APPENDIX D

State of Utah, Rule317-3. Design Requirements for Wastewater Collection, Treatment and Disposal Systems.

Rule R317-3. Design Requirements for Wastewater Collection, Treatment and Disposal Systems.

As in effect on November 1, 2007

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R317-3-1. Technical and Procedural Requirements.

1.1. Scope of This Rule

A. General. This rule is intended to aid the logical development, from feasibility study to startup, of a wastewater collection, treatment and disposal project.

B. Authority. Construction permits and approvals are issued pursuant to the provisions of Sections 19-5-107 and 19-5-108. Violation of construction permit or approval including compliance with the conditions thereof, or beginning of construction, or modification without the executive secretary's approval, is subject to the penalties provided in Section 19-5-115.

C. Applicability

1. This rule applies to:

a. communities, sewerage agencies, industries, and federal or state agencies (hereinafter referred to as the applicant), and

b. i. construction, installation, modification or operation of any treatment works or part thereof or any extension or addition thereto, or

ii. construction, installation, modification or operation of any establishment or any extension or modification or addition to it, the operation of which would probably result in a discharge.

2. The applicant must not advertise the project for bids and must not begin construction without receiving a construction permit.

D. Requirements

1. The design requirements in this rule are for collection, treatment and disposal of wastewater largely originating from domestic sources. These criteria are intended to be limiting values for items upon which an evaluation of such plans and specifications will be made and to establish, as far as practicable, uniformity of practice. This rule also provides for a mechanism to apply water pollution control research and recommendations for further evaluation by the design engineer.

2. Communities, and the engineering profession should discuss with the staff of the executive secretary possible combinations of wastewater treatment and disposal processes or situations not covered in detail by this rule.

E. Construction Permit and Approvals

1. When a Permit or an Approval is Issued. A construction permit or an approval is issued when the applicant has met all requirements of this rule, including any additional requirements of funding programs administered by the executive secretary. The applicant or the designee or the consultant should meet with the staff of the executive secretary to discuss the plan of study

before undertaking extensive engineering studies for construction of treatment works. A permit for construction of a new treatment works or a sewerage system, or modifications to an existing treatment works or sewerage system for multiple units under separate ownership will be issued only if the treatment works or sewerage system are under the sponsorship of a body politic as defined in R317-1-1.

2. Variance. The executive secretary may grant a variance from the minimum requirements stated in this rule, subject to site-specific consideration and justification, but not overriding safeguarding of public health or protection of water quality or engineering practice. The applicant must submit pertinent and relevant material in support of a variance from the minimum requirements.

3. Limitations

a. The issuance of a construction permit does not relieve in any way the applicant of the obligation to obtain other approvals and permits, i.e., ground water discharge permit, clearances etc., from other agencies which may have jurisdiction over the project.

b. The permit will expire at the end of one year from the date of issuance if the approved project is not under substantial construction. Plans and specifications must be resubmitted for review and reissuance of the expired permit.

F. Definitions

1. The annual average daily rate of flow is defined as:

a. an average of daily rates of flow over a period of not less than one year; or

b. the rate of flow equal to or greater than 50 percent of the daily flow rate data.

2. The average design rate of flow or the average peak-monthly rate of flow is defined as:

a. a moving average of daily rates of flow over a thirty consecutive days; or over a period of month whichever produces a higher rate of flow; or

b. the rate of flow equal to or greater than 92 percent of the daily flow rate data.

3. The maximum design rate of flow or peak-daily rate of flow is defined as:

a. the maximum rates of flow over a 24 hour period; or

b. the rate of flow equal to or greater than 99.7 percent of the daily flow data.

4. The peak design rate of flow or peak-hourly rate of flow is defined as:

a. the maximum rate of flow over a 60-minute period; or

b. the rate of flow equal to or greater than 99.9 percent of the daily flow data.

5. The minimum daily rate of flow is defined as the minimum rate of flow over a twenty-four hour period.

6. Industrial waste flow is defined as the maximum rate of flow for each of industries tributary to the sewer system.

7. Other Definitions. Other definition of terms and their use in this rule is intended to be in accordance with:

a. R317-1 (Definitions and General Requirements), and

b. Glossary - Water and Wastewater Control Engineering, jointly prepared by American Public Health Association (APHA), American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF).

8. Units of Expression The units of expression used are in accordance with those recommended in WPCF Manual of Practice Number 6, Units of Expression for Wastewater Treatment.

9. Terms

a. The term shall is used where practice is standardized to permit specific delineation of requirements or where safeguarding of the public health or protection of water quality justifies such definite action.

b. Other terms, such as should, recommended, preferred, indicate desirable procedures or methods, with deviations subject to individual consideration and justification, but not overriding safeguarding of public health or protection of water quality or engineering practice.

c. Desirable procedures or methods may be mandatory requirements for projects using state or federal funds.

1.2. Engineering Report

A. The Scope of the Report

1. The applicant or the applicant's consulting engineer should submit an engineering report to the executive secretary at least 60 days before the date when action by the executive secretary is desired. The report shall be prepared under the direction of a registered professional engineer licensed to practice in the State of Utah. The report must establish the need, scope, basis and viability for:

a. all projects involving innovative treatment and disposal processes, and

b. collection and pumping systems handling flows in excess of 1 million gallons per day (3,785 cubic meters per day).

2. The documents submitted for formal approval should include all pertinent and relevant material to aid in the review of the submitted reports.

B. What is Required in the Report

1. The magnitude and complexity of the project will determine the scope of the report.

2. The report must provide basic information; criteria and assumptions; evaluation of alternate projects, with preliminary layouts and cost estimates; assessment of environmental factors; financing methods, anticipated charges for users; organizational and staffing requirements; conclusions or recommendations with a proposed project for consideration; and an outline of official actions and procedures required to implement the project.

3. The report should detail various concepts (including process description and sizing), factual data, and controlling assumptions and considerations for the functional planning of sewerage facilities. These data form the continuing technical basis for the detailed design and preparation of construction plans and specifications.

4. The report should include preliminary architectural, structural, mechanical, and electrical designs, sketches and outline specifications of process units, special equipment, etc.

5. The applicant or the consultant must address specific program and funding requirements in the report.

6. A detailed topical outline is available from the division.

C. Supplemental Requirements for Lagoons and Land Application. The engineer's report shall contain pertinent information on location, geology, hydrology, hydrogeology, soil conditions, area for expansion and any other factors that will affect the feasibility and acceptability of the proposed lagoon and land application projects.

1. Project Location. The engineer's report shall include on a 7.5-minute US Geological Survey topographic map showing the following within two mile (3.22 kilometers) radius of the proposed project site:

a. the location and direction of all residences, commercial developments, parks, recreational areas, land requirements for future additional treatment units and increased waste loadings, and land use zoning of area;

b. elevations and contours of the site and adjacent area;

c. watercourses and water supplies (including a log of each well, unless waived by the executive secretary);

d. location, depth, and discharge point of any field tile in the immediate area of the proposed site;

e. buffer zones;

f. limits of all flood plains, public drinking water supply watersheds and inland wetlands; and

g. natural site drainage zones.

2. Soil Borings and Geology. The applicant must determine representative subsurface soil characteristics and geology of the project site using a number of soil borings logged by an independent soil testing laboratory. At least one boring shall be a minimum of 25 feet (7.6 meters) in depth or into bedrock, whichever is shallower. The borings shall be filled and sealed. The report must address the following items as a minimum:

a. depth, type and texture of soil, all confirmed field data by the Soil Conservation Service (US Department of Agriculture);

b. hydraulic conductivity of the project site or the lagoon bottom as determined in the field, and lagoon bottom materials;

c. soil chemical properties such as, pH, nutrient levels, cation exchange capacity, etc.;

d. depth to bedrock;

e. bedrock type;

f. geologic discontinuities - faults, fractures, sinkholes;

g. jointing and permeability of rock.

3. Ground Water Issues

a. ground water depth confirmed by field investigations, for various seasons, including data from the period between March and May;

b. location of perched water tables;

c. ground water contours;

d. direction of ground water movement and flow;

e. ground water points of discharge;

f. available analyses of site ground water quality and drinking water wells in the vicinity, including but not limited to: coliform bacteria, pH, nitrates, total nitrogen, chlorides, sulfates, and total hardness;

g. a description of the depth and type of all water supply wells within two-mile (3.22 kilometers) radius of the proposed project site;

h. ground water monitoring needs using a system of wells or lysimeters around the perimeter of the project site; and

i. compliance with the requirements of R317-6 (Ground Water Quality Protection Rules) including securing a ground water discharge permit.

4. Climate Data

a. total precipitation for each month;

b. mean number of days per year with temperatures less than or equal to 32 degrees Fahrenheit (0 degree Centigrade);

c. wind velocities and direction;

d. evapotranspiration data.

D. Reports on Supplementary Investigations. Reports on soils, foundation, geological and hydrogeological investigations must be submitted by the applicant or the consultant, to the executive secretary. These reports are supplementary to a proposal, predesign or design report, plans and specifications for all projects. The reports must focus on any existing site conditions which may affect feasibility or constructibility of the project. If such problems do exist, mitigative and remedial measures thereto must be recommended by the applicant's consultant. The basis of conclusions reached should be supported with relevant and detailed information, graphically and narratively. The recommendations must be incorporated in the design.

1.3. Predesign Report

A. A predesign report must be prepared for the projects designed to:

1. treat domestic sewage flow in excess of 5 million gallons per day (18,900 cubic meters per day); or

2. incorporate emerging, innovative and alternative technologies.

B. The report must be submitted for review and approval by the division. The report shall include a summary of process design criteria, the basis of design, process and hydraulic profiles, outline of all appurtenant facilities, and supporting information.

C. Approval of a predesign report represents an agreement-in-principle subject to receipt, review and approval of satisfactory engineering plans and specifications. Such agreement-in-principle will be modified or revised in light of new information that may become available later. Also, an approval of prefinal documents is not an authorization to advertise the project for bids or to begin construction; but allows the applicant to proceed with preparing final engineering drawings and specifications.

1.4. Construction Plans

A. General. A complete set of construction drawings covering all disciplines shall be submitted for review in fulfillment of the requirements of this rule. The size, complexity and nature of the project will determine the extent of involvement of various disciplines. Such disciplines are, but not necessarily limited to, Civil, Structural, Mechanical, Architectural, Mechanical, Electrical, Geotechnical, Instrumentation, Heating, Ventilating and Air Conditioning etc. All designs shall be in accordance with the requirements of applicable local, state and federal rules or regulations, the latest recognized practice standards including the Uniform Building Code, the National Electrical Code, the Uniform Mechanical Code, the Uniform Plumbing Code and other industry standards. The plans shall be clear, legible and suitable for microfilming or image processing.

1. Standard Information

a. Plans shall show a suitable project title, the name of municipality, sewer district, sewerage agency, sponsoring institution or industry, current revision date, and the name of engineer in charge of the project, engineer's registration number, an imprint of registration seal and signature.

b. Plans shall be drawn to a scale which will permit all necessary information to be plainly shown. Numerical and graphical scales in foot-pound-second (FPS or English) system shall be shown. The use of the international system (metric or MKS or meter-kilogram-second) of units is encouraged.

c. All plan views shall indicate a north point, preferably in a standardized direction. A suitable geographical reference for the project shall also be shown. Topographical and elevation data should be presented on a recognized standard datum. Such datum should be clearly indicated.

2. Vicinity and Location Plans. A large scale vicinity map should be provided for a suitable geographical reference to the project. It should also indicate vehicular access to the project.

3. General Site Work Plans.

a. A site plan showing the project lay out should be included to establish a reference to the existing features. Similarly, a reduced-scale site or key plan should be drawn on all drawings to provide the context of work shown on the drawing to the site.

b. For the entire project site, information shall be provided on topography, survey data, location of test borings, limits of work, staging area for contractors, areas of project related site work, and other work that may overlap the areas of concentrated work activities. Information shall be compiled to the extent practicable on utility locations, above and below ground utilities which might interfere with the proposed construction, particularly water mains, gas mains, storm drains, and telephone and power conduits, outside piping, all known existing structures, security improvements, roads, signage, lighting, and other site improvements. Compiled information should be shown on plans.

4. Detailed Plans. Construction to be performed in areas of concentrated work such as individual installations, buildings, rooms or assemblies shall be shown on the detailed plans. Such plans shall show 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 works. They shall also include detailed design data in all applicable disciplines, dimensions and relative elevations of structures, the location and outline form of equipment, location size of piping, water levels, water surface and hydraulic profiles, and ground elevations.

B. Plans for Sewers. Construction plans are required to be submitted for projects involving new sewer systems. Projects for substantial additions to the existing systems are required to be submitted only in fulfillment of the requirements of the funding agency. These plans must detail the following information:

1. Geographical Features

a. Topography and elevations. Existing or proposed improvements, streets, the boundaries of all streams and water impoundments, and water surfaces shall be clearly shown. Contour lines at suitable intervals should be included.

b. Streams. The direction of flow in all natural or artificial streams, and high and low water elevations of all water surfaces at sewer outlets shall be shown.

2. Boundaries. The boundary lines of the municipality or the sewer district, and the area to be sewered, shall be shown.

3. Sewers. The plan shall show the location, size and direction of flow of all existing and proposed sanitary sewers draining to the treatment works concerned.

4. Plans and Profiles. Detailed plans and profiles shall be submitted. Profiles should have a horizontal scale of not more than 100 feet to the inch and vertical scale of not more than 10 feet to the inch. Plan views should be drawn to a corresponding horizontal scale and preferably be shown on the same sheet. Plans and profiles shall show:

a. Location of streets and sewers;

b. ground surface; size of pipe; length between manholes; manhole identifiers, such as numbers etc.; invert and surface elevation at each manhole; and grade of sewer between each two adjacent manholes;

c. the elevation and location of the basement floor on the profile of the sewer, showing feasibility to serve adjacent basements except where otherwise noted on the plans; and

d. Locations of all special features such as inverted siphons, concrete encasements, elevated sewers, special construction to implement proper separation from water mains etc.

5. Detailed drawings, made to a scale to clearly show the nature of the design, shall be furnished to show the following particulars:

a. all stream crossings and sewer outlets, with elevations of the stream bed and of normal and extreme high and low water levels;

b. details of all special sewer joints, pipeline construction or installation, and cross-sections; and

c. details of all sewer appurtenances such as manholes, inspection chambers, inverted siphons, regulators, flow measurement or control stations and elevated sewers.

C. Plans for Pumping Stations. Construction plans shall be submitted for construction or modifications of pumping stations having the installed capacity in excess of 1 million gallons per day (3,785 cubic meters per day). These plans must detail the following information besides vicinity, site and location, and engineering information required:

1. Vicinity, Site and General Site Work Plans

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; and

d. availability of power sources, including alternative sources.

2. Detailed Plans. Detailed plans shall be submitted showing the following:

a. topography of the site with all pertinent elevations;

b. soils or foundation report;

c. existing pumping station with all adjacent improvements;

d. proposed pumping station, including provisions for installation of future pumps or ejectors, emergency power generation, and other reliability features;

e. maximum hydraulic gradient including calculations in downstream gravity sewers when all installed pumps are in operation; and

f. elevation of high water at the site, and maximum elevation of sewage in the collection system upon occasion of power failure.

D. Plans for Treatment Plants. Construction plans shall be submitted for construction or modifications of treatment plants. These plans must detail the following information besides vicinity, site and location, and engineering information required:

1. Location Plan. A plan shall be submitted showing the treatment plant in relation to the remainder of the system.

2. General Layout. Layouts of the proposed treatment plant shall be submitted, showing:

a. topography of the site;

b. size and location of plant structures, and adjacent improvements;

c. schematic flow diagram(s), including mass balance, showing the flow through various plant units, and showing utility systems serving the plant processes;

d. outside or yard piping, including any arrangements for bypassing individual units (Materials handled and direction of flow through pipes shall be shown.); and

e. hydraulic profiles, including calculations, showing the flow of the major liquid or solid process streams including raw or treated sewage, supernatant liquor, scum and sludge.

3. Detailed Plans. Detailed plans shall show the following:

a. location, dimensions, and elevations of all existing and proposed plant facilities;

b. elevations of a 100-year water level of the body of water to which the plant effluent is to be discharged;

c. type, size, pertinent features, and operating capacity of all pumps, blowers, motors, and other mechanical devices;

d. schematics, sectional or isometric views of all process and utility piping not shown on the General Site Work Plans;

e. hydraulic profile at the minimum, average, and maximum rate of flow; and

f. description of any features not otherwise covered by other drawings or specifications or engineer's report.

1.5. Technical Specifications. Complete technical specifications for the construction of sewers, pumping stations, treatment plants, and all other appurtenances, shall accompany the plans. The specifications accompanying construction drawings shall include all construction information not shown on the drawings which is necessary to inform the builder in detail of the design requirements for the quality of materials, workmanship and fabrication of the project. They shall also include: the type, size strength, operating characteristics, and rating of equipment; allowable infiltration; the complete requirements for all mechanical and electrical equipment, including machinery, valves, piping, and jointing of pipe; electrical apparatus, wiring, instrumentation, and meters; laboratory fixtures and equipment; operating tools, construction materials; special filter materials, such as, stone, sand, gravel, or slag; miscellaneous appurtenances; chemicals when used; instructions for testing materials and equipment as necessary to meet design standards; and performance tests for the completed work and component units. Performance tests must be conducted at design load conditions wherever practical.

1.6. Revisions to the Approved Plans and Specifications. Any changes, such as addenda, change orders, field change etc., to the approved plans or specifications affecting capacity, flow, operation of units, or point or quality of discharge shall be submitted for review and approval before any such change is made in either contract documents or construction. Plans or specifications proposed to be so revised must, therefore, be submitted at least 30 days in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Changes under emergency conditions may be communicated verbally, and then submitted in writing. Structural revisions or other minor changes not affecting capacities, flows, or operation are to be permitted during construction without approval.

1.7. Construction Supervision. The applicant must demonstrate that adequate and competent inspection will be provided during construction. It is the responsibility of the applicant to provide frequent and comprehensive inspection of the project.

1.8. Plan of Operation

A. Submittal. A plan of operation must be prepared at the mid-point of construction, but no later than at the time of 80 percent completion of construction, unless waived by the executive secretary on the basis of funding program requirements, and the scope and the complexity of the project.

B. Contents of the Plan. The plan of operation must provide a concise, sequential description of and implementation schedule for the following activities:

1. hiring and training of operators;

2. start-up schedules and services;

3. safety programs, plans and procedures;

4. emergency operations procedures and plan;

5. process monitoring program;

6. laboratory and testing services;

7. user charge and pretreatment program, necessary to assure cost-effective, efficient and reliable startup and operation of the facility, future expansion and upgrade; and

8. maintenance of water quality and public health.

1.9. Operation and Maintenance Manual

A. Submittal. A draft of the manual must be submitted at the mid-point of construction, unless waived by the executive secretary on the basis of funding program requirements, and the scope and the complexity of the project. Final draft must be submitted for review and approval, no later than at the 90 percent stage of construction in the final form or 30 days prior to startup, whichever occurs first.

B. Contents of the Manual

1. The manual presents procedures to facilitate operation and maintenance of the plant under all conditions, technical guidance for troubleshooting, and requirements for compliance with the permits and approvals issued. The manual must address the needs of the system being employed and must be directed toward the level of training required of the operating staff.

2. The manual must include all information pertinent for the facilities besides information from manufacturers' catalogs or brochures.

1.10. Start-up

A. Certificate of Completion. The engineer in charge of construction management or inspection of the approved project or facilities shall submit a certificate, bearing the seal of the professional engineer, to the effect that the facilities were constructed in accordance with approved plans, specifications, addenda and change orders to the owner with a copy thereof to the division.

B. Authorization to Operate. The applicant will request a final inspection the division upon receipt of the certificate of completion. No facilities may be placed in service before the final inspection by the division, and authorization to operate the facility is issued in writing by the executive secretary.

C. As-built or Record Drawings.

1. Within 30 days of acceptance by the owner of wastewater or industrial waste facilities from the contractor, a copy of such acceptance must be submitted to the division for record.

2. As-built or record drawings clearly showing the as-built project shall be submitted to the executive secretary within 120 days after the completion of the construction of the approved project or facilities.

1.11. Operation During Construction

A. Construction-related Bypass. Operation of all existing sewers, pump stations, and treatment plants must continue without interruption during the construction of new facilities or modification of existing facilities. Therefore, bypassing will not be allowed except under extenuating circumstances. If this is not possible and construction will result in the discharge of partially treated and untreated sewage into the surface waters of the state, an approval for such a discharge shall be required from the executive secretary before such discharge occurs.

B. Request for a Construction-related Bypass. A formal request for the consideration of a construction-related bypass shall be submitted to the executive secretary by the permittee not less than 90 days prior to the date of proposed bypass initiation. Such request shall contain at least the following information:

1. a detailed description of the construction work to be performed which the owner has deemed warrants a bypass;

2. an analysis of all known alternatives which would eliminate or reduce the need for plant bypassing;

3. cost-benefit and effective analysis of alternatives, including an assessment of resource damages;

4. the minimum and maximum duration of bypassing under each alternative;

5. the applicant's preferred alternative for conducting the bypass;

6. the projected date of initiation of bypass.

C. Approval or Denial of a Construction-related Bypass

1. The request for a construction-related bypass will be approved or denied following a thorough review with due consideration of compliance with the discharge permit(s); water quality standards; and all known available and reasonable methods to abate water pollution.

2. An approval issued to permit bypass will contain all restrictions necessary to minimize the duration of bypassing. A denial determination will state the reasons for the denial and will direct the permittee to initiate a plan of action to implement an alternative to bypassing.

1.12. Innovative Processes Evaluation

A. Basic requirements. The executive secretary will consider the evaluation of innovative approaches to wastewater treatment in the interest of encouraging advances in technology, processes, equipment and material not covered by this rule, provided that:

1. a favorable recommendation has been made by a professional engineer licensed to practice in Utah, following his own evaluation of developmental processes or equipment or material, for a specific project;

2. the applicant has capital and technical resources to replace or modify developmental processes, equipment and material with conventional processes, equipment and material;

3. the risk incurred with the experimentation rests solely with the proponent of processes, equipment and material as evidenced by the written acknowledgement to the executive secretary; and

4. the applicant will replace the failed processes, equipment and material with a proven conventional processes, equipment and material as evidenced by the written acknowledgement to the executive secretary.

B. Approval Limitations

1. The executive secretary may approve developmental processes, equipment and material may be approved in the form of terms and conditions to a construction permit, when reliable operating data from full scale installations are not available. The term and conditions may include such as, but not necessarily limited to, demonstration period for a successful application, requirements to submit reports on the operation of the system during the experimental period.

2. The executive secretary may limit the number of approvals for the same developmental processes, equipment and material until reliable and valid operational experience is gained.

C. Evaluation Criteria. The evaluation of innovative processes will include the following factors:

1. anticipated performance of the system in full scale field conditions,

2. ability to consistently meet required effluent and water quality standards,

3. any evidence of equivalence to conventional technology,

4. the owner's ability to finance, and to operate and maintain the system with the level of expertise necessary, and

5. submission of process descriptions, schematics, reports, monitoring and performance data, costs, specific studies, bench scale test data and pilot plant test data, and any other information appropriate and necessary for the evaluation.

R317-3-2. Sewers.

2.1. General. Construction of a new sewer system project may not begin unless the applicant has submitted an engineering report detailing the design, and construction plans to the executive secretary for review and approval evidenced by a construction permit. The executive secretary will not normally review construction plans for extensions of the existing sewer systems to new areas or replacement of sanitary sewers in the existing sewer systems unless requested or required by state or federal funding programs. Rain water from roofs, streets, and other areas, and ground water from foundation drains must not be allowed to enter the sewer system through planning, design and construction quality assurance and control measures.

2.2. Basis of Design

A. Planning Period. Sewers should be designed for the estimated ultimate tributary population or the 50-year planning period, whichever requires a larger capacity. The executive secretary may approve the design for reduced capacities provided the capacity of the system can be readily increased when required. The maximum anticipated capacity required by institutions, industrial parks, etc. must be considered in the design.

B. Sewer Capacity. The required sewer capacity shall be determined on the basis of maximum hourly domestic sewage flow; additional maximum flow from industrial plants; inflow; ground water infiltration; potential for sulfide generation; topography of area; location of sewage treatment plant; depth of excavation; and pumping requirements.

1. Per Capita Flow. New sewer systems shall be designed on the basis of an annual average daily rate of flow of 100 gallons per capita per day (0.38 cubic meter per capita per day) unless there are data to indicate otherwise. The per capita rate of flow includes an allowance for infiltration/inflow. The per capita rate of flow may be higher than 100 gallons per day (0.38 cubic meter per day) if there is a probability of large amounts of infiltration/inflow entering the system.

2. Design Flow

a. Laterals and collector sewers shall be designed for 400 gallons per capita per day (1.51 cubic meters per capita per day).

b. Interceptors and outfall sewers shall be designed for 250 gallons per capita per day (0.95 cubic meter per capita per day), or rates of flow established from an approved infiltration/inflow study.

c. The executive secretary will consider other rates of flow for the design if such basis is justified on the basis of supporting documentation.

C. Design Calculations. Detailed computations, such as the basis of design and hydraulic calculations showing depth of flow, velocity, water surface profiles, and gradients shall be submitted with plans.

2.3. Design and Construction Details

A. Minimum Size

1. No gravity sewer shall be of less than eight inches (20 centimeters) in diameter.

2. A 6-inch (15 centimeters) diameter pipe may be permitted when the sewer is serving only one connection, or if the applicant justifies the need for such diameter on the basis of supporting documentation.

B. Depth. Sewers should be sufficiently deep to receive sewage from basements and to prevent freezing. Insulation shall be provided for sewers that cannot be placed at a depth sufficient to prevent freezing.

C. Odor and Sulfide Generation. The design shall incorporate features to control and mitigate odor and sulfide generation in sewers. Such features may include steeper slope to achieve higher velocity, reaeration through induced turbulence, etc.

D. Slope

1. The pipe diameter and slope shall be selected to obtain velocities to minimize settling problems.

2. All sewers shall be designed and constructed to give mean velocities of not less than 2 feet per second (0.61 meter per second), when flowing full, based on Manning's formula using an n value of 0.013.

3. Sewers shall be laid with uniform slope between manholes.

4. Table R317-3-2.3(D)(4) shows the minimum slopes which shall be provided; however, slopes greater than these are desirable.

E. Flatter Slopes. Slopes flatter than those required for the 2-feet-per-second (0.61 meter per second)-velocity criterion when flowing full, may be permitted by the executive secretary provided that:

1. there is no other practical alternative;

2. the depth of flow is not less than 30 percent of the diameter at the average design rate of flow;

3. the design engineer has furnished with the report the computations showing velocity and depth of flow corresponding to the minimum, average and peak rates of flow for the present and design conditions in support of the request for variance; and

4. the operating authority of the sewer system submits a written acknowledgement of the ability to provide any additional sewer maintenance required by flatter slopes.

F. Steep Slopes

1. Where velocities greater than 15 feet per second (4.6 meters per second) are attained, special provision shall be made to protect against displacement by erosion and shock.

2. Sewers on 20 percent slopes or greater shall be anchored securely against lateral and axial displacement with suitable thrust blocks, concrete anchors or other equivalent restraints, spaced as follows:

a. Not over 36 feet (11 meters) center to center on grades 20 percent and up to 35 percent;

b. Not over 24 feet (7.3 meters) center to center on grades 35 percent and up to 50 percent;

c. Not over 16 feet (4.9 meters) center to center on grades 50 percent and over.

G. Alignment. Sewers 24 inches (61 centimeters) in diameter or less shall be laid with a straight alignment between manholes. The alignment shall be checked by either using a laser beam or lamping.

H. Changes in Pipe Size. When a smaller sewer joins a large one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

I. Materials

1. The material of pipe selected should be suitable for local conditions. The material of sewer pipe should be compatible with factors such as industrial wastewater characteristics, putrecibility, physical and chemical properties of adjacent soil, heavy external loading, etc.

2. The material of pipe must withstand superimposed loads without any damage. The design of trench widths and depths should allow for loads. Special bedding, concrete cradle or encasement, or other special construction may be used to withstand extraordinary superimposed loading.

2.4. Curved Sewers. Curved sewers are permitted only under circumstances where conventional sewer construction is not feasible. A conceptual approval must be obtained before beginning the design.

A. Design

1. The minimum radius of curvature shall be greater than 200 feet or one-half of the maximum deflection angle for the material of pipe allowed by the manufacturer.

2. The design n value for the sewer pipe shall be 0.018.

3. Only one horizontal curve in the sewer alignment will be allowed between manholes. No vertical curves shall be permitted.

4. Manhole spacing shall not exceed 400 feet (122 meters).

5. Manholes must be provided at the beginning and the end of a curved alignment (i.e. change in radius of curvature).

6. The design should consider increased erosion potential due to high velocities.

B. Other Requirements

1. Maintenance equipment shall be available at all times for inspection and cleaning.

2. Horizontal and vertical alignment of the sewer after the construction must be verified and certified by a registered professional engineer.

a. Accurate record or as-built drawings must be prepared showing the physical location of the pipe in the ground, and submitted to the division in accordance with the requirements of R317-3-1.

2.5. Installation Requirements

A. Standards

1. The technical specifications shall require that installation be in accordance with the requirements based on the criteria, standards and procedures established by:

a. this rule;

b. recognized industry standards and practices as published in their technical publications;

c. the product manufacturer's recommendations and guidance;

d. Uniform Building Code, Uniform Plumbing Code, Uniform Mechanical Code and National Electrical Code;

e. American Society of Testing Materials;

f. American National Standards Institute; and

g. Occupational Safety and Health Administration (OSHA), US Department of Labor or its succeeding agencies.

2. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

B. Identification of Sewer Lines. A clearly labelled tracer location tape shall be placed two feet above the top of sewer lines less than or equal to 24 inch (61 centimeters) in diameter, along its entire length.

C. Deflection Test

1. Deflection test shall be performed on all flexible pipes. The test shall be conducted after the final backfill has been in place at least 30 days.

2. No pipe shall show a deflection in excess of 5 percent.

3. If the deflection test is run using a rigid ball or mandrel, it shall have a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.

D. Joints and Infiltration

1. Joints. The installation procedures of joints and the materials to be used shall be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

2. Leakage Tests. Procedures for leakage tests shall be specified. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day (0.19 cubic meter per centimeter of pipe diameter per kilometer per day) for any section of the system. An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet (0.61 meter). The air test, if used, shall, as a minimum, conform to the test procedure described in the American Society of Testing Materials standards. The testing methods selected should take into consideration the range in ground water elevations projected during the test.

E. Inspection

1. The specifications shall include requirements for inspection of manholes for water-tightness prior to placing in service, including television inspection.

2. Records of television inspection shall be retained for future reference.

2.6. Manholes

A. Location. Manholes shall be installed at:

1. the end of each line exceeding 150 feet (46 meters) in length;

2. all changes in grade, size, or alignment;

3. all intersections; and

4. distances not greater than:

a. 400 feet (120 meters) for sewers 15 inches (38 centimeters) or less; and

b. 500 feet (150 meters) for sewers 18 inches (46 centimeters) to 30 inches (76 centimeters).

5. Distances up to 600 feet (180 meters) may be approved in cases where adequate cleaning equipment for such spacing is provided.

6. Greater spacing may be permitted in larger sewers.

7. Cleanouts shall not be substituted for manholes nor installed at the end of lines greater than 150 feet (46 meters) in length.

B. Drop Type Manholes

1. A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches (61 centimeters) or more above the manhole invert. Where the difference in elevation between the incoming sewer and manhole invert is less than 24 inches (61 centimeters), the invert should be filleted to prevent solids deposition.

2. Drop manholes should be constructed with an outside drop connection. If an inside drop connections is necessary, it shall be secured to the interior wall of the manhole and provide access for cleaning.

3. Due to the unequal earth pressures that would result from the backfilling operation in the vicinity of the manhole, the entire outside drop connection shall be encased in concrete.

C. Diameter. The minimum diameter of manholes shall be 48 inches (1.22 meters); larger diameter manholes are preferable for large diameter sewers. A minimum diameter of 22 inches (56 centimeters) shall be provided for safe access.

D. Flow Channel. The flow channel through manholes should be made to conform in shape and slope to that of the sewers. The depth of flow channels should be up to one-half to three-quarters of the diameter of the sewer. Adjacent floor area should drain to the channel with the minimum slope of 1 inch per foot (8.3 centimeters per meter).

E. Watertightness

1. Manholes shall be of the pre-cast concrete or poured-in-place concrete type. Manholes shall be waterproofed on the exterior.

2. Inlet and outlet pipes shall be joined to the manhole with a gasketed flexible watertight connection arrangement that allows differential settlement of the pipe and manhole wall to take place.

3. Watertight manhole covers shall be used wherever 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.

F. Electrical. Electrical equipment installed or used in manholes shall conform to appropriate National Electrical Code requirements.

2.7. Inverted Siphons. Inverted siphons shall consist of at least two barrels, with a minimum pipe size of 6 inches (15 centimeters) with an arrangement to exclude debris and solids. The siphon shall be provided with necessary appurtenances for convenient flushing and maintenance. The manholes shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second (0.92 meter per second) for average flows. The inlet and outlet details shall be so arranged that the normal flow is diverted to 1 barrel, and that either barrel may be cut out of service for cleaning. The vertical alignment should permit cleaning and maintenance.

2.8. Sewers In Relation To Streams

A. Location of Sewers on Streams

1. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the stream bed to protect the sewer line. In general, the following cover requirements must be met:

a. one foot (30 centimeters) of cover is required where the sewer is located in bedrock;

b. three feet (90 centimeters) of cover is required in other material;

c. cover in excess of 3 feet (90 centimeters) may be required in streams having a high erosion potential; and

d. in paved stream channels, the top of the sewer must be placed below the bottom of the channel pavement.

2. If the proposed sewer crossing will not interfere with the future improvements to the stream channel, then reduced cover may be permitted.

B. Horizontal Location. Sewers shall be located along streams outside of the stream bed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

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

D. Alignment

1. Sewers crossing streams should be designed to cross the stream as nearly at right angles to the stream flow as possible, and shall be free from change in grade.

2. Sewer systems shall be designed to minimize the number of stream crossings.

E. Construction

1. Materials. Sewers entering or crossing streams shall be constructed of cast or ductile iron pipe with mechanical joints; otherwise they shall be constructed so they will remain watertight and free from changes in alignment or grade. Material used to backfill the trench shall be stone, coarse aggregate, washed gravel, or other materials which will not cause siltation.

2. Siltation and Erosion. Construction methods that will minimize siltation and erosion shall be employed. The design engineer shall include in the project specifications the method(s) to be employed in the construction of sewers in or near streams to provide adequate control of siltation and erosion. Specifications shall require that cleanup, grading, seeding, and planting or restoration of all work areas shall begin immediately. Exposed areas shall not remain unprotected for more than seven days.

F. Aerial Crossings

1. A carrier pipe shall be provided for all aerial sewer crossings. Support shall be provided for all joints in pipes utilized for aerial crossings. The supports shall be designed to prevent frost heave, overturning and settlement.

2. Precautions against freezing, such as insulation and increased slope, shall be provided. Expansion jointing shall be provided between above-ground and below-ground sewers.

3. The design engineer shall consider the impact of flood waters and debris for aerial stream crossings. The bottom of the pipe should be placed below the elevation of twenty-five (25) year flood. Crossings, in no case, shall block the channel.

2.9. Protection of Water Supplies. The applicant must review the requirements stated in R309-112-2 - Distribution System Rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

A. Water Supply Interconnections. There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply. No water pipe shall pass through or come in contact with any part of a sewer manhole.

B. Relation to Water Mains

1. Horizontal Separation

a. Sewers shall be laid at least 10 feet (3.0 meters) horizontally from any existing water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, a deviation may be allowed based on the supportive data from the design engineer. Such deviation may allow installation of the sewer closer to a water main, provided that the sewer is laid:

(1) in a separate trench, or

(2) on an undisturbed earth shelf located on one side of the sewer trench, or

(3) in the sewer trench which has been backfilled and compacted to not less than 95 percent of the optimum density as determined by the ASTM Standard D-690, as amended, and

b. In each of the above cases, the bottom of the water main shall be at least 18 inches (46 centimeters) above the top of the sewer.

2. Crossings. Sewers crossing above water mains shall be laid to provide a minimum vertical distance of 18 inches (46 centimeters) between the outside of the water main and the outside of the sewer. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer, adequate structural support shall be provided for the sewer to prevent damage to the water main.

3. Special Conditions. When it is impossible to obtain proper horizontal and vertical separation as stated above, the sewer shall be designed and constructed of cast iron, ductile iron, galvanized steel or protected steel pipe with mechanical joints for the minimum distance of 10 feet on either side of the point of crossing. The design engineer may use other types of joints if equivalent joint integrity is demonstrated. The lines shall be pressure tested to assure watertightness before backfilling.

R317-3-3. Sewage Pumping Stations.

3.1. General. Sewage pumping station structures, and electrical and mechanical equipment shall be protected from physical damage that would be caused by a 100-year flood. Sewage pumping stations must remain fully operational and accessible during a 25-year flood.

3.2. Design

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

B. System - Head Calculation

1. The design engineer shall submit system-head calculations and curves. System-head curves for C values of 100, 120 and 140 in the Hazen William's equation for calculating head loss corresponding to minimum, median and maximum water levels shall be developed.

2. A system-head curve for C value of 120 corresponding to median (normal operating) water level shall be used to make preliminary selection of motor and pump. The pump and motor must operate satisfactorily over the entire range of system-head curves for C values of 100 and 140 corresponding to minimum and maximum water levels intersected by the head-discharge relationship of a given pump.

3. Pumps and motors shall be sized for the 10-year peak flows; preferably the 20-year sewage flow requirements. These operating points shall be shown on the system-head curves.

C. Accessibility. The pumping station shall be readily accessible by maintenance vehicles during all weather conditions. The facility should be located off the traffic way of streets and alleys.

D. Grit. Where it is necessary to pump sewage before grit removal, the design of the wet well and pump station piping shall be such that operational problems from the accumulation of grit are avoided.

E. Odor and Corrosion Control. The pumping station design should incorporate measures for:

1. mitigating the effects of sulfide corrosion to structure and equipment; and

2. effective odor control when a populated area is within close proximity.

F. Structures

1. Dry wells, including their superstructure, shall be completely separated from the wet well.

2. Provision shall be made to facilitate maintenance and removal of pumps, motors, and other mechanical and electrical equipment.

3. Safe means of access and proper ventilation shall be provided to dry wells and to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

a. For built-in-place pump stations, a stairway with rest landings shall be provided at vertical intervals not to exceed 12 feet (3.7 meters). For factory-built pump stations over 15 feet (4.6 meters) deep, a rigidly fixed landing shall be provided at vertical intervals not to exceed 10 feet (3.0 meters). Where a landing is used, a suitable and rigidly fixed barrier shall be provided to prevent an individual from falling past the intermediate landing to a lower level.

b. Where space requirements are insufficient, the design may provide for a manlift or elevator in lieu of landings in a factory-built station if the design includes an emergency access or exit.

c. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code, etc., must be reviewed and complied with. Those requirements, if more stringent than the ones stated above, shall be incorporated in the design.

4. Construction Materials. The materials selected in construction and installation must be safe and able to withstand adverse operating environmental conditions caused by presence of hydrogen sulfide and other corrosive gases, greases, oils, and other constituents frequently present in sewage.

3.3. Pumps and Pneumatic Ejectors

A. Multiple Units

1. At least two pumps or pneumatic ejectors shall be provided. A minimum of three pumps shall be provided for stations handling flows greater than 1 million gallons per day (3,785 cubic meters per day).

2. If only two units are provided, they should have the same capacity. Each shall be capable of handling flows in excess of the expected maximum flow. 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 of the largest units out of service, the remaining units shall have capacity to handle maximum sewage flows.

B. Protection Against Clogging

1. Pumps handling sewage from 30 inch (76 centimeters) or larger diameter sewers shall be protected by readily accessible bar racks from clogging or damage.

2. Bar racks should have clear openings not exceeding 1-1/2 inches (6.4 centimeters). The design shall provide for a mechanical hoist.

3. The design engineer shall consider installation of mechanically cleaned and duplicate bar racks in the pumping stations handling larger than five million gallons per day (18,900 cubic meters per day) rate of flow.

4. Small pumping stations pumping less than one million gallons per day (3,785 cubic meters per day) shall be equipped with bar racks or inline grinding devices, etc., to prevent clogging.

C. Pump Openings. Except where grinder pumps are used, pumps shall be capable of passing spheres of at least 3 inches (7.6 centimeters) in diameter, and pump suction and discharge piping shall be at least 4 inches (10.2 centimeters) in diameter.

D. Priming. The pump shall be so placed that it will operate under a positive suction head under normal operating conditions, except for submersible pumping stations.

E. Electrical Equipment. Electrical systems and components (e.g., motors, lights, cables, conduits, switchboxes, and control circuits) in raw sewage wet wells, or in enclosed or partially enclosed spaces where hazardous concentrations of flammable gases or vapors may be present, shall comply with the National Electrical Code requirements for Class 1 Group D, Division 1 locations. In addition, equipment located in the wet well shall be suitable for use under corrosive conditions. Each flexible cable shall be provided with watertight seal and separate strain relief. A fused disconnect switch located above ground shall be provided for all pumping stations. When such equipment is exposed to weather, it shall as a minimum, meet the requirements of weatherproof equipment (NEMA 3R).

F. Intake. Each pump should have an individual intake. Turbulence should be avoided near the intake in wet wells. Intake piping should be as straight and short as possible.

G. Dry Well Dewatering. A separate sump pump equipped with dual check valves shall be provided in dry wells to remove leakage or drainage. Discharge shall be located as high as possible. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved. All floor and walkway surfaces should have an adequate slope to a point of drainage. Pump seal water shall be piped to the sump.

H. Controls

1. Type. Control systems for liquid level monitoring shall be of the air bubbler type, the capacitance type, the encapsulated float type, or the non-contact type. The selection of type of controls must be based on wastewater characteristics and other site related conditions. The executive secretary may approve the existing float- tube control systems on pumping stations being upgraded. The electrical equipment shall comply with the National Electrical Code requirements for Class I, Group D, Division 1 locations.

2. Location. The level control system shall be located away from the turbulence of incoming flow and pump suction.

3. Alternation. The design engineer must consider automatic alternation of the sequencing of pumps in use.

I. Valves

1. Suction Line. An isolation valve shall be placed on the suction line of each pump except on submersible pumps.

2. Discharge Line

a. Isolation and check valves shall be placed on the discharge line of each pump. The check valve shall be located between the isolation valve and the pump.

b. Check valves shall not be placed in the vertical run of discharge piping unless the valve is designed for that specific application.

c. Ball valves may be permitted in the vertical runs.

d. All valves shall be suitable for the material being handled, and capable of withstanding normal operating pressure and water hammer.

e. Where limited pump backspin will not damage the pump and low discharge head conditions exist, a short individual force main for each pump, may be approved by the executive secretary in lieu of a discharge manifold.

3. Location. Valves shall not be located in wet well. They shall be located in a dry well adjacent to the pumps or in an adjacent isolated pit appropriately protected from physical, weather or freezing damage, with proper access for operation and maintenance.

J. Wet Wells

1. Divided Wells. Wet well should be divided into multiple sections, properly interconnected, to facilitate repairs and cleaning, and non-turbulent hydraulic operating condition to each pump inlet.

2. Size. The wet well size and level control settings shall be appropriate to avoid heat buildup in the pump motor due to frequent starting (short cycling), and septic conditions due to excessive detention time.

3. Floor Slope. The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be not greater than necessary for proper installation and function of the pump inlet.

K. Ventilation. All pump stations must be ventilated to maintain safe operating environment. Where the pump pit is below the ground surface, mechanical ventilation is required, so arranged as to independently ventilate the dry well and the wet well if screens or mechanical equipment requiring maintenance or inspection are located in the wet well. There shall be no interconnection between the wet well and dry well ventilation systems. In pits over 15 feet (4.6 meters) deep, multiple inlets and outlets are recommended. Dampers should not be used on exhaust or fresh air ducts. Fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment should be marked and located for convenient operation from outside of the enclosed environment. All intermittently operated ventilating equipment shall be interconnected with the respective pit lighting system. Automatic controls are recommended for intermittently ventilated pump stations. Fan parts should be of non-corrosive material. All parts adjacent to moving ones should be of non-sparking materials. Consideration should be given to installation of automatic heating and dehumidification equipment.

1. Wet Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 12 complete air changes per hour; if intermittent, at least 30 complete air changes per hour. Ventilating equipment should force air into wet well rather than exhaust it from wet well.

2. Dry Wells. Ventilation may be either continuous or intermittent. Ventilation, if continuous, shall provide at least 6 complete air changes per hour; if intermittent, at least 30 complete air changes per hour.

L. Flow Measurement. Continuous measuring and recording of sewage flow shall be provided at all pumping stations with a design pumping capacity greater than one million gallons per day (3,785 cubic meters per day).

M. Water Supply. There shall be no physical connection between any potable water supply and a sewage pumping station which under any condition might cause contamination of the potable water supply. The potable water supply to a pumping station shall be protected against cross connection or backflow.

3.4. Self-Priming Pumps. Self-priming pumps shall be capable of rapid priming and repriming at the lead pump on elevation. Such self-priming and repriming shall be accomplished automatically under design operating conditions. Suction piping should not exceed the size of the pump suction and shall not exceed 25 feet (7.6 meters) in total length. Priming lift at the lead pump on elevation shall include a safety factor of at least 4 feet (1.2 meters) from the maximum allowable priming lift for the specific equipment at design operating conditions. The combined total of dynamic suction lift at the pump off elevation and required net positive suction head at design operating conditions shall not exceed 22 feet (6.7 meters).

3.5. Submersible Pump Stations. Submersible pump stations may be used for flows less than 0.25 million gallons per day (946 cubic meters per day). The executive secretary may approve submersible pump stations for flows greater than 0.25 million gallons per day (946 cubic meters per day), based on operational, reliability and maintenance considerations. The submersible pumps stations shall meet the design requirements stated above, except as modified in this section.

A. Construction. Submersible pumps and motors shall be designed specifically for raw sewage use, including totally submerged operation during a portion of each pumping cycle. An effective method to detect shaft seal failure or potential seal failure shall be provided, and the motor shall be of squirrel-cage type design without brushes or other arc-producing mechanisms.

B. Pump Removal. Submersible pumps shall be readily removable and replaceable without dewatering the wet well or disconnecting any piping in the wet well.

C. Electrical

1. Power Supply and Control. Electrical supply, control and alarm circuits shall be designed to allow for disconnection of the equipment from outside and inside of pumping station. Terminals and connectors shall be protected from corrosion by location outside of wet well or through use of watertight seals. If located outside of the pumping station, weatherproof equipment shall be used.

2. Controls. The motor control center shall be located outside of the wet well and be 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. The seal shall be so located that the motor may be removed and electrically disconnected without disturbing the seal.

3. Power Cord. Pump motor power cords shall be designed for flexibility and serviceability under severe service conditions and shall meet the requirements of the Mine Safety and Health Administration for trailing cables. Ground fault interruption protection shall be used to deenergize the circuit in the event of any failure in the electrical integrity of the cable. Power cord terminal fittings shall be corrosion-resistant and constructed in a manner to prevent the entry of moisture into the cable, shall be provided with strain relief appurtenances, and shall be designed to facilitate field connecting.

3.6. Valves. Valves shall be located in a separate valve pit. Accumulated water shall be drained to the wet well or the soil. If the valve pit is drained to the wet well, an effective method shall be provided to prevent sewage gases and liquid from entering the pit during surcharged wet well conditions.

3.7. Alarm Systems.

A. Alarm systems shall be provided for pumping stations. The alarm shall be activated in cases of power failure, high water level in dry or wet well, pump failure, use of the lag pump, air compressor failure, or any other pump malfunction.

B. Pumping station alarms shall be telemetered, including identification of the alarm condition, to the operating agency's facility that is manned 24 hours a day. If such a facility is not available and 24-hour holding capacity is not provided, the alarm shall be telemetered to the operating agency's facility during normal working hours and to the home of the person(s) responsible for the lift station during off-duty hours.

C. The executive secretary may approve audio-visual alarm systems with a self-contained power supply in lieu of the telemetering system outlined above, depending upon location, station holding capacity and inspection frequency.

3.8. Emergency Operation

A. Pumping stations and collection systems shall be designed to prevent bypassing of raw sewage and backup into the sewer system. For use during possible periods of extensive power outages, mandatory power reductions, or uncontrolled storm events, a controlled high-level wet well overflow or emergency power generator shall be provided. Where a high level overflow is utilized, storage or retention tanks, or basins, shall be provided having at least a 2-hour retention capacity at the anticipated overflow rate.

B. The applicant must review the requirements of R317-6 (Ground Water Quality Protection Rule) for compliance with the said rule for earthen retention basins.

C. The operating agency shall provide:

1. an in-place or portable pump, driven by an internal combustion engine or an emergency generator capable of pumping from the wet well to the discharge side of the station for pump stations with a capacity in excess of one million gallons per day (3,785 cubic meters per day), and

2. an engine-driven generating equipment or an independent source of electrical power or emergency generators capable of pumping from the wet well to the discharge side of the station for pump stations with a capacity in excess of five million gallons per day (18,925 cubic meters per day).

3.9. Auxiliary and Emergency Equipment Requirements

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

1. Engine Protection. The engine must be protected from damaging operating conditions. Protective equipment shall shut down the engine and activating an alarm on site unless continuous manual supervision is planned. Protective equipment shall monitor for conditions of low oil pressure and overheating, Oil pressure monitoring is not required for engines with splash lubrication.

2. Size. The engine shall have adequate rated power to start and continuously operate all connected loads.

3. Fuel Type. The type of fuel must be carefully selected for maintaining reliability and ease of starting, especially during cold weather conditions. Unused fuel from the fuel storage tank should be removed annually, and the tank refilled with fresh fuel.

4. Engine Ventilation. The engine shall be located above grade with adequate ventilation of fuel vapors and exhaust gases.

5. Routine Start-up. All emergency equipment shall be provided with instructions indicating the need for regular starting and running of such units at full loads.

6. Protection of Equipment. Emergency equipment shall be protected from damage at the restoration of regular electrical power.

B. Engine-Driven Pumping Equipment. Where permanently installed or portable engine-driven pumps are used, the following requirements in addition to general requirements apply:

1. Pumping Capacity. Engine-driven pump(s) shall be capable of pumping at the design pumping rates unless storage capacity is available for flows in excess of pump capacity. Pumps shall be designed for anticipated operating conditions, including suction lift if applicable.

2. Operation. Provisions shall be made for automatic and manual start-up and load transfer. The pump must be protected against damage from adverse operating conditions. Provisions should be considered to allow the engine to start and stabilize at operating speed before assuming the load. Where manual start-up and transfer is justified, storage capacity and alarm system must meet the requirements stated hereinabove.

3. Portable Generating Equipment. Where portable generating equipment or manual transfer of power to the pumping equipment is provided, sufficient storage capacity shall be provided in the design of pumping station, to allow time for detection

of pump station failure and transportation and connection of generating equipment. The use of special electrical connections and double throw switches are recommended for connecting portable generating equipment.

3.10. Instructions and Equipment

A. Sewage pumping stations and their operators must be supplied with a complete set of operational instructions, including emergency procedures, maintenance schedules, special tools, and necessary spare parts.

B. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code etc., must be reviewed and complied with. Those requirements take precedence over the foregoing requirements, if more stringent, and should be incorporated in the design.

3.11. Force Mains

A. Velocity. A velocity of not less than 2 feet per second (0.61 meter per second) shall be maintained at the average design flow, to avoid septic sewage and resulting odors.

B. Air Relief Valve. An automatic air relief valve shall be placed at high points in the force main to prevent air locking.

C. Termination. Force mains should enter the gravity sewer system at a point not more than 2 feet (30 centimeters) above the flow line of the receiving manhole.

D. Design Pressure. The force main and fittings, including reaction blocking, shall be designed to withstand normal pressure and pressure surges (water hammer).

E. Special Construction. Force main construction near streams or used for aerial crossings shall meet the requirements stated in Sewers.

F. Design Friction Losses

1. Friction losses through force mains shall be based on the Hazen and Williams formula or other hydraulic analysis to determine friction losses. When the Hazen and Williams formula is used, the design shall be based on the value of C equal to 120; for unlined iron or steel pipe the value of C equal to 100 shall be used.

2. When initially installed, force mains will have a significantly higher C factor. The higher C factor should be considered only in calculating maximum power requirements.

G. Separation from Water Main. The applicant or the design engineer must review the requirements stated in R309-112.2 - Distribution System rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

H. Identification. A clearly labelled tracer location tape shall be placed two feet above the top of force mains less than or equal to 24 inch (61 centimeters) in diameter, along its entire length.

R317-3-4. Treatment Works.

4.1. Plant Location

A. The treatment plant structures and all related equipment shall be protected from physical damage by the 100-year flood. Treatment works must remain fully operational and accessible during the 25-year flood.

B. These conditions shall apply to all new facilities under construction as well as the existing facilities being expanded, upgraded or modified.

4.2. Quality of Effluent. The effluent requirements and water quality standards established in the discharge permit, R317-1 (Definitions and General Requirements), R317-2 (Standards of Quality for Waters of the State) shall be used to determine the required degree of wastewater treatment, and unit processes and operations.

4.3. Design

A. Basis of Design. The plant design shall be based on the higher value of:

1. a moving average of daily rates of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests over a period of 30 consecutive days; or

2. an average of values rate of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests, over a period of month; or

3. the rate of flow and wastewater strength as measured by five-day biochemical oxygen demand (BOD_5) and suspended solids determination tests, equal to or greater than 92 percent of the daily flow rate and wastewater strength data.

B. Hydraulic Design. The hydraulic capacities of all units and conveyance structures shall be computed and checked for the maximum and average design rates of flow with one largest unit out of service. No overtopping of any structure under any condition shall be permitted.

1. New Systems. The design for sewage treatment plants shall be based upon an average daily per capita flow of 100 gallons (0.38 cubic meter) unless the applicant provides and justifies a better estimate of flow based on water use data. An allowance shall be made in the design for industrial wastewaters and rates of infiltration/inflow.

2. Existing Systems. For an existing system, the applicant may use the data based on both dry- weather and wet-weather conditions. The data over a minimum period of one year shall be taken as the basis for the design.

C. Organic Design

1. New System Design

a. Domestic waste treatment design shall be on the basis of at least 0.17 pounds (0.08 kilogram) or 200 milligrams per liter of BOD_5 per capita per day and 0.20 pounds (0.09 kilogram) or 250 milligrams per liter of suspended solids per capita per day, unless information is submitted to justify alternate designs.

b. When garbage grinders are used in areas tributary to a domestic treatment plant, the design basis may be increased to 0.22 pounds (0.10 kilogram) or 260 milligram per liter of BOD_5 per capita per day and 0.25 pounds (0.11 kilogram) or 300 milligram per liter of suspended solids per capita per day.

c. An allowance shall be made in the design for industrial wastewaters and rates of infiltration/inflow.

d. Other approved methods for measurement of organic strength of wastewater published in Standard Methods for Examination of Water and Wastewater, jointly prepared by American Public Health Association (APHA), American Society of Civil Engineers (ASCE), American Water Works Association (AWWA), and Water Pollution Control Federation (WPCF), will be accepted in lieu of the five-day biochemical oxygen demand (BOD_5) test.

2. Existing Systems

a. For an existing system, the applicant may use the data based on the actual strength of the wastewater as determined by analysis of composite samples for five-day biochemical oxygen demand (BOD_5) and suspended solids. An appropriate increment for growth shall be included in the basis of design.

b. The data over a minimum period of one year shall be taken as the basis for the design.

D. Shock Loadings. The applicant shall consider the shock loadings of high concentrations and diurnal peaks for short periods of time on the treatment process, particularly for small treatment plants.

E. Design by Analogy. The applicant may utilize the data from similar municipalities in the case of new systems, provided that the reliability and applicability of such data is established through thorough investigations and documentation.

F. Flow Conduits. All piping and channels shall be designed to carry the maximum rates of flows. The incoming sewer shall be designed for unrestricted flow. Bottom corners of the channels must be filleted. Conduits shall be designed to avoid creation of pockets and corners where solids can accumulate. Suitable gates shall be placed in channels to seal off unused sections which might accumulate solids. The use of shear gates or stop planks is permitted where they can be used in place of gate valves or sluice gates. Corrosion resistant materials shall be used for these control gates.

G. Arrangement of Process Units. The design should provide for an arrangement of component parts of the plant, for greatest operating and maintenance convenience, reliability flexibility, economy, continuity of maximum effluent quality, and ease of installation of future units.

H. Flow Division Control. The design shall provide for flow division control facilities to insure organic and hydraulic loading control to various process units. Convenient, easy and safe access, change, observation, and maintenance shall be considered in the design of such facilities. Flow division shall be measured using flow measurement devices to assure uniform loading of all unit processes and operations.

4.4. Plant Design Details

A. Mechanical Equipment. The specifications should provide for:

1. services of a representative of the manufacturer to supervise the installation and initial operation of major items of mechanical equipment; and

2. performance tests of the installed equipment before acceptance by the applicant.

B. Unit Bypasses

1. A minimum of two units in the liquid treatment process train shall be provided for all unit processes and operations in all plants rated at over 1 million gallons per day (3,785 cubic meters per day).

2. The executive secretary will approve any exceptions based on reliability and operability of the components.

3. The design shall provide for properly located and arranged bypass structures and piping so that each unit of the plant can be removed from service independently. The bypass design shall facilitate plant operation during unit maintenance and emergency repair so as to minimize deterioration of effluent quality and insure rapid process recovery upon return to normal operational mode.

C. Unit Bypass During Construction. Any bypass during construction or operation must be approved by the executive secretary before such bypass occurs, as provided in this rule.

D. Drains. The design shall incorporate means to completely drain each unit with a discharge to a point within the process or the plant.

E. Protection of Structures. The design shall incorporate hydrostatic pressure relief devices to prevent flotation of structures.

F. Pipe Cleaning and Maintenance. Fittings, valves, and other appurtenances shall be provided for pipes subject to clogging, to facilitate proper cleaning through mechanical cleaning or flushing. Pipes subject to clogging, such as pipes carrying sludge, shall be lined with a material which creates a smooth and nonadhering surface, thereby reducing clogging and resistance to flow.

G. Construction Materials. The materials of construction and equipment shall be resistant to hydrogen sulfide and other corrosive gases, greases, oils, chemicals, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints. Contact between dissimilar metals should be avoided to minimize galvanic action, and consequent corrosion.

H. Painting

1. Piping within the plant shall be color coded to facilitate identification of piping, particularly in the plants rated over 5 million gallons per day (18,925 cubic meters per day). Table R317-3-4.4(H)(1) shows color and identification scheme recommended by the American National Standards Institute (ANSI 253.1 and 13.1) shall be used for the purposes of standardization.

2. The labels shall be stenciled in conformance with the ANSI standard A13.1.

3. The executive secretary may approve painting of piping with one color with a labelling scheme in conformance with the ANSI standard A13.1 provided that:

a. labels are color coded as directed above;

b. piping contents and direction of flow are legibly stenciled on the label; and

c. labels are securely on the piping at interval and all locations required in the above referenced standard.

I. Operating Equipment. A complete outfit of tools, accessories, and spare parts necessary for the plant operator's use should be provided. Readily-accessible storage space and workbench facilities should be provided, and consideration be given to provision of a garage for large equipment storage, maintenance, and repair.

J. Erosion Control During Construction. Effective site erosion control shall be provided during construction.

K. Grading and Landscaping. The site should be graded and landscaped upon completion of the plant. Concrete or gravel walkways should be provided for access to all units. Steep slopes should be avoided to prevent erosion. Surface water shall not be permitted to drain into any unit. Particular care shall be taken to protect all treatment plant components from storm water runoff.

4.5. Plant Outfall Lines

A. Discharge Impact Control. The outfall sewer shall be designed to discharge to the receiving stream in a manner not to impair the beneficial uses of the receiving stream and acceptable to the executive secretary. The outfall design should provide for:

1. Free fall or submerged discharge at the site selected;

2. Cascading of effluent to increase dissolved oxygen concentration in the effluent; and

3. Limited or complete dispersion of discharge across stream to minimize impact on aquatic life movement, and growth in the immediate reaches of the receiving stream; and

B. Protection and Maintenance. The outfall sewer shall be so constructed and protected against the effects of floodwater, ice, or other hazards as to reasonably insure its structural stability and freedom from stoppage.

C. Sampling Provisions. All outfall lines shall be designed with a safe and convenient access, preferably using a manhole, 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.

4.6. Essential Facilities

A. Emergency Power Facilities

1. General. All plants shall have an alternate source of electric or mechanical power to allow continuity of operation during power failures. Methods of providing alternate sources include:

a. provision of at least two independent sources of power, such as feeders, grid, etc., to the plant;

b. portable or in-place internal combustion engine equipment which will generate electrical or mechanical energy; or

c. portable pumping equipment when only emergency pumping is required.

2. Power for Aeration. Standby power generating capacity normally is not required for aeration equipment used in the activated sludge type processes or aerated lagoons. In cases where a history of long-term (4 hours or more) power outages have occurred, auxiliary power for minimum aeration of the activated sludge type processes or aerated lagoon will be required. Full power generating capacity may be required when discharge is to critical stream segments to protect downstream uses identified in R317-2 (Standards for Quality for Waters of the State).

3. Power for Disinfection. Standby power generating capacity shall include the capacity needed for continuous disinfection of wastewater during power outages.

B. Plant Water Supply

1. General. An adequate supply of potable water under pressure should be provided for use in the laboratory and for general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which, under any conditions, might cause the contamination of a potable water supply. The chemical quality of the water should be checked for suitability for its intended uses such as in heat exchangers, chlorinators, etc.

2. Direct Connections

a. Potable water from a municipal or separate supply may be used directly at points above grade for hot and cold supplies in lavatory, water closet, laboratory sink (with vacuum breaker), shower, drinking fountain, eye wash fountain, and safety shower; unless local authorities require a positive break at the property line.

b. The applicant must review the requirements stated in R309-112.2 - Distribution System Rules, Drinking Water and Sanitation Rules, to assure compliance with the said rule.

c. Hot water for any of the above units shall not be taken directly from a boiler or piping used for supplying hot water to a sludge heat exchanger or digester heating unit.

3. Indirect Connections

a. Where a potable water supply is used for any purpose in a plant, a break tank, pressure pump, and pressure tank shall be provided. Water shall be discharged to the break tank through an air gap at least 6 inches (15.2 centimeters) above the maximum flood line or the spill line of the tank, whichever is higher.

b. A sign shall 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.

4. Separate Potable Water Supply. Where it is not possible to provide potable water from a public water supply, a separate well may be provided. Location and construction of the well shall be in accordance with the requirements of R309, Drinking Water and Sanitation Rules.

5. Separate Non-Potable Water Supply. Where a separate non-potable water supply or plant effluent is to be provided, a break tank will not be necessary, but all system outlets shall be posted with a permanent sign indicating the water is not safe for drinking.

C. Sanitary Facilities. Toilet, shower, lavatory, and locker facilities shall be provided in convenient locations to serve the expected staffing level at the plant.

D. Floor Slope. All floor surfaces shall be sloped adequately to a collection floor drain system.

E. Stairways

1. Stairways shall be installed wherever possible in lieu of ladders. Spiral or winding stairs are permitted only for secondary access where dual means of egress are provided. Stairways shall have slopes between 50 degrees and 30 degrees (preferably nearer the latter) from the horizontal to facilitate carrying samples, tools, etc. Each tread and riser shall be of uniform dimension in each flight. Minimum tread run shall not be less than 8 inches (20.3 centimeters). The sum of the tread run and riser shall not be less than 17 inches (43 centimeters) nor more than 18 inches (46 centimeters). A flight of stairs shall consist of not more than a 12-foot (3.7 meters) continuous rise without a platform.

2. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code, etc., must be reviewed and complied with. Those requirements take precedence over the foregoing requirements, if more stringent, and should be incorporated in the design.

4.7. Flow Measurement. Flow measurement devices, preferably of the primary type (devices which create a hydrodynamic condition that is sensed by the secondary element), shall be provided at the plant to continuously indicate, totalize and record volume of wastewater entering the plant in a unit time.

A. Flumes. Installation of flumes shall be as follows:

1. Flumes with throat widths of less than 6 inches (15 centimeters) shall not be installed. Throat width shall be selected to measure the entire range of anticipated flow rates at all measurement locations.

2. Locations close to turbulent, surging or unbalanced flow, or a poorly distributed velocity pattern shall be avoided. For super-critical upstream flow, a hydraulic jump should be forced to occur in a section upstream of the flume at a distance of at least 30 times maximum upstream operating depth of flume followed by a straight approach section of a length specified in this rule.

3. For flumes with throat width less than half the width of the approach channel, the length of approach channel - straight upstream section - shall be the greater of 20 times the throat width or ten times maximum upstream operating depth in flume.

4. For flumes with throat width greater than half the width of the approach channel, the length of approach channel - straight upstream section - shall be not less than ten times the maximum upstream operating depth in flume.

5. Parshall flumes shall be permitted only in locations where free discharge conditions exists on the downstream side at the average design flow. Submergence must not exceed 60 percent at the maximum design flow.

6. The stilling well, if used, and secondary measuring elements, such as floats, sensors, or gages, shall be protected against extreme weather conditions.

B. Other Flow Measurement Devices. Effluent discharged to receiving waters should be measured using flow measurement devices, such as weirs, sonic or capacitance type, etc.

C. Flow Recorders

1. Clock-wound mechanisms for recording of flow are not permitted.

2. Battery powered flow measurement devices may be permitted at locations where electrical power is not available, and continuous operability of flow measurement devices is demonstrated.

4.8. Safety and Hazardous Chemical Handling. Adequate provision shall be made to effectively protect the operator and visitors from hazards. Local, state and federal safety requirements must be reviewed and complied with. Typical items for consideration are fence, splash guards, hand and guard rails, labeling of containers and process piping, warning signs, protective clothing, first aid equipment, containments, eye-wash fountains and safety showers, dust collection, portable emergency lighting, etc.

4.9. Laboratory.

A. Treatment plants rated in excess of 1 million gallons per day (3,785 cubic meters per day) shall include a laboratory for making the necessary analytical determinations and operating control tests. Otherwise, the applicant shall show availability of services of state-certified laboratories on a continuous contract basis.

B. The laboratory size, bench space, equipment and supplies shall be such that it can perform analytical work for:

1. All self-monitoring parameters required by discharge permits;

2. The process control necessary for good management of each treatment process included in the design; and

3. Industrial waste control or pretreatment programs.

R317-3-5. Screening and Grit Removal.

5.1. Screening Devices. Coarse bar racks or screens shall be used to protect pumps, comminutors, flow measurement devices and other equipment.

5.2. Bar Racks and Screens

A. Location

1. Indoor. Screening devices, installed in a building where other equipment or offices are located, shall be accessible only through a separate outside entrance to protect the operating personnel and the equipment from damage and nuisance caused by gases, odors and potential flooding.

2. Outdoors. Screening devices not installed in enclosures or buildings shall be protected from freezing or other adverse environmental conditions.

B. Access. Screening areas shall be provided with proper work and safe access and egress, proper and emergency lighting, ventilation, and a convenient and safe means for removing the screenings.

C. Design and Installation

1. Bar Spacing. Clear openings between bars should be:

a. not more than 1 inch (2.54 centimeters) for manually cleaned screens; and

b. less than 5/8 of an inch (1.59 centimeters) for mechanically cleaned screens.

2. Bar Slope. Manually cleaned screens, except those for emergency use, should be placed on a slope of 30 to 45 degrees from the horizontal.

3. Approach Velocities. At average design flow conditions, approach velocities should be no less than 1.25 feet per second (38 centimeters per second), to prevent settling; and no greater than three (3) feet per second (91 centimeters per second) to prevent forcing material through the openings.

4. Channels. Dual channels shall be provided and equipped with the necessary gates to isolate flow from any screening unit. Provisions shall also be made to facilitate dewatering each unit. The channel preceding and following the screen shall be shaped to eliminate stranding and settling of solids. Entrance channels should be designed to provide equal and uniform distribution of flow to the screens.

5. Reliability. A minimum of two screens shall be provided. Each screen shall be designed to handle the peak design rate of flow. Where more than two screens are provided, the peak design rate of flow shall be handled with one of the largest units out of service. Where a single mechanical screen handles the peak design rate of flow, then other unit can be a manually cleaned screen.

6. Flow Measurement. The types and locations of flow measurement devices should be selected for reliability and accuracy. The effect of changes in backwater elevations, due to intermittent blinding and cleaning of screens, should be considered in the selection of the locations for flow measurement equipment.

7. Invert. The screen channel invert should be 3.0 to 6.0 inches (7.6-15.2 centimeters) below the invert of the incoming sewer.

D. Safety

1. Railings and Gratings.

a. All screening installations shall be equipped with guard rails and deck grating to insure operator safety.

b. The manually cleaned bar rack shall be accessible for cleaning insuring operator safety.

c. Proper guard rails and enclosures shall be used to protect the operator from moving parts of mechanically operated and cleaned screens. These guard rails and enclosures shall be removable for safe access to maintain and repair mechanically operated and cleaned screens. Catchments shall be provided to prevent dripping of liquids in multi- level installations.

2. Equipment Deactivation and Lockout. Each piece of electrical power mechanical equipment shall be equipped with a positive means of deactivating or locking out or isolating from its power source. Such device shall be located in close proximity to the equipment.

3. Removal of Screenings. The design shall provide for mechanical conveying or lifting systems for safe transport of screenings from a subgrade installation to a collection point on grade.

E. Power Control Systems

1. Timing Devices. All mechanical units which are operated by timing devices shall be provided with auxiliary override controls which will set the cleaning mechanism in operation at a preset high water elevation or water differential across the screen.

2. Electrical Fixtures and Controls. Electrical fixtures and controls in screening areas where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class I, Group D, Division 1 locations.

3. Manual Override. Automatic controls shall be supplemented with a manual override.

F. Disposal of Screenings

1. Facilities shall be provided for removal, handling, storage, and disposal of screenings in a sanitary manner. Separate grinding of screenings and return to the sewage flow is unacceptable. Manually cleaned screening facilities should include an

accessible platform from which the operator may rake screenings easily and safely. Suitable drainage facilities shall be provided for both the platform and the storage areas.

2. Screenings may be landfilled. The ultimate disposal of screenings shall conform to and comply with the requirements for the ultimate disposal of residues or sludge management plan.

5.3. Comminutors

A. General. Comminutors may be used in plants, excepting aerated or facultative or total containment lagoons, where mechanically cleaned bar screens are not used.

B. Design Considerations

1. Location. Comminutors should be located downstream of bar screen and any grit removal equipment.

2. Size. Comminutor capacity shall be adequate to handle the peak design rate of flow.

3. Installation.

a. A comminutor bypass channel, with manually cleaned bar screen, shall be provided. The use of the bypass channel should be automatic at depths of flow exceeding the design capacity of the comminutor. The bypass channel should be able to pass the peak design rate of flow when the comminutor channel is out of service.

b. Each comminutor that is not preceded by grit removal equipment should be protected by a 6-inch (15.2 centimeters) deep easily cleaned gravel trap.

PC Maintenance. Gates shall be provided for isolation of comminutor, comminutor channel including bypass channel for draining, repairs and maintenance. Provisions shall be made to facilitate servicing of units in place and removing units from their location for servicing.

5. Electrical Power Controls and Motors. Electrical equipment in comminutor chambers where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations. Motors in areas not governed by this requirement may need protection against accidental submergence.

5.4. Grit Removal Facilities

A. General. Grit removal facilities shall be provided for all mechanical treatment plants. Pumps, comminutors, and other mechanical equipment preceding grit removal, shall be protected from the damaging effects of grit. Storage capacity shall be provided in treatment units where grit is likely to accumulate.

B. Location. Grit removal facilities should be located ahead of pumps and comminuting devices. Coarse bar racks should be placed ahead of grit removal facilities.

C. Enclosed Facilities

1. Ventilation. Uncontaminated air shall be introduced continuously at a minimum rate of 12 air changes per hour, or intermittently at a minimum rate of 30 air changes per hour. Odor control facilities are recommended.

2. Access. Grit removal facilities shall be provided with proper and safe access, and egress from equipment and facilities.

3. Electrical Work. All electrical work in enclosed grit removal areas where hazardous gases may accumulate shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations.

D. Outdoor Facilities. Grit removal facilities located outside the buildings shall be protected from freezing, and other adverse environmental conditions.

E. Type and Number of Units

1. Number of Units. For plants treating:

a. more than 1 million gallons per day rate of flow (3,785 cubic meters per day), two mechanically cleaned grit removal units shall be installed in a parallel configuration. Each grit channel shall be designed to handle the peak design rate of flow.

b. less than 1 million gallons per day rate of flow (3,785 cubic meters per day), a single manually cleaned or mechanically cleaned grit chamber with a bypass channel shall be provided.

2. Other types. When arrangements other than channel-type of grit removal is considered, equipment for agitation, air supply, grit collection, grit removal, and grit washing shall be provided with controls for handling variations in rates of flow, and providing operating flexibility.

F. Design Factors

1. General. The designed effectiveness of a grit removal system shall be commensurate with the requirements of the subsequent process units.

2. Inlet Configuration. Inlet turbulence shall be minimized. The inlet flow direction must be parallel to the induced roll direction within aerated grit chambers.

3. Velocity and Detention Time.

a. Horizontal Channel-type Grit Chambers.

(1) Velocity of flow through a channel-type chamber shall be controlled such that it is not less than one foot per second (30 centimeters per second) during normal variations in flow.

(2) The detention time shall be based on the size of particle to be removed but not less than 20 seconds at the maximum design flow. Velocity and detention time in the channel shall be regulated by installation of control devices such as proportional flow, Sutro weirs, etc.

b. Aerated grit chambers.

(1) The velocity of flow through an aerated grit chamber shall not be less than 1 foot per second (30 centimeters per second) during normal variations in flow, in the direction of induced roll.

(2) A minimum detention time of two to five minutes at the maximum design flow shall be provided. Rate of aeration shall not be less than 4 cubic feet per minute per lineal foot (1.5 liters per second per meter). Outlet weir shall be provided parallel to the direction of induced roll.

c. Square grit chambers. Detention time and overflow rate for square grit chambers shall be based on the size of particles intended to be removed. Overflow rate should not exceed 40,000 gallons per day per square foot of the chamber area (1,600 cubic meters per day per square meter).

4. Grit Washing. Grit should be washed before the disposal.

5. Drains. Provision shall be made for to adequately bypass, isolate and dewater each grit removal unit for maintenance.

6. Water. An adequate supply of service or non-potable plant water under pressure shall be provided for cleanup.

G. Grit Handling.

1. Mechanical equipment for hoisting or transporting grit to ground level shall be provided in grit removal facilities located in deep pits. Impervious, non-slip, working surfaces with adequate drainage shall be provided for grit handling areas. Grit transporting facilities shall be provided with protection against freezing and loss of material.

2. Grit may be landfilled. The ultimate disposal of grit shall conform to and comply with the requirements for the ultimate disposal of residues or sludge management plan.

R317-3-6. Settling.

6.1. General Considerations

A. Number of Units. Multiple units capable of independent operation shall be provided in all plants where the design rate of flow exceed 1 million gallons per day (3,785 cubic meters per day). Plants where the design rate of flow is less than one (1) million gallons per day (3,785 cubic meters per day), shall include other provisions to assure continuity of treatment.

B. Arrangement. Settling tanks shall be arranged for optimum site utilization, and shall be consistent with the hydraulic head requirements for other ancillary units.

C. Flow Distribution. Effective flow measurement devices and control appurtenances (e.g. valves, gates, splitter, boxes, etc.) should be provided to permit proper proportioning of flow to each unit.

D. Tank Configuration. The selection of tank size and shape, and inlet and outlet type and location shall be based on the site and flow patterns.

6.2. Design Considerations

A. Dimensions.

1. The minimum length of flow from inlet to outlet should not be less than be 10 feet (3 meters) unless special provisions are made to prevent short circuiting. The sidewater depth for primary clarifiers shall be not less than 8 feet (2.4 meters).

2. Clarifiers following an activated sludge process shall have sidewater depths of at least 12 feet (3.7 meters) to provide adequate separation zone between the sludge blanket and the overflow weirs.

3. Clarifiers following fixed film reactors shall have sidewater depth of at least 8 feet (2.4 meters).

B. Surface Loading (Overflow) Rates

1. Primary Settling Tanks

a. Surface loading or overflow rates at the average design rate of flow for primary tanks shall not exceed:

(1) 600 gallons per day per square foot (24 cubic meters per square meter per day) for plants treating at the rate of flow less than 1 million gallons per day (3,785 cubic meter per day), or

(2) 1,000 gallons per day per square foot (41 cubic meters per square meter per day) for plants treating at the rate of flow more than 1 million gallons per day (3,785 cubic meter per day).

b. For primary settling, expected influent BOD_5 removal and surface loading is as shown by the relationship: E = (41.5 - (0.01 x Surface loading at average design Q)) where, E = efficiency, percent, and surface loading less than or equal to 2,000 gallons per day per square foot (82 cubic meters per square meter per day). However, anticipated higher BOD_5 removal than the one predicted using above relationship for sewage or sewage containing appreciable quantities of industrial wastes (or chemical additions to be used), shall be validated by plant performance data.

2. Intermediate Settling Tanks. Surface loading or overflow rates for intermediate settling tanks following fixed film reactor processes shall not exceed 1,000 gallons per day per square foot (41 cubic meters per square meter per day) at the average design rate of flow.

3. Final Settling Tanks

a. Settling tests should be conducted wherever a pilot study of biological treatment is warranted by unusual waste characteristics or treatment requirements.

b. The applicant will conduct pilot testing where proposed loadings go beyond the limits set forth in this section.

c. Surface loading or overflow rates for settling tanks following fixed film processes shall not exceed 800 gallons per day per square foot (33 cubic meters per square meter per day) at the average design rate of flow.

d. Settling tanks following activated sludge processes must be designed to meet thickening as well as solids separation requirements. Surface loading or overflow, and weir overflow rates must be adjusted for the various processes to minimize the problems with sludge loadings, density currents, inlet hydraulic turbulence, and occasional poor sludge settleability. The high rate of recirculation of return sludge from the final settling tanks to the aeration or reaeration tanks requires careful consideration of above factors. The hydraulic design of intermediate and final settling tanks following the activated sludge process shall be based upon the average design rate of flow excluding activated sludge return flow as shown in Table R317-3-6.2(B)(3)(d).

C. Inlet Structures. Inlets should be designed to dissipate the inlet velocity and to distribute the flow equally both horizontally and vertically and to prevent short circuiting. Channels should be designed to maintain a velocity of at least one foot per second (0.3 meter per second) at the minimum design flow. Corner pockets and dead ends should be eliminated and corner fillets or channeling used where necessary. Provisions shall be made for elimination or removal of floating materials in inlet structures.

D. Effluent Overflow Weirs

1. General. Effluent overflow weirs shall be adjustable for leveling.

2. Location. Effluent overflow weirs shall be located to optimize actual hydraulic detention time, and minimize short circuiting.

3. Design Rates. Weir loadings shall not exceed 10,000 gallons per day per lineal foot (124 cubic meters per meter per day) for plants treating the average design rate of flow of one (1) million gallons per day (3,785 cubic meters per day) or less. Higher weir loadings may be used for plants designed for larger average flows, but shall not exceed 15,000 gallons per day per lineal foot (186 cubic meters per meter per day). If pumping is required, weir loadings must be related to pump delivery rates to avoid short circuiting.

4. Weir Troughs. Weir troughs shall be designed to prevent submergence at the maximum design rate of flow (peak daily flow), and to maintain a velocity of at least one foot per second (0.3 meter per second) at one-half of the average design rate of flow. Submergence may be permitted at the maximum design rate of flow (peak daily flow) with one unit out of service.

E. Submerged Surfaces. The tops of troughs, beams, and similar submerged construction elements shall have a minimum slope of 1.4 vertical to 1 horizontal; the underside of such elements should have a slope of 1 to 1 to prevent the accumulation of scum and solids.

F. Unit Dewatering. The bypass design shall provide for redistribution of the plant flow to the remaining units in operation.

G. Freeboard. Walls of settling tanks shall extend at least 6 inches (15 centimeters) above the surrounding ground surface and shall provide not less than 12 inches (30 centimeters) freeboard. Additional freeboard or the use of wind screens should be provided where larger settling tanks are subject to high velocity wind currents that would cause tank surface waves and inhibit effective scum removal.

6.3. Sludge and Scum Removal

A. Scum Removal. Effective scum collection and removal facilities, including baffling, shall be provided for primary, intermediate and secondary settling tanks. The unusual characteristics of scum which may adversely affect pumping, piping, sludge handling and disposal, should be recognized in design. Provisions may be made for the discharge of scum with the sludge; however, other special provisions for disposal may be necessary.

B. Sludge Removal. Sludge collection and withdrawal facilities shall be designed to assure rapid removal of the sludge. Suction withdrawal of sludge from the tank floor should be provided for activated sludge plants designed for reduction of the nitrogenous oxygen demand.

1. Sludge Hopper. When scrapers are used to move sludge into a discharge hopper, the minimum slope of the side walls shall be 1.7 vertical to 1 horizontal. Hopper wall surfaces should be made smooth with rounded corners to aid in sludge removal. Hopper bottoms shall have a maximum dimension of two feet (0.6 meter). Deep sludge hoppers for sludge thickening are not acceptable.

2. Sludge Removal Piping. Each hopper shall have an individually valved sludge withdrawal line at least six inches (15 centimeters) in diameter. The static head available for withdrawal of sludge shall be 30 inches (76 centimeters) or greater, as necessary to maintain a three foot per second (0.91 meter per second) velocity in the withdrawal pipe. Clearance between the end of the withdrawal line and the hopper walls shall be sufficient to prevent bridging of the sludge. Adequate provisions shall be made for rodding or back-flushing individual pipe runs for activated sludge secondary clarifiers except for oxidation ditch clarifiers. Piping shall also be provided to return waste sludge to primary clarifiers.

3. Sludge Removal Control. Sludge wells shall be provided with telescoping valves or other equipment for viewing, sampling and controlling the rate of sludge withdrawal. The use of sight glass and sampling valves may be appropriate. A means of measuring the sludge removal rate shall be provided. Air lift type of sludge removal must not be used for removal of primary sludges. Sludge pump motor control systems shall include time clocks and valve controls for regulating the duration and sequencing of sludge removal.

6.4. Protective and Service Facilities

A. Operator Protection. All settling tanks shall be equipped to provide safe working conditions for operators. Such features shall include machinery covers, life lines, stairways, walkways, handrails and slip resistant surfaces.

B. Mechanical Maintenance Access. The design shall provide for convenient and safe access to routine maintenance items such as gear boxes, scum removal mechanisms, baffles, weirs, inlet stilling baffle area, sludge and scum pumps, and effluent channels.

C. Electrical Fixtures and Controls. Electrical fixtures and controls in enclosed settling basins shall meet the requirements of the National Electrical Code for Class 1, Group D, Division 1 locations. The fixtures and controls shall be located so as to provide convenient and safe access for operation and maintenance. Walkways, bridge area and area around settling tanks shall be illuminated with area lighting for operating personnel safety.

R317-3-7. Biological Treatment.

7.1. Trickling Filters

A. General. Trickling filters shall be preceded by effective settling tanks equipped with scum and grease collecting devices, or other suitable pretreatment facilities.

B. Hydraulics

1. Distribution. The sewage may be distributed over the filter by rotary distributors or other suitable devices which will ensure uniform wastewater distribution to the surface area. Uniform hydraulic distribution of sewage on the filters is required.

2. For reaction type distributors, a minimum head of 24 inches (61 centimeters) between low water level in the siphon chamber and center of the arms is required. Similar allowance in design shall be provided for added pumping head requirements where pumping to the reaction type distributor is used. The applicant should evaluate other types of drivers and drives.

3. A minimum clearance of 6 inches (15 centimeters) between media and distributor arms shall be provided. Larger clearance than 6 inches (15 centimeters) must be provided where ice buildup may occur.

C. Wastewater Application. Application of the sewage shall be continuous. The piping system shall be designed for recirculation. The design must provide for routine flushing of filters by heavy dosing at intermittent intervals.

D. Piping System. The piping system, including dosing equipment and distributor, shall be designed to provide capacity for the peak design rate of flow, including recirculation.

E. Media

1. Quality

a. The media may be crushed rock, slag, or specially manufactured material. The media shall be durable, resistant to spalling or flaking and insoluble in sewage. The top 18 inches (46 centimeters) shall have a loss by the 20-cycle, sodium sulfate soundness test of not more than 10 percent. The balance is to pass a ten-cycle test using the same criteria. Slag media shall be free from iron.

b. Manufactured media shall be resistant to ultraviolet degradation, disintegration, erosion, aging, all common acids and alkalies, organic compounds, and fungus and biological attack. Such media shall be structurally capable of supporting a man's weight or a suitable access walkway shall be provided to allow for distributor maintenance.

2. Depth. The filter design shall provide for a depth of:

a. not less than 5 feet (1.5 meters) above the underdrains, but not more than 10 feet (3 meters) when rock or slag media is used in the filters.

b. not less than 10 feet (3 meters) above the underdrains to provide adequate contact time with the wastewater, but not more than 30 feet (9 meters) unless additional structural construction and aeration are provided, when manufactured media is used in the filters.

3. Size and Grading of Media

a. Rock, Slag and Similar Media

(1) Rock, slag, and similar media shall not contain more than 5 percent by weight of pieces whose longest dimension is three times the least dimension.

(2) Media shall be free from thin, elongated and flat pieces, dust, clay, sand or fine material and shall conform to the size and grading when mechanically graded over vibrating screens with square openings, as shown in Table R317-3-7.1(E)(3(a)(2).

b. Manufactured Media. The applicant must evaluate suitability of manufactured media on the basis of experience with installations handling similar wastes and loadings.

c. Handling and Placing of Media. Material delivered to the filter site shall be stored on wood- planked or other approved clean, hard-surfaced areas. All material shall be rehandled at the filter site and no material shall be dumped directly into the filter. Crushed rock, slag and similar media shall be washed and rescreened or forked at the filter site to remove all fines. Such material shall be placed by hand to a depth of 12 inches (30 centimeters) above the tile underdrains. The remainder of material may be placed by means of belt conveyors or equally effective methods approved by the design engineer. All material shall be carefully placed so as not to damage the underdrains. Manufactured media shall be handled and placed as approved by the engineer. Trucks, tractors, and other heavy equipment shall not be driven over the filter during or after construction.

F. Underdrain System

1. Arrangement. Underdrains with semicircular inverts or equivalent should be provided and the underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 15 percent of the surface area of the filter.

2. Hydraulic Capacity and Ventilation.

a. The underdrains shall have a minimum slope of 1 percent. Effluent channels shall be designed to produce a minimum velocity of two (2) feet per second (0.61 meters per second) at average daily rates of application to the filter.

b. The underdrainage system, effluent channels, and effluent pipe shall be designed to permit a free passage of air preventing septicity within the filter. The size of drains, channels, and pipe should be such that not more than 50 percent of their cross-sectional area will be submerged under the design peak hydraulic loading, including proposed or possible future recirculated flows. Forced air ventilation must be provided for deep or covered filters using manufactured media. The design of filters should be compatible for the installation of odor control equipment such as covers, forced air ventilation, scrubber, etc., as a retrofit.

3. Flushing. The design should include means for flushing of the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. Means or facilities of inspection of underdrainage should be provided.

G. Special Features

1. Flooding. Appropriate valves, sluice gates, or other structures shall be provided to enable flooding of filters comprised of rock or slag media.

2. Freeboard. A freeboard of not less than 4 feet (1.2 meters) should be provided for tall filters using manufactured media, to maximize the containment of windblown spray.

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

4. Freeze Protection. When climatic conditions are expected to result in operational problems due to cold temperatures, the filters may be covered for protection against freezing; maintaining operation and treatment efficiencies.

5. Recirculation. The piping and pumping systems shall be designed for recirculation rates as required to achieve sufficient wetting of biofilm and the design efficiency.

6. Recirculation Measurement. Recirculation rate to the filters shall be measured using flow measurement and recording devices. Time lapse meters and pump head recording devices are acceptable for facilities treating less than 1 million gallons per day (3,785 cubic meters per day).

H. Rotary Distributor Seals. Mercury seals are not permitted. The design of the distributor support septum shall provide for convenient and easy seal replacement to assure continuity of operation.

I. Multi-Stage Filters. The foregoing standards in this rule also apply to all multi-stage filters.

J. Unit Sizing

1. Required volumes of rock or slag media filters shall be based upon the following equations: For Single or First stage of Trickling Filter: $E = 100 - ((100 / (3 + 2 (R/I))) + (0.4 x (W / V) - 10))$. For Second stage of Trickling Filter: $E = 100 x ((1 + (R_2 / I)) / (2 + (R_2 / I)))$ where, E = Efficiency, percent R = recirculated flow through trickling filter, mgd I = raw sewage flow, mgd W = pounds of BOD_5 per day in raw sewage V = volume of filter media in 1000 cubic feet R_2 = recirculated flow through second-stage trickling filter, mgd.

2. The required volume of media may be determined by pilot testing or use of any of the various empirical design equations that have been verified through actual full scale experience. Such calculations must be submitted if pilot testing is not utilized. Pilot testing is recommended to verify performance predictions based upon the various design equations, particularly when significant amounts of industrial wastes are present.

3. Expected performance of filters packed with manufactured media shall be determined from documented full scale experience on similar installations or through actual use of a pilot plant on site.

K. Nitrification

1. Trickling filters may be used for nitrification. The design should be based as shown in Table R317-3-7.1(K)(1).

2. Nitrification is affected by variations in flow, loadings and temperature, and other factors. Therefore, the applicant must conduct pilot studies before developing the design criteria.

L. Design Safety Factors. Trickling filters are affected by diurnal load conditions. The volume of media determined from either pilot plant studies or use of acceptable design equations shall be based upon organic loading at the maximum design rate of flow rather than the average design rate of flow.

7.2. Activated Sludge

A. General. The activated sludge process and its several modifications may be used to accomplish varied degrees of removal of suspended solids, and reduction of carbonaceous and nitrogenous oxygen demand. The degree and consistency of treatment required, type of waste to be treated, proposed plant size, anticipated degree of operation and maintenance, and operating and capital costs determine the choice of the process to be used. The design shall provide for flexibility in operation. Plants over 1 million gallons per day (3,785 cubic meters per day) shall be designed to facilitate easy conversion to various operational modes. In severe climates, protection against freezing shall be provided to ensure continuity of operation and performance.

B. Aeration

1. Capacities and Permissible Loadings

a. The design of the aeration tank for any particular adaptation of the process shall be based on full scale experience at the plants receiving wastewater of similar characteristics under similar climatic conditions, pilot plant studies, or calculations based on process kinetics parameters reported in technical literature. The size of treatment plant, diurnal load variations, degree of treatment required, temperature, pH, and reactor dissolved oxygen when designing for nitrification, influence the design. Calculations using values differing substantially from those in the table shown below must reference actual operational data.

b. The applicant must substantiate capability of the aeration and clarification systems in the processes using mixed liquor suspended solids levels greater than 5,000 milligrams per liter.

c. The applicant shall use the values shown in Table R317-3-7.2(B)(1)(c) to determine the aeration tank capacities and permissible loadings for the several adaptations of the processes, when process design calculations are not submitted. These values are based on the average design rate of flow, and apply to plants receiving peak to average diurnal load ratios ranging from about 2:1 to 4:1.

2. Arrangement of Aeration Tanks

a. Dimensions. Effective mixing and utilization of air must be the basis of dimensions of each independent mixed liquor aeration tank or return sludge reaeration tank. Liquid depths should not be less than 10 feet (3 meters) or more than 30 feet (9 meters) unless the applicant justifies the need for shallower or deeper tanks.

b. Short-circuiting. The shape of the tank and the installation of aeration equipment should provide for positive control of short-circuiting through the aeration tank.

c. Number of Units. Total aeration tank volume shall be divided among two or more units, capable of independent operation, to meet applicable effluent limitations and reliability guidelines.

d. Inlets and Outlets. Inlets and outlets for each aeration tank unit shall be suitably equipped with valves, gates, stop plates, weirs, or other devices to permit controlling the flow to any unit and to maintain reasonable constant liquid level. The hydraulic properties of the system shall permit the maximum instantaneous hydraulic load to be carried with any single aeration tank unit out of service.

e. Conduits. Channels and pipes carrying liquids with solids in suspension shall be designed to maintain self-cleaning velocities or shall be agitated to keep such solids in suspension at all rates of flow within the design limits. Drains shall be installed in the aeration tank to drain segments or channels which are not being used due to alternate flow patterns.

f. Freeboard. All aeration tanks should have a freeboard of not less than 18 inches (46 centimeters). Additional freeboard or windbreak may be necessary to protect against freezing or windblown spray.

3. Aeration Requirements

a. Oxygen requirements must be calculated based on factors such as, maximum organic loading, degree of treatment, level of suspended solids concentration (mixed liquor) to be maintained, and uniformly maintaining a minimum dissolved oxygen concentration in the aeration tank, at all times, of two milligrams per liter.

b. When pilot plant or experimental data on oxygenation requirements are not available, the design oxygen requirements shall be calculated on the basis of:

(1) 1.2 pounds 0_2 per pound of maximum BOD_5 applied to the aeration tanks (1.2 kilograms 0_2 per kilogram of maximum BOD_5), for carbonaceous BOD_5 removal in all activated sludge processes with the exception of the extended aeration process,

(2) 2 pounds 0_2 per pound of maximum BOD_5 applied to the aeration tanks (two kilograms 0_2 per kilogram of maximum BOD_5) for carbonaceous BOD_5 removal in the extended aeration process,

(3) 4.6 pounds 0_2 per pound of maximum total kjeldahl nitrogen (TKN) applied to the aeration tanks (1.2 kilograms 0_2 per kilogram of maximum TKN), for oxidizing ammonia in the case of nitrification, and

(4) oxygen demand due to the high concentrations of BOD_5 and TKN associated with recycle flows such as, digester supernatant, heat treatment supernatant, belt filter pressate, vacuum filtrate, elutriates, etc.

c. Oxygen utilization should be maximized per unit power input. The aeration system should be designed to match the diurnal organic load variation while economizing on power input.

4. Diffused Air Systems

a. The design of the diffused air system to provide the oxygen requirements shall be done using data derived from pilot testing or an empirical approach.

b. Air requirements for a diffused air system may be determined by use of any of the recognized equations incorporating such factors as:

(1) tank depth;

(2) alpha factor of waste;

(3) beta factor of waste;

(4) certified aeration device transfer efficiency;

(5) minimum aeration tank dissolved oxygen concentrations;

(6) critical wastewater temperature; and

(7) altitude of plant.

c. In the absence of experimentally determined alpha and beta factors by an independent laboratory for the manufacturer or at the site, wastewater transfer efficiency shall be assumed to be 50 percent of clean water efficiency for plants treating primarily (90 percent or greater) domestic sewage. Treatment plants where the waste contains higher percentages of industrial wastes shall use a correspondingly lower percentage of clean water efficiency and shall submit calculations to justify such a percentage.

d. The design air requirements shall be calculated on the basis of:

(1) 1,500 cubic feet per pound of maximum BOD_5 applied to the aeration tanks (94 cubic meters per kilogram of maximum BOD_5), for carbonaceous BOD_5 removal in all activated sludge processes with the exception of the extended aeration process,

(2) 2,000 cubic feet per pound of maximum BOD_5 applied to the aeration tanks (125 cubic meters per kilogram of maximum BOD_5) for carbonaceous BOD_5 removal in the extended aeration process,

(3) 5800 cubic feet per pound of maximum total kjeldahl nitrogen (TKN) applied to the aeration tanks (360 cubic meters per kilogram of maximum TKN), for oxidizing ammonia in the case of nitrification,

(4) corresponding air quantities for satisfaction of oxygen demand due to the high concentrations of BOD_5 and TKN associated with recycle flows such as, digester supernatant, heat treatment supernatant, belt filter pressate, vacuum filtrate, elutriates, etc., and

(5) air required for channels, pumps, aerobic digesters, or other uses.

e. The capacity of blowers or air compressors, particularly centrifugal blowers, must be calculated on the basis of air intake temperature of 40 degrees Centigrade (104 degrees Fahrenheit) or higher and the less than normal operating pressure. The capacity of drive motor must be calculated on the basis of air intake temperature of -30 degrees Centigrade (-22 degrees Fahrenheit) or less. The design must include means of controlling the rate of air delivery to prevent overheating or damage to the motor.

f. The blowers shall 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. The design shall also provide for varying the volume of air delivered in proportion to the load demand of the plant. Aeration equipment shall be easily adjustable in increments and shall maintain solids suspension within these limits.

g. Diffuser systems shall be capable of providing for the maximum design oxygen demand or 200 percent of the average design oxygen demand, whichever is larger. The air diffusion piping and diffuser system shall be capable of delivering normal air requirements with minimal friction losses.

h. Air piping systems should be designed such that total head loss from blower outlet (or silencer outlet where used) to the diffuser inlet does not exceed 0.5 pounds per square inch (0.04 kilogram per square centimeter) at average operating conditions.

i. 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. Removable diffuser assemblies are recommended to minimize downtime of aeration tanks.

j. Individual assembly units of diffusers shall be equipped with control valves, preferably with indicator markings for throttling, or for complete shutoff. Diffusers in any single assembly shall have substantially uniform pressure loss.

k. Air filters shall 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.

5. Mechanical Aeration Systems

a. Oxygen Transfer Performance. The mechanism and drive unit shall be designed for the expected conditions in the aeration tank in terms of the power performance. The mechanical aerator performance shall be verified by certified testing.

b. Design Requirements. The design requirements of a mechanical aeration system shall accomplish the following:

(1) Maintain a minimum of 2.0 milligrams per liter of dissolved oxygen in the mixed liquor at all times throughout the tank or basin;

(2) Maintain all biological solids in suspension;

(3) Meet maximum oxygen demand and maintain process performance with the largest unit out of service; and

(4) Provide for varying the amount of oxygen transferred in proportion to the load demand on the plant.

c. Winter Protection. Due to high heat loss and the nature of spray-induced agitation, the mechanism, as well as subsequent treatment units, shall be protected from freezing where extended cold weather conditions occur.

6. Return Sludge Equipment

a. Return Sludge Rate

(1) 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 it, 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 average design flow of sewage should be between the limits set forth in Table R317-3-7.2(B)(6)(a)(1).

(2) The rate of sludge return shall be varied by means of variable speed motors, drives, or timers (in plants designed for less than one million gallons per day - 3,785 cubic meters per day) to pump sludge at the above rates.

b. Return Sludge Pumps

(1) If motor driven return sludge pumps are used, the maximum return sludge capacity shall be with the largest pump out of service. A positive head should be provided on pump suctions. Pumps should have at least 3 inch (7.6 centimeters) suction and discharge openings.

(2) If air lifts are used for returning sludge from each settling tank hopper, no standby unit is required provided the design of the air lifts are such to facilitate their rapid and easy cleaning and provided standby air lifts are provided. Air lifts should be at least 3 inches (7.6 centimeters) in diameter.

c. Return Sludge Piping. Discharge piping shall not be less than 4 inches (10 centimeters) in diameter, and should be designed to maintain a velocity of not less than two (2) feet per second (0.61 meters per second) when return sludge facilities are operating at normal return sludge rates. Sight glasses, sampling ports and rate of flow controllers for return activated sludge flow from each settling tank hopper shall be provided.

7. Waste Sludge Facilities

a. The design of waste sludge control facilities should be based on a logically developed solids mass balance at the maximum design flow. Otherwise, a maximum capacity of not less than 25 percent of the average design flow shall be provided, and function satisfactorily at rates of 0.5 percent of average sewage flow or a minimum of 10 gallons per minute (0.63 liters per second), whichever is larger.

b. Sight glasses, sampling ports and rate of flow controllers for waste activated sludge flow shall be provided.

c. Waste sludge may be discharged to the concentration or thickening tank, primary settling tank, sludge digestion tank, vacuum filters, other thickening equipment, or any practical combination of these units.

7.3. Flow Measurement. Instrumentation should be provided in all plants for indicating flow rates of raw sewage or primary effluent, return sludge, and air to each tank unit. For plants designed for the average design rate of flow of 1 million gallons per day (3,785 cubic meters per day) or more, these devices should total, record, and indicate the rate of flow. Where the design provides for all return sludge to be mixed with the raw sewage (or primary effluent) at one location, then the mixed liquor flow rate to each aeration unit should be measured.

7.4. Other Biological Systems. The executive secretary may consider and approve new biological treatment processes with promising applicability in wastewater treatment. The approval will be based on the required engineering data for new process evaluation as provided in this rule.

7.5. Packaged Plants. The executive secretary may consider and approve packaged biological treatment plants only when there are no other and appropriate alternatives for waste treatment. These type of plants shall be designed for handling large flow variations and to meet all requirements contained in this rule. The applicant must consider the need for close attention and competent operating supervision, including routine laboratory control, when proposing a packaged plant.

R317-3-8. Disinfection.

8.1. General

A. All wastewaters containing pathogens or coliform bacteria must be disinfected before discharge to a water course. The disinfection procedures must consider any effect on the natural aquatic habitat and biota of the receiving water course. Effectiveness of disinfection also varies with BOD_5 and suspended solids in the effluent. If chlorination is utilized, it may be necessary to dechlorinate if the residual chlorine level would otherwise impair the receiving water course. The applicant must submit justification to the executive secretary for the determination of the acceptability of any disinfection system other than chlorination or ultraviolet irradiation.

B. If effluent to be discharged meets applicable bacteriologic standards before disinfection, the executive secretary may waive the disinfection process. However, all plants must have an ability to introduce a disinfectant in the effluent with proper reaction time before discharge. An example could be multi-celled (more than three cells) lagoon discharge following extended storage in excess of 150 days.

C. The disinfection method should be selected after due consideration of wastewater flow rates, application rates, demand rates and effects, pH of the wastewater, cost of equipment, availability, maintenance, reliability and safety problems.

D. Chlorine is the most commonly used chemical for wastewater disinfection. The forms most often used are liquid-gaseous chlorine and sodium and calcium hypochlorite. The executive secretary may review and accept other disinfection methods based on the information submitted.

8.2. Design

A. Capacity of System

1. Required disinfection capacity will vary, depending on the uses and points of application of the disinfectant, e.g., prechlorination, post chlorination, odor and process control uses, etc.

2. For disinfection of the wastewater before its discharge to a water course, the disinfection system capacity shall be sufficient to produce an effluent that will meet the coliform bacteria limits specified for that installation at all times. This condition must be attainable when maximum flow rates occur and during emergency conditions. For non-chemical disinfecting systems, an equivalent installed capacity shall be provided. Normal dosage requirements for disinfection will vary with the quality of effluent to be treated.

3. Duplicate disinfection systems shall be provided. Where only two units are installed, each shall be capable of feeding the expected maximum dosage rate.

4. Disinfection system equipment should be provided with necessary changeable parts to permit operation of system at initial anticipated flows at mid-scale on flow meters and other devices. Spare parts shall be provided for all disinfection equipment to replace parts which are subject to wear and breakage. Operation and maintenance data for all equipment shall be furnished.

5. Dosage control based on effluent flow rate should be provided because of the diurnal variations in the disinfectant demand of the wastewater. A residual disinfectant concentration must be maintained to insure the pathogen destruction, and subsequent reactivation, if any.

B. Contact Period

1. For a chlorination system, a minimum contact period is required after a thorough mixing of disinfectant with the effluent. The minimum contact period shall be greater of:

a. 30 minutes at the maximum design rate of flow (peak daily rate of flow) or the maximum pumping rate, or

b. 60 minutes at the average design rate of flow.

2. This contact period shall normally be provided in the contact tank. Contact period in pipeline or outfalls before discharge into a water course, may be credited towards the contact time if the effluent discharge point can be sampled.

C. Contact Chambers

1. The contact chambers must be designed such that:

a. effectiveness of disinfection is maximized;

b. accumulation of solids is minimized;

c. maintenance and cleaning is facilitated; and

d. short circuiting of flow is reduced to a practical minimum by installation of baffles.

2. Two tanks are required for all plants treating more than 1 million gallons per day (3,785 cubic meters per day). Means of removal of solids from the tank bottom shall be provided. Solids and drainage water must be returned to the head end of the plant. Skimming devices should be provided in all contact tanks. Covered tanks must have means of access for maintenance and cleaning.

3. Pipelines and outfall sewers may be acceptable as effective plug-flow contact chambers.

4. The applicant must incorporate all of the above process and design features in devices using other disinfecting methods.

D. Point of Application

1. The design shall provide for application of chlorine or other disinfectants to all fully treated, partially treated, or untreated wastewater discharged from the treatment plant. Other points of application shall be incorporated in the design for process considerations such as prechlorination, odor control, control of sludge bulking, etc. All application points shall be submerged below the wastewater surface.

2. Chlorine shall be positively mixed as rapidly as possible, with a complete mix being effected in three seconds. This may be accomplished by either the use of turbulent flow regime or a mechanical flash mixer.

8.3. Disinfection Methods

A. Chlorination (Liquid or Gaseous Chlorine)

1. Equipment

a. The installed capacity of a chlorine feed system shall be sufficient to provide a dosage of 25 milligrams per liter at the maximum design rate of flow. Procedures recommended by the Chlorine Institute and the Occupational Safety and Health Administration, the US Department of Labor, and succeeding organizations should be carefully followed in handling, installation, operation and maintenance of chlorination equipment. The requirements, procedures and recommendations from these organizations take precedence over the requirements stated herein, if more stringent.

b. Liquid chlorine lines from tank cars to evaporators shall be buried and installed in a conduit and shall not be exposed in below grade spaces. Systems shall be designed for the shortest possible pipe transportation of liquid chlorine. When chlorine cylinders are used, two scales, indicating and recording type, should be used for weighing the cylinders in use. Each scale should be sized to accommodate the maximum number of cylinders required to deliver chlorine at the maximum chlorine feeding rate. Adequate means for supporting cylinders on the scales should be provided. Scales shall be of corrosion-resistant material.

c. Separate manifolds shall be provided for the bank of cylinders on each scale. The manifolds shall be properly valved so that one bank of cylinders may be replaced while chlorine is being withdrawn from the other bank of cylinders. Provision should be made for automatically changing the withdrawal of chlorine from one bank of cylinders to the second when the chlorine in the first bank of cylinders has been exhausted.

d. Gas chlorinators shall be of the solution feed type. The design capacity of evaporators must correspond to gaseous chlorine demand, where several cylinders or ton containers are manifolded to evaporate sufficient chlorine. Chlorine gas systems and piping should be of vacuum type.

2. Housing and Storage

a. Local, state and federal safety requirements, including fire code, shall be carefully followed in storing and handling of chlorine containers, cylinders or tank cars.

b. Gaseous chlorine and chlorination equipment rooms shall be isolated from other sections of the building by gas-tight partitions. Separation of the chlorine storage room and the chlorination equipment room is required for safety. All doors and rooms containing gas chlorination equipment and rooms used for chlorine gas storage should open only to the outside of the building, and all doors should be equipped with panic hardware and a viewing window. Multiple exits to the outside should be provided for each room in which chlorine gas is stored or used. Rooms housing chlorination equipment should be heated to 70 degrees Fahrenheit (21 degrees Centigrade), but never in excess of normal summer temperatures. Rooms containing chlorine cylinders from which chlorine is being withdrawn should be heated to above 60 degrees Fahrenheit (16 degrees Centigrade), but never above the temperature of the equipment room. Where chlorine containers are stored out of doors, the storage area shall be provided with a canopy. Similar precautions should be taken for tank cars. Also, if containers are stored out of doors, cylinders and containers must be allowed to reach room temperature before being placed in use. Floor drains from chlorine rooms must not be connected to floor drains from other rooms.

c. Chlorine rooms shall be at ground level, and should permit easy access to all equipment. The storage area should be separated from the feed area. Chlorination equipment should be situated as close to the application point as reasonably possible.

3. Ventilation and Heating

a. With chlorination systems, forced, mechanical ventilation shall be installed which will provide one complete air change per minute when the room is occupied.

b. When unoccupied, facilities in the ventilation system may be provided with means to reduce the number of air changes to twenty per hour to conserve energy. Whenever such a two-speed ventilation system is used, adequate provisions shall be made to insure that one complete air change per minute is provided when the room is occupied.

c. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas.

d. Air inlets shall be so located as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade or to the scrubbing system.

e. Switches for exhaust fans and cylinders shall be kept at essentially room temperature.

f. Chlorine scrubbing systems should be incorporated in the design of handling and storage areas where required by the state or local codes.

4. Ancillary Services

a. Water Supply. An ample supply of water meeting a minimum of secondary effluent quality, R317-1, Definitions and General Requirements, shall be available for operating the chlorinator. All in-plant use of effluent shall be taken from downstream of the sampling point for effluent quality monitoring and permit compliance. Where a booster pump is required, a standby booster pump shall be provided, and standby power shall be available.

b. Other Equipment. All electrical fixtures and drainage conduits in chlorination equipment rooms and chlorine storage rooms shall be gas-tight to prevent the spread of chlorine gas in the event of a leak.

5. Piping and Material. Piping systems should be as simple as possible, specifically selected and manufactured to be suitable for chlorine service, with a minimum number of joints. Piping should be well supported and protected against temperature extremes. Low pressure lines made of hard rubber, saran-lined, rubber-lined, polyethylene, polyvinyl chloride (PVC), or Uscolite materials are satisfactory for wet chlorine or aqueous solutions of chlorine.

6. Reliability. The design of the system must include the necessary provisions that will either prevent failures or allow immediate corrective action to be taken. Standby power, duplicate equipment and water storage shall be incorporated in the design to prevent interruption of feed, water supply and backup to power and equipment failures.

7. Residual Monitoring

a. An indicating and recording type residual chlorine analyzer using accepted test procedures shall be installed to monitor residual chlorine as required in the discharge permit.

b. Where dechlorination is used, residual chlorine analyzers shall be equipped with audible and visual alarms to indicate discharge of chlorine in the effluent.

8. Safety

a. At least two complete sets of respiratory air-pac protection equipment, meeting the requirements of the Occupational Safety and Health Administration (OSHA), shall be available where chlorine gas is handled, and shall be stored at a convenient location, but not inside any room where chlorine is used or stored. Instructions for using the equipment shall be posted near the equipment. The equipment shall, using compressed air, have at least 30-minute capacity, and be compatible with the equipment used by the fire department responsible for the plant.

b. Where ton containers or tank cars are used, a leak repair kit approved by the Chlorine Institute shall be provided. Caustic soda solution reaction tanks for absorbing the contents of leaking ton containers must be provided where such containers are in use. The installation of automatic gas detection and related alarm equipment must be provided.

B. Ultraviolet Irradiation

1. The executive secretary will consider and approve the use of ultraviolet irradiation for disinfection of wastewater treatment plant effluent based on the information submitted. Effectiveness of this system depends upon shallowness of depth or contact volume at the point of application and relative absence of suspended solids.

a. The applicant must submit supporting data describing the proposed system and including such items as contact geometry between the ultraviolet light source and water, reliability, and suitability of the effluent for this process. Designs should be investigated for sound application of the fundamentals of UV disinfection theory.

b. The design shall be based on factors such as, plug-flow hydraulics, intimate contact with the UV light for a sufficient period, short-circuiting, illumination. Tracer test results are helpful in assessment of hydraulic characteristics.

c. Materials of construction should be consistent with the wastewater and environment.

2. The design of ultraviolet disinfection systems shall be based on on-site testing and the following considerations:

a. Wastewater characteristics. Concentration of total suspended solids (TSS), calcium, magnesium, iron, etc., should be such that UV disinfection is effective. The wastewater should contain low levels of total suspended solids, preferably 20 milligrams per liter or below, and must transmit at least 50 percent of UV light through a wastewater depth of one (1) centimeter.

b. Layout

(1) Adequate space around the UV units to accommodate maintenance activities is required.

(2) Easy removal and replacement of lamps without the use of special tools by one man should be a feature of the equipment design.

(3) The ballasts should be arranged for ready and unhindered access for removal or replacement of any ballast without having a need to remove others.

(4) The layout design must provide adequate floor space for any separate components of the UV system in addition to the UV reactor itself, including requirements for power supply cabinets or cleaning equipment.

(5) Modular design with multiple units to allow uninterrupted service when performing maintenance must be specified.

3. Electrical Requirements

a. power consumption of this process alone should be separately metered.

b. UV lamps and ballasts must be properly matched. The proper matching of lamp and ballast will improve the lamps output and extend its useful life.

c. arrangements for shutting off banks of lamps within a single unit must be provided for lamp replacement or maintenance.

d. power controls should be provided for matching output of lamps with the rate of flow, and system maintenance by the plant staff.

e. minimum electrical standards of construction shall conform to the National Electrical Code, and other applicable codes and standards, consistent with the location or environment surrounding the UV unit and associated equipment.

4. Ventilation. Adequate ventilation to the structure housing the electrical components of the system must be provided to prevent failures from overheating.

5. Cleaning

a. The various means of chemical cleaning available must be evaluated. The evaluation must cover methods required for the unit to be drained; volume of cleansing agent required per cleaning; disposition of spent cleaning solution; manpower requirements to accomplish a cleaning cycle; capital costs of the cleaning and equipment; cleaner cost availability; and special storage and handling needs.

b. The system design must provide for complete draining and easy cleaning.

c. Ultrasonic cleaning must be considered for prevention of biofilm growth on non-illuminated quartz sleeves.

6. Monitoring and Instrumentation

i. Adequate staffing and resources to conduct the data collection and monitoring required for assessing performance must be provided.

ii. Each individual lamp output shall be measured and recorded.

8.4. Dechlorination

A. Sulfur Dioxide (SO_2)

1. Sulfur dioxide is most readily available in liquid (gaseous) form in ton containers similar to chlorine. Approximately, 1 milligram per liter of sulfur dioxide is required to dechlorinate 1 milligram per liter of chlorine residual (free or combined).

2. The dechlorination reaction between sulfur dioxide and both free and combined chlorine is a rapid reaction and requires only a few seconds of contact. The design of sulfur dioxide system must be based on the following considerations:

a. Equipment. Generally sulfur dioxide shall be fed as a gas similar to chlorine gas, as described in R317-3-8. The sulfur dioxide header should be heated to prevent re-liquefaction.

b. Housing and Storage. These requirements are same as to those for chlorine, as described in R317- 3-8.

c. Ventilation. These requirements are same as to those for chlorine, as described in R317-3-8.

d. Ancillary Services. These requirements are same as to those for chlorine, as described in R317-3- 8.

e. Piping and Material. Pipe material (plastics) inside the sulfonator must be compatible with continuous exposure to sulfur dioxide gas.

f. Reliability. These requirements are same as to those for chlorine, as described in R317-3-8.

g. Residual Monitoring. Control is critical when sulfur dioxide is used as the dechlorinating agent because excess sulfur dioxide consumes excess dissolved oxygen in the wastewater or receiving waters. The dechlorination reaction between sulfur dioxide and both free and combined chlorine is rapid, a few seconds at the most, so sampling can be performed immediately downstream of good mixing. The system should be monitored with a residual chlorine analyzer.

h. The design shall incorporate reaeration of the effluent to be in compliance with the dissolved oxygen requirement, if any, of the discharge permit.

i. Safety

(1) Adequate precautions must be taken for storing sulfur dioxide as it is a potentially hazardous chemical to store.

(2) Provide the same amount of air changes per hour as would be required for chlorine, together with a sulfur dioxide sensing and alarm detector.

B. Other Dechlorinating Agents. The executive secretary may review and approve other methods and chemicals for dechlorination based on the information submitted.

R317-3-9. Sludge Processing and Disposal.

9.1. Design Considerations

A. Process Selection

1. The selection of sludge handling and disposal methods must be based on the following considerations:

a. Energy requirements;

b. Efficiency of equipment for sludge thickening;

c. Complexity and costs of equipment and operations;

d. Staffing requirements;

e. Toxic effects of heavy metals and other substances on sludge stabilization and disposal alternatives;

f. Treatment and disposal of side-stream flows, such as digester and thickener supernatant;

g. Process considerations and good house keeping procedures for minimum waste stream generation;

h. A back-up method of sludge handling and disposal; and

i. The long term effects and regulatory requirements on methods of ultimate sludge disposal.

2. The selected process shall be designed to result in stabilized sludge prior to disposal. Significant reduction of odors, volatile solids and reduction or deactivation of pathogenic organisms can be achieved by chemical, physical, thermal or biological treatment processes; thereby reducing public health hazards and nuisance conditions.

B. Sludge Quantities

1. The sludge treatment system shall be designed to accommodate the quantities of sludge generated through the design period. Individual process sizing shall consider the sludge generation peaking factors appropriate for the size and type of facility, with allowance for: seasonal variations, industrial loads, and type of collection system. Reserve capacity in the form of off-line storage, standby units or use of extended hours of operation should be considered to handle peak sludge loads.

2. In plants treating less than one million gallons per day (3,785 cubic meters per day), sludge dewatering equipment may operate for less than 35 hours per week. Sludge processing equipment must be designed to operate efficiently over the range of sludge characteristics expected from the preceding unit process. The design engineer shall submit to the executive secretary, copies of design sizing calculations and relevant information to include:

a. average and maximum sludge quantities;

b. number and size of units;

c. equipment characteristics, conditioning chemical requirements and basic sizing parameters;

d. hours of operation;

e. expected capture efficiency;

f. expected percent solids yield.

C. Recycle loads. The sludge system as well as the liquid handling system shall be designed to take into consideration the recycle BOD5, suspended solids, nitrogen and phosphorus from the solids processing units. The magnitude of such recycle loads and resulting additional sludge will normally range from 5 to 30 percent of the influent loads. Solids balances to account for the additional solids must be calculated.

D. Sludge Storage

1. Design Considerations

a. When the plant design, except for the lagoons, does not include aerobic or anaerobic digesters, or gravity thickeners, etc., a minimum sludge storage for the entire sludge production over a two week period must be provided.

b. In-line storage by increasing mixed liquor solids concentration in aeration tanks or increasing retention in settling tanks is not permitted.

c. Aerated off-line sludge storage of not less than seven days shall be provided for oxidation ditch type activated sludge plants without a sludge digestion process.

2. Equipment Design. The sludge storage system should be equipped with mixing devices to prevent separation of solids and provide a more uniform feed to dewatering devices. Provision for adding lime, chlorine or air to prevent septicity and resulting odors is desirable. Decanting systems to provide thicker solids and flushing water to clean out tankage are necessary. Covering and odor control devices should be provided to minimize nuisance conditions.

9.2. Sludge Pumps and Piping

A. Design Basis

1. Pump Capacity. Capacity shall be adequate to cover the full range of solid concentrations and sludge production. Variable speed or other rate control systems should be provided for all sludge pumps. Maximum operating pressure should be calculated to account for the high friction factor when pumping thixotropic sludges in low velocity laminar ranges.

2. Duplicate Units. Duplicate units shall be provided where failure of one unit would seriously hamper plant operation. Pump suction and discharge manifolds should be interconnected so that one pump discharge can be used to backflush other suction piping.

3. Minimum Head. A minimum positive static head of 24 inches (61 cm) shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lift should not exceed 10 feet (3 meters) for plunger or diaphragm pumps.

4. Piping

a. Size. Sludge withdrawal piping shall have a minimum diameter of 8 inches (20 cm) for gravity withdrawal and 6 inches (15 cm) for pump suction and discharge lines. Where withdrawal is by gravity, available head shall be adequate to provide sufficient velocity in pipe; thereby preventing solids deposition in pipe.

b. Slope. Gravity flow piping should be laid on a uniform grade and alignment. The slope of gravity discharge lines should not be less than 3 percent.

c. Lining. Scum and primary sludge conveying piping should be lined with a low roughness material such as, glass lining, to reduce friction and to aid in cleaning and maintenance.

B. Equipment Features

1. Plunger type, screw feed type, rotary lobe type, recessed-impeller centrifugal type, progressive cavity type or other types of pumps with demonstrated solids handling capability shall be provided for handling raw sludge. Plunger pump backup for centrifugal pumps is recommended. The abrasive nature of sludges, especially those containing grit, must be considered in the selection of pump type and materials of construction.

2. Sludge grinders should be used where downstream process equipment, such as frame and plate presses, centrifuges, heat exchangers, sludge mixing devices or progressive cavity pumps, is susceptible to rag or trash build-up.

3. Valves. The piping system shall be equipped with isolation valves to allow for repairs and replacement of equipment or metering devices.

4. Piping Layout. Provisions should be made for cleaning, draining and flushing sludge piping. Flanges tees and crosses and cleanouts to allow rodding of suction line are desirable. Provision for back flushing with positive displacement pump discharge is desirable. Provision for cleaning by hot water, steam injection, in-line pigging or chemical degreasing should be considered in long lines containing raw sludge or scum.

C. Control Devices

1. Flow meters should be provided on all process and ancillary lines such as feed, withdrawal, gas, transfer, recirculation, hot water etc. Provision should be made for equipment isolation, cleaning and calibrating.

2. Sludge pumps used on intermittent withdrawal service should be equipped with variable timer equipment.

3. Quick-closing sampling valves shall be installed at the sludge pump, unless sludge sampling is provided separately elsewhere. The size of the valve and piping shall be at least 1 1/2 inches in diameter (3.8 centimeters).

9.3. Sludge Thickeners

1. The design of thickeners (gravity, dissolved-air flotation, centrifuge, and others) should consider the type and concentration of sludge, the sludge stabilization processes, the method of ultimate sludge disposal, chemical needs, and the cost of operation. The pumping rate and piping of the concentrated sludge should be selected such that anaerobic conditions are prevented.

2. No credit towards sludge storage or digestion, if any, in thickeners shall be permitted.

A. Gravity Thickening

1. Design Basis

a. Typical loading rates and resulting solids concentration for gravity thickening are as shown in Table R317-3-9.3(A)(1)(a).

b. Equipment and piping must be designed to deliver sufficient dilution water to gravity thickeners. Flow rate of dilution water shall be measured and recorded. Hydraulic loading to produce overflow rates of 400 to 800 gallons per day per square foot (16-33 cubic meter per day per square meter) shall be maintained to prevent septicity.

2. Equipment Features

a. Heavy duty scrapers capable of withstanding extra heavy torque loads should be provided.

b. Sidewater depths of 10-14 feet (3-4.2 meters) are recommended.

c. Ability to add chlorine solution should be provided to prevent septicity.

d. Tank covers and odor control systems should be considered depending on adjacent land use.

B. Co-Settling. Trickling filter or activated sludge may be returned to primary clarifiers for co- settling. If this method is utilized:

1. Peak design overflow rates for the primary clarifier shall not exceed 1,500 gallons per day per square foot (61 cubic meters per day per square meter), including recirculated sludge flow, and

2. Minimum sidewater depth in the primary clarifier must not be less than 12 feet (3.7 meters).

9.4. Anaerobic Digestion

A. Design Basis

1. The anaerobic digestion system shall provide for active digestion, supernatant separation, sludge concentration and storage. Heating and gas collection systems are required. Mixing systems for primary digesters shall be provided, and are recommended for secondary digesters.

2. Multiple digestion units shall be provided in all plants designed for more than 1 million gallons per day (3,7854 cubic meter per day) rate of flow. For plants designed for less than one million gallons per day (3,785 cubic meters per day), alternative methods of sludge stabilization and emergency storage must be available if only one unit is available.

3. The total digestion tank capacity should be determined by rational calculations based upon the following factors:

a. sludge characteristics - volume and percent solids,

b. the temperature to be maintained in the digesters,

c. the degree and extent of mixing in the digesters, and

d. the degree of volatile solids reduction desired.

4. Calculations shall be submitted to justify the basis of design. Otherwise, the following assumptions shall be used:

a. sludge characteristics - domestic wastewater sludge volume generated as shown in Table R317-3- 9.4(A)(4)(a).

b. the temperature to be maintained in the digesters: 90 to 100 degrees Fahrenheit (32-38 degrees Centigrade).

c. the degree and extent of mixing in the digesters: 40 horsepower per million gallons (8 watts per cubic meter).

d. volatile solids in digested sludge: 50 percent.

5. Completely-mixed systems, mixed at an intensity such that digester contents are completely turned over every 30 minutes, may be loaded at a rate up to 120 pounds of volatile solids per 1,000 cubic feet of volume per day (1.92 kilograms per cubic meter per day) in the active digestion units. When grit removal facilities are not provided, the digester volume must be increased to accommodate grit accumulation.

6. Moderately mixed digestion systems, mixed by circulating sludge through an external heat exchanger, may be loaded at a rate up to 40 pounds of volatile solids per 1,000 cubic feet of volume per day (0.64 kilograms per cubic meter per day) in the active digestion units. This loading may be modified upward or downward depending upon the degree of mixing provided.

7. For those units intended to serve as supernatant separation tanks, the depth should be sufficient to allow for the formation of a reasonable depth of supernatant liquor. A minimum sidewater depth of 20 feet (6.1 meters) is recommended.

B. Tank Covers

1. All anaerobic digestion tanks shall be covered. Primary tanks may be equipped with gas-tight, fixed steel or concrete covers or floating steel covers made gas-tight by extended rims. Secondary tank covers may be of the fixed type or floating steel type, including gas storage type units.

2. Floating covers shall be equipped with a guide rail system to prevent tipping and lower-landing ridges, and cover restraints.

C. Sludge Inlets and Outlets

1. Multiple recirculation, withdrawal and return points, should be provided, to enhance flexible operation and effective mixing, unless mixing facilities are incorporated within the digester. The returns, in order to assist in scum breakup, should discharge above the liquid level and be located near the center of the tank.

2. Raw sludge feed to the digester should be through the sludge heater and recirculation return piping, or directly to the tank if internal mixing facilities are provided.

3. Sludge withdrawal to disposal should be from the bottom of the tank. This pipe should be interconnected with the recirculation piping, if such piping is provided, to increase versatility in mixing the tank contents. Additional alternative withdrawal lines should be provided.

D. Supernatant Withdrawal

1. Supernatant piping should not be less than 6 inches (15 centimeters) in diameter. Piping should be arranged so that withdrawal can be made from three or more levels in the digester. A positive, unvalved, vented overflow shall be provided with a drop leg for a liquid seal and downstream vent.

2. If a supernatant selector is provided, provisions shall be made for at least one other draw-off level, located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe. High pressure back-wash facilities shall be provided.

3. Multiple supernatant draw-offs should be provided for sampling at different levels. Sampling pipes must be at least 1 1/2 inches (3.8 centimeters) in diameter, and should terminate at a suitably-sized sampling sink or basin.

E. Sampling. Sampling hatches shall be provided in all tank covers with water seal tubes extending to beneath the liquid surface.

F. Gas Collection, Piping and Appurtenances

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

2. Safety Equipment. All safety equipment shall be provided where gas is produced. Pressure and vacuum relief valves, flame traps, gas detectors, and automatic safety shut off valves, shall be provided.

3. Gas Piping and Condensate. Gas piping shall be of adequate diameter for gas flow rate and shall slope to condensate traps at low points. The use of float-controlled condensate traps is not permitted.

4. Gas Utilization Equipment.

a. Gas-fired boilers for heating digesters shall be located in a separate room not directly connected to the digester gallery. Gas lines to these units shall be provided with flame traps.

b. Dual fuel engines on major pumps or blowers, should be installed with possible recovery of exhaust and jacket cooling heat for use in heating digester or building spaces. An alternate system would consist of direct electric power generation. Gas cleaning and storage may be desirable.

5. Electrical Fixtures. Electrical fixtures and controls in enclosed places where hazardous gases may accumulate shall comply with the National Electrical Code for Class I, Division I Group D locations. Digester galleries must be isolated from normal operating areas to avoid an extension of the hazardous location.

6. Waste Gas.

a. Waste gas burners shall be readily accessible and should be located at least 25 feet (7.6 meters) away from any plant structure if placed at ground level, or they may be located on the roof of the control building at a height of not less than three feet (0.9 meter) from the top of the roof.

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

c. Necessary approvals from the Utah Air Conservation Committee and its succeeding authorities, shall be obtained for burning any waste gas and any other emissions from the treatment plant.

7. Ventilation. Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment shall be forced ventilated. The piping gallery for digesters should not be connected to other passages.

8. Metering. Gas meters, with by-pass, shall be provided to meter total and waste gas production.

G. Digester Heating

1. Insulation. Wherever possible, digesters should be constructed above ground water level and should be suitably insulated to minimize heat loss.

2. Heating Facilities

a. External Heating. Sludge may be heated by circulating the sludge through external heaters. Piping should be designed to provide for the preheating of feed sludge before introduction to the digesters, especially if sludge thickeners are not used, or if feed is a batch feed resulting in high intermittent feed rates. Provisions shall be made in the lay-out of the piping and valving to facilitate cleaning of these lines. Heat exchanger sludge piping should be sized for heat transfer requirements.

b. Other Heating Methods. The executive secretary may approve review other types of heating facilities based on the information submitted by the applicant.

3. Heating Capacity. Heating capacity sufficient to consistently maintain the design sludge temperature shall be provided. Where digester tank gas is used for sludge heating, an auxiliary fuel supply is required.

4. Hot Water Internal Heating Controls

a. A suitable automatic mixing valve shall be provided to temper the boiler water with return water so that the inlet water to the heat jacket can be held below a temperature at which caking will be accentuated. Manual control should also be provided by suitable by-pass valves.

b. The boiler should be provided with suitable automatic controls to maintain the boiler temperature at approximately 180 degrees Fahrenheit (82.2 degrees Centigrade), to minimize corrosion, and to shut off the main gas supply in the event of pilot burner or electrical failure, low boiler water level, or excessive temperatures.

c. Thermometers shall be provided to show temperatures of the sludge, hot water feed, hot water return, and boiler water.

H. Mixing Systems. Sludge mixing systems shall be gas recirculation, draft tube mixing, mechanical mixer or pump recirculation types. The mixing system should be designed such that routine maintenance can be performed without taking the digester out of service.

I. Operational Considerations

1. Piping Flexibility. Where two stage digestion is practiced, provision shall be made to feed and heat the secondary digester. Mixing systems should be installed in secondary digestion units.

2. Provision to pump secondary sludge to primary units for reseeding and extending sludge detention time is recommended.

3. When digested sludge is pumped to the dewatering unit, piping shall be laid out so as to prevent uncontrolled gravity flow.

4. Provisions to adjust pH and alkalinity by addition of chemicals shall be made.

J. Maintenance Features for draining, cleaning, and maintenance must be considered in the design of the digesters.

1. Slope. The tank bottom should slope to drain toward the withdrawal pipe. For tanks equipped with a suction mechanism for withdrawal of sludge, a bottom slope of 1:12 or greater is recommended. Where the sludge is to be removed by gravity alone, 1:4 slope is recommended.

2. Access Manholes. At least two 36 inch (91 centimeters) diameter access manholes should be provided in the top of the tank in addition to the gas dome. There should be stairways to reach the access manholes. A separate sidewall manhole shall be provided. The opening should be large enough to permit the use of mechanical equipment to remove grit and sand.

3. Safety. Local, state and federal safety requirements, including those in applicable fire code, the Uniform Building Code etc., must be reviewed and complied with. Those requirements take precedence over the requirements stated herein, if more stringent, and should be incorporated in the design. Nonsparking tools, safety lights, rubber-soled shoes, safety harness, gas detectors for inflammable and toxic gases, and at least two self-contained breathing units shall be provided for emergency use.

9.5. Aerobic Digestion

A. General. Aerobic digestion may be used for stabilization of primary sludge, and activated or trickling filter sludge. Digestion may take place in single or multiple tanks designed to provide effective air mixing, reduction of the organic matter, supernatant separation, and sludge concentration under controlled conditions.

B. Tank Capacity. The digestion tank capacity shall be based on such factors as, quantity of sludge produced, sludge concentration and related characteristics, time of aeration, sludge temperature, etc.

1. Volatile Solids Loading. Volatile suspended solids loading shall not exceed 100 pounds per 1,000 cubic feet of volume per day (1.60 kilograms per cubic meter per day) in the digestion units.

2. Detention Time. The minimum detention time of 15 days shall be provided for aerobic digestion. The detention time may vary with sludge characteristics. Where sludge temperature is lower than 50 degrees Fahrenheit (10 degrees Centigrade) additional detention time should be considered. Covering of the aerobic digesters may be considered to prevent heat losses to atmosphere.

3. Multiple Units. Multiple tanks are required for plants designed to treat more than 1 million gallons per day (3,785 cubic meters per day). Adequate provision must be made for sludge handling and storage for the plants treating less than 1 million gallons per day (3,785 cubic meters per day). When multiple units are provided, ability to utilize them in serial operation is recommended.

4. Mixing and Air Requirements

a. Aerobic sludge digestion tanks shall be designed for effective mixing. Sufficient air shall be provided to keep the solids in suspension and maintain dissolved oxygen between 1 to 2 milligrams per liter.

b. A minimum air volume of 30 cubic feet per minute per 1,000 cubic feet of tank volume (0.51 liters per cubic meter per second) shall be provided with the largest blower out of service for the mixing and aeration requirements. For the diffused aeration systems, the nonclog type air diffusers are recommended, and shall be designed to permit continuity of service.

c. A minimum of 75 horsepower per million gallon of tank volume (15 watts per cubic meter) shall be provided for mechanical aeration systems. Mechanical aerators must be protected where freezing temperatures are expected. Submerged turbine units or floating surface aerators may be considered to allow for liquid level variation.

5. Supernatant Separation. Facilities shall be provided for effective separation and withdrawal of supernatant and for effective collection and removal of scum and grease. Multiple level decant withdrawal lines should be provided.

6. Foam Spray. Foam suppression spray water piping and nozzles should be provided.

9.6. Sludge Dewatering

A. Belt Filter Press

1. Design Basis

a. Hydraulic and solids loading rates, conditioning requirements, and performance shall be based on pilot unit performance or operational results on similar sludges.

b. Multiple units are required unless storage capacity or alternate dewatering methods are available to handle sludge during prolonged power outage.

c. In plants designed for 1 million gallons per day (3,785 cubic meters per day), the operational period should not usually exceed 35 hours per week which allows one shift operation with time for chemical makeup, cleanup and delays. In plants designed for over 1 million gallons per day (3,785 cubic meters per day), the operational period may approach 20 hours per day.

2. Equipment Features

a. The facility should provide for chemical storage, feed equipment, belt wash water, and filtrate return and for conveying and loading sludge cake onto transport vehicles.

b. Belt alignment and tensioning should be regulated automatically.

c. If a single unit is provided, standby equipment should be provided for the sludge feed pump, belt wash, and chemical feed.

d. Facilities or piping for filtrate and wash water sampling should be provided.

3. Operational Considerations. Good house keeping and maintenance features should include press housing, ventilation, safe and convenient access for cleanup and maintenance, floor drains, minimum splashing of filtrate or wash water, etc.

9.7. Sludge Drying Beds

A. Design Basis

1. The area of sludge drying beds is determined by factors such as, climatic conditions, the character and volume of the sludge to be dewatered, the method and schedule of sludge removal, and other methods of sludge disposal.

2. The applicant or the design engineer must submit the basis of design including calculations for review. When the basis of design is not submitted, the drying bed area shall be determined on the basis of 4 square feet per population equivalent (0.38 square meter per population equivalent) when the drying bed is the primary method of dewatering, and 2.0 square feet per population equivalent (0.19 square meter per population equivalent) if it is to be used as a backup dewatering unit. An increase of bed area by 25 percent is required for paved beds. Sludge storage or alternate dewatering methods should be considered for winter weather.

3. A ground water discharge permit may be required for beds without an impervious base. Hydraulic conductivity shall not be greater than 1 x 10-6 centimeters per second or as required for compliance with the provisions of R317-6 (Ground Water Quality Protection Regulations).

B. Design Features

1. Gravel. The lower course of gravel around the underdrains should be properly graded and not less than 12 inches (30.5 centimeters) in depth, extending at least 6 inches (15.2 centimeters) above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least 3 inches (7.6 centimeters) must consist of gravel 1/8 inch to 1/4 inch (3.18 to 6.35 millimeters) in size. The remaining layer of gravel below the top 3-inch (7.6 centimeters) layer may be 3/4 to 1 inch (1.9 to 2.5 centimeters) in size.

2. Sand. The top course placed above the gravel should consist of at least 6 to 9 inches (15.2 to 22.9 centimeters) of clean coarse sand. The finished sand surface should be level.

3. Underdrains. Underdrains should be clay pipe or concrete drain tile at least 4 inches (10.2 centimeters) in diameter laid with open joints. Underdrains should be spaced not more than 20 feet (6.1 meters) apart. Underdrainage should be returned to the process with raw or settled sewage.

4. Partially Paved Type. The partially paved drying bed should be designed with consideration for the space requirement to operate mechanical equipment for removing the dried sludge. Paving must positively slope to the underdrains.

5. Containment Walls. Walls should be water-tight and extend 15 to 18 inches (38 to 46 centimeters) above and at least 6 inches (15 centimeters) below the surface of the drying bed. Outer walls should be curbed to prevent soil from washing onto the beds.

6. Sludge Removal. Not less than two beds should be provided and they should be arranged to facilitate sludge removal. Paved truck tracks should be provided for all percolation-type sludge beds.

7. Sludge Feed Line. The sludge pipe to the drying beds should terminate at least 12 inches (30.5 centimeters) above the floor surface and be so arranged that it will drain into the bed. Concrete splash blocks should be provided at sludge discharge points.

9.8. Other Sludge Treatment Methods. Other methods for sludge dewatering, treatment, and stabilization will be considered by the executive secretary based on such factors as the need, suitability of application and process, reliability and flexibility, etc.

R317-3-10. Lagoons.

10.1. Lagoon Siting

A. Distance from Habitation. A lagoon should be sited as far as practicable, with a minimum of 1/4 mile (0.4 kilometer), from areas developed for residential or commercial or institutional purposes or may be developed for such purposes within a foreseeable future. Site characteristics such as topography, prevailing wind direction, forests, etc., must be considered in siting the lagoon.

B. Prevailing Winds. The lagoon should be sited where the direction of local prevailing winds is towards uninhabited areas.

C. Surface Runoff. The lagoon should not be sited in watersheds receiving significant amounts of storm-water runoff. Storm-water runoff should be diverted around the lagoon and protect lagoon embankments from erosion.

D. Hydrology and hydrogeology. Close proximity to water supplies and other facilities subject to wastewater contamination should be avoided in siting the lagoon. A minimum separation of four (4) feet (1.2 meters) between the bottom of the lagoon and the maximum ground water elevation should be maintained.

E. Geology

1. The lagoon shall not be located in areas which may be subjected to karstification, i.e., sink holes or underground streams generally occurring in area underlain by porous limestone or dolomite or volcanic soil.

2. A minimum separation of 10 feet (3.0 meters) between the lagoon bottom and any bedrock formation is recommended.

10.2. Small Facilities. The executive secretary will review and approve the construction of a lagoon for a design rate of flow less than 25,000 gallons per day (95 cubic meters per day) only if:

A. there are no other alternatives for wastewater treatment and disposal available to the applicant;

B. there is no other appropriate technology for wastewater treatment and disposal except lagoon; and

C. the applicant has resources to satisfactorily operate and maintain the lagoon.

10.3. Basis of Design. Design variables such as lagoon depth, number of units, detention time, and additional treatment units must be based on effluent standards for BOD_5, total suspended solids (TSS), E. coli, dissolved oxygen (DO), and pH.

A. Design for Discharging and Total Containment Lagoons

1. The design shall be based on BOD_5 loading ranging from 15 to 35 pounds per acre per day (16.8-39.2 kilograms per hectare per day).

2. The design for total containment lagoons shall be based on conservative estimates of precipitation, evaporation, seepage or percolation and inflow relevant to the site. A mass diagram showing each of the foregoing factors on a month-by-month basis, shall be prepared and submitted with the design and plans for review.

B. Design Depth. The minimum operating depth should be such that growth of aquatic plants is suppressed to prevent damage to the dikes, bottom, control structures, aeration equipment and other appurtenances.

1. Discharging or Total Containment Lagoons. The maximum water depth shall be 6 feet (1.8 meters) in primary cells. Greater depth in subsequent cells may be deeper than 6 feet provided that supplemental aeration or mixing is incorporated in the design. Minimum operating depth shall be three feet.

2. Aerated Lagoons. The design water depth should range from 10 to 15 feet (three to 4.5 meters). The type of the aeration equipment, waste strength and climatic conditions affect the selection of the design water depth.

3. Sludge Accumulation. The minimum depth of 18 inches (45 centimeters) for sludge accumulation shall be provided in primary cells of facultative lagoons.

C. Freeboard. The minimum freeboard shall be three (3) feet (1.0 meter). For small systems - less than 50,000 gallons per day (190 cubic meters per day), the minimum freeboard can be reduced to two (2) feet (0.6 meter).

D. Slope

1. Maximum Dike Slope. The inner and outer dike slopes shall not be steeper than 3 horizontal to 1 vertical (3:1).

2. Minimum Dike Slope. Inner dike slope shall not be flatter than 4 horizontal to 1 vertical (4:1). A flatter slope can be specified for larger installations because of wave action, but have the disadvantages of added shallow areas, that are conducive to emergent vegetation.

E. Seepage

1. The bottom of lagoons treating domestic sewage shall be no less than 12-inch (30 centimeters) in thickness, constructed in two six-inch (15 centimeters) lifts. The selection of the type of seals using soils, bentonite, or synthetic liners for the lagoon bottom shall be based on the design hydraulic conductivity, durability, and integrity of the proposed material.

2. Hydraulic conductivity of the lagoon bottom as constructed or installed, shall be such that it meets the requirements of ground water discharge permit issued under R317-6, (Ground Water Quality Protection rules). It shall not exceed 1.0×10^{-6} centimeters per second.

3. The seepage loss may vary with the thickness of the bottom seal and hydraulic head thereon. Detailed calculations on the determination of seepage loss shall be submitted with the design. It shall not exceed 6,500 gallons per acre per day (60.8 cubic meters per hectare per day).

4. Results of field and laboratory hydraulic conductivity tests, including a correlation between them, shall meet the design and ground water discharge permitting requirements, before the use of lagoon can be authorized.

5. Hydraulic conductivity for the lagoon where industrial waste is a significant component of sewage, shall be based on ground water protection criteria contained in R317-6 (Ground Water Quality Protection rules).

F. Detention time

1. Discharging Lagoons. Detention time in the lagoon shall be the greater, and exclusive of the capacity provided for sludge build-up, of:

a. 120 days based on winter flow and the maximum operating depth of the entire system; or

b. 60 days based on summer flow and peak monthly infiltration/inflow.

c. The detention time shall not be less than 150 days at the mean operating depth for effluent discharge without chlorination. In order to meet bacteriologic standards in such a case, at least 5 cells shall be provided. The detention time and organic loading rate shall depend on climatic or stream conditions.

2. Aerated Lagoons

a. The detention time shall be the greater of:

(1) 30 days minimum; or

(2) the value determined using the following formula: $E = (1/(1 + (2.3 \times K_1 \times t)))$ where: t = detention time, days; E = fraction of BOD_5 remaining in an aerated lagoon; K_1 = reaction coefficient, aerated lagoon, base 10. For normal domestic sewage, the K_1 value may be assumed to be 0.12 day^{-1} at 20 degrees Centigrade, and 0.06 day^{-1} at one degree Centigrade.

b. The reaction rate coefficient for domestic sewage which includes some industrial wastes must be determined experimentally for various conditions which might be encountered in the aerated lagoons. The reaction rate coefficient based on temperature used in the experimental data, shall be adjusted for the minimum sewage temperature.

G. Aeration Requirements for Aerated Lagoons

1. The design parameters for the aerated lagoon should be based on pilot testing or validated experimental data.

2. When pilot testing is not conducted, the design should be based on two pounds of oxygen input per pound of BOD_5 applied (two kilograms of oxygen input per kilogram of BOD_5 applied). However, it may vary with the degree of treatment, and the concentration of suspended solids to be maintained. A tapered mode of aeration is permitted based on applied BOD_5 to each cell.

3. Aeration equipment shall be capable of maintaining a minimum dissolved oxygen level of 2 milligrams per liter in the lagoon at all times such that their circles of influence meet.

a. Circle of Influence. It is that area in which return velocity is greater than 0.15 feet per second as indicated by the manufacturer's certified data. Table R317-3-10.3(G)(3)(a) may be used when the manufacturer's certified data is not available.

b. Freezing. Suitable protection from weather shall be provided for aerators and electrical controls.

H. Industrial Wastes. For industrial waste treatment using lagoon, the design parameters shall be based on the type and treatability of industrial wastes using biological processes. In some cases it may be necessary to pretreat industrial waste or combine with domestic sewage.

10.4. Lagoon Construction Details

A. Cell Shape. The shape of all cells should be such that there are no narrow or elongated portions. Round, square or rectangular lagoons with a length not exceeding three times the width are most desirable. No islands, peninsulas or coves are permitted. Dikes should be rounded at corners to minimize accumulations of floating materials. Common-wall dike construction, wherever possible, is strongly encouraged.

B. Multiple Units

1. At a minimum, the lagoon system shall consist of three cells of approximately equal capacity designed to facilitate both series and parallel operations.

2. The executive secretary may approve less than three cells on the basis of review of factors such as, the rate of flow, the need, treatment reliability, etc.

3. All systems shall be designed with piping:

a. to permit isolation of any cell without affecting the transfer and discharge capabilities of the total system, and

b. to split the influent waste load to a minimum of two cells or all primary cells in the system.

C. Embankments and Dikes

1. Material. Dikes shall be constructed of relatively impervious material and compacted to no less than 90 percent Standard Proctor Density at 3 percent above the optimum moisture density to form a stable structure. The area where the embankment is to be placed shall be from vegetation and unstable organic material.

2. Top Width. The minimum dike width shall be 8 feet (2.4 meters) and shall permit access by maintenance vehicles.

D. Lagoon Bottom

1. Soil. Soil used in constructing the lagoon bottom (not including seal) and dike cores shall be incompressible and tight and compacted at a moisture content of 3 percent above the optimum water content to at least 90 percent Standard Proctor Density.

2. Uniformity. The lagoon bottom should be as level as possible at all points. Finished elevations shall not be more than three (3) inches (7.5 centimeters) from the average elevation of the bottom.

3. Prefilling. The lagoon should be prefilled to a level which protects the liner, prevents weed growth, reduces odor, and maintains moisture content of the seal. However, the dikes must be completely prepared before the introduction of any water.

E. Construction Quality Control and Assurance. A construction quality control and assurance plan showing frequency and type of testing for materials used in construction shall be submitted with the design for review and approval. Results of such testing, gradation, compaction, field permeability, etc., shall be submitted to the executive secretary.

F. Erosion Control

1. The site shall be protected from erosion. The design of control measures shall be based on factors, such as lagoon location and size, seal material, topography, prevailing winds, cost breakdown, application procedures, etc.

2. For aerated lagoons, the slopes and bottom shall be protected from erosion resulting from turbulence.

3. Exterior face of the dike slope shall be protected from erosion due to severe flooding of a water course.

4. Seeding. The outside surface of dikes shall have a cover layer of at least 4 inches (10 centimeters), of fertile topsoil to promote establishment of an adequate vegetative cover wherever riprap is not utilized. Prior to prefilling, adequate vegetation shall be established on dikes from the outside toe to 2 feet (0.6 meter) above the lagoon bottom on the interior as measured on the slope. Perennial-type, low-growing, native, spreading grasses that minimize erosion and can be mowed are most satisfactory for seeding on dikes. Alfalfa and other deep-rooted crops must not be used for seeding since the roots of this type are apt to impair the water holding efficiency of the dikes.

5. Riprap or equivalent material shall be placed from 1 foot (0.3 meter) above the high water mark to two feet (0.6 meter) below the low water mark (measured on the vertical) for protection from severe wave action.

a. Riprap. The interior face of dikes must be protected from erosion by riprap or other equivalent methods of erosion control.

(1) Riprap layer shall be of durable, angular, sound and hard, field or quarry stones, and shall be free from seams, cracks and structural defects.

(2) The thickness of riprap layer shall be at least 8 inches (20 centimeters).

(3) Stones to be used in the riprap layer shall meet the following requirements:

(a) A minimum of 50 percent of stones by weight, shall be of sizes between two-thirds and one and one-half of the layer thickness;

(b) No more than ten percent of stones by weight, shall be of a size less than one-tenth of the layer thickness;

(c) The specific weight of stones must range between 2.5 and 2.82;

(d) Durability shall be tested in accordance with ASTM Standard C-535, as amended, and stones wearing in excess of 40 percent shall not be used.

(e) Stones shall be graded and manipulated in size so as to produce a regular surface of dense and stable mass. A stable foundation for the placed riprap shall be provided at the toe of the dike.

10.5. Influent Piping

A. Influent and Effluent Structures

1. All influent and effluent structures shall be located to minimize short-circuiting within lagoons, and to avoid blocking of lagoon circulation. Such structures must have protection against freezing or ice damage under winter conditions.

2. Inlets to the primary cells shall meet the following criteria:

a. Surcharging of upstream sewer from the inlet manhole is not permitted.

b. Multiple influent discharge points for primary cells of 20 acres (8 hectares) or larger should be provided to enhance the distribution of waste load in the cell.

c. Discharge shall be in the center of a round or a square cell, or at the third point farthest from the outlet structure in a rectangular cell, or at least 100 feet (30 meters) from the toe of the dike.

d. All aerated cells shall have an influent line which distributes the load within the mixing zone of the aeration equipment. Multiple inlets may be considered for a diffused aeration system.

e. Force mains shall be valved at the lagoon, and may terminate in a vertically or horizontally discharging section. The discharge end of the vertical pipe must be located no more than one foot above the lagoon bottom. Flow velocities in the discharge section entering the lagoon must not be in excess of two feet per second.

B. Influent Discharge Apron

1. The influent line shall discharge horizontally into a shallow, saucer-shaped, depression extending below the lagoon bottom not more than the diameter of the influent pipe plus 1 foot.

2. The end of the discharge line shall rest on a suitable concrete apron large enough to prevent the terminal influent velocity at the end of the apron from causing soil erosion. A 2-foot (0.6 meter) square apron shall be provided at the minimum.

C. Flow Measurement. Influent flow to the lagoon shall be continuously indicated and recorded. Flow measurement and recording equipment shall be weatherproof.

D. Level Gauges. Level gauges with clear markings shall be provided in:

1. each cell to measure and manually record the depth; and

2. the primary flow measurement device structure to indicate the depth or the rate of flow.

E. Manhole

1. A manhole or vented cleanout wye shall be installed prior to entrance of the influent line into the primary cell and shall be located close to the dike as topography permits. Its invert shall be at least 6 inches (15 centimeters) above the maximum operating level of the lagoon and provide sufficient hydraulic head without surcharging the manhole.

2. A manhole is required for small systems to house flow measurement device. For larger systems, flow measurement device and related instrumentation must be housed in a headworks type structure.

F. Flow Distribution. Flow distribution structures shall be designed to effectively split hydraulic and organic loads equally to primary cells.

G. Material. The material for influent line to the lagoon should meet the requirements of material for underground sewer construction described in this rule. Unlined corrugated metal pipe is not permitted due to corrosion problems. The material selection shall be based on factors such as, wastewater characteristics, heavy external loadings, abrasion, soft foundations, etc.

10.6. Control Structures and Interconnecting Piping

A. Structure

1. As a minimum, control structures shall:

a. be accessible for maintenance and adjustment of controls;

b. be adequately ventilated for safety and to minimize corrosion;

c. be locked to discourage vandalism;

d. contain controls to permit water level and flow rate control, and complete shutoff;

e. be constructed of non-corrodible materials (metal-on-metal); and

f. be located to minimize short-circuiting within the cell and avoid freezing and ice damage.

2. Recommended devices to regulate water level are valves, slide tubes or dual slide gates. Regulators should be designed so that they can be preset to stop flows at any lagoon elevation.

B. Piping. All piping shall be of cast iron or other material for installation of underground piping. The piping shall be located along the bottom of the lagoon with the top of the pipe just below average elevation of the lagoon bottom. Pipes should be anchored and protected from erosion.

10.7. Effluent Discharge Piping

A. Submerged Takeoffs. For lagoons designed for shallow or variable depth operations, submerged takeoffs are required. Intakes shall be located a minimum of 10 feet (3.0 meters) from the toe of the dike and 2 feet (0.6 meter) from the seal, and shall employ vertical withdrawal.

B. Multi-level Takeoffs. For lagoons that are designed deeper than 10 feet (3 meters), enough to permit stratification of lagoon content, multiple takeoffs are required. There shall be a minimum of three withdrawal pipes at different elevations. Adequate structural support for takeoffs shall be provided.

C. Emergency Overflow. An emergency overflow should be provided to prevent overtopping of dikes. The hydraulic capacity for continuous discharge structures and piping shall allow for a minimum of 250 percent of the design flow of the system. The hydraulic capacity for controlled-discharge systems shall permit transfer of water at a minimum rate of six (6) inches (15 centimeters) of lagoon water depth per day at the available head.

10.8. Miscellaneous

A. Fencing. The lagoon area shall be enclosed with not less than 6 feet high chain link fence to prevent entering of livestock and to discourage trespassing. Fencing must not obstruct vehicle traffic on top of the dikes. A vehicle access gate of sufficient width to accommodate all maintenance equipment shall be provided. All access gates shall be provided with locks.

B. Access. An all-weather access road shall be provided to the lagoon site to allow year-round maintenance of the facility.

C. Warning Signs. Permanent signs shall be provided along the fence around the lagoon to designate the nature of the facility and advise against trespassing. At least one sign shall be provided on each side of the site and one for every 500 feet (150 meters) of its perimeter.

D. Service Building A service building for laboratory and maintenance equipment should be considered.

10.9. Industrial Waste Lagoons. The executive secretary will review the design of lagoons for treatment of industrial wastes on the basis of such factors as treatability, operability, reliability, ground water protection levels, water quality objectives, etc.

R317-3-11. Land Application of Wastewater Effluents.

11.1. Effluent Criteria. Land application of effluents is permitted following treatment if standards are met as defined in R317-1, Definitions and General Requirements. The proposal for land application must include detailed site information, effluent characteristics, meteorological data, type of crop to be grown, ground water data, and a site management plan and practices.

11.2. Site Operation and Management

A. Piping System

1. All distribution pipes and sprinklers must have the capability to be completely drained.

2. Main distribution headers must have flow measurement devices and pressure gages. All land applied flow must be totalized.

B. Warning Signs. Signs warning of the nature of the facility shall be provided at the boundaries of the site.

R317-3-12. Effluent Filtration.

12.1. Granular Media Filters. Granular media filters may be used as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. A pretreatment process such as chemical coagulation and sedimentation or other acceptable process must precede the filter units, where effluent suspended solids requirements are less than 10 milligrams per liter, or where secondary effluent quality can be expected to fluctuate significantly, or where filters follow a treatment process and where significant amounts of algae will be present.

12.2. Design Considerations. The plant design should incorporate flow-equalization facilities to moderate filter influent quality and quantity. The selection of pumping equipment ahead of filter units should be designed to minimize shearing of floc particles.

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

B. Filtration Rates. Filtration rates shall not exceed 5 gallons per minute per square foot. (3.4 liters per square meter per second) based on the maximum hydraulic flow rate applied to the filter units.

C. Number of Units. Total filter area shall be provided in two or more units, and the filtration rate shall be calculated on the total available filter area with one unit out of service.

D. Filter Backwash

1. Backwash Rate. The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. The backwash system shall be capable of providing a variable backwash rate having a maximum of at least 20 gallons per minute per square foot, (13.6 liters per square meter per second) and a minimum backwash period of 10 minutes.

2. Backwash Pumps. Pumps for backwashing filter units shall be sized and interconnected to provide the required rate to any filter with the largest pump out of service. Filtered water should be used as the source of backwash water. Waste filter backwash shall be returned to the treatment process or otherwise adequately treated.

E. Filter Media

1. Selection. Selection of proper media size will depend on the rate of filtration rate, the type of pretreatment, filter configuration, and effluent quality objectives. In dual or multi-media filters, media size selection must consider compatibility among media.

2. Media Specifications. Table R317-3-12.2(E)(2) provides minimum media depths and the normally acceptable range of media sizes. The applicant has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

12.3. Filter Appurtenances. The filters shall 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. If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air if provided) without danger of clogging from solids in the backwash water. Provision shall be made to allow periodic chlorination of the filter influent or backwash water to control slime growths.

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

12.5. Backwash Surge Control. The rate of waste filter backwash water return to treatment units shall be controlled such that the rate does not exceed 15 percent of the design average daily flow rate to the treatment units. The hydraulic and organic loads from waste backwash water shall be considered in the overall design of the treatment plant. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest unit out of service.

12.6. Backwash Water Storage. Total backwash water storage capacity provided in an effluent clearwell or surge tank or other unit shall equal or exceed the volume required for two complete backwash cycles. Additional storage capacity should be considered for operational flexibility.

12.7. Proprietary Equipment. Where proprietary filtration equipment, not conforming to the preceding requirements is proposed, data which supports the capacity of the equipment to meet effluent requirements under design conditions shall be submitted for review and approval by the executive secretary.

TABLE R317-3-2.3(D)(4).
Minimum Slopes

Sewer Size, inch (centimeter)	Minimum Slope, feet per feet or meter per meter
8 (20)	0.00334
9 (23)	0.00285
10 (25)	0.00248
12 (30)	0.00194
14 (36)	0.00158
15 (38)	0.00144
16 (41)	0.00132
18 (46)	0.00113
21 (53)	0.00092
24 (61)	0.00077
27 (69)	0.00066
30 (76)	0.00057
36 (91)	0.00045

TABLE R317-3-4.4(H)(1).
Painting

Service	Color
Sludge	Brown
Gas	Orange
Potable Water	Blue
Non-Potable Water	Blue with a 6-inch (15 centimeters) red band spaced 30 inches

	(76 centimeters) apart
Chlorine	Yellow
Compressed Air	Green
Sewage	Gray

TABLE R317-3-6.2(B)(3)(d). Loadings for Final Settling Tanks Following Activated Sludge Process

Process	Average Design Rate of Flow, million gallons per day (cubic meters per day)	Surface Loading, gallons per day per square foot (cubic meters per day per square meter)	Surface Loading, pounds per day per square foot (kilograms per day per square meter)
Contact Stabilization	0.5 (1,893) to 1.5 (5,678)	400 (16.3) to 600 (24.5)	
	Greater than or equal to 1.5 (5,678)	500 (20.4) to 700 (28.5)	
Extended Aeration	Less than or equal to 0.5 (1,893)	200 (8.2) to 400 (16.3)	
	0.5 (1,893) to 1.5 (5,678)	300 (12.3) to 500 (20.4)	25 (122.1)
	Greater than or equal to 1.5 (5,678)	400 (16.3) to 600 (24.5)	
Other than Contact Stabilization and Extended Aeration	Less than or equal to 0.5 (1,893)	400 (16.3) to 600 (24.5)	
	0.5 (1,893) to 1.5 (5,678)	500 (20.4) to 700 (28.5)	25 (122.1)

Greater than or equal to 1.5 (5,678)	600 (24.5) to 800 (32.6)

TABLE R317-3-7.1(E)(3)(a)(2).
Media Grading

	Percent by Weight
Passing 4-1/2 inch (11.4 centimeters) screen	100
Retained on 3 inch (7.6 centimeters) screen	95 - 100
Retained on 2 inch (5.1 centimeters) screen	98

TABLE R317-3-7.1(K)(1).
Hydraulic and Organic Loadings for Nitrification in Trickling Filters

Trickling Filter Configuration	Loadings
Rock or Slag Media Filters	
Hydraulic Loading	Less than or equal to 4 million gallons per acre per day, or less than or equal to 4 cubic meters per square meter per day
Organic Loading	Less than or equal to 25 pounds BOD_5 per day per 1000 cubic feet, or less than or equal to 0.4 kilograms BOD_5 per day per cubic meter
Deep Manufactured Media Filters	
Hydraulic Loading	Less than or equal to 25 million gallons per acre per day, or less than or equal to 25 cubic meters per square

meter per day

Organic Loading — Less than or equal to 100 pounds BOD_5 per day per 1000 cubic feet, or less than or equal to 1.6 kilograms BOD_5 per day per cubic meter

TABLE R317-3-7.2(B)(1)(c)
Permissible Aeration Tank Capacities and Loadings

Process	Hydraulic Retention Time (HRT), hours	Solids Retention Time (SRT), days	Aeration Tank Loading, pounds of BOD_5 per day per 1000 cubic feet	Food:Mass (F:M) Ratio, pounds of BOD_5 per day per pound of MLVSS (2)	Mixed Liquor Suspended Solids (1) (MLSS) milligrams per liter
Conven-tional	4-8	4-8	20-40	0.2-0.4	1,500-4,000
Step Aeration					
Complete Mix					
Contact Stabili-zation	1-3 (4) 3-6 (5)	3-10	50 (3)	0.2-0.6	2,000-4,000
Extended Aeration, or Oxidation Ditch	24	30	10-12	0.05-0.1	2,000-4,000

Notes:
(1) Mixed Liquor Suspended Solids (MLSS) values are dependent upon the surface area provided for sedimentation and the rate of sludge return as well as the aeration process.
(2) Mixed Liquor Volatile Suspended Solids (MLVSS)
(3) Total Aeration capacity, includes both contact and reaeration capacities. Normally, the contact zone equals 30 to 35 percent of the total aeration capacity.
(4) Contact zone
(5) Reaeration zone

TABLE R317-3-7.2(B)(6)(a)(1).
Return Sludge Rate

Process	Q_R / Q, Percent
Standard Rate	15-75
Carbonaceous stage of separate stage nitrification	15-75
Step Aeration	15-75
Contact stabilization	50-150
Extended aeration	50-150
Nitrification stage of separate stage nitrification	50-200

TABLE R317-3-9.3(A)(1)(a).
Gravity Thickening

Type	Solids Loading Rate, pounds per day per square foot (kilograms per square meter per day)	Percent solids in thickened sludge
Primary sludge	20-30 (98-146)	8-10
Trickling filter sludge	8-10 (39-49)	7-9
Activated sludge	4-8 (20-49)	2.5-3
Combined primary and trickling filter sludges	10-12 (49-59)	7-9
Combined primary and activated sludges	6-10 (29-49)	3-6

TABLE R317-3-9.4(A)(4)(a).
Sludge Volume Generated

Type of Plant	cubic feet per Population Equivalent (P.E.) or cubic meters per Population Equivalent (P.E.)
Trickling Filter	5 (0.14)