet the guidelines for continuity of treatment established by the reviewing authority.

Due to the advanced level of treatment associated with BNR, facilities are to evaluate the need for increased process control testing and/or the use of automated process monitoring equipment.

The use of Oxidation Reduction Potential (ORP) probes is to be considered for both biological phosphorus and nitrogen removal processes.

92.41 Definitions

The following terms are to be used by the design engineer to describe biological nutrient removal processes in an Engineering Report or Facility Plan.

a. Aerobic (or Oxidic) Condition

A condition in which free and dissolved oxygen is available in an aqueous environment.

b. Anoxic Condition

A condition in which oxygen is only available in a combined form, such as nitrate (NO_3^-), nitrite (NO_2^-), or sulfate (SO_4^{--}), in an aqueous environment.

c. Anaerobic Condition

A condition in which free, dissolved and combined oxygen are not available in an aqueous environment.

92.42 Biological Phosphorus Removal

A number of process configurations for enhanced biological phosphorus removal (BPR) have been developed as alternatives to phosphorus removal by chemical treatment (outlined in Section 111). BPR microorganisms incorporate phosphorus into their cell mass in excess of their metabolic requirements, allowing them to remove phosphorus from wastewater. Exposure of activated sludge microorganisms to alternating anaerobic and aerobic conditions allows BPR microorganisms to proliferate in numbers sufficient to remove phosphorus.

The design is to ensure that readily biodegradable organic matter in sufficient quantities is available in an anaerobic environment to promote the growth of BPR microorganisms. The amount of readily biodegradable organic matter can be increased by fermentation of wastewater or sludge or by the addition of a supplemental carbon source such as methanol or acetic acid.

To create truly anaerobic conditions, both oxygen and nitrate are to be excluded. Many BPR configurations include the denitrification process to limit the nitrate concentration in anaerobic zones.

Sludge containing the excess phosphorus from the BPR microorganisms can be wasted, or the excess phosphorus can be removed from the sludge by a sidestream

treatment process. The BPR process may require chemical treatment as a backup system or for polishing to achieve very low effluent phosphorus levels. The BPR process is often combined with nitrification and denitrification processes.

92.43 Biological Nitrogen Removal

Biological nitrogen removal is accomplished by biological oxidation of ammonia to nitrate (nitrification) followed by biological denitrification of nitrate to nitrogen gas.

92.431 Nitrification

Biological nitrification is used to remove ammonia to meet effluent requirements or as the first step in nitrogen removal. Ammonia is oxidized to nitrite and then to nitrate by nitrifying bacteria in an aerobic environment. Nitrification consumes alkalinity.

Nitrification can be achieved with either a single stage nitrification process (combined carbonaceous oxidation and nitrification) or with a separate stage nitrification process. In each case, suspended growth, attached growth or hybrid systems can be used. Temperature, alkalinity, pH and dissolved oxygen are to be considered in nitrification design.

92.432 Denitrification

Denitrification is the biological process where bacteria convert nitrate to nitrogen gas under anoxic conditions. Denitrification generates alkalinity and therefore restores some of the alkalinity consumed during nitrification.

A soluble carbon source is required to drive the denitrification process. The carbon requirements for denitrification may be provided by influent wastewater or by an external source such as methanol.

92.44 Combined Biological Nitrogen and Phosphorus Removal

A number of BNR processes have been developed for the combined removal of nitrogen and phosphorus. Many of these are proprietary and use a form of the activated sludge process. Combinations of anaerobic, anoxic and aerobic zones or compartments are designed to accomplish biological nitrogen and phosphorus removal.

93. WASTEWATER TREATMENT PONDS (formerly 85)

93.1 General (formerly 85.1)

93.11 Applicability

The use of wastewater treatment ponds should be considered in those instances where the required level of wastewater treatment is compatible with pond technology and where adverse environmental impacts can be avoided. Each proposal to use ponds will be evaluated in light of the effects of the proposed discharge on water quality (both surface and groundwater), including ability to meet the effluent requirements on a consistent basis and any other considerations necessary to protect the public health.

This Section deals with generally used variations of treatment ponds capable of achieving secondary treatment including controlled-discharge pond systems, flow-through pond systems and aerated pond systems. Ponds utilized for equalization, percolation, evaporation, and sludge storage are not discussed in this Section. The term “pond” is used in this Section to include the total earthen treatment facility and the term “cell” is used to designate the individual units of the total facility.

Due to Pennsylvania’s experience with wastewater treatment ponds in cold weather, that a supplemental treatment unit will likely be required to meet typical ammonia-nitrogen permit limits during cold weather months.

93.12 Design Engineer’s Report (formerly 85.2)

- a. The Design Engineer’s Report is to contain pertinent information on location, geology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed project.
- b. The following information must be submitted in addition to that required in Chapter 10.
- c. As all biological processes produce waste sludge, provisions for the monitoring of sludge levels and removal of sludge upon reaching a predetermined level are required.

93.13 Supplementary Field Survey Data (formerly 85.21)

- a. The location and direction of all residences, commercial developments, parks, recreational areas and water supplies, within ½ mile of the proposed pond are to be included in the Design Engineer’s Report.
- b. Land use zoning adjacent to the proposed pond site is to be included.
- c. A description, including maps showing elevations and contours of the site and adjacent area, is to be provided.
 1. Due consideration is to be given to additional treatment units to

meet any applicable discharge standards and/or increased waste loadings in determining land requirements.

2. Current USGS and Soil Conservation Service maps may be considered adequate for preliminary evaluation of the proposed site.
- d. The location, depth and discharge point(s) of any field tiles in the immediate area of the proposed site **are to** be identified.
- e. Data from soil borings conducted by a soil testing laboratory to determine subsurface soil characteristics and groundwater characteristics, including elevation and flow of the proposed site and their effect on the construction and operation of a pond, **are to** be provided.
 1. At least one boring **is to** be a minimum of 25 feet in depth or into bedrock, whichever is shallower.
 2. If bedrock is encountered, structure and corresponding geological formation data should be provided.
 3. The boring **is to** be filled and sealed.
 4. The permeability characteristics of the pond bottom and pond seal materials **are also to** be studied. (Refer to Paragraph **93.422**)

93.14 Pond Types and Classification

93.141 Pond Types

The wastewater treatment ponds are basically grouped into the following two types based on discharge method.

- a. Flow through ponds in which the pond discharges relatively continuously throughout the year; and
- b. Controlled discharge ponds in which the pond is designed to retain the wastewater without discharge for a long period and discharge it over a short period.

93.142 Pond Classification

The wastewater treatment ponds are broadly classified as aerobic, anaerobic and facultative.

- a. Aerobic ponds are characterized by having DO distributed throughout

their contents practically all of the time. The required oxygen may be supplied by algae during daylight, and by mechanical or diffused aeration.

- b. Anaerobic ponds usually are without any DO throughout their entire depth. The treatment depends on fermentation of sludges at the bottom. This process can be quite odorous and is generally not utilized for treating domestic wastewater.
- c. Facultative ponds are the most common type used in treating domestic wastewater. The upper layer of these ponds is aerobic, while the bottom layer is anaerobic. Algae supply most of the required oxygen to the upper layer. Aeration of the upper layer to dissolve and mix oxygen in the wastewater may also be required.

93.2 Location (formerly 85.22)

93.21 Distance from Habitation (formerly 85.221)

A pond site should be located as far away as practicable from habitation or any area which may be built up within a reasonable future period, taking into consideration site specifics such as topography, prevailing winds, forests, etc.

93.22 Prevailing Winds (formerly 85.222)

If practicable, unaerated ponds **are to** be located so that local prevailing winds will be in the direction of uninhabited areas.

93.23 Surface Runoff (formerly 85.223)

Adequate provisions must be made to divert stormwater **runoff** around the ponds to prevent excess hydraulic loading and protect pond embankments from erosion.

93.24 Groundwater Separation (formerly 85.224)

- a. Construction of ponds in close proximity to public and/or private groundwater supplies subject to contamination **is to** be avoided.
- b. A minimum separation of 4 feet between the **bottom of the pond** and the maximum **ground water elevation** should be maintained.

93.25 Bedrock Separation (formerly 85.225)

- a. Ponds **are not to** be located in areas which may be subject to sink holes or solution channeling generally occurring in areas underlain by limestone or dolomite.

- b. A minimum separation of 10 feet between the pond bottom and any bedrock formations is recommended.

93.3 Basis of Design (formerly 85.4)

93.31 Area and Loading for Controlled Discharge Facultative Treatment Pond Systems (formerly 85.41)

- a. Pond design for BOD₅ loading should range from 15 to 35 pounds per acre per day at the mean operating depth in the primary cells. Refer to Paragraph 11.512.
- b. A minimum of ~~90~~ 180 days detention time between the minimum and the maximum operating depth of the entire pond system should be provided, as described in Paragraph 93.416.
- c. The mean operating depth can be calculated as the maximum operating depth plus minimum operating depth divided by two.
- d. The detention time and organic loading rate are to depend on climatic condition and effluent requirements.

93.32 Area and Loadings for Flow-Through Facultative Treatment Ponds Systems (formerly 85.42)

- a. Pond design for design average BOD₅ loading should vary from 15 to 35 pounds per acre per day for the primary cells. Refer to Paragraph 11.52. The major design considerations for BOD₅ loading must be directly related to the climatic conditions.
- b. Design variables such as pond depth, multiple units, detention time and additional treatment units must be considered with respect to applicable standards for BOD₅, total suspended solids (TSS), fecal coliforms, nutrients, DO and pH.
- c. A detention time of 90-120 days for the entire pond system should be provided; however, this must be properly related to other design considerations. It should be noted that the major factor in the design is the duration of the cold weather period [water temperature less than 40°F].

93.33 Aerated Treatment Pond Systems (formerly 85.43)

- a. For the development of final design parameters, it is recommended that actual experimental data be obtained. However, the aerated treatment pond system design for minimum detention time may be estimated using the following formula, applied separately to each aerated cell:

$$t = \frac{E}{2.3k_1 \times (100 - E)}$$

Where:

t = hydraulic detention time, days

E = percent of BOD₅ to be removed in an aerated cell

k_1 = reaction coefficient, aerated pond, base 10. For normal domestic wastewater, the k_1 value may be assumed to be 0.12/day at 68°F and 0.06/day at 34°F.

- b. The reaction rate coefficient for wastewater to be treated, which may include domestic and nondomestic wastewater, must be determined experimentally for various conditions which might be encountered in the aerated pond cells. Conversion of the reaction rate coefficient at temperatures other than 20°C is to be based on empirical data.
- c. The design should consider the effect of any return sludge. Additional storage volume for 20 years of operation should be considered for sludge and for ice cover.
- d. Oxygen requirements generally will depend on the BOD₅ loading, the degree of treatment and the concentration of suspended solids to be maintained. Aeration equipment is to be capable of maintaining a minimum dissolved oxygen level of 2 mg/L in the ponds at all times.
- e. Sizing of the aeration equipment is to be based on the larger of the following:
 - 1. mixing requirements; or
 - 2. oxygen requirements using summertime kinetics, including allowance for nitrification.

See Paragraph 92.33 for details on aeration equipment.
- f. Aerated ponds should be designed to achieve complete mixing.
- g. Suitable protection is to be provided for electrical controls.
- h. Aerated pond cells are to be followed by a polishing cell with a volume of at least 0.3 of the total volume of the aerated cells.

93.34 Industrial Wastes (formerly 85.44)

- a. Consideration are to be given to the type and effects of industrial wastes on the treatment process. In some cases it may be necessary to pretreat

industrial or other discharges.

- b. Industrial wastes **are not to** be discharged to ponds without assessment of the effects such wastes may have upon the treatment process or discharge requirements in accordance with state and federal laws.

93.35 Number of Cells **Required** (formerly 85.45)

93.351 General

- a. At a minimum, a pond system should consist of three cells designed to facilitate both series and parallel operations.
- b. The maximum size of a pond should be 40 acres.
- c. Two-cell systems may be utilized in very small installations having a flow of 50,000 gpd or less.
- d. All systems should be designed with piping flexibility to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system.
- e. **The piping should be arranged such that effluent from any primary cell cannot be discharged directly to the receiving stream.**
- f. The ability to discharge the influent waste load to a minimum of two cells and/or all primary cells in the system should be provided.

93.352 Controlled Discharge Facultative Treatment Pond Systems (formerly 85.451)

- a. The area specified as the primary cell(s) should be equally divided into two cells.
- b. The third cell or secondary cell volume should, **as a minimum, be equal to the volume of each of the primary cells.**
- c. The design should permit for adequate elevation difference between primary and secondary cells to permit gravity filling of the secondary from the primary. Where this is not feasible, pumping facilities **are to** be provided.

93.353 Flow-Through Facultative Treatment Pond Systems (formerly 85.452)

- a. At a minimum, primary cell(s) **are to** provide adequate detention

time to maximize BOD₅ removal.

- b. Secondary cell(s) should be provided for additional detention time with depths up to 8 feet to facilitate solids reduction.
- c. Design should also consider recirculation within the system.

93.354 Aerated Treatment Pond Systems (formerly 85.453)

- a. A minimum of two aerated cells, plus a polishing cell, are required.
- b. A tapered mode of aeration is recommended.
- c. The first two aerated cells should be of equal size and no one aerated cell should provide more than 50 percent of the total required volume.
- d. When utilizing wastewater by method of spray irrigation, aerated ponds are recommended, followed by an unaerated storage pond.

93.36 Pond Shape (formerly 85.46)

- a. The shape of all cells is to be such that there are no narrow or elongated portions.
- b. Round, square or rectangular cells with a length not exceeding three times the width are considered most desirable.
- c. No islands, peninsulas or coves are to be permitted.
- d. Dikes are to be rounded at corners to minimize accumulations of floating materials.
- e. Common-wall dike construction whenever possible is strongly encouraged.

93.37 Additional Treatment (formerly 85.47)

Consideration should be given in the design stage to the utilization of additional treatment units as may be necessary to meet applicable discharge standards.

93.34 Pond Construction Details (formerly 85.5)

93.41 Embankments and Dikes (formerly 85.51)

93.411 Material (formerly 85.511)

- a. Dikes **are to** be constructed of relatively impervious material and compacted to at least **95** percent Standard Proctor Density to form a stable structure.
- b. Vegetation and other unsuitable materials **are to** be removed from the area where the embankment is to be placed.

93.412 Top Width (formerly 85.512)

The minimum dike top width **is to** be 10 feet to permit access of maintenance vehicles.

93.413 Maximum Slopes (formerly 85.513)

Inner and outer dike slopes **are not to** be steeper than three horizontal to one vertical (3:1).

93.414 Minimum Slopes (formerly 85.514)

- a. Inner slopes should not be flatter than four horizontal to one vertical (4:1). Flatter slopes can be specified for larger installations because of wave action but have the disadvantage of added shallow areas being conducive to emergent vegetation.
- b. Outer slopes **are to** be sufficient to prevent surface runoff from entering the ponds.

93.415 Freeboard (formerly 85.515)

Minimum freeboard **is to** be 3 feet. For systems having maximum monthly average flow of 50,000 gpd or less, 2 feet may be acceptable.

93.416 Design Depth (formerly 85.516)

- a. General
 - i. The minimum operating depth should be sufficient to prevent growth of aquatic plants and damage to the dikes, bottom, control structures, aeration equipment, **aeration equipment**, and other appurtenances due to freezing and erosion.
 - ii. In no case **is** the minimum operating depth **to** be less than 2 feet.

- b. Controlled Discharge and Flow-Through Facultative Treatment Ponds
 - i. The maximum water depth **is to** be 6 feet in primary cells.
 - ii. Greater depths in subsequent cells are permissible although supplemental aeration or mixing may be necessary.
- c. Aerated Treatment Pond Systems

The design water depth **is to** be 10-15 feet. This depth limitation may be altered depending on the aeration equipment, waste strength and climatic conditions.

93.417 Erosion Control (formerly 85.57)

A justification including detailed discussion of the method of erosion control which encompasses all relative factors such as pond location and size, seal material, topography, prevailing winds, runoff, **cost breakdown, application procedures**, etc. **are to** be provided.

- a. Seeding
 - a. The dikes **are to** have a cover layer of at least 4 inches of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap is not utilized.
 - b. Prior to prefilling (in accordance with **Paragraph 93.426**), adequate vegetation **is to** be established on dikes from the outside toe **2 feet above the pond bottom on the interior as measured on the slope**.
 - c. Perennial-type, low-growing, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding of dikes. In general, alfalfa and other long-rooted crops should not be used for seeding since their roots are apt to impair the water holding efficiency of the dikes.
- b. Additional Erosion Protection
 - a. Riprap or some other acceptable method of erosion control is required at a minimum around all piping entrances and exits.
 - b. For aerated cells, the design should ensure erosion

protection on the slopes and bottoms in the areas where turbulence will occur.

- c. Additional erosion control may also be necessary on the exterior dike slope to protect the embankment from erosion due to severe flooding of a water course.

- c. Alternate Erosion Protection

Alternate erosion control on the interior dike slopes may be necessary for ponds which are subject to severe wave action. In these cases, riprap or an acceptable equal **is to** be placed from **at least** 1 foot above the high water mark to 2 feet below the low water mark (measured on the vertical).

93.42 Pond Bottom (formerly 85.52)

93.421 Soil

- a. The soil used to construct the pond bottom (not including the seal and dike cores **is to** be relatively incompressible, tight, and compacted at or up to 4 percent above the optimum water content to at least 95 percent Standard Proctor Density.
- b. The pond bottom **is to** be as level as possible at all points and
- c. The pond bottom **is to** be at least 4 feet above the high groundwater table.

93.422 Seal (formerly 85.531)

- a. Ponds **are to** be sealed in such a manner that seepage losses through the pond sides and bottom are minimized.
- b. Sealing methods using on-site soils, bentonite or other types of synthetic liners may be approved if it can be demonstrated that the proposed sealing method will be sufficiently impermeable and will remain structurally sound during all anticipated working conditions.
- c. **Results of a testing program which substantiates the adequacy of the proposed seal are to be incorporated into and/or accompany the engineering report.**
- d. **Standard ASTM International procedures or acceptable similar methods are to be used for all tests.**

- e. To achieve an adequate seal in pond systems using soil, bentonite, or other seal materials, the hydraulic conductivity (k) in centimeters per second specified for the seal is not to exceed the value derived from the following expression, where L equals the thickness of the seal in centimeters.

$$k = 2.6 \times 10^{-9} L$$

The " k " obtained by the above expression corresponds to a percolation rate of pond water of less than 500 gallons per day per acre at a water depth of 6 feet and a liner thickness of 1 foot, using the Darcy's law equation.

- f. For a seal consisting of a synthetic liner, seepage loss through the liner is not to exceed the quantity equivalent to seepage loss through an adequate soil seal.

93.423 Uniformity

The pond bottom is to be as level as possible at all points. Finished elevations are not to be more than 3 inches from the average elevation of the bottom.

93.424 Liner Materials (formerly 85.532)

- a. Bentonite and other forms of synthetic liners are to be designed and constructed in accordance with manufacturers' recommendations.
- b. The project engineer is to confirm the physical-chemical compatibility of the lining material with the wastewater being treated (with particular emphasis on any industrial wastes which may be present).
- c. Flexible membrane liners are to have a minimum thickness of 0.030 inches or 30 mills.

93.425 Groundwater Monitoring and Leak Detection (formerly 85.533)

- a. A means of monitoring ambient groundwater quality before and during pond operation are to be provided.
- b. A minimum of one groundwater observation point is to be located in close proximity to the pond system to intercept the groundwater table at a location downgradient from the pond system (in each

major groundwater flow direction).

- c. The following types of groundwater observation points may be acceptable depending upon local conditions.
 - a. New or existing wells
 - b. Springs
 - c. Well points or lysimeters
 - d. Rock-lined test pits or trenches
- d. Leak-detection mechanisms such as underdrain systems or soil-resistivity sensing devices will be acceptable as alternatives to the above-mentioned groundwater observation points.

93.426 Prefilling (formerly 85.534)

Prefilling the pond should be considered in order to protect the liner, to prevent weed growth, to reduce odor and to maintain the moisture content of the seal. However, the dikes must be completely prepared as described in **Paragraphs 93.417 (a) and (b)** before the introduction of water.

93.43 Influent Lines (formerly 85.54)

93.431 Material (formerly 85.541)

- a. Generally accepted material for underground sewer construction should be given consideration for the influent line to the pond.
- b. Unlined corrugated metal pipe should be avoided due to corrosion problems. Other materials selected **are to** be suited to local conditions.
- c. In material selection, consideration must be given to the **characteristics** of the wastes, exceptionally heavy external loadings, abrasion, soft foundations, **buoyancy** and similar problems.

93.432 Manhole (formerly 85.542)

- a. A manhole or vented cleanout wye **is to** be installed prior to entrance of the influent line into the primary cell(s).
- b. The manhole **is to** be located as close to the dike as topography permits.
- c. The invert **is to** be at least 6 inches above the maximum operating

level of the pond.

- d. The invert **is to** provide sufficient hydraulic head without surcharging the manhole.

93.433 Flow Distribution (formerly 85.543)

Flow distribution structures **are to** be designed to effectively split hydraulic and organic loads equally to primary cells.

93.434 Placement (formerly 85.544)

- a. Influent lines may be located along the bottom of the pond with the top of the pipe just below the average upper elevation of the pond seal or liner.
- b. The full seal depth **is to** be maintained below the bottom of the pipe and throughout the transition area from the bottom of the pipe to the pond bottom.
- c. In situations where pipes penetrate the pond seal, provisions to prevent seepage (such as anti-seep collars) **are to** be made.

93.435 Point of Discharge (formerly 85.545)

- a. All primary cells **are to** have individual influent lines which terminate at the midpoint of the width and at approximately two-thirds the length away from the outlet structure so as to minimize short-circuiting.
- b. Consideration should be given to multi-influent discharge points for large primary cells (20 acres or larger) to enhance distribution of load on the cell.
- c. All aerated cells **are to** have influent lines which distribute the load within the mixing zone of the aeration equipment. Consideration of multi-inlets should be closely evaluated for any diffused aeration systems.

93.436 Influent Discharge Apron (formerly 85.546)

- a. The influent line(s) **is to** discharge horizontally into a shallow saucer-shaped depression.
- b. The ends of the discharge lines **are to** rest on a suitable concrete apron large enough such that the terminal influent velocity at the

end of the apron does not cause soil erosion.

- c. A minimum size apron of 2 feet square **is to** be provided.

93.44 Control Structures and Interconnecting Piping (formerly 85.55)

93.441 Structure (formerly 85.551)

- a. Where possible, facilities design **is to** consider the use of multipurpose control structures to facilitate normal operational functions such as:
 - 1. drawdown and flow distribution,
 - 2. flow and depth measurement,
 - 3. sampling,
 - 4. pumps for recirculation,
 - 5. chemical addition and mixing, and
 - 6. minimization of **the number of** construction sites within the dikes.
- b. As a minimum, control structures **are to** be:
 - 1. accessible for maintenance and adjustment of controls;
 - 2. adequately ventilated for safety and to minimize corrosion;
 - 3. locked to discourage vandalism;
 - 4. equipped with controls to allow variable water level and flow rate control, complete shut-off and complete draining;
 - 5. constructed of noncorrosive materials (metal on metal contact in controls should be of like alloys to discourage electrochemical reaction); and
 - 6. located to minimize short-circuiting within the cell and avoid freezing and ice damage.
- c. Recommended devices to regulate water level are valves, slide tubes or dual slide gates.
- d. Regulators should be designed so that they can be preset to **prevent the pond surface elevation from dropping below the desired operational level.**

93.442 Piping (formerly 85.552)

All piping **is to** be of suitable materials. Pipes should be anchored with adequate erosion control.

In situations where pipes penetrate the pond seal, provisions to prevent

seepage (such as anti-seep collars) are to be made.

a. Drawdown Structure Piping

1. Submerged Discharges

For ponds designed for shallow or variable depth operations, submerged discharges are recommended. Discharge pipes are to be located a minimum of 10 feet from the toe of the dike and 2 feet from the top of the seal and are to employ a vertical withdrawal.

2. Multi-Level Discharges

For ponds that are designed deep enough to permit stratification of pond content, multiple discharges are recommended. There is to be a minimum of three withdrawal pipes at different elevations. The bottom pipe is to conform with submerged discharge. Other pipes should utilize horizontal entrance, provided that the design includes provisions to ensure that scum and floating materials are not to be drawn off with the cell effluent. Adequate structural support is to be provided.

3. Near Surface Discharge

For use under constant discharge conditions and/or relatively shallow ponds under warm weather conditions, near surface overflow-type withdrawal is recommended. Design should evaluate floating weir box or slide tube entrance, with baffles for scum control and should permit adequate drawoff approximately 2 feet below the water surface.

4. Emergency Overflow

To prevent overtopping of dikes, emergency overflow should be provided with capacity to carry the peak instantaneous flow.

5. Pond Drain

All ponds are to have emergency drawdown piping to allow complete draining by either gravity or pumping for maintenance. These should be incorporated into the above-described structures.

b. Hydraulic Capacity

The hydraulic capacity of structures and piping for the flow-through system is to allow for a minimum of 250 percent of the design maximum day flow of the system.

The hydraulic capacity for controlled discharge systems is to permit transfer of water at a minimum rate of 6 inches of pond water depth per day at the available head. The discharge is to be as constant throughout the day as possible.

93.5 Sludge Removal and Disposal

- a. Sludge removal may be required when upgrading an existing pond system to ensure the best effluent quality. The final disposal site is to be acceptable to the regulatory agency.
- b. Transferring sludge from an existing pond into a new primary pond cell for disposal is unacceptable.
- c. Controlled discharge facultative treatment pond systems should provide a sludge storage volume which does not exceed one half of the minimum operating depth of the primary cells.
- d. The pond system following sludge removal is to remain sealed and is to meet applicable seepage loss requirements.

93.6 Miscellaneous (formerly 85.6)

93.61 Fencing (formerly 85.61)

- a. The pond area is to be enclosed with an adequate fence to prevent livestock watering and discourage trespassing.
- b. Fencing should not obstruct vehicle traffic on top of the dike.
- c. A vehicle access gate of sufficient width to accommodate mowing equipment is to be provided.
- d. All access gates are to be provided with locks.

93.62 Access (formerly 85.62)

An all-weather access road is to be provided to the pond site to allow year-round maintenance of the facility.

93.63 Warning Signs (formerly 85.63)

- a. Appropriate permanent signs **are to** be provided along the fence around the pond to designate the nature of the facility and advise against trespassing.
- b. At least one sign **is to** be provided on each side of the site and one for every 500 feet of its perimeter.

93.64 Flow Measurement (formerly 85.64)

- a. Flow measurement requirements are presented in Paragraph 46.7 Paragraph 56.6.
- b. Effective weather protection **is to** be provided for the **recording equipment**.

93.66 Pond Level Gauges (formerly 85.65)

Pond level gauges **are to** be provided.

93.67 Service Building (formerly 85.66)

A service building for laboratory and maintenance equipment is to be provided, if required. Refer to Section 58.

93.65 Groundwater Monitoring (formerly 85.67)

An approved system of wells or lysimeters may be required around the perimeter of the pond site to facilitate groundwater monitoring. The need for such monitoring will be determined on a case-by-case basis.

94. INTERMITTENT SAND FILTERS (formerly 84)**94.1 General**

- a. Sand filters should not be considered where treatment beyond secondary is required.
- b. Treatment by sand filters is generally considered feasible only for institutional or relatively small community treatment plants.
- b. The use of subsurface or covered sand filters is not recommended except for private installations where flows do not exceed 10,000 gpd.

94.2 Loading on Sand Filters (formerly 84.1)

94.21 Primary Effluent (formerly 84.11)

With acceptable primary treatment of normal wastewater, loading is not to exceed 2.3 gallons per square foot of filter area per day.

94.22 Trickling Filter and Activated Sludge Effluent (formerly 84.12)

Loading is not to exceed 10 gallons per square foot of filter area per day.

94.23 Septic Tank Effluent on Surface Filters (formerly 84.13)

- a. For the effluent of septic tanks treating normal domestic wastewater from small community installations, institutions, motels, etc., the loading is not to exceed 2.3 gallons per square foot of filter area per day.
- b. For summertime operations extending not longer than 90 days per year, this loading may be increased to 2.9 gallons per square foot per day, provided the septic tank is cleaned at least once each year.

94.24 Organic Loading

- a. For the effluent of septic tanks treating normal domestic wastewater from private installations, the flow is not to exceed 10,000 gpd.
- b. The hydraulic loading is not to exceed 1.5 gallons per square foot of filter area per day.

94.25 Septic Tank Effluent on Subsurface Filters (formerly 84.14)

In no case may the maximum daily BOD₅ load reaching the filter exceed 140 pounds per acre per day.

94.3 Media (formerly 84.2)**94.31 Gravel Base (formerly 84.21)**

Clean, graded gravel, preferably placed in at least three layers, should be placed around the underdrains and to a depth of at least 6 inches over the top of the underdrains. Suggested gradings for the 3 layers are 1½ inches to ¾ inch, ¾ inch to ¼ inch, and ¼ inch to 1/8 inch.

94.32 Sand (formerly 84.22)

- a. At least 24 inches of clean sand should be provided.

- b. For open filters dosed by flooding, the effective size **is to** be 0.3 to 0.6 mm; for filters dosed by rotary distributors, the effective size **are to** be 0.5 to 1.0 mm.
- c. The uniformity coefficient **is not to** be greater than 3.5.

94.4 Dosing (formerly 84.3)

94.41 General (formerly 84.31)

Facilities for dosing of the filter media **are to** be provided to ensure an adequate rest period between two subsequent applications.

94.42 Duplicate Units (formerly 84.32)

Two or more filters are necessary to provide for maintenance and adequate rest periods between doses.

94.43 Volume (formerly 84.33)

- a. The dosing tank volume **is to** be such that any open filter bed will be covered to a depth of 2 to 4 inches by each dose.
- b. Subsurface filter dosing should be done such that pipes are filled to 60-75 percent depth per dose.

94.44 Siphons or Pumps (formerly 84.34)

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

94.45 Discharge Lines (formerly 84.35)

The discharge lines to the beds **are to** have sufficient capacity to permit the full rated discharge of the siphons or pumps.

94.4 Distribution (formerly 84.4)

94.51 Arrangement (formerly 84.41)

- a. Troughs or piping may be used for distribution of the settled wastewater over the filter surface and should be so located that the maximum lateral travel is not more than 20 feet.
- b. Provisions should be made for adjustment of the flow.

94.52 Splash Slabs (formerly 84.42)

Splash slabs are needed at each point of discharge.

94.53 Drain (formerly 84.43)

A drain opening from troughs or discharge piping is essential.

94.6 Underdrains (formerly 84.5)

Open joint or perforated pipe underdrains of durable material may be used.

Underdrains should be sloped to the outlet and spaced not to exceed 10-foot centers.

94.7 Earthen Base (formerly 84.6)

- a. The earthen base of the filters should be sloped to the trenches in which the underdrains are laid.
- b. An impervious liner *is to* be installed on the pervious earth base to prevent seepage to the groundwater table.

94.8 Curbs (formerly 84.7)

Provision should be made to prevent soil from washing onto the beds.

94.9 Covers (formerly 84.8)

To ensure effective winter operation, filter covers *are to* be a design consideration.

95 Sequencing Batch Reactors (SBR)**95.1 General**

The sequencing batch reactor (SBR) process is a fill and draw mode of the activated sludge process in which all major steps occur in the same tank in sequential order - Fill, React, Settle, Decant, and Idle. The SBR may be used where wastewater to be treated is amenable to aerobic biological treatment. This process may be used to accomplish carbonaceous and/or nitrogen and phosphorus removal. The design should be based on experiences at other facilities and should meet the applicable requirements under Domestic Wastewater Facilities Manual (362-0300-001) Sections 50, 70, and 90.

95.2 Pretreatment

- a. Pre-Screening Devices

One of the following should be provided:

- A bar screen with maximum opening of 5/8 of an inch meeting the other applicable requirements of Section 61.1, or
- A comminutor with automatic reversing controls meeting the other applicable requirements of Section 62.

For applicable design provisions, refer to Section 60.

b. Screens

1. Automatically cleaned fine screens or medium fine screens capable of removing material of ¼ inch diameter or larger should be provided.
2. Screens should be removable for maintenance.
3. Screens should incorporate an automatic washdown system or other means to reduce organic material in the screening load.
4. Other provisions of Section 61.2 apply to the design of a fine screen.

c. Grit Removal

1. Permanent grit removal facilities meeting the requirements of Section 63 should be provided for combined sewer systems and sewer systems receiving substantial amount of grit.
2. If a plant serving a separate sewer system is designed without grit facilities, consideration should be given to possible damaging effects on pump, comminutors, other preceding equipment, and the need for additional storage capacity in treatment units where grit is likely to accumulate.

d. Alkalinity

Piping for chemicals to allow for alkalinity adjustment (if necessary) should be provided to the influent flow equalization tank and/or SBR tanks. The minimum alkalinity should be kept between 40-70 mg/L at the decant phase.

95.3 Flow Equalization

- a. Influent flow equalization must be considered for all SBR systems. Systems not using flow equalization should utilize a means of allowing the SBR system to operate with a tank offline.

- b. Flow equalization should meet requirements of Section 67.

95.4 Tank (Reactor) Design

- a. The basic parameters for the tank design include the hydraulic, organic, nitrogen and phosphorus loading. These parameters should be in accordance with Section 92.32. These are used to determine the tank size, cycle frequency, rate of draw and discharge of treated effluent and total oxygen demand. Temperature is an important consideration when dealing with nitrogen removal.
- b. The effective part of the tank (the volume between the lowest operating level and the highest level, allowing for at least 18" of freeboard) should be sized to contain the volume of the peak hourly flow received during that portion of the SBR(s) cycle time when there will be no forward flow or the volume of one batch, whichever is larger. In addition to this, side stream/recycle flows should be included in the sizing.
- c. The plant hydraulic capacity should be based on treating 100% of the maximum month average flow.
- d. The basins should be sized to treat 100% of the maximum day dry weather flows without advancing cycles. Cycles may be advanced to process maximum day wet weather peak flows to assure biomass retention and treatment stability.
- e. Consideration should be given to dividing the required aeration tank volume into two or more units at all plants. For plants designed to receive maximum monthly average flow of 50,000 gpd or more, total aeration tank volume should be divided among two or more units capable of independent operation to meet applicable effluent limitations and reliability guidelines.
- f. A single SBR reactor may be provided with a pre-equalization tank. The pre-equalization tank should be sized for the peak flow that may occur over the non-fill portion of one cycle.
- g. Flow division control facilities preceding the SBR tanks should be designed for greatest operating and maintenance convenience, flexibility, continuity of maximum effluent quality, and ease of installation of future units. Automatic influent valves or dedicated influent pumps should be provided for each basin, if more than one basin is provided. A means of isolation and /or bypass should be provided for each of these valves to allow for servicing.
- h. The aeration tank volumetric loading should not exceed 15 lb BOD₅/day/1000 ft³ [0.24 kg BOD₅/(m³·d)] based on the maximum daily BOD₅ load to the aeration tank. Higher loadings may be acceptable with proper justification and calculations.

- i. Reactor design MLSS concentration at low or minimum water level should be in the range of 2,000 mg/L to 5,000 mg/L. Other values may be accepted, if justified.
- j. A means of completely emptying each reactor of all grit, debris, liquid, and sludge should be provided.
- k. Automatic influent valves should be used for normal operation as a means to control fill to tanks in or out of service.
- l. Influent baffling should be included to provide physical separation of the influent from the decanter in single tank SBR design or if the peak wet weather flows are anticipated to cause advancement of the design cycle. In lieu of this, an influent manifold may be utilized to distribute the influent without disturbing the sludge blanket.
 1. Average horizontal velocities through each baffle wall or manifold opening should not exceed 1 ft/sec at design peak hourly flow.
 2. The baffling or manifold should direct the influent wastewater into the sludge blanket.
- m. SBR systems should be designed to interrupt flow during the SETTLE and DECANT phases, but may choose to operate as a continuous influent feed system. In this case, the reactor should have a minimum length to width ratio of 3:1 with inlet and outlet separation maximized.
- n. Each reactor should be provided with inter-reactor overflow to another SBR tank or a storage tank.
- o. The detention time at minimum water level at maximum monthly average flow should be at least 12 hours.
- p. The hydraulic grade line calculations should consider decanter system head requirements, operating depth changes, operation during stream flooding elevations, future plant expansions, and potential for treatment units or pumps to be out of service.
- q. As a minimum, the following mechanical requirements shall be considered:
 - 1 SBR with one or two basins should be provided with equipment that is accessible for inspection, routine maintenance, and operation from the top or side of the basin without dewatering the basins.
 - 2 A detailed description of how the in-basin equipment can be serviced while still processing a minimum of 75% of the maximum monthly

average flow and peak daily load with a basin out of service is required. If more than two basins are required to achieve this requirement, an independent blower and mixing system should be provided for each basin.

- r. Tank bottoms should be sloped towards a drain or sump. Circular basins should be sloped towards the middle for maintenance. For rectangular basins slightly slope to one corner to allow for hosing down the unit.
- s. Structures using a common wall should be designed to accommodate the stresses generated when one basin is full and an adjacent basin is empty.
- t. Every wall of the SBR should be water tight and resist buoyant uplift when empty.
- u. The minimum side water depth of a tank should be 9 feet.
- v. The tank should have a minimum freeboard of 18 inches at the maximum liquid level.

95.5 Mixing and Aeration Systems

Mechanical mixing independent of aeration should be provided for all plants designed to provide biological phosphorus removal or denitrification. The aeration and mixing equipment should not interfere with settling.

- a. Mixing Systems
 - a. Mixing equipment should be of the number, size, and location to provide adequate complete suspension of the MLSS in order to prevent accumulation of settled solids throughout react phases and to ensure sufficient distribution of dissolved oxygen during aerobic events throughout the basin. This determination should be based on manufacturer supplied test data on tanks of similar geometry.
 - b. The mixing system should be sized to thoroughly mix the entire basin from a settled condition within 5 minutes without aeration, regardless of tank geometry. Specifications should require verification of the mixing effectiveness at system startup.
 - c. Mixing equipment should be provided in multiple units, so arranged and in such capacities as to meet the maximum mixing demand with the single largest unit out of service unless the equipment is serviceable without basin dewatering and the motor incorporates design enhancements that provide for three (3) years of operation without routine maintenance. Backup mixing may take the form of the diffused aeration system, if sized

sufficiently to provide complete mix conditions and in accordance with prior requirements within this document.

- d. The mixing equipment should provide for a mixing pattern that is unobstructed.
 - e. Floating mixers should be accessible, adequately moored to assure that they operate in the design location without interfering with, or stressing, any other tank or process function, and protected from excessive icing.
 - f. Provisions should be included to lift equipment for removal, installation, maintenance, and repair. In the case where a crane may be needed to lift equipment, access for the crane should be considered.
 - g. Mixing systems that are fixed to the floor (rather than floating and removable) should provide provisions for additional equalization or storage as necessary to dewater and inspect the fixed equipment.
- b. Aeration Systems
1. The aeration equipment should be suitable for varying water depths and cyclical operation in a sequencing batch reactor based on experience with installations handling similar wastes and loadings. The discharge pressure of the blowers should be established at the maximum water depth.
 2. Oxygen transfer rates from the aerators based on average water depth between the low-water level and the maximum water level for the critical flow conditions, should be considered to provide a dissolved oxygen concentration of 2.0 mg/L during aeration.
 3. The blowers should be sized to deliver the total oxygen demand in a shorter period of time than allocated to the FILL/REACT and REACT phases of the cycle if oxic and anoxic conditions are required during these phases. A standby blower with complete system may be required in case of emergency.
 4. The blowers should be provided in multiple units, so arranged and in such capacities as to meet the maximum air demand in the oxic portions of the FILL/REACT phases of the cycle with the single largest unit out of service. Variable frequency drives should be considered.
 5. The aeration blower should be designed to provide 100% of the total air requirement with one unit out of service. The remaining components of the aeration system should be capable of providing a minimum of 100% of total air requirement to the basin during aeration system servicing.

6. The nitrogenous oxygen demand should be based on 4.6 lbs. of O₂/lb. of maximum daily TKN to the aeration tanks.
7. The minimum oxygen requirement should be based on 1.25 lbs. of O₂ / lb. of maximum daily BOD₅ applied to the aeration tanks at working conditions.
8. Diffused air systems should meet requirements of Section 92.332. Mechanical aeration system should meet requirements of Section 92.333.
9. Motors, gear housing, bearings, grease fittings, etc. associated with mechanical aeration systems should be easily accessible and protected from inundation and spray as necessary for proper functioning.
10. The aerator mechanism and associated structures for mechanical aeration system should be protected from freezing and ice accumulation.
11. The SBR design should allow for the removal of air diffusers or mechanical aeration devices without dewatering the tank or inhibiting the operation of other equipment.
12. If a jet aeration system used, the jet motive pumps should be either located in a dry pit, or furnished with a means to remove submersible jet pumps without dewatering the tank.

95.6 Decant Mechanism

- a. Design should allow the decanter to withdraw decant fluid from beneath the liquid surface, regardless of liquid depth, down to the minimum allowable water level specified. The decanter should not pass through the water surface before or after decant where scum, foam and floatable may enter the weir.
- b. The decantable volume of the SBR system should be sized for at least 100% of the maximum day dry weather peak flow without changing the cycle times.
- c. The decanter capacity of the SBR system with the largest reactor out of service should be sized to pass at least 75 percent of the peak daily flow without changing cycle times.
- d. The decanter design should take into account the depth of the settled liquid and solids, and should be located to allow even withdrawal throughout the tank. Decant overflow velocity should be generally kept to less than 1.0 ft/sec.
- e. An adequate zone of separation between the sludge blanket and the decanter(s) should be maintained at all times during the decant phase.

- f. Decant inlet velocities should be limited throughout the decant phase to prohibit vortexing, entry of scum or other floating material, or disturbance of settled sludge layer.
- g. For reactors where simultaneous fill and decant occur, the location and design of the influent and effluent ports should prevent short-circuiting through the tank.
- h. The decanter should draw decant fluid from below the water surface and a means of excluding solids, especially floating solids and scum, from entering the decanter during any phase of the cycle besides the decant phase.
- i. Two independent means of controlling effluent discharge should be provided for each decanter device.
- j. Protection against ice build-up on the decanter(s) and freezing of the discharge piping and decant valves should be provided.
- k. Decanters should be moored at enough points to allow adequate movement of the mechanisms as necessary to accommodate all liquid levels.
- l. The design should eliminate the potential for the decanters to get stuck at a level where they are not intended to operate.
- m. The design should include a mechanical restraint to prevent the decanter from falling below the sludge blanket level.
- n. A fixed decanter should not be used in a basin where simultaneous fill and decant may occur.
- o. Additional settling time before a discharge may begin must be considered for systems with fixed decanters.
- p. Fixed decant equipment and decant volumes that do not accommodate the maximum monthly average flow should be provided with an equalization basin.
- q. An SBR system utilizing more than two basins should allow the decanting of at least two tanks simultaneously. If the systems are using two tanks, the downstream equipment should be sized based on the maximum number of tanks decanting at the same time.
- r. The decanter should be accessible from the side of the basin.

95.7 Decant Flow Equalization

- a. Decant flow equalization facilities should be considered for all facilities, and may be required for discharges having potential for stream bed scouring and/or other water quality impacts.
- b. The basin should be of sufficient size to store the differential between the average decant rate and the maximum discharge rate from the equalization basin times the decant time and time between decant available.
- c. These basins should also have a means of removing solids from the bottom of the unit, such as a sloped bottom with a drain or sump.
- d. If decant flow equalization is not provided, downstream units should be sized to handle peak decant rates.
- e. If decant flow equalization is not provided, effluent limits will need to be determined based on decant rate to ensure that toxic effects of ammonia and chlorine do not impact aquatic life in the receiving stream.

95.8 Sludge Removal

- a. A sludge removal system separate from decant piping should allow sludge to be wasted during the DECANT and/or IDLE phases.
- b. The sludge wasting points should be away from the decanters if wasting can occur during the DECANT phase.
- c. Sludge withdrawal should be at a location and in a manner that will insure consistent and even withdrawal from the sludge layer and not disrupt any of the other settled layers.
- d. Where there is a possibility for siphoning of the sludge to occur, siphon breaks should be installed.
- e. Automatic wasting controls should be provided in all designs to insure that over wasting of sludge will not occur; however, manual controls for adjustment by the operator should also be included. The controls should allow for operator adjustments for the duration of the wasting period.
- f. The capability to transfer sludge from each reactor to another should be provided to allow for seeding of other reactors if needed or to allow for the use of off-line reactors.
- g. If decant pumps are used for sludge transfer, all solids in the decant piping should be flushed and recycled back to the SBR.

- h. All sludge transfer and wasting pumps should be accessible for maintenance without dewatering the tank.

95.9 Process Control Equipment

- a. Programmable Logic Controllers (PLC) or microprocessors should be provided with surge protector and programmed to meet the treatment requirements for the design loadings with limited operator adjustment.
 - 1. The design and installation should consider all factors affecting the flow and organic loading for each cycle, such as diurnal, first flush, industrial, etc.
 - 2. Where automatic process control is used, hard-wired manual backup controls for operation of the entire system should also be provided at the control panel.
 - 3. Each control panel should be provided with a remote access such a modem so the program can be modified or reloaded in a short period of time.
- b. Both automatic and manual controls should be designed and installed to allow independent operation of each tank.
- c. An Uninterruptible Power Supply (UPS) or other similar equipment should be provided for each PLC or microprocessor to retain program memory (process control program, last known set points, and measured process/equipment status) through a power loss.
- d. A means of recording and displaying all activities of the SBR process, including the time and status of each cycle stage and batch change and all alarms should be provided.
 - 1. The current process cycle stage and time remaining should also be recorded and displayed.
 - 2. This information should be available in a visual display as well as a historical record if a SCADA system is provided.
- e. A scroll-through display that identifies each cycle's length and time remaining in the current cycle should be provided.
- f. There should be an operator interface provided for operator adjustment of all cycle settings and other control logic.

- g. A fail-safe timer control which cannot be adjusted by the operator, allowing not less than 20 minutes between the REACT and DECANT phases, should be provided.
- h. All designs should include a “high flow” mode with a program that will recognize flow above the diurnal peak flow. All equipment and controls should be designed to accommodate this high flow mode and to optimize the treatment processes. A description of this control logic should be included in the Design Engineer’s report and O & M Manual.
- i. All designs should include programming and operational capabilities for lower than average startup flows and loadings that may be realized during new system startup and/or other prolonged periods where the plant may experience flows and loadings less than the design criteria.
 - 1. The programming and controls should at least be able to provide for consistent, reliable treatment and operation at 25%, 50%, 75%, and 100% of the maximum monthly average flow and/or peak daily loading.
 - 2. A description of this control logic should be included in the Design Engineer’s report and O & M Manual.
- j. Control panel switches should be installed for all of the following:
 - 1. Pumps: manual/off/auto
 - 2. Valves: open/close/auto
 - 3. Blowers and mixers: manual/off/auto
 - 4. Selector switch for tank(s) in operation/standby
- k. Control panel visual displays or indicating lights should be installed and similar to those that are provided for flow-through systems and should include the following:
 - 1. Mimic diagram of the process that shows the status and position of any pumps, valves, blowers or aerators, and mixers;
 - 2. Process cycle and time remaining;
 - 3. Instantaneous and totalized flow to the facility and of the final discharge;
 - 4. Tank level gauges or levels;
 - 5. Sludge pumping rate and duration; and

6. Airflow rate and totalizer.
1. Annunciator panel or display screen to indicate alarm conditions should include the following:
 1. High and low water levels in each tank;
 2. Failure of all automatically operated valves;
 3. Decanter failure;
 4. Blowers, if used – failure;
 5. Mechanical aerator, if used – failure;
 6. Pump – failure; and
 7. Mixers, if used – failure
- m. A tank level system should include floats or pressure transducers.
 1. A float system should be protected from prevailing winds and freezing.
 2. A bubbler system should not be used in a tank level system.
 3. An ultrasonic system or sensor should not be used where foam is anticipated.

95.10 Disinfection

- a. When chlorination is used for disinfection, the chlorine contact tank should be sized to assure a minimum contact period of 15 minutes at maximum decant rate unless decant equalization is provided. The dosage should conform to Section 102.2.
- b. When other means of disinfection is used, the facilities should be designed to provide required disinfection at maximum decant rate unless decant equalization is provided.

95.11 Sampling

- a. Composite samplers should be provided that allow for at least three equal-sized samples from each batch of effluent discharged from the reactors.

- b. Sampling and flow measurement equipment should allow monitoring of the operation of each reactor separately.
- c. All effluent sampling for compliance reporting should be conducted using an automatic sampler controlled by an effluent flow meter.

96 Membrane Bioreactor (MBR)

96.1 General

Membrane Bioreactors (MBR) combine conventional biological treatment processes with membrane filtration to provide an advanced level of organic and suspended solids removal, along with the capabilities of advanced level nutrient removal in wastewater. This process may be used to accomplish carbonaceous and/or nitrogenous oxygen demand reductions. The design should be based on experiences at other facilities and should meet the applicable requirements under Sections 40, 60, and 80.

This chapter contains criteria for low-pressure ultrafiltration or microfiltration membrane bioreactors. Typical membrane system configurations include hollow fiber, tubular, or flat plate. Any other membrane system configuration should be considered innovative treatment technology and conduct a pilot study.

96.2 Pretreatment

96.21 General

- a. Pretreatment is critical in MBR plant design to ensure adequate protection of membranes from physical damage. All MBR systems require fine screening and grit removal to prevent membrane damage from abrasive particles common in influent sewage.
- b. Removal of fibrous or stringy material is also important. This material can become entangled and wrap around the hollow fibers or stuck within the gaps between membrane flat plates. This can plug the membrane scour aeration systems leading to problems with operation of and potential damage to the system.
- c. If the influent oil and grease concentration exceeds 100 mg/L, or if historic problems with fats, oils and grease (FOG) exist within the community, oil and grease removal may also be necessary to prevent membranes from being coated.

96.22 Bar Screens

A mechanically cleaned bar screen with a manually cleaned emergency bypass bar screen or self-cleaning screening device should be provided. Bar screens should meet provisions of Section 51.1.

96.23 Grit Removal

- a. Permanent grit removal facilities meeting the requirements of Section 53 should be provided for combined sewer systems and sewer systems receiving substantial amount of grit.
- b. If a plant serving a separate sewer system is designed without grit facilities, consideration shall be given to possible damaging effects on pump, comminutors, other preceding equipment, and the need for additional storage capacity in treatment units where grit is likely to accumulate.

96.24 Primary Clarification

- a. Primary clarification must be considered for all plants.
- b. Proposals that do not include primary clarification should justify why primary clarifiers are not practical due to facility size constraints or limited benefit in comparison to the cost of handling primary solids.
- c. Fine screens designed in accordance with Section 51.2 may be considered in lieu of primary clarifiers.

96.25 Flow Equalization

Influent flow and load equalization shall be considered for all MBR systems. Flow equalization should meet requirements of Section 55.

96.26 Fine screens

- a. Location
 - Fine screens should be located downstream of primary clarifiers.
- b. Design
 - 1. Coarse screens followed by fine screens may be used to minimize the complications of fine screening due to high flow restrictions and increased solid waste handling.
 - 2. Fine screens may be rotary drum or traveling band screen with either perforated plate or wire mesh.

3. Fine screens should have an opening size between 0.25 mm – 2.0 mm for hollow-fiber and tubular membranes, or 2.0 – 3.0 mm screening for flat plate membranes.
- c. Number of Units
1. A minimum of two fine screens should be provided, with each unit being capable of independent operation.
 2. Capacity should be provided to treat peak design flows with one unit out of service.
- d. Electrical Fixtures and Controls
- Electrical fixtures and screening areas where hazardous gases may accumulate should meet the requirements of the National Electric Code for Class I, Division 1, Group D locations.
- e. Servicing
1. Hosing equipment should be provided to facilitate cleaning.
 2. Provisions should be made for isolating or removing units from location for servicing.

96.3 Tank (Reactor) Design

96.31 Capacities and Loadings

- a. The design sludge retention time (SRT) should be at least 10 days but no more than 25 days. An SRT outside this range may be acceptable if supported by a pilot study.
- b. The design hydraulic retention time (HRT) should be between 6 hours and 15 hours.
- c. Organic loadings for reactors not required to provide biological nutrient removal should be in accordance with Section 82.31.
- d. Organic loadings for reactors required to provide biological nutrient removal should be based on one of these models for nutrient removal:
 - Modified Ludzak-Etinger (MLE);
 - Bardenpho;
 - Modified University of Cape Town (MUCT);

- Sequencing Batch Reactor (SBR); or
 - An alternative method approved by the Department
- e. The food to microorganism (F/M) ratio for the reactors should not be greater than 0.1 mg BOD₅/mg MLVSS for plants requiring nitrification and 0.3 mg BOD₅/mg MLVSS for plants not requiring nitrification. Greater ratios may be accepted, if justified by a pilot study.
- f. Bioreactor MLSS concentration should be in the range of 4,000 mg/L to 10,000 mg/L. Other values may be accepted, if justified to the Department.
- g. Membrane tank MLSS concentration should be in the range of 4,000 mg/l to 15,000 mg/l. Other values may be accepted, if justified to the Department.

96.32 Arrangement of Tanks

96.321 General Tank Configuration

- a. A system designed for enhanced nutrient removal, other than an SBR, should include an isolated tank or baffled zone for anoxic treatment, anaerobic treatment, or both.
- b. A facility designed for nitrogen or biological nutrient removal should contain a mixed deoxygenation basin, a larger anoxic basin, or another method approved by the Department for decreasing dissolved oxygen concentration, if the recycled activated sludge is returned to an anoxic or anaerobic basin.
- c. An advanced nutrient removal system should be designed with recycle rates sufficient to sustain the designed mixed liquor concentrations in both the aeration and anoxic basins; typically totaling 600% or more of the influent flow.
- d. Facilities without advanced treatment should be designed with recycle rates sufficient to sustain the design mixed liquor concentrations; typically from 300% to 500% of the facility's influent flow.
- e. A system with a peak flow rate that is greater than 2.5 times the average daily flow should use equalization storage, or reserve membrane capacity to accommodate the higher peak flow.
- f. An inner-tank valve should be provided for refilling tanks when one is taken out of service. The valve should be placed near the inlet side of the tank(s) near floor level.

- g. Each reactor should include a dewatering system and provisions for transfer to another aeration tank or a storage tank.
- h. The hydraulic grade line calculations should consider, operating depth changes, operation during stream flooding elevations, future plant expansions, and potential for treatment units or pumps to be out of service.
- i. Structures using a common wall should be designed to accommodate the stresses generated when one basin is full and an adjacent basin is empty. Every wall of the MBR should be water tight and resist buoyant uplift when empty.

96.322 Number of Units

- a. Consideration should be given to dividing the required aeration tank volume into two or more trains at all plants.
- b. For plants designed to receive maximum monthly average flow of 50,000 gpd or more, total aeration tank volume should be divided among two or more trains capable of independent operation.
- c. The MLSS design basis should allow the plant to operate at normal operating parameters and conditions for maximum monthly average flow with one MBR unit or train out of service

96.323 Inlets and Outlets

- a. Controls
 - 1. Inlets and outlets for each aeration tank unit should be suitably equipped to permit controlling the flow to any unit.
 - 2. The hydraulic properties of the system should permit the peak instantaneous flow, including the maximum sludge return flow, to be carried with any single aeration tank unit out of service.
- b. Conduits
 - 1. Channels and pipes carrying liquids with solids in suspension should be designed to maintain self-cleansing velocities or should be agitated to keep such solids in suspension at all rates of flow within the design limits.

2. Adequate provisions should be made to drain segments of channels which are not being used due to alternate flow patterns.

96.324 Freeboard

- a. The tank should have a minimum freeboard of 18 inches at the maximum liquid level.
- b. Where a mechanical surface aerator is used, the freeboard should be not less than three feet to protect against windblown spray freezing on walkways.

96.325 Froth Spray

- a. Use of a froth spray system to cut down the foam in the aeration tank should be considered.
- b. The froth spray pump(s) should preferably use permeate in order to prevent clogging of nozzles.
- c. The froth spray lines in the aeration tank should point perpendicular to the flow.

96.33 Mixing and Aeration Equipment

96.331 General

- a. Mechanical mixing independent of aeration should be provided for all plants designed to provide biological phosphorus removal or denitrification.
- b. Provisions should be included to lift equipment for removal, installation, maintenance, and repair.
- c. In the case where a crane may be needed to lift equipment, access for the crane shall be considered.

96.332 Mixing Systems

- a. Mixing equipment should be of the number, size, and location to provide adequate mixing at the proposed length, width, and depth throughout the intended mixing phase. This determination should be based on manufacturer supplied test data on tanks of similar geometry.

- b. The mixing equipment should be effective to provide a complete mix, with consistent dissolved oxygen throughout the basin.
- c. The mixing system should be sized to thoroughly mix the entire basin from a settled condition within 5 minutes without aeration, regardless of tank geometry.
- d. Specifications should require verification of the mixing effectiveness at system startup.
- e. Mixing equipment should be provided in multiple units, so arranged and in such capacities as to meet the maximum mixing demand with the single largest unit out of service.
- f. The mixing equipment should also provide for a mixing pattern that is unobstructed.
- g. Floating mixers should be accessible, adequately moored to assure that they operate in the design location without interfering with, or stressing, any other tank or process function, and protected from excessive icing.
- h. Un aerated (deoxygenation, pre/post anoxic, and anaerobic) zones should have submersible mixers or an alternative mixer approved by the Department which do not add any oxygen to the water.

96.333 Diffused Aeration Systems

Except as noted below, the diffused air system should meet requirements of Section 82.332.

- a. The minimum oxygen requirement should be based on 1.5 lbs. of O₂ / lb. of influent BOD₅ to the reactor at design flow. Oxygen required for ammonia nitrogen removal should be based on 4.6 lbs. of O₂/lb. of influent NH₃-N to the reactor.
- b. Due to higher MLSS interfering with oxygen transfer, a reduced transfer efficiency correction factor should be calculated in accordance with the following:

$$\alpha = e^{-0.082 \cdot MLSS}$$
 Where MLSS is expressed in g/L, not mg/L
- c. The design oxygen concentration ranges for aeration system sizing should be:
 - 1. no more than 0.5 mg/L O₂ in the anoxic zone,

2. between 1.5 mg/L – 3.0 mg/L O₂ in the aerobic zone, and
3. between 2.0 mg/L – 8.0 mg/L O₂ at the membranes.
4. Air operated pinch valves to control the flow in the reactors should be insulated to prevent freezing or located at places not affected by weather.
5. The blowers and piping required for aeration should be installed separately from the blowers and piping required for scouring of the membranes.

96.334 Mechanical Aeration Systems

The mechanical aeration system should meet requirements of Section 82.333.

96.4 Membrane Design

- a. MBR hydraulics should be based on maximum design flow rate criteria at the coldest expected wastewater temperature. Maximum day or peak hour flows at the expected coldest wastewater temperature will dictate the membrane surface area required.
- b. Membranes need to be mechanically robust, chemically resistant to high chlorine concentrations used in cleaning, and non-bio-degradable.
- c. Membranes should be made from the following materials
 - Polyethersulfone (PES);
 - Polyvinylidene fluoride (PVDF);
 - Polypropylene (PP);
 - Polyethylene (PE);
 - Polyvinylpyrrolidone (PVP); or
 - Chlorinated polyethylene (CPE).
- d. The nominal pore size used in a MBR for microfiltration membranes should be at least 0.10 um but not more than 0.4 um.
- e. The nominal pore size used in a MBR for ultrafiltration should be at least 0.02 um but not more than 0.10 um.
- f. The MBRs should be designed for an average daily net flux rate of not more than 15 gallons per day per square foot of membrane area (gfd) at 20°C. An alternative flux rate may be approved by the Department.

- g. The MBRs should be designed for a peak daily net flux rate equal to or less than 1.5 times the average daily net flux rate.
- h. Hollow fiber transmembrane pressure (TMP) should have an operational pressure range of at least 2.0 pounds per square inch (psi) but not more than 10.0 psi. The maximum pressure should not exceed 12.0 psi.
- i. Flat plate TMP should have an operational pressure rate of at least 0.3 psi but not more than 3.0 psi. The maximum pressure should not exceed 4.5 psi.
- j. Tubular, out of Basin TMP should have an operational pressure range of at least 0.5 psi but not more than 5.0 psi. The maximum pressure should not exceed 10.0 psi.

96.5 Membrane Operations and Cleaning

- a. Membrane Operations
 - 1. A facility should be able to operate at normal operating parameters and conditions for peak daily flow with one MBR unit or train out of service.
 - 2. Acceptable methods of providing redundancy are additional treatment trains, additional treatment units, or storage. Redundancy should be demonstrated to the Department in the Design Engineer's report and O & M Manual.
- b. Membrane Maintenance
 - 1. A means of completely emptying each reactor of all grit, debris, liquid, and sludge should be provided.
 - 2. All equipment should be accessible for inspection, maintenance, and operation.
 - 3. A means of positive drainage should be provided in any basin with a flat bottom.
- c. Membrane Cleaning
 - 1. Air scouring of at least 0.01 standard cubic feet per minute of air per square foot of membrane area but not more than 0.04 standard cubic feet per minute of air per square foot of membrane area;
 - 2. A mixture of air scouring with mixed liquor jet feed;

3. Back-flushing, as appropriate;
4. Relaxation, which is short periods of air scouring without filtration; or
5. Chemical cleaning:
 - i. The chemicals used in treatment and maintenance should not harm the MBR system or interfere with treatment.
 - ii. The chemicals, including concentrations and disposal methods, should be identified in the Operations & Maintenance (O & M) Manual.

96.6 Scum and Surface Solids Removal

- a. Facilities or mechanism should be provided for scum and surface solids removal in each basin.
- b. Scum and foam should not interfere with treatment or overflow a treatment unit.
- c. Surface wasting of excess mixed liquor or skimmers may be used to control scum and foam.
- d. Surface wasting may be performed in an aerated basin, a membrane basin, or both.
- e. Entrainment by mixing should not be the sole means for the removal.
- f. The design shall consider winter operation and address freezing concerns.

96.7 Controls and Operation

- a. A minimum of two Programmable Logic Controllers (PLC) or microprocessors, programmed to meet the treatment requirements for the design loadings, should be provided.
- b. The design and installation should consider all factors affecting the flow and organic loading for each cycle, such as diurnal, first flush, industrial, etc.
- c. A means of reprogramming the process operations should be provided.
- d. Both automatic and manual controls should be installed to allow independent operation of each tank.
- e. An Uninterruptible Power Supply (UPS) or other similar equipment with electrical surge protection should be provided for each PLC or microprocessor to

retain program memory (process control program, last known set points, and measured process/equipment status) through a power loss.

- f. A means of recording and displaying all activities of the MBR process, including the sequence and set points, oxygen levels, turbidity and all alarms should be provided.
- g. The continuous turbidity monitoring and time should also be recorded and displayed. This information should be available in a visual display as well as a historical record.
- h. A scroll-through display that identifies each sequence and set point should be provided.
- i. There should be an operator interface provided for operator adjustment of all sequences, set points, and other control logic.
- j. All designs should include a “high flow” mode with a program that will recognize flow above the diurnal peak flow.
 1. All equipment and controls should be designed to accommodate this high flow mode and to optimize the treatment processes.
 2. A description of this control logic should be included in the Design Engineer’s Report and O & M Manual.
- k. All designs should include programming and operational capabilities for lower than average startup flows and loadings that may be realized during new system startup and/or other prolonged periods where the plant may experience flows and loadings less than the design criteria.
 1. The programming and controls should at least be able to provide for consistent, reliable treatment and operation at 25%, 50%, 75%, and 100% of the design flow and/or loading.
 2. A description of this control logic should be included in the Design Engineer’s Report and O & M Manual.
- l. Control switches should be installed for all of the following:
 1. Pumps: manual/off/auto
 2. Valves: open/close/auto
 3. Blowers and mixers: manual/off/auto

- 4. Selector switch for tank(s) in operation/standby
- m. Control panel visual displays should be installed for all of the following:
 - 1. Mimic diagram of the process that shows the status and position of any pumps,
 - 2. valves, blowers or aerators, mixers, and membranes;
 - 3. Process cycle and time remaining;
 - 4. Instantaneous and totalized flow to the facility and of the final discharge;
 - 5. Tank level gauges or levels;
 - 6. Oxygen Monitoring.
- n. Annunciator panel to indicate alarm conditions should include the following:
 - 1. High and low water levels in each tank;
 - 2. Failure of all automatically operated valves;
 - 3. Membrane failure;
 - 4. Blowers, if used – low pressure, high temperature, and failure;
 - 5. Mechanical aerator, if used – high temperature and failure;
 - 6. Pump – high pressure and failure; and
 - 7. Mixers, if used – failure
 - 8. Oxygen deprivation
- o. A tank level system should include floats or pressure transducers.
 - 1. A float system should be protected from prevailing winds and freezing.
 - 2. A bubbler system in a tank level system is prohibited.

96.8 Disinfection

- a. When chlorination is used for disinfection, the chlorine contact tank should be sized to assure a minimum contact period of 15 minutes at maximum flow rate unless flow equalization is provided. The dosage should conform to Section 103.32.
- b. All effluent sampling for compliance reporting should be conducted using an automatic sampler controlled by an effluent flow meter, and should include samples pre and post membrane filtration.

- c. When other means of disinfection is used, the facilities should be designed to provide required disinfection at maximum flow rate unless a flow equalization tank is provided.
- d. Log credit may be given for membrane filtration according to challenge testing that is verified through direct and indirect integrity testing to reduce the required chlorine concentration.
 - 1. The combined effect of inactivation and removal of *E. coli* should be 4 logs.
 - 2. To be awarded removal credit, a membrane system should have undergone challenge testing by an independent third-party testing organization in accordance with the *Membrane Filtration Guidance Manual* (EPA 815-R-06-009).
 - 3. The removal credit awarded to the membrane process is the lesser of the log removal that can be verified by the direct integrity test or the log removal awarded by the challenge test.

96.9 Monitoring

Monitoring can be done by indirect or direct methods. The following standards apply to monitoring equipment.

- a. Indirect Integrity Method:
 - 1. Sampling and flow measurement equipment should allow monitoring of the operation of each reactor separately.
 - 2. All effluent sampling for compliance reporting should be conducted using an automatic sampler controlled by an effluent flow meter, and should include samples pre- and post-membrane filtration.
 - 3. Continuous filtrate turbidity monitoring from each membrane train or cassette or an equivalent should be provided for operational control and indirect membrane integrity monitoring. The membrane unit effluent should be monitored independently for each membrane train in operation. The continuous monitoring consists of tests being performed at least once every 15 minutes.
 - 4. If turbidity is used for indirect integrity monitoring, the control limit should have a reading less than or equal to 0.1 nephelometric turbidity units. Two consecutive filtrate turbidity readings above 0.1 NTU on any membrane unit should trigger an alarm.

5. The measurement of turbidity should meet USEPA approved analytical methods. These are as follows:
 - Hach FilterTrak Method 10133
 - Great Lakes Instrument Method 2 (GLI2)
 - Standard Method 2130B, Turbidity – Nephelometric Method
 - USEPA Method 180.1, Determination of Turbidity by Nephelometry.

b. Direct Integrity Method:

1. Direct integrity testing should be performed if credit towards chlorine disinfection is given. The procedures in the *Membrane Filtration Guidance Manual* (EPA 815-R-06-009) should be used.
2. The direct integrity test should be responsive to an integrity breach on the order of 0.08 μm or less. For pressure-based direct integrity testing, the resolution should be recalculated if the system backpressure is adjusted during direct integrity testing.
3. The direct integrity test should be able to verify a LRV equal to or greater than the removal credit awarded to the membrane filtration process. The maximum removal credit that a membrane can receive is the lowest of the LRV of the challenge test and the LRV of the direct integrity test.
4. A direct integrity test should be conducted on each membrane unit at a frequency of no less than once each day that the unit is in operation. This testing should be conducted at the same time each day to maintain a consistent time interval between testing.

97. OTHER BIOLOGICAL SYSTEMS (formerly 86)

The use of secondary treatment processes other than those listed above will be considered by DEP on the merit of the process involved.

98. LAND TREATMENT (formerly 87)

For detailed design criteria for projects utilizing land application, refer to *Manual for Land Application of Treated Sewage and Industrial Wastewater*, DEP ID: 362-2000-009, available on DEP's website.

99 - RESERVED FOR FUTURE USE

**CHAPTER 100
DISINFECTION****101. GENERAL**

- a. DEP requires effective disinfection of wastewater to control disease-producing organisms.
- b. The disinfection facilities design is to consider meeting both the bacterial standards and disinfectant residual requirements in the effluent.
- c. The disinfection process should be selected after due consideration of:
 1. waste characteristics,
 2. type of treatment provided prior to disinfection,
 3. waste flow rates,
 4. pH of wastewater,
 5. disinfectant demand rates,
 6. current technology application,
 7. cost of equipment,
 8. construction and operation,
 9. chemical availability, and
 10. maintenance problems.
- d. If chlorination is utilized, it may be necessary to dechlorinate if the chlorine level in the effluent would impair the natural aquatic habitat of the receiving stream.
- e. Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid chlorine and calcium or sodium hypochlorite. Chlorine tablets which erode in a controlled manner may be used. Other disinfectants, including chlorine dioxide, ozone, bromine, ultraviolet radiation, or hydrogen peroxide, may be accepted by DEP in individual cases.
- f. Where a disinfection process other than those specified in this chapter is proposed, supporting data from pilot plant installations or similar full scale installations may be required as a basis for the design of the system. Refer to Paragraph 53.2.

102. CHLORINE DISINFECTION (formerly 103)**102.1 Type (formerly 103.1)**

Chlorine is available for disinfection in gas, liquid (hypochlorite solution) and **solid** (hypochlorite tablet) form. The type of chlorine supply should be carefully evaluated during the facilities planning process. The use of chlorine gas or liquid will be most dependent on the size of the facility and the chlorine dose required.

Large quantities of chlorine such as are contained in ton containers and tank cars represent a significant potential hazard to plant personnel and to the surrounding area should the container develop leaks. Both monetary considerations and the potential public

exposure to chlorine should be considered when making the final determination.

102.2 Dosage (formerly 103.32 Capacity)

- a. Disinfection capacity is to be adequate to produce an effluent that will meet the applicable bacterial limits specified by DEP for that installation.
- b. Required disinfection capacity will vary, depending on the uses and points of application of the disinfection chemical.
- c. The chlorination system is to be designed on a rational basis and calculations justifying the equipment sizing and number of units are to be submitted for the whole operating range of flow rates for the type of control to be used.
- d. System design considerations are to include:
 1. the controlling wastewater flow meter (sensitivity and location),
 2. telemetering equipment, and
 3. chlorination controls.
- e. For domestic wastewater, the following minimum dosing capacity may be used as a guide in sizing chlorination facilities.

Type of Treatment	Chlorine Dosage
Fixed Film/Attached Growth Process Effluent	12 mg/L
Waste Stabilization Pond Effluent	12 mg/L
Activated Sludge Plant Effluent	8 mg/L
Tertiary Filtration Effluent	6 mg/L
Nitrified Effluent	6 mg/L

102.3 Containers (formerly 103.2)

102.31 Cylinders (formerly 103.21)

- a. 150-pound cylinders are typically used where chlorine gas consumption is less than 150 pounds per day.
- b. Cylinders should be stored in an upright position with adequate support brackets and chains at 2/3 of cylinder height for each cylinder.

102.32 Ton Containers

The use of one-ton containers should be considered where the average daily chlorine consumption is over 150 pounds.

102.33 Tank Cars (formerly 103.22)

- a. At large installations, consideration should be given to the use of tank

- cars, generally accompanied by gas evaporators.
- b. Area-wide public safety **is to** be evaluated as a part of the consideration.
 - c. Provision of chlorine supply during tank car switching **is to** be provided.
 - d. The tank car being used for the chlorine supply **is to** be located on a dead-end, level track that is a private siding.
 - e. The tank car **is to** be protected from accidental bumping by other railway cars by a locked derail device or a closed locked switch or both.
 - f. The area **is to** be clearly posted “DANGER-CHLORINE.”
 - g. The tank car **is to** be secured by adequate fencing with gates provided with locks for personnel and rail access.
 - h. The tank car site **is to** be provided with a suitable operating platform at the unloading point for easy access to the protective housing or the tank car for connection of flexible feedlines and valve operation.
 - i. Adequate area lighting **is to** be provided for night time operation and maintenance.

102.34 Liquid Hypochlorite Solutions (formerly 103.23)

- a. Storage containers for hypochlorite solutions **are to** be of sturdy, nonmetallic lined construction and **are to** be provided with secure tank tops and pressure relief and overflow piping.
- b. **The overflow piping should be provided with a water seal or other device to prevent tanks from venting to the indoors.**
- c. Storage tanks should be either located or vented outside.
- d. Provision **is to** be made for adequate protection from light and extreme temperatures.
- e. Tanks **are to** be located where leakage will not cause corrosion or damage to other equipment.
- f. A means of secondary containment **is to** be provided to contain spills and facilitate cleanup.
- g. Due to deterioration of hypochlorite solutions over time, it is recommended that containers not be sized to hold more than 1 month’s needs. At larger facilities and locations where delivery is not a problem, it may be desirable to limit on-site storage to 1 week. **Refer to Section 57.**

102.35 Dry Hypochlorite Compounds (formerly 103.24)

- a. Dry hypochlorite compounds should be kept in tightly closed containers and stored in a cool, dry location.
- b. Some means of dust control should be considered, depending on the size of the facility and the quantity of compound used. Refer to Section 57.

102.4 Feed Equipment (formerly 103.3)**102.41 Feed Equipment Type (formerly 103.31)**

- a. Solution-feed, vacuum-type chlorinators are generally preferred for large chlorination installations.
- b. The use of hypochlorite feeders of the positive displacement type may be considered.
- c. The preferred method of generation of chlorine dioxide is the injection of a sodium chlorite solution into the discharge line of the solution-feed gas-type chlorinator, with subsequent formation of the chlorine dioxide in a reaction chamber at a pH of four or less.
- d. Erosion feed chlorinators capable of producing a design residual are acceptable, but use should be limited to plants where the **maximum monthly average** flow does not exceed 10,000 gpd or as an emergency measure in larger plants with malfunctioning disinfection equipment.
- e. The feed equipment should at least provide for disinfectant dosages which are proportionate to the effluent flow.
- f. Automatic dosage equipment should be provided for larger plants.

102.42 Scales (formerly 103.25)

- a. Scales for weighing cylinders **and containers** are to be provided at all plants using chlorine gas.
- b. At large plants, scales of the indicating and recording type are recommended.
- c. As a minimum, a platform scale **is to** be provided.
- d. Scales **are to** be of corrosion-resistant material.

102.43 Evaporators (formerly 103.26)

- a. Where manifolding of several cylinders or ton containers will be required to evaporate sufficient chlorine gas, consideration should be given to the

installation of evaporators to produce the quantity of gas required.

- b. The connection of cylinders or ton containers discharging liquid chlorine to a manifold is not recommended.

102.44 Mixing (formerly 103.71)

The disinfectant **is to** be positively mixed as rapidly as possible, with a complete mix being effected in 3 seconds. This may be accomplished by either the use of a turbulent flow regime or a mechanical flash mixer.

102.45 Contact Period and Tank (formerly 103.72 and 103.73)

- a. A minimum contact period of 15 minutes at **design** peak hourly flow or maximum rate of pumpage, or a minimum contact period of 30 minutes at maximum monthly average flow **is to** be provided after thorough mixing.
- b. For evaluation of existing chlorine contact tanks, field tracer studies should be done to ensure adequate contact time.
- c. The chlorine contact tank **is to** be constructed to reduce short-circuiting of flow to a practical minimum.
- d. Tanks not utilizing continuous mixing **are to** be provided with “over-and-under” or “end-around” baffling to minimize short-circuiting.
- e. A 40:1 length-to-width ratio for baffled tanks is desirable to prevent short-circuiting.
- f. The tank **is to** be designed to facilitate maintenance and cleaning without reducing effectiveness of disinfection.
- g. Duplicate tanks, mechanical scrapers or portable deck level vacuum cleaning equipment **are to** be provided.
- h. Consideration should be given to providing skimming devices on all contact tanks.
- i. Covered tanks are discouraged.
- j. If needed, aeration of effluent to meet the DO requirement **is to** follow the chlorine contact tank.

102.46 Piping and Connections (formerly 103.4)

- a. Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, and with a minimum number of joints.

- b. Piping should be well supported and protected against temperature extremes.
- c. Due to the corrosiveness of wet chlorine, all lines designed to handle dry chlorine **are to** be protected from the entrance of water or air containing water. Even minute traces of water added to chlorine results in a corrosive attack.
- d. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, PVC or other approved materials are satisfactory for wet chlorine or aqueous solutions of chlorine.
- e. Sections of piping that convey liquid chlorine and are isolated with valves at both ends must be provided with a suitable expansion chamber.
- f. **The chlorine system piping is to be color coded and labeled to distinguish it from other plant piping. Refer to Paragraph 54.5.**
- g. **Where sulfur dioxide is used, the piping and fittings for chlorine and sulfur dioxide systems are to be designed so that interconnection between the two systems cannot occur.**

102.47 Standby Equipment and Spare Parts (formerly 103.33)

- a. Standby equipment of sufficient capacity should be available to replace the largest unit during shut downs.
- b. Spare parts **are to** be available for all disinfection equipment to replace parts which are subject to wear and breakage.

102.48 Chlorinator Water Supply (formerly 103.34)

- a. An ample supply of water **is to** be available for operating the chlorinator.
- b. Where a booster pump is required, duplicate equipment should be provided.
- c. Standby power should be provided to ensure adequate disinfection in case of a power outage.
- d. Protection of a potable water supply **is to** conform to the requirements of **Paragraph 56.2**
- e. Adequately filtered plant effluent should be considered for use in the chlorinator.

102.49 Leak Detection and Controls (formerly 103.27)

- a. A bottle of 56 percent ammonium hydroxide solution **is to** be available for

detecting chlorine leaks.

- b. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute **is to** be provided.
- c. Consideration should be given to **the provision of** caustic soda solution reaction tank for absorbing the contents of leaking ton containers where such containers are in use.
- d. Consideration should be given to the installation of automatic gas detection and related alarm equipment.

102.5 Housing (formerly 103.5)

102.51 Feed and Storage Room (formerly 103.51)

- a. If gas chlorination equipment or chlorine cylinders are to be in a building used for other purposes, a gas-tight room **is to** separate this equipment **from any other portion of the building**.
- b. Such rooms **are to** be at ground level, and should permit easy access to all equipment.
- c. Floor drains from the chlorine room **are not to** be connected to floor drains from other rooms.
- d. Doors to this room **are to** open only to the outside of the building, and **are to** be equipped with panic hardware.
- e. The storage area should be separated from the feed area and the storage area should have designated areas for “full” and “empty” containers.
- f. Chlorination equipment should be situated as close to the application point as reasonably possible.

102.52 Inspection Window (formerly 103.52)

A clear glass, gas-tight window **is to** be installed in an exterior door or interior wall of the chlorinator room to permit the units to be viewed without entering the room.

102.53 Heat (formerly 103.53)

- a. Rooms containing chlorination equipment **are to** be provided with a means of heating so that a temperature of at least 60°F can be maintained.
- b. The room **is to** be protected from excess heat.
- c. Cylinders **are to** be kept at essentially room temperature.

- d. If liquid hypochlorite solution is used, the containers may be located in an unheated area.

102.54 Ventilation (formerly 103.54)

- a. With chlorination systems, forced, mechanical ventilation is to be installed which will provide one complete air change per minute when the room is occupied.
- b. The entrance to the air exhaust duct or fan from the room is to be near the floor, and the point of discharge is to be so located as not to contaminate the air inlet to any buildings or present a hazard at the access to the chlorinator room or other inhabited areas.
- c. Air inlets are to be so located as to provide cross ventilation through the room and at such temperature that will not adversely affect the chlorination equipment.
- d. The outside air inlet is to be at least three feet above grade.
- e. The vent hose from the chlorinator is to discharge to the outside atmosphere above grade and away from public exposure.
- f. In areas where public exposure may be extensive or unavoidable, scrubbers may be required on the vent discharge.

102.55 Electrical Controls and Ambient Gas Detectors (formerly 103.55)

- a. Switches for fans and lights are to be outside of the room at the entrance.
- b. A labeled signal light indicating fan operation should be provided at each entrance if the fan can be controlled from more than one location.
- c. The controls for the fans and lights are to be such that they will automatically operate when the door is opened and can also be manually operated from the outside without opening the door.
- d. An ambient chlorine gas detector should be provided in the chlorine storage room.
- e. The gas detector should be interlocked with the fan and audible or visual alarms.

102.56 Protective and Respiratory Gear (formerly 103.6)

- a. Respiratory air-pac protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) are to be available where chlorine gas is handled and are to be stored at a

- convenient location, but not inside any room where chlorine is used or stored.
- b. Instructions for using the equipment **are to** be posted adjacent to the equipment.
 - c. The units **are to** use compressed air, have at least 30-minute capacity and be compatible with the units used by the fire department responsible for the plant.

102.6 Sampling and Control

102.61 Sampling (formerly 103.74)

- a. Facilities **are to** be included for sampling the disinfected effluent for residual chlorine **after the contact chamber as monitoring requirements warrant.**
- b. Provisions **are to** be made for continuous monitoring of effluent chlorine residual.

102.62 Testing and Control (formerly 103.75)

- a. Equipment **is to** be provided for measuring chlorine residual using accepted test procedures.
- b. The installation of demonstrated effective facilities for automatic chlorine residual analysis, recording, and proportioning systems should be considered at all large installations.
- c. Equipment **is also to** be provided for measuring fecal coliforms **and/or** *E. coli* bacteria using accepted test procedures.

103. DECHLORINATION (formerly 104)

103.1 Type (formerly 104.1)

- a. Dechlorination of wastewater effluents may be necessary to reduce the toxicity due to chlorine residuals. The most common dechlorination chemicals are sulfur compounds, particularly sulfur dioxide gas or aqueous solutions of sulfide or bisulfite. **Tablet** dechlorination systems are also available for **systems with a design maximum monthly average flow of less than 10,000 gallons per day.**
- b. The type of dechlorination system should be carefully selected. Consideration should be given to:
 1. the amount of chemical needed,
 2. type of chemical storage required,
 3. ease of operation,

4. compatibility with existing equipment, and
5. safety.

103.2 Dosage (formerly 104.22)

- a. In determining the dosage of dechlorination chemical, consideration **is to** be given to the residual chlorine in the disinfected waste stream, the final residual chlorine effluent limits and the particular form of the dechlorinating chemical used. A form of sulfur is most commonly used as a dechlorinating agent. Commonly used forms of the sulfur compounds and their theoretical application rates are:

Dechlorination Chemical	Theoretical mg/L required to neutralize 1 mg/L Cl ₂
Sodium thiosulfate (solution)	0.56
Sulfur dioxide (gas)	0.9
Sodium metabisulfite (solution)	1.34
Sodium bisulfite (solution)	1.46
Sodium sulfite (tablet)	1.78

- b. Theoretical values may be used for initial approximations to size feed equipment with the consideration that under good mixing conditions, 10 percent excess dechlorinating chemical is required above theoretical values.
- c. **Design should consider that excess dechlorination chemicals** may consume oxygen at a maximum rate of 1 mg DO for every 4 mg sulfur dioxide.
- d. The liquid solutions come in various strengths. These solutions may need to be further diluted to provide the proper dosage of sulfite.

103.3 Containers (formerly 104.3)

- a. Depending on the chemical selected for dechlorination, the storage containers will vary from gas cylinders, liquid in 50 gallon drums or dry compounds.
- b. Dilution tanks and mixing tanks will be necessary to deliver the proper dosage of dry compounds and may be necessary for liquid compounds.
- c. **Solution containers should be covered to prevent evaporation and spills.**

103.4 Feed Equipment, Mixing, and Contact Requirements (formerly 104.2)

103.41 Equipment (formerly 104.21)

- a. In general, the same type of feeding equipment used for chlorine gas may be used, with minor modifications, for sulfur dioxide gas. However, the manufacturer should be contacted for specific equipment

recommendations. No equipment should be alternately used for the two gasses.

- b. The common types of dechlorination feed equipment utilizing sulfur compounds include vacuum solution feed for sulfur dioxide gas and positive displacement pump for aqueous solutions of sulfite or bisulfite.
- c. The selection of the type of feed equipment utilizing sulfur compounds is to include consideration of operator safety and overall public safety relative to the wastewater treatment plant's proximity to populated areas and the security of gas cylinder storage.
- d. The selection and design of sulfur dioxide feeding equipment are to take into account that the gas reliquifies quite easily. Special precautions must be taken when using ton containers to prevent reliquification.
- e. Where necessary to meet the operating ranges, multiple units are to be provided for adequate peak capacity and to provide a sufficiently low feed rate on turn down to avoid depletion of the DO concentrations in the receiving waters.

103.42 Mixing Requirements (formerly 104.61)

The dechlorination reaction with free or combined chlorine will generally occur within 20 seconds. Mechanical mixers are required unless the mixing facility will provide the required hydraulic turbulence to ensure thorough and complete mixing.

103.43 Contact Time (formerly 104.62)

- a. A minimum of 30 seconds for mixing and contact time is to be provided at the design peak hourly flow or maximum rate of pumpage.
- b. A suitable sampling point is to be provided downstream of the contact zone.
- c. Consideration is to be given to a means of reaeration to ensure maintenance of an acceptable dissolved oxygen concentration in the stream following sulfonation.

103.44 Standby Equipment and Spare Parts (formerly 104.23)

The same requirements apply as for chlorination systems. See Paragraph 102.47 of this chapter.

103.45 Sulfonator Water Supply (formerly 104.24)

The same requirements apply as for chlorination systems. See Paragraph 102.48 of this chapter.

103.46 Piping and Connections (formerly 104.4)

- a. The piping system should be as simple as possible, specifically selected and manufactured to be suitable for sulfur compounds, with a minimum number of joints.
- b. Piping is to be well supported and protected against temperature extremes.

103.5 Housing Requirements (formerly 104.5)**103.51 Feed and Storage Rooms**

- a. The requirements for housing SO₂ gas equipment are to follow the same guidelines as used for chlorine gas. Refer to Paragraph 102.5 of this chapter for specific details.
- b. When using solutions of the dechlorinating compounds, the solution may be stored in a room that meets the safety and handling requirements under Section 57.
- c. The mixing, storage and solution delivery areas must be designed to contain or route solution spillage or leakage away from traffic areas to an appropriate containment unit.

103.52 Protective and Respiratory Gear (formerly 104.63)

- a. The respiratory air-pac protection equipment is to be provided as described for chlorination facilities in Paragraph 102.56 of this chapter.
- b. Leak repair kits of the type used for chlorine gas that are equipped with gasket material suitable for service with sulfur dioxide gas may be used (Refer to The Compressed Gas Association Publication CGA G-3-1995, "Sulfur Dioxide").
- c. For additional safety considerations, see Section 57.

103.6 Sampling and Control**103.61 Sampling (formerly 104.64)**

- a. Facilities are to be included for sampling the dechlorinated effluent for residual chlorine.
- b. When required by DEP, provisions are to be made for monitoring the DO concentration following sulfonation.

103.62 Testing and Control (formerly 104.65)

- a. There is no control system specifically for sulfur dioxide so chlorine residual measurements control the feed rate.
- b. Manual or automatic provisions are to be provided for control of sulfonation feed rates based on chlorine residual measurements or effluent flow.

104. ULTRAVIOLET RADIATION DISINFECTION (formerly 105)

104.1 General

Ultraviolet (UV) radiation from the UVC portion of the electromagnetic spectrum has been shown to be an effective disinfectant. UVC radiation is defined as radiation with wavelengths between 200-280 nm. Any source that can generate UVC radiation can be used in a UV disinfection system. Common sources of UVC radiation include: low-pressure (LP) mercury (Hg) lamps, which emit predominantly at a characteristic wavelength of 254 nm, and medium-pressure (MP) Hg lamps, which are characterized by polychromatic output across the UVC range and other parts of the electromagnetic spectrum.

In designing UV treatment for existing plants, representative sampling for design parameters should be obtained. Design parameters include peak hourly flow, TSS concentrations, and UV transmittance. Data on potential fouling parameters, such as iron and hardness should also be obtained.

The UV system should monitor the disinfection process consistent with the equipment validation testing and target disinfection limit(s).

104.2 Validation

- a. In order to show disinfection adequacy over a range of flow rates and UV transmittances, UV reactors must have undergone third party biosimetry-based validation established under the *International Ultraviolet Association (IUVA)*, or a similar protocol such as UVDGM or NWRI, prior to being approved for use.
- b. In order to allow for evaluation of the design, the specific reactor proposed for installation must be accompanied by a validation report which identifies the range of conditions under which the reactor has been validated.
- c. Scale-up for open-channel (OC) UV reactors may be permitted if the design “flow per lamp” is within the validated “flow per lamp” range documented in the reactor validation report.

104.3 Pretreatment

- a. Pretreatment beyond that required for secondary treatment may be required if the 90th percentile total suspended solids concentration to the UV unit on secondary effluent is greater than 30 mg/L.

- b. Additional pretreatment may be required if the influent to the UV has a total iron concentration of > 0.1 mg/L or a hardness level (as CaCO_3) of >300 mg/L. These parameters indicate a high fouling potential, especially for unwiped systems or medium pressure UV systems.
 1. Automatic quartz wiping systems (physical or physical/chemical) may be able to address these wastewaters.
 2. For units without automatic cleaning systems, a fouling study may be necessary for system design.
- c. Pretreatment requirements for dedicated UV disinfection units for wet-weather flows will be evaluated on a case-by-case basis.

104.4 Ultraviolet Disinfection Unit

104.41 General Design Considerations

- a. The system components should not be adversely affected by the normal operating environment including:
 - wastewater flowrate,
 - water quality variations,
 - upstream treatment chemicals,
 - vibration,
 - shock,
 - climate and corrosion, and
 - recommended cleaning procedures.
- b. The minimum, average, and maximum values of flow rate and parameters affecting the water quality (including but not limited to UV transmittance, suspended solids) are to be specified.
 1. In addition to the minimum, average, and maximum flow rate, the 90th percentile flow is to be specified.
 2. In addition to the minimum, average, and maximum UV transmittance, the 10th percentile UV transmittance is to be specified.
- c. Ambient temperature range should be considered when designing the ballast cooling and electrical components and is to be specified.
- d. The system or component should be designed to be accessible for cleaning and maintenance of the UV equipment.
- e. For open channel designs, water level control and management is to be described for UV equipment protection and to ensure disinfection efficacy.

- f. For open channel designs, water depth is to be maintained by means of fixed weir, a modulating weir gate or flap gate to prevent hydraulic short-circuiting or air exposure to the quartz sleeves.
- g. Design should not promote solids accumulation within channel.
- h. The system should be designed based on the treated wastewater maximum suspended solids concentration, minimum UV transmittance and peak instantaneous flow rate. To avoid significant over designs, in lieu of above criteria, a detailed monitoring study showing how the treated wastewater 90th percentile suspended solids concentration, 10th percentile UV transmittance and 90th percentile peak instantaneous flow rate are related, may be performed with the concurrence of DEP to establish design levels that adequately represent effluent flow and water quality.
- i. For SBRs without post-flow equalization, the design is to be based on the peak decant rate.
- j. If flow measurement is not provided for every treatment train, the design is to promote even distribution of flow to within 10 percent among online trains.
- k. Materials
 - 1. All materials exposed to UV radiation should be formulated to resist deterioration.
 - 2. All materials exposed to UV radiation should not impart undesirable odor, color, and/or toxic chemicals to the water upon irradiation.
 - 3. Systems and/or components should be constructed of material suitable to withstand temperatures generated during continuous operation and sustained periods when the unit is not in use.
 - 4. Reactor channel (approach, throat and discharge) should be consistent with the manufacturer's recommendations.
 - 5. The upstream and downstream sections of the UV reactor should be light tight.
 - 6. The upstream and downstream sections of the UV reactor should prevent infiltration from external sources such as external runoff from entering the disinfection train.

104.42 Arrangement of Units

104.421 Number and Arrangement of Units

- a. Each channel is to be equipped with multiple banks of the same capacity.
- b. Treatment reliability is to be achieved by either a standby channel or a standby reactor/bank per train/channel at maximum monthly average design conditions.
- c. The reactor trains/channels are to be designed to enable them to be isolated during maintenance.
- d. The reactor trains/channels are to have enough spacing between reactors to allow for adequate maintenance.

104.422 Inlets and Outlets

- a. The hydraulic conditions in the UV facility should result in a UV dose delivery that is equal to or greater than the UV dose delivered when the UV reactor was validated. There are two alternatives for meeting this condition:
 1. The length of unobstructed straight pipe/channel upstream of each UV reactor at the UV facility is the length of straight pipe/channel used in the validation testing plus 20 percent, but not less than 10 feet; or
 2. Inlet and outlet configurations at the UV facility match those used during validation for at least five pipe diameters/channel widths upstream and five pipe diameters/channel widths downstream of the reactor.
 3. In conditions where space limitations do not allow for 1) or 2) above, stilling plates and other flow distribution devices may be used when hydraulics have been properly verified with flow testing, CFD modeling or other protocol satisfactory to DEP.
- b. The piping system should promote uniform velocity upstream of the 1st reactor in the treatment train.
- c. Each reactor train should be identically designed.
- d. The outlet conditions should ensure the hydraulics in the last reactor are not adversely affected by any control devices or pipefittings.
- e. CFD modeling may be used to support hydraulic design assumptions.

104.5 Lamps

A lamp output of 50% should be used for design unless an end of lamp life factor corresponding to the replacement frequency has been established by the manufacturer, verified by third party testing using an industry recognized lamp testing protocol such as the National Water Research Institute or similar protocol.

104.6 Sleeves

- a. The UV lamps should be jacketed so that a proper operating lamp temperature is maintained.
- b. The jacket should be of quartz or high silica glass with similar optical characteristics.
- c. The unit should be designed with a minimum transmittance value of 80% through the sleeve.

104.7 Cleaning System

- a. For manually cleaned systems, a fouling factor of 80% is to be used for design.
- b. For automatic mechanical or mechanical/chemical cleaning systems, a fouling factor of 90% is to be used.
- c. A higher value verified by third party testing using an industry recognized fouling testing protocol such as the National Water Research Institute may be used, with prior approval of DEP.

104.8 Design UV Transmittance

The effluent 10th percentile UV transmittance shall be within the validation range of the UV equipment.

104.9 Design UV Dosage

- a. The design UV dose shall be set with the objective of meeting the discharge permit. The discharge permit is dependent on local state regulations determined in part by the nature and use of the receiving body. Ideally, the required inactivation will be determined by the water quality delivered by the upstream processes and the discharge permit.
- b. A complete basis of design is to be submitted with the design engineer's report, including the number of log inactivations or regulated organism, such as *E. coli* or fecal coliforms that are required.
- c. In absence of more information on required inactivation, the minimum design UV dose for activated sludge secondary effluents with an effluent fecal coliform concentration of 200/100 mL is 30 mJ/cm² MS2 at a UVT of 65% per 1cm .

1. Lower effluent fecal coliform requirements, lower UV transmittances, or higher influent fecal coliform levels may require a higher dose.
 2. Lower UV dose values or higher UVT values may only be used if extensive site-specific, analogous, pilot, or collimated beam bench-scale data is presented to justify the exception.
 3. The applicant is encouraged to meet DEP at the beginning of the project phase to review the applicant's plan and safety factors for justifying the use of a lower design delivered UV dose for the specific application.
- d. Compared to activated sludge, fixed film secondary effluents tend to have lower UVTs and higher suspended solids concentrations, both of which can increase the UV dose required to achieve given levels of inactivation.
1. For fixed-film effluents, a collimated beam study is to be performed to determine the required UV dose.
 2. Water quality data extending over at least one year is to be provided to determine adequacy.
 3. DEP must approve the plan to determine the required design delivered UV dosage and UVT before it is implemented by the applicant.
- e. Dose delivery of the equipment must be validated with a bioassay test using a challenge organism that has UV sensitivity similar to or greater than the target design pathogen. A challenge organism is one that is non-pathogenic, easily grown to high concentrations, easily enumerated in a growth or infectivity assay, display minimal shoulder (lag) or tailing of the dose response curve, stable for relatively long periods with minimal die-off, robust under typical testing conditions, and effectively model the reactor's disinfection efficiency toward the target pathogen. MS2 is a bacteriophage which has a history of being used for this purpose, and should be used to quantify the MS2 dose specified above.

104.10 Operations, Safety and Alarm Systems

104.101 Operations and Monitoring

- a. The minimum continuous monitoring of the following is to be recorded and displayed. This information should be available in a visual display as well as a historical record.
 - Flowrate,
 - UV transmittance,
 - Water level relative to the UV lamps for open channel units with modulating gates (not required for fixed weir applications),
 - Lamp hours of operation,
 - Operational UV dose during operation, and

- All critical alarms identified during design.
- b. Provide an operator interface for operator adjustment of all reactors, set points, and other control logic.
- c. The manufacturers' recommendations should be used to calibrate the UV transmittance monitoring equipment. Any on-line UV transmittance monitoring should be verified with grab samples on a weekly basis.
- d. UV lamps should be replaced with OEM lamps. If OEM lamps are not used, the permittee must demonstrate independent certification of operational equivalency of the non-OEM lamps.

104.102 Safety

- a. GFCI circuitry should be provided or equivalent safety mechanisms as provided in the UV ballasts.
- b. Each electrical control panel is to have an emergency shutdown push button.
- c. Consideration should be given to providing a sump downstream of the UV reactor to capture mercury and debris from broken lamps/sleeves.
- d. UV system design must provide a safe working environment for the operator. The UV design is to include provisions to prevent exposing the operator to UV light.

104.103 Alarm Systems

- a. To ensure that appropriate UV dose levels are maintained, a warning alarm should be installed to ensure prompt replacement of a burned-out-lamp.
- b. Alarms should be divided into major alarms and minor alarms.
 - 1. Major alarms should be for situations where an action must be taken by the operator to correct the situation causing the alarm.
 - 2. Minor alarms should be notifications only, for situations which may be addressed by system controls design or other intervention.
- c. During design, the list of minor and critical alarms system response is to be established and incorporated into the UV system controls.
 - 1. Examples of critical alarms may include:

- High ballast temperature alarm – this should be considered a critical alarm because it can be a precursor to complete equipment shutdown.
- Multiple lamp failure alarm – this should be considered a critical alarm because multiple lamp failures will compromise dose, and therefore, disinfection adequacy.

2. Examples of minor alarms may include:

- Low UV intensity alarm – This alarm indicates that maintenance of some kind is required – most likely sleeve cleaning or lamp replacement.
- Low flow alarm – This alarm indicates that the unit is operating outside of the validation range, and that flow modulation needs to occur.
- High flow alarm – This alarm indicates that the unit is operating outside of the validation range, and that flow modulation needs to occur.

104.11 Electrical Controls

- a. The unit should have an automatic flow control device, accurate within the expected range of operating flows or pressures, so that the maximum design flow rate of the unit is not exceeded.
- b. The UV disinfection system should be installed with standby power.
- c. Power-distribution panels or power distribution within a cabinet shall be provided to divide like-type disinfection system components to prevent common mode failure.
- d. Control panel visual displays shall be established during design to enable adequate UV disinfection controls by system operators. Example visual displays may include:
 - Status of each UV reactor on/off
 - Status of each UV lamp on/off
 - Lamp age, in hours of each lamp
 - Cumulative number of reactor on/off cycles
 - Reactor power set point (if variable power input)
 - Dose set point
 - Flowrate
 - Wiper status, if automatic wiper is provided
 - GFI (if required)
 - UV transmittance

- e. A Programmable Logic Controllers (PLC) or microprocessor, programmed to meet the treatment requirements, should be provided for each reactor train.
- f. A means of reprogramming the reactors should also be provided. An available Ethernet port should be located in each panel to allow a laptop to be connected
- g. Both automatic and manual controls should be installed to allow independent operation of each reactor.
- h. The plant SCADA system shall transfer the following information to each UV reactor panel so that trains may communicate for coordination:

- Status of each UV reactor (on/off)
- Select next UV reactor to be powered on in event of a failure
- Position status of upstream and downstream valve/gate
- Setpoint for each upstream and downstream valve/gate

If a SCADA system is not available, the UV reactor system shall have a Master Panel installed to coordinate operation and select the rotation of online and offline trains.

- i. The SCADA system or Master Panel shall determine the valve/gate position to ensure an even flow distribution.
- j. The control panel should have a remote-local-off switch on either the touchscreen or a physical switch on the panel to allow the UV reactor train to be operated locally for maintenance or remotely by the SCADA or Master Panel. The normal position should be Remote so that the train may be shut down or brought online in the event of a train failure.
- k. An Uninterruptible Power Supply (UPS) or other similar equipment with electrical surge protection should be provided for each PLC or microprocessor to retain program memory (process control program, last known set points, and measured process/equipment status) through a power loss.
- l. All designs should include a “high flow” mode with a program that will recognize flow above the diurnal peak hourly flow.
 - 1. All equipment and controls should be designed to accommodate this high flow mode and to optimize the treatment processes.
 - 2. A description of this control logic should be included in the Design Engineer’s Report and O & M Manual.
- m. The UV system or component should be provided with a visual means to verify electrical operation of lamps.

- n. The unit must protect the operator against electrical shock or excessive ultraviolet radiation.
- o. Design elements to maximize disinfection efficiency and minimize short-circuiting shall be incorporated into the UV system controls and documented in the Design Engineer's Report.

105. OZONE DISINFECTION

105.1 General

- a. Ozonation may be used for disinfection of wastewater. The effectiveness of oxidation is varied, depending on pH and alkalinity of the water. High levels of hydroxyl radicals cause lower levels of residual ozone. For disinfection, residual ozone is necessary for development of CT.
- b. Bench scale studies should be conducted to determine minimum and maximum ozone dosages for disinfection compliance. More involved pilot plant studies should be conducted when necessary to document benefits. Care must be taken during bench and pilot scale studies to ensure accurate results. Particularly sensitive measurements include gas flow rate, water flow rate and ozone concentration.
- c. Because of the more sophisticated nature of the ozone process, a higher degree of operator maintenance skills and training is required. The ability to obtain qualified operators must be evaluated in selection of the treatment process. The necessary operator training is to be provided prior to plant start-up.
- d. The production of ozone is an energy intensive process. Substantial economies in electrical usage, reduction in equipment size and waste heat removal requirements can be obtained by using oxygen enriched air or oxygen as feed, and by operating at increased electrical frequency.
- e. Use of ozone may result in increases in the biologically available organics content of the treated wastewater. Ozone use may also lead to increased chlorinated byproduct levels if the water is not stabilized and free chlorine is available.

105.2 Feed Gas Preparation

105.21 General

- a. Feed gas can be air, high purity oxygen, oxygen enriched air or liquid oxygen (LOX) delivered to a storage vessel or generated on-site. Air handling equipment on conventional low pressure air-feed systems should consist of an air compressor, water/air separator, refrigerant dryer, heat reactivated desiccant dryer and particulate filters. Some "package" ozonation systems for small plants may work effectively operating at high pressure without the refrigerant dryer and with a "heatless" desiccant dryer.

- b. In all cases the design engineer must ensure that the maximum dewpoint of minus 60°C (minus 76°F) will not be exceeded at any time.
- c. For high-purity oxygen-feed systems, dryers typically are not required.

105.22 Air Compression

- a. Air compressors are to be of the liquid-ring or rotary lobe, oil-less, positive displacement type for smaller systems, or dry rotary screw compressors for larger systems.
- b. The air compressors must have the capacity to simultaneously provide for maximum ozone demand, provide the air flow required for purging the desiccant dryers (where required), and allow for standby capacity.
- c. Air feed for the compressor should be drawn from a point protected from rain, condensation, mist, fog and contaminated air sources to minimize moisture and hydrocarbon content of the air supply.
- d. A compressed air filter-cooler and/or entrainment separator with automatic drain is to be provided prior to the dryers to reduce the water vapor.
- e. A backup air compressor must be provided so that ozone generation is not interrupted in the event of a breakdown.

105.23 Air Dryer

- a. Dry, dust-free and oil-free feed gas must be provided to the ozone generator. Dry gas is essential to prevent formation of nitric acid, to increase the efficiency of ozone generation and to prevent damage to the generator dielectrics. Sufficient drying to a maximum dew point of minus 60°C (minus 76°F) must be provided at the end of the drying cycle.
- b. Drying for high pressure systems may be accomplished using heatless desiccant dryers only. For low pressure systems, a refrigeration air dryer in series with heat-reactivated desiccant dryers should be used.
- c. A refrigeration dryer capable of reducing inlet air temperature to 4°C (40°F) is to be provided for low pressure air preparation systems. The dryer can be of the compressed refrigerant type or chilled water type.
- d. For heat-reactivated desiccant dryers, the unit is to contain two desiccant-filled towers complete with pressure relief valves, two four-way valves and a heater. In addition, external type dryers are to have a cooler unit and blowers. The size of the unit is to be such that the specified dew point will be achieved during a minimum adsorption cycle time of 16 hours while operating at the maximum expected moisture loading conditions.

- e. Multiple air dryers must be provided so that the ozone generation is not interrupted in the event of dryer breakdown.
- f. Each dryer must be capable of venting dry gas to the atmosphere, prior to the ozone generator, to allow start-up when other dryers are on-line.

105.24 Air Filters

- a. Air filters are to be provided on the suction side of the air compressors, between the air compressors and the dryers, and between the dryers and the ozone generators.
- b. The filter before the desiccant dryers is to be of the coalescing type and be capable of removing aerosol and particulates larger than 0.3 micron in diameter.
- c. The filter after the desiccant dryers is to be of the particulate type and be capable of removing all particulates greater than 0.1 micron in diameter, or smaller if specified by the generator manufacturer.

105.25 Air Preparation Piping

- a. Piping in the air preparation system can be common grade steel, seamless copper, stainless steel or galvanized steel.
- b. The piping must be designed to withstand the maximum pressures in the air preparation system.

105.3 Ozone Generator

105.31 Capacity

- a. The production rating of the ozone generators is to be stated in pounds per day and kWh per pound at a maximum cooling water temperature and maximum ozone concentration.
- b. The design is to ensure that the maximum concentration of ozone in the generator exit gas will not be less than 1 percent (by weight).
- c. Generators are to be sized to have sufficient reserve capacity so that the system does not operate at peak capacity for extended periods of time. This can result in premature breakdown of the dielectrics.
- d. The production rate of ozone generators will decrease as the temperature of the coolant increases.
- e. If there is to be a variation in the supply temperature of the coolant throughout the year, then graphs or other means are to be used to determine production changes due to the temperature change of the

supplied coolant.

- f. The design is to ensure that the generators can produce the required ozone at maximum coolant temperature.
- g. Appropriate ozone generator backup equipment must be provided.

105.32 Electrical

The generators can be low, medium or high frequency type. Specifications are to require that the transformers, electronic circuitry and other electrical hardware be proven, high quality components designed for ozone service.

105.33 Cooling

- a. Adequate cooling is to be provided. The required water flow to an ozone generator varies with the ozone production. Normally, unit design provides a maximum cooling water temperature rise of 5°F. However, in cases where it is advantageous to decrease the volume of water used for cooling, up to a 10°F increase in temperature has been successfully employed.
- b. The cooling water must be properly treated to minimize corrosion, scaling and microbiological fouling of the water side of the tubes. A closed loop cooling water system is often used to ensure proper water conditions.
- c. Where cooling water is treated, cross-connection control is to be provided to prevent contamination of the potable water supply in accordance with Paragraph 56.23.

105.34 Materials

To prevent corrosion, the ozone generator shell and tubes are to be constructed of Type 316L stainless steel.

105.4 Ozone Contactors

The selection or design of the contactor and method of ozone application depends on the purpose for which the ozone is being used.

105.41 Bubble Diffusers

- a. A minimum of two contact chambers, each equipped with baffles to prevent short-circuiting and induce countercurrent flow, are to be provided.
- b. Ozone is to be applied using porous-tube or dome diffusers.
- b. The minimum contact time (hydraulic detention time) is to be 10 minutes.

A shorter contact time may be approved by DEP if justified by appropriate design and CT considerations.

- c. For ozone applications in which precipitates are formed, porous diffusers should be used with caution.
- d. Contactors are to be separate closed vessels that have no common walls with adjacent rooms.
- e. The contactor must be kept under negative pressure, and sufficient ozone-in-air monitors are to be provided to protect worker safety.
- f. Placement of the contactor where the entire roof is exposed to the open atmosphere is recommended.
- g. In contactor vessels made of reinforced concrete, all reinforcement bars are to be covered with a minimum of 1.5 inches of concrete.
- h. A system is to be provided between the contactor and the off-gas destruct unit to remove froth from the off-gas and return the froth to the contactor or other location acceptable to DEP. If foaming is expected to be excessive, then a potable water spray system is to be placed in the contactor head space.
- i. All openings into the contactor for pipe connections, hatchways, etc. are to be properly sealed using welds or ozone resistant gaskets such as Teflon or Hypalon.
- j. Multiple sampling ports are to be provided to enable sampling of each compartment's effluent water and to confirm CT calculations.
- k. A pressure relief valve is to be provided in the contactor.
- l. The diffusion system is to work on a countercurrent basis such that the ozone is fed at the bottom of the vessel and water is fed at the top of the vessel.
- m. The depth of water in bubble diffuser contactors is to be a minimum of 18 feet.
- n. The contactor is to have a minimum of 3 feet of freeboard to allow for foaming.
- o. All contactors are to have provisions for cleaning, maintenance and drainage of the contactor.
- p. Each contactor compartment is to be equipped with an access hatchway.

105.42 Other Contactors

Other contactors, such as venturi or aspirating turbine mixer contactor, may be approved by DEP provided adequate ozone transfer is achieved and the required contact times and residuals can be met and verified. Injectors may be acceptable as ozone contactors subject to DEP approval.

105.5 Ozone Destruction Unit

- a. A system for treating the final off-gas from each contactor must be provided in order to meet safety and air quality standards. Acceptable systems include thermal destruction and thermal/catalytic destruction units.
- b. In order to reduce the risk of fires, the use of units that operate at lower temperatures is encouraged, especially where high purity oxygen is the feed gas.
- c. The maximum allowable ozone concentration in the off-gas discharge is 0.1 ppm (by volume).
- d. A sufficient number of units are to be provided so that the system is capable of handling the entire gas flow with one unit out of service.
- e. Exhaust blowers are to be provided in order to draw off-gas from the contactor into the destruct unit.
- f. Catalysts must be protected from froth, moisture and other impurities which may harm the catalyst.
- g. The catalyst and the heating elements are to be located where they can be easily reached for maintenance.

105.6 Piping Materials

Only low carbon 304L and 316L stainless steels are to be used for ozone service, with the 316L preferred.

105.7 Joints and Connections

- a. Connections on piping used for ozone service are to be welded where possible.
- b. Connections with meters, valves or other equipment are to be made with flanged joints with ozone resistant gaskets, such as Teflon or Hypalon. Screwed fittings are not to be used because of their tendency to leak.
- c. A positive closing plug or butterfly valve plus a leak-proof check valve is to be provided in the piping between the generator and the contactor to prevent moisture from reaching the generator.

105.8 Instrumentation

- a. Pressure gauges are to be provided at:
 1. the discharge from the air compressor,
 2. the inlet to the refrigeration dryers,
 3. the inlet and outlet of the desiccant dryers,
 4. the inlet to the ozone generators and contactors, and
 5. the inlet to the ozone destruction unit.
- b. Electric power meters are to be provided for measuring the electric power supplied to the ozone generators.
- c. Each generator is to have a trip which shuts down the generator when the wattage exceeds a maximum preset level.
- d. Dew point monitors are to be provided for measuring the moisture of the feed gas from the desiccant dryers. Because it is critical to maintain the specified dew point, it is recommended that continuous recording charts be used for dew point monitoring which will allow the proper adjustment of the dryer cycles. Charts may not be necessary if a computer-based control system is in use.
- e. Where there is potential for moisture entering the ozone generator from downstream of the unit or where moisture accumulation can occur in the generator during shutdown, post-generator dew point monitors should be used.
- f. Air flow meters are to be provided for measuring air flow from the desiccant dryers to each of the ozone generators, air flow to each contactor and purge air flow to the desiccant dryers.
- g. Temperature gauges are to be provided for the inlet and outlet of the ozone cooling water, the inlet and outlet of the ozone generator feed gas and, if necessary, for the inlet and outlet to the ozone power supply cooling water.
- h. Water flow meters are to be installed to monitor the flow of cooling water to the ozone generators and, if necessary, to the ozone power supply.
- i. Ozone monitors are to be installed to measure ozone concentration in both the feed-gas and off-gas from the contactor and in the off-gas from the destruct unit.
- j. Monitors are to be provided for monitoring ozone residuals in the water. The number and location of ozone residual monitors are to be such that the amount of time that the water is in contact with the ozone residual can be determined.
- k. A minimum of one ambient ozone monitor is to be installed in the vicinity of the generator, and one adjacent to the first atmospherically vented process unit downstream of the contactor, if that unit is indoors.

1. Ozone monitors are to be installed in any areas where ozone gas might accumulate.

105.9 Alarms

The following alarm/shutdown systems are to be considered at each installation:

105.91 Dew Point Shutdown/Alarm

This system will shut down the generator in the event the system's dew point exceeds -60°C (-76°F).

105.92 Ozone Generator Cooling Water Flow Shutdown/Alarm

This system will shut down the generator in the event that cooling water flow decreases to the point that generator damage could occur.

105.93 Ozone Power Supply Cooling Water Flow Shutdown/Alarm

This system is to shut down the power supply in the event that cooling water flow decreases to the point that damage could occur to the power supply.

105.94 Ozone Generator Cooling Water Temperature Shutdown/Alarm

This system will shut down the generator if either the inlet or outlet cooling water exceeds a certain preset temperature.

105.95 Ozone Power Supply Cooling Water Temperature Shutdown/Alarm

This system will shut down the power supply if either the inlet or outlet cooling water exceeds a certain preset temperature.

105.96 Ozone Generator Inlet Feed-Gas Temperature Shutdown/Alarm

This system will shut down the generator if the feed-gas temperature is above a preset value.

105.97 Ambient Ozone Concentration Shutdown/Alarm

The alarm will sound when the ozone level in the ambient air exceeds 0.1 ppm or a lower value chosen by the water supplier. Ozone generator shutdown is to occur when ambient ozone levels exceed 0.3 ppm (or a lower value) in either the vicinity of the ozone generator or the contactor.

105.98 Ozone Destruction Temperature Alarm

The alarm will sound when temperature exceeds a preset value.

105.10 Safety

- a. The maximum allowable ozone concentration in the air to which workers may be exposed must not exceed 0.1 ppm (by volume).
- b. Noise levels resulting from the operating equipment of the ozonation system should be reasonably controlled by special room construction and equipment isolation.
- c. High voltage and high frequency electrical equipment must meet current applicable electrical and fire codes.
- d. Emergency exhaust fans must be provided in the rooms containing the ozone generators to remove ozone gas if leakage occurs. The generating system must be shut down following detection of a leak.
- e. A portable purge air blower that will remove residual ozone in the contactor prior to entry for repair or maintenance is to be provided.
- f. A sign is to be posted indicating “No smoking, oxygen in use” at all entrances to the treatment plant. In addition, no flammable or combustible materials are to be stored within the oxygen generator areas.

105.11 Construction Considerations

- a. Prior to connecting the piping from the desiccant dryers to the ozone generators, the air compressors should be used to blow the dust out of the desiccant.
- b. The contactor should be tested for leakage after sealing the exterior. This can be done by pressurizing the contactor and checking for pressure losses.
- c. Connections on the ozone service line should be tested for leakage using the soap-test method.
- d. The feed gas and ozone piping must be properly cleaned prior to start-up.

106. OTHER DISINFECTION PROCESSES (formerly 106)

The use of other disinfection processes will be considered by DEP on the merit of the process involved.

CHAPTER 110
SUPPLEMENTAL TREATMENT PROCESSES

111. PHOSPHORUS REMOVAL BY CHEMICAL TREATMENT (formerly 92)**111.1 General****111.11 Method**

Addition of lime or the salts of aluminum or iron may be used for chemical removal of soluble phosphorus. The phosphorus reacts with the calcium, aluminum or iron ions to form insoluble compounds. Those insoluble compounds may be flocculated with or without the addition of a coagulant aid such as polyelectrolyte to facilitate separation by sedimentation, **or sedimentation followed by filtration.**

111.12 Design Basis (formerly 92.1)**111.121 Preliminary Testing (formerly 92.11)**

- a. Laboratory, pilot or full-scale studies of various chemical feed systems and treatment processes are recommended for existing plant facilities to determine the achievable performance level, cost-effective design criteria and ranges of required chemical dosages.
- b. The selection of a treatment process and chemical dosage for a new facility should be based on such factors as influent wastewater characteristics, **the proposed chemical**, effluent requirements and anticipated treatment efficiency.

111.122 System Flexibility (formerly 92.12)

Systems **are to** be designed with sufficient flexibility to allow for several operational adjustments in chemical feed locations, chemical feed rates and feeding alternate chemical compounds.

111.2 Process Requirements (formerly 92.2)**111.21 Dosage (formerly 92.21)**

The design chemical dosage **is to** include the amount needed to react with the phosphorus in the wastewater, the amount required to drive the chemical reaction to the desired state of completion, **including consideration of competing reactions**, and the amount required due to inefficiencies in mixing or dispersion. Excessive chemical dosage should be avoided.

111.22 Chemical Selection (formerly 92.22)

- a. The choice of lime or the salts of aluminum or iron should be based on:
 1. the wastewater characteristics,
 2. **chemical availability and handling,**
 3. **sludge processing and disposal methods,** and
 4. the economics of the total system.
- b. When lime is used, it may be necessary to neutralize the high pH prior to subsequent treatment in secondary biological systems or prior to discharge in those flow schemes where lime treatment is the final step in the treatment process.
- c. **Considerations associated with lime usage, handling, and sludge production and dewatering are to be evaluated.**

111.23 Chemical Feed Points (formerly 92.23)

- a. Selection of chemical feed points **is to** include consideration of the chemicals used in the process, necessary reaction times between chemical and polyelectrolyte additions, the need for effective mixing, and the wastewater treatment processes and components utilized.
- b. Flexibility in feed location **is to** be provided to optimize chemical usage **and overall treatment efficiency.**

111.24 Flash Mixing (formerly 92.24)

- a. Each chemical must be mixed rapidly and uniformly with the flow stream.
- b. Where separate mixing basins are provided, they should be equipped with mechanical mixing devices.
- c. **Flash mixing should comply with Paragraph 65.1.**

111.25 Flocculation (formerly 92.25)

- a. The particle size of the precipitate formed by chemical treatment may be very small. Consideration should be given in the process design for the addition of synthetic polyelectrolytes to aid settling.
- b. The flocculation equipment should be adjustable in order to obtain optimum floc growth, control deposition of solids and prevent floc destruction.
- c. **Flocculation should comply with the requirements of Section 66.**

111.26 Liquid-Solids Separation (formerly 92.26)

- a. Entrance works to settling basins should also be designed to minimize floc shear.
- b. Settling basin design **is to** be in accordance with criteria outlined in Chapter 70.
- c. For design of the sludge handling system, special consideration should be given to the type and volume of sludge generated in the phosphorus removal process.

111.27 Filtration (formerly 92.27)

Effluent filtration, **such as with granular media filters or membrane separation technologies**, **is to** be considered in conjunction with chemical treatment where effluent phosphorus concentrations of less than 1 mg/L must be achieved.

111.3 Feed Systems (formerly 92.3)**111.31 Location**

- a. **All liquid chemical mixing and feed installations should be installed on corrosion-resistant pedestals and elevated above the highest liquid level anticipated during emergency conditions.**
- b. The chemical feed equipment **is to** be designed to meet the maximum dosage requirements for the design conditions.
- c. When lime is used as a coagulant, the feed equipment **is to** be designed as a minimum to meet the chemical dosage requirements of 150 mg/L and 300 mg/L of CaO for single stage lime treatment and two stage lime treatment, respectively.
- d. When alum or ferric chloride is used as a coagulant, the feed equipment **is to** be designed, as a minimum, to meet the dosage requirement of 16 mg/L of alum or 45 mg/L of ferric chloride for each mg/L of phosphorus removal.
- e. Lime feed equipment should be located so as to minimize the length of slurry conduits. All slurry conduits **are to** be accessible for cleaning.

111.32 Liquid Chemical Feed Systems (formerly 92.31)

- a. Liquid chemical feed pumps should be of the positive displacement type with variable feed rate.
- b. Pumps **are to** be selected to feed the full range of chemical quantities

required for the phosphorus mass loading conditions anticipated with the largest unit out of service.

- c. Consideration should be given to systems including pumps and piping that will feed either iron or aluminum compounds to provide flexibility. Refer to Paragraph 111.51.
- d. Screens and valves are to be provided on the chemical feed pump suction lines.
- e. An air break or anti-siphon device is to be provided where the chemical solution stream discharges to the transport water stream to prevent an induction effect resulting in overfeed.
- f. Consideration is to be given to providing pacing equipment to optimize chemical feed rates.

111.33 Dry Chemical Feed System (formerly 92.32)

- a. Each dry chemical feeder is to be equipped with a dissolver which is capable of providing a minimum retention time of 5 minutes at the maximum feed rate.
- b. Polyelectrolyte feed installations should be equipped with two solution vessels and transfer piping for solution make-up and daily operation.
- c. Make-up tanks are to be provided with an educator funnel or other appropriate arrangement for wetting the polymer during the preparation of the stock feed solution.
- d. Adequate mixing should be provided by a large-diameter, low-speed mixer.

111.4 Storage Facilities (formerly 92.4)

111.41 Size (formerly 92.41)

- a. Storage facilities are to be sufficient to ensure that an adequate supply of the chemical is available at all times. Exact size required will depend on size of shipment, length of delivery time and process requirements.
- b. Storage for a minimum of 10-day's supply should be provided.

111.42 Location and Containment (formerly 92.42)

- a. The liquid chemical storage tanks and tank fill connections are to be located within a containment structure having a capacity exceeding the total volume of all storage vessels.

- b. Valves on discharge lines **are to** be located adjacent to the storage tank and within the containment structure. **Refer to Paragraph 57.2.**
- c. Auxiliary facilities **within the containment area**, including pumps and controls, **are to** be located above the highest anticipated liquid level.
- d. Containment areas **are to** be sloped to a sump area and **are not to** contain floor drains.
- e. Bag storage should be located near the solution make-up point to avoid unnecessary transportation and housekeeping problems.

111.43 Accessories (formerly 92.43)

- a. Platforms, stairs and railings **are to** be provided as necessary to afford convenient and safe access to all filling connections, storage tank entries and measuring devices.
- b. Storage tanks **are to** be provided with reasonable access to facilitate cleaning.
- c. **Platforms, stairs, and railings are to be provided as necessary, to afford convenient and safe access to all filling connections, storage tank entries, and measuring devices.**

111.5 Other Requirements (formerly 92.5)

111.51 Materials (formerly 92.51)

All chemical feed equipment and storage facilities **are to** be constructed of materials resistant to chemical attack by all chemicals normally used for phosphorus removal in accordance with **Section 57.**

111.52 Temperature, Humidity and Dust Control (formerly 92.52)

- a. Precautions **are to** be taken to prevent chemical storage tanks and feed lines from reaching temperatures likely to result in freezing or chemical crystallization at the concentrations employed. A heated enclosure or insulation may be required.
- b. Consideration **is to** be given to temperature, humidity and dust control in all chemical feed room areas.

111.53 Cleaning (formerly 92.53)

Consideration **is to** be given to the accessibility of piping. Piping should be installed with plugging wyes, tees or crosses with removable plugs at changes in

direction to facilitate cleaning.

111.54 Filling Drains and Draw-Off (formerly 92.54)

- a. Above-bottom draw-off from chemical storage or feed tanks **is to** be provided to avoid withdrawal of settled solids into the feed system.
- b. A bottom drain **is to** also be installed for periodic removal of accumulated settled solids.
- c. Provisions **are to** be made in the fill lines to prevent back siphonage of chemical tank contents.

111.6 Safety and Hazardous Chemical Handling (formerly 92.6)

The chemical handling facilities **are to** meet the appropriate safety and hazardous chemical handling facilities requirements of **Section 57**.

111.7 Sludge Handling

Consideration **is to** be given to the type and additional capacity of the sludge handling facilities that will be needed when chemicals are added. Refer to Chapter 80.

112. HIGH RATE EFFLUENT FILTRATION (formerly 91)

112.1 General

112.11 Applicability

Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. Filters may be necessary where effluent concentrations of less than **20 mg/L** of suspended solids and/or **1.0 mg/L** of phosphorus must be achieved **or to obtain adequate turbidity reduction for water reuse**.

A pretreatment process such as chemical coagulation, **flocculation** and sedimentation or other acceptable process should precede the filter units where effluent suspended solids requirements are less than 10 mg/L.

112.12 Design Considerations

- a. Care should be given in designing pipes or conduits ahead of filter units, if applicable, to minimize shearing of floc particles.
- b. Consideration should be given in the plant design to provide flow equalization facilities to moderate filter influent quality and quantity.

112.2 Filter Types (formerly 91.1)

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

112.3 Filtration Rates (formerly 91.2)

112.31 Allowable Rates

- a. Filtration rates are not to exceed 5 gpm/sq. ft. based on the design peak hourly flow rate applied to the filter units.
- b. The expected design maximum suspended solids loading to the filter should also be considered in determining the necessary filter area.

112.32 Number of Units (formerly 91.2)

Total filter area is to be provided in two or more units, and the filtration rate is to be calculated on the total available filter area with one unit out of service.

112.33 Structural Details and Hydraulics

The filter structure is to be designed as to provide for:

- a. Vertical walls within the filter.
- b. No protrusion of the filter walls into the filter media.
- c. Cover by superstructure as determined necessary for temperature control or for intrusion protection where needed.
- d. Head room to permit normal inspection and operation.
- e. Minimum depth of filter box of 8.5 feet.
- b. Minimum water depth over the surface of the filter media of 3 feet.
- c. Trapped effluent to prevent backflow of air to the bottom of the filters.
- d. Prevention of floor drainage to the filter with a minimum 4-inch curb around the filters.
- e. Prevention of flooding by providing overflow.
- f. Maximum velocity of treated water in pipe and conduits to filters of 2 feet per second.

- g. Cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy, or following lime-soda softening.
- h. Washwater drain capacity to carry maximum flow.
- i. Walkways around filters to be not less than 24 inches wide.
- j. Safety handrails or walls around filter areas adjacent to normal walkways.
- k. Construction to prevent cross-connections and common walls between potable and nonpotable water.

112.4 Backwash (formerly 91.3)

112.41 Backwash Rates (formerly 91.31)

- a. The backwash rate is to be 15 gpm per square foot or a rate adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected.
- b. The backwash system is to be capable of providing a variable backwash rate.
- c. The system should be designed to prevent rapid changes in backwash water flow.
- d. Minimum and maximum backwash rates are to be based on demonstrated satisfactory field experience under similar conditions.
- e. The design is to provide for a minimum backwash period of ~~10~~ 15 minutes.
- f. A rate-of-flow indicator, preferably with a totalizer, should be provided on the main washwater line and located so that it can be easily read by the operator during the washing process
- g. A washwater regulator or valve should be provided on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide.

112.42 Backwash Pumps (formerly 91.32)

- a. Multiple pumps for backwashing filter units are to be sized and interconnected to provide the required backwash rate to any filter with the largest pump out of service.
- b. Filtered water from a clear well or chlorine tank is to be used as the source

of backwash water.

- c. Waste filter backwash is to be adequately treated.

112.43 Backwash Surge Control (formerly 91.33)

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

112.44 Backwash Water Storage (formerly 91.34)

Total backwash water storage capacity in an effluent clearwell or chlorine contact tank is to be equal or exceed the volume required for two complete backwash cycles.

112.5 Filter Media (formerly 91.4)

- a. Proper media installation procedures must be used to ensure that the filter will result in effective filtration.
- b. Before placement of any media, each filter cell should be thoroughly cleaned and inspected.
- c. All underdrain and backwash systems should be tested to the maximum extent possible.
- d. Filter media are to be clean, free from clay, dust, micaceous material, organic matter and detrimental chemical or bacterial contaminants and have the following characteristics:
 1. A total depth of not less than 24 inches and generally not more than 30 inches.
 2. A uniformity coefficient of the smallest material not greater than 1.65.
 3. A minimum of 12 inches of media with an effective size range no greater

than 0.45 to 0.55 mm, and a specific gravity greater than the other filtering materials within the filter.

4. Types of filter media

i. Anthracite

Only clean crushed anthracite may be used and is to meet the following conditions:

- 1) When used alone, the effective size is to be in the range of 0.45 mm to 0.55 mm with a uniformity coefficient not greater than 1.65
- 2) When used as a cap, the effective size is to be in the range of 0.8 mm to 1.2 mm with a uniformity coefficient not greater than 1.7
- 3) A specific gravity greater than 1.4
- 4) An acid solubility less than 5 percent
- 5) A Mho's scale of hardness greater than 2.7

ii. Sand

Sand is to consist of hard, durable and dense grains of at least 85 percent siliceous material that will resist degradation during handling and use, and is to have:

- 1) An effective size of 0.45 to 0.55 mm.
- 2) A uniformity coefficient of not greater than 1.65.
- 3) A specific gravity greater than 2.5.
- 4) An acid solubility less than 5 percent.

Larger size media may be allowed by DEP where full-scale tests have demonstrated that treatment goals can be met under all conditions.

iii. High Density Sand

High density sand is to consist of hard, durable and dense grain garnet, ilmenite, hematite, magnetite, or associated minerals of those ores that will resist degradation during handling and use, and is to:

- 1) Contain at least 95 percent of the associated material with a specific gravity of 3.8 or higher.
- 2) Have an effective size of 0.2 to 0.3 mm.
- 3) Have a uniformity coefficient of not greater than 1.65.
- 4) Have an acid solubility less than 5 percent.

iv. Granular Activated Carbon (GAC)

Full bed or full depth GAC may be used, but only after consultation with DEP in addition to the following:

- 1) The effective size is to be in the range of 0.45 mm to 0.75 mm with a uniformity coefficient not greater than 1.9.
- 2) As a minimum, disinfection of the water from the GAC filters must be provided prior to distribution.
- 3) Provisions must be made for replacement or regeneration where GAC is used for filtration and organics removal.

v. Other media

Other media will be considered based on experimental data and operating experience.

5. Support media

i. Gravel

Gravel, when used as a supporting media, is to consist of hard, rounded particles and is not to include flat or elongated particles. The coarsest gravel is to be 2.5 inches in size when the gravel rests directly on the strainer system and must extend above the top of the perforated laterals. Not less than four layers of gravel are to be provided in accordance with the following size and depth distribution when used with perforated laterals:

Size	Depth
3/16 to 3/32 inches	2 to 3 inches
1/2 to 3/16 inches	2 to 3 inches
3/4 to 1/2 inches	3 to 5 inches
1.5 to 3/4 inches	3 to 5 inches
2.5 to 1.5 inches	5 to 8 inches

Reduction of gravel depths may be considered upon justification to DEP when proprietary filter bottoms are specified.

ii. Torpedo Sand

A 3-inch layer of torpedo sand should be used as a supporting media for filter sand where supporting gravel is used and should have:

- 1) An effective size of 0.8 mm to 2.0 mm.
- 2) A uniformity coefficient not greater than 1.7.

112.6 Filter Appurtenances (formerly 91.5)

- a. The filters are to be equipped with wash water 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.
- b. If automatic controls are provided, there is to be a manual override for operating equipment, including each individual valve essential to the filter operation.
- c. The underdrain system is to be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water.
- d. If air is to be used for filter backwash, separate backwash blower(s) are to be provided.
- e. Provisions are to be made for periodic chlorination of the filter influent or backwash water to control slime growths. When chemical disinfection is not provided, manual dosage of chlorine compounds may be utilized.
- f. Washwater Troughs

Washwater troughs are to be designed to provide:

1. The bottom elevation above the maximum level of expanded media during washing.
2. A 2-inch freeboard at the maximum rate of wash.
3. The top edge to be level and all at the same elevation.
4. Spacing so that each trough serves the same number of square feet of filter area.

5. Maximum horizontal travel of suspended particles to reach the trough not to exceed 3 feet.

g. Filter Bottoms and Strainer Systems

Departures from these standards may be acceptable for high rate filters and for proprietary bottoms. The design of manifold-type collection systems are to be such as to:

1. Minimize loss of head in the manifold and laterals.
2. Ensure even distribution of washwater and even rate of filtration over the entire area of the filter.
3. Provide the ratio of the area of the final openings of the strainer system to the area of the filter at about 0.003.
4. Provide a total cross-sectional area of the laterals at about twice the total area of the final openings.
5. Provide the cross-sectional area of the manifold at 1.5 to 2 times the total area of the laterals.
6. Lateral perforations without strainers are to be directed downward.

h. Surface Wash or Subsurface Wash

Surface or subsurface wash facilities should be provided and may be accomplished by a system of fixed nozzles or a revolving-type apparatus. All devices are to be designed with:

1. Provisions for water pressures of at least 45 psi.
2. A properly installed vacuum breaker or other approved device to prevent back-siphonage if connected to the treated water system.
3. Rate of flow of 2 gpm per square foot of filter area with fixed nozzles or 0.5 gpm per square foot with revolving arms.
4. Simultaneous air and water wash may be used provided experimental data and operating experiences indicate media will not be lost. A fluidization wash at the end of the backwash cycle must be provided to re-stratify the media.

i. Air scouring

Air scouring can be considered in place of surface wash.

1. Air flow for air scouring the filter must be 3-5 standard cubic feet per minute per square foot of filter area when the air is introduced in the underdrain; a lower air rate must be used when the air scour distribution system is placed above the underdrains.
 2. A method for avoiding excessive loss of the filter media during backwashing must be provided.
 3. Air scouring must be followed by a fluidization wash sufficient to restratify the media.
 4. Air must be free from contamination.
 5. Air scour distribution system should be placed below the media and supporting bed interface; if placed at the interface the air scour nozzles are to be designed to prevent media from clogging the nozzles or entering the air distribution system.
 6. Piping for the air distribution system are not to be flexible hose which will collapse when not under air pressure and are not to be a relatively soft material which may erode at the orifice opening with the passage of air at high velocity.
 7. Air delivery piping is not to pass down through the filter media nor is there to be any arrangement in the filter design which would allow short-circuiting between the applied unfiltered water and the filtered water.
 8. Consideration should be given to maintenance and replacement of air delivery piping.
 9. The backwash water delivery system must be capable of 15 gpm per square foot of filter surface area; however, when air scour is provided the backwash water rate must be variable and should not exceed 8 gpm per square foot while air is being delivered unless operating experience shows that a higher rate is necessary to remove scoured particles from filter media surfaces.
 10. The filter underdrains are to be designed to accommodate air scour piping when the piping is installed in the underdrain.
 11. Duplicate blowers should be provided.
 12. The provisions of Paragraph 112.4 are to be followed.
- j. Control Appurtenances
1. The following are to be provided for every filter:

- i. The necessary piping, valves and control equipment needed to filter-to-waste or recycle the effluent water at actual/current and permitted production rates at the beginning of the filter cycle.
 - ii. A flow rate controller capable of providing gradual rate increases when placing the filters back into operation.
 - iii. Influent and effluent sampling taps.
 - iv. An indicating loss of head gauge.
 - v. An indicating rate-of-flow meter. A modified rate controller which limits the rate of filtration to a maximum rate may be used. However, equipment that simply maintains a constant water level on the filters is not acceptable, unless the rate of flow on to the filter is properly controlled. A pump or a flow meter in each filter effluent line may be used as the limiting device for the rate of filtration only after consultation with DEP.
 - vi. Provisions for draining the filter-to-waste with appropriate measures for backflow prevention.
2. It is recommended the following be provided:
- i. Wall sleeves providing access to each filter interior at several locations for sampling or pressure sensing
 - ii. A 1 to 1.5 inch pressure hose and storage rack at the operating floor for washing the filter
 - iii. Access to particle counting equipment as a means to enhance overall treatment operations

112.7 Access and Housing (formerly 91.6)

- a. Each filter unit is to 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.
- b. Housing for filter units is to be provided. The housing is to be constructed of suitable corrosion-resistant materials.
- c. All controls are to be enclosed, and the structure housing filter controls and equipment are to be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

112.8 Proprietary Equipment (formerly 91.7)

Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which support the capability of the equipment to meet effluent requirements under design conditions **are to** be provided. Such equipment will be reviewed by DEP on a case-by-case basis. **Refer to Paragraph 53.2.**

113 through 119. RESERVED FOR FUTURE USE

**APPENDIX A
HANDLING AND TREATMENT OF SEPTAGE
AT A
WASTEWATER TREATMENT PLANT**

General

One method of septage disposal is the discharge to a municipal wastewater treatment plant. All plants require special design considerations prior to the acceptance of septage.

Definition

Septage is a general term for the contents removed from septic tanks, portable vault toilets, privy vaults, holding tanks, very small wastewater treatment plants, or semi-public facilities (i.e., schools, motels, mobile home parks, campgrounds, small commercial endeavors) receiving wastewater from domestic sources.

Non-domestic (industrial) wastes are not included in the definition and are not covered by this appendix.

Contents from grease traps should not be hauled to most municipal wastewater treatment plants for disposal.

Characteristics

Compared to raw domestic wastewater from a conventional municipal sewer collection system, septage usually is quite high in organics, grease, hair, stringy material, scum, grit, solids, and other extraneous debris. Substantial quantities of phosphorus, ammonia nitrogen, bacterial growth inhibitors, and cleaning materials may be present in septage, depending on the source. Tables A-1 and A-2 (Tables 3-4 and 3-8 from the U.S. EPA Handbook entitled "Septage Treatment and Disposal" 1984, EPA-625/6-84-009 reprinted herein) give a comparison of some of the common parameters for septage and municipal wastewater.

Data for local septage to be received should be collected for design of septage receiving and treatment systems. The characteristics of septage should be expected to vary widely from load to load depending on the source.

Treatment

Septage is normally considered treatable at a plant. However, unless proper engineering planning and design is provided, septage may represent a shock loading or have other adverse impacts on plant processes and effluent quality which will be influenced by many factors. The Design Engineer's report should evaluate the following:

- a. Capacity (MGD) of the plant relative to the amount and rate of septage directed to the plant;

- b. Unused plant capacity available (above current sewer collection system loadings) to treat septage loadings;
- c. Sensitivity of the treatment plant process to daily fluctuations in loadings brought about by the addition of septage;
- d. Slug septage loadings of BOD, ammonia nitrogen, or phosphorus which may cause process upset, odor nuisance, aeration tank/aerated digester foaming, or pass through to the effluent;
- e. The point of introduction of the septage into the plant process. Feasible alternative points of feed to the treatment units are to be evaluated including feed to the sludge processing units provided the unit function will not be adversely affected;
- f. Screening to remove inert solids and other untreatable substances.
- g. The ability to control feed rates of septage to the plant for off peak loading periods; and,
- h. The volume and concentrations of bacterial growth inhibitors in septage from some portable vault toilets and recreational dump station holding tanks.

The permitted plant effluent limits are to be considered when evaluating these factors.

Considerations

An adequate engineering evaluation is to be made of the existing plant and the anticipated septage loading prior to receiving septage at the plant. The regulatory agency is to be contacted to obtain the appropriate approvals prior to the acceptance of septage. For proposed plant expansion and upgrading, the Engineering Report or Facility Plan (refer to Chapter 10) is to include anticipated septage loading when addressing treatment plant sizing and process selection. The following items should be included, as appropriate, in the engineering evaluation and facility planning:

- a. The uninterrupted and satisfactory treatment (within the plant regulatory limits) of waste loads from the sewer system is not to be adversely affected by the addition of septage to the plant;
- b. In general, the smaller the plant design capacity relative to the septage loading, the more subject the plant will be to upset and potential violation of permitted discharge effluent limits;
- c. Allocation of organic plant capacity originally planned for future growth;
- d. For plants to be expanded and upgraded, the sensitivity of the treatment process to receiving septage and the impact on discharge parameter limits should be jointly

considered;

- e. An evaluation of available plant operating personnel and the staffing requirements necessary when septage is to be received. Plant staff should be present when septage is received and unloaded. Added laboratory work associated with receiving septage for treatment should be included in the staffing and laboratory facilities evaluation;
- f. The space for constructing septage receiving facilities that are to be off-line from the raw wastewater from the sewer system. Other plant activity and traffic flow should be considered when locating the septage receiving facility and the septage hauler unloading area; and,
- g. The impact of the septage handling and treatment on the plant sludge handling and processing units and ultimate sludge disposal procedures.

Receiving Facility

The design of the septage receiving station at the plant should provide for the following elements:

- a. A hard surface haul truck unloading ramp sloped to a drain to allow ready cleaning of any spillage and washing of the haul tank, connector hoses, and fittings. The ramp drainage is to be tributary to treatment facilities and is to exclude excessive stormwater;
- b. A flexible hose fitted with easy connect coupling to provide for direct connection from the haul truck outlet to minimize spillage and help control odors;
- c. Washdown water with ample pressure, hose, and spray nozzle for convenient cleaning of the septage receiving station and haul trucks. The use of chlorinated effluent may be considered for this purpose. If a potable water source is used, it is to be protected in accordance with Paragraph 56.2;
- d. An adequate off-line septage receiving tank designed to provide complete draining and cleaning by means of a sloped bottom equipped with a drain sump should be provided. The design should give consideration to adequate mixing for testing, uniformity of septage strength, chemical addition (if necessary), for treatability and odor control. The capability to collect a representative sample of any truck load of waste accepted for discharge at the plant is to be provided. The operator is to have authority to prevent and/or stop any disposal that is likely to cause an effluent violation;
- e. Screening, grit, and grease removal of the septage as appropriate to protect the treatment units;
- f. Pumps for handling the septage should be nonclogging and capable of passing 3-inch (75 mm) diameter solids;

- g. Valving and piping for operational flexibility to allow the control of the flow rate and point of septage discharge to the plant;
- h. Safety features to protect the operational personnel. Refer to Section 57; and
- i. Laboratory and staffing capability to determine the septage strength and/or toxicity to the treatment processes and provisions for operation reports to include the plant load attributed to septage.

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HANDLING AND TREATMENT OF SEPTAGE APPENDIX A

TABLE A-1*
PHYSICAL AND CHEMICAL CHARACTERISTICS OF SEPTAGE, AS
FOUND IN THE LITERATURE, WITH SUGGESTED DESIGN VALUES^{a,b}

Parameter	United States (5) (9-19)				Europe/Canada (4) (20)				EPA Mean	Suggested Design Value
	Average	Minimum	Maximum	Variance	Average	Minimum	Maximum	Variance		
TS	34,106	1,132	130,475	115	33,800	200	123,860	619	38,800	40,000
TVS	23,100	353	71,402	202	31,600	160	67,570	422	25,260	25,000
TSS	12,862	310	93,378	301	45,000	5,000	70,920	14	13,000	15,000
VSS	9,027	95	51,500	542	29,900	4,000	52,370	13	8,720	10,000
BOD ₅	6,480	440	78,600	179	8,343	700	25,000	36	5,000	7,000
COD	31,900	1,500	703,000	469	28,975	1,300	114,870	88	42,850	15,000
TKN	588	66	1,060	16	1,067	150	2,570	17	677	700
NH ₃ -N	97	3	116	39	—	—	—	—	157	150
Total P	210	20	760	38	155	20	636	32	253	250
Alkalinity	970	522	4,190	8	—	—	—	—	—	1,000
Grease	5,600	208	23,368	112	—	—	—	—	9,090	8,000
pH	—	1.5	12.6	8.0	—	5.2	9.0		6.9	6.0
LAS	—	110	200	2	—	—	—		157	150

^a Values expressed as mg/L, except for pH.

^b The data presented in this table were compiled from many sources. The inconsistency of individual data sets results in some skewing of the data and discrepancies when individual parameters are compared. This is taken into account in offering suggested design values.

^{*} Appendix A - Table A-1 including footnotes is taken from the USEPA Handbook entitled "Septage Treatment and Disposal", 1984, EPA-625/6-84-009 and is designated in that document as "Table 3-4".

HANDLING AND TREATMENT OF SEPTAGE APPENDIX A

TABLE A-2*
COMPARISON OF SEPTAGE AND MUNICIPAL WASTEWATER^a

Parameter	Septage ^b	Wastewater ^c	Ratio of Septage to Wastewater
TS	40,000	720	55:1
TVS	25,000	360	69:1
TSS	15,000	210	71:1
VSS	10,000	160	62:1
BOD ₅	7,000	190	37:1
COD	15,000	430	35:1
TKN	700	40	17:1
NH ₃ -N	150	25	6:1
Total P	250	7	36:1
Alkalinity	1,000	90	11:1
Grease	8,000	90	89:1
pH	6.0	—	—
Linear Alkyl Sulfonate	150	—	—

^a Values expressed as mg/L, except for pH.

^b Based on suggested design values in Appendix A - Table A-1 (USEPA Table 3-4).

^c From Metcalf and Eddy, 4th Edition, "medium strength sewage".

* Appendix A - Table A-2 including footnotes is taken from the USEPA Handbook entitled "Septage Treatment and Disposal", 1984, EPA-625/6-84-009 and is designated in that document as "Table 3-8".

Table B-1			
Information on materials which inhibit biological treatment processes			
Pollutant	Inhibiting or toxic concentration (1), mg/L		
	Aerobic processes	Anaerobic processes	Nitrification
1,1,1 Trichloroethane	*	1.0 (2)	*
Acrylonitrile	*	5.0 (2)	*
Ammonia	*	1,500 (2)	*
Benzene	*	50	*
Boron	1.0	*	*
Cadmium	*	0.02 (2)	*
Calcium	*	2,500	*
Carbon tetrachloride	*	10 (2)	*
Chloroform	18.0	0.1 (2)	*
Chromium (hexavalent)	2.0	5.0	2.0
Chromium (trivalent)	2.0	2,000 (2)	*
Copper	1.0	1.0	0.5
Cyanide	*	1.0	2.0
Lead	0.1	*	0.5
Magnesium	*	1,000	*
Methylene chloride	*	1.0	*
Nickel	1.0	2.0	0.5
Pentachlorophenol	*	0.4	*
Potassium	*	2,500	*
Silver	0.03	*	*
Sodium	*	3,500	*
Sulfates	*	500	*
Sulfides	*	100 (2)	*
Total chromium	5.0	5.0	-
Total oil (petroleum origin)	50	50	50
Trichlorofluoroethane	*	5.0 (2)	*
Trichlorofluoromethane	*	0.7	*
Vanadium	10	*	*
Zinc	5.0	5.0	0.5

(*) Insufficient data available to determine effect.

(1) Raw wastewater concentration unless otherwise indicated.

(2) Digester influent concentration only; lower values may be required for protection of other treatment processes.

(3) Petroleum-based oil concentration measured by API Method 733-58.