MINIMUM STANDARDS

FOR

PUBLIC WATER SYSTEMS

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION

WATERSHED PROTECTION BRANCH
DRINKING WATER PROGRAM

Revised March 2021

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MINIMUM STANDARDS FOR PUBLIC WATER SYSTEMS

FOREWORD

This publication has been prepared and revised to provide minimum design criteria and establish certain standards in the development and construction of public water supply systems. This document would help water system owners, operators, professional engineers, and the public in general to understand about the standards used in the design and construction of public water supply systems. We consider these standards to be dynamic and subject to periodic updates and revisions, as necessary, to conform with the latest drinking water regulations. If you are planning to develop a new public water supply system, or make additions, extensions, repairs, improvements or modifications to an existing public water system, please make sure that you are using the latest edition of the "Minimum Standards for Public Water Systems".

There has been no attempt to include or address every situation in this publication. Certainly, there may be occasions when these standards may not apply or cover. In those circumstances, the design of the facilities should meet the needs of the particular situation. Nothing in these minimum standards should be construed as preventing the professional engineer from recommending or the Georgia Environmental Protection Division from approving more effective treatment where local conditions dictate such action. You must contact the Drinking Water Permitting and Engineering Program of the Division for clarification and guidance prior to any construction. Any exceptions will be handled on an individual basis. However, it must be understood that development and operation of all public water systems are required, by law, to comply with the Georgia Rules for Safe Drinking Water, Chapter 391-3-5, promulgated under the Georgia Safe Drinking Water Act.

Should at any time an experimental installation, made based on engineering data, fail to produce results satisfactory to the Division, then immediate steps must be taken to replace it by a conventional installation approved by the Division.

The term “Division” as used herein refers to the Georgia Environmental Protection Division, Drinking Water Permitting and Engineering Program. Other terms, such as “shall” and “must” are intended to mean mandatory procedures. The terms “should,” “recommended,” and “preferred,” indicate desirable procedures or methods.

The Recommended Standards for Water Works, 2018 Edition, "Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers", commonly known as the "Ten-State Standards” were used as a guide in the preparation and updating of Georgia’s Minimum Standards for Public Water Systems.

ACKNOWLEDGEMENTS and REFERENCES

We have reviewed and incorporated by reference standards from various state drinking water agencies along with a number of other nationally accepted standards for inclusion in the updating of this document. Therefore, these standards are a compilation of information from the current Georgia Rules for Safe Drinking Water, Chapter 391-3-5, and other acceptable sources as listed below:

1. Georgia Rules for Safe Drinking Water, Chapter 391-3-5, December 2019.

2. Recommended Standards for Water Works, 2018 Edition, "Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers", commonly known as "Ten-State Standards".

3. American Water Works Association (AWWA) Standards, 2018 Edition.

4. Surface Water Treatment Rule (SWTR) – 40 CFR 141.70-141.75

5. Ground Water Rule (GWR) – 40 CFR 141.400-141.405

6. "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources", U.S.E.P.A., October 1990.

7. "Manual of Small Public Water Supply Systems", U.S.E.P.A., Office of Water, May 1992.

8. "Small System Compliance Technology List for the Surface Water Treatment Rule" and "Total Coliform Rule", U.S.E.P.A., Office of Water, August 1998.

9. Small Water Systems Serving the Public – Manual (correlated with National Drinking Water Regulations), Conference of State Sanitary Engineers in cooperation with Office of Drinking Water, U.S.E.P.A., September 1998.

10. Tennessee Department of Environment and Conservation, "Community Public Water Systems Design Criteria", 2018.

11. North Carolina Department of Environment, Health, and Natural Resources, "Rules Governing Public Water Systems", Subchapter 18C-Water Supplies, January 8, 2016.

12. "Design Standards for Public Water Supply Systems", Environmental Health Services, Division of Sanitary Engineering, West Virginia State Department of Health, May 2012.

13. Handbook for Capacity Development: Developing Water System Capacity under the Safe Drinking Water Act as amended in 1996, U.S.E.P.A., Office of Water, July 1999.

14. Implementation of Capacity Development Program- Related Safe Drinking Water Act, Amendments in the America's Water Infrastructure Act, U.S.E.P.A., Office of Water, December 2019.

15. State Programs to Ensure Demonstration of Technical, Managerial, and Financial Capacity of New Water System, U.S.E.P.A., Office of Water, July 2001.

16. Iowa Department of Natural Resources, Water Supply Section, "Self-Assessment Manual for Iowa Water System Viability", November 2016.

17. Pennsylvania Department of Environmental Protection, Bureau of Water Supply Management, "Public Water Supply Manual, 383-2125-108 Part II Community System Design Standards, May 6, 2006.

18. Pennsylvania Department of Environmental Protection, Bureau of Water Supply Management, "Public Water Supply Manual, Part V (Appendix A) Operations and Maintenance for Small Groundwater Systems (ID No. 383-3110-211)", May 1, 1999.

PART 1 - GENERAL REQUIREMENTS FOR DEVELOPING PUBLIC WATER SYSTEMS

1.1 APPROVAL REQUIREMENTS FOR PUBLIC WATER SYSTEMS

a. In accordance with Section 391-3-5-.04 of the Rules for Safe Drinking Water (Rules), no person shall erect, construct, or operate a public water system, nor undertake substantial enlargements, extensions, additions, modifications, renovations or repairs to any public water system, including storage, distribution, purification, or treatment components, without having first secured the Division's approval of: the source of water supply; the means and methods of treating, purifying, storing and distributing said water; and obtaining a permit to operate a public water system, except as provided by paragraph (b.) of this Section. The approval of the Director must be obtained prior to the dividing of a public water system. For purposes of these rules "substantial" as used in this Section shall not include routine maintenance.

b. Governmentally owned public water systems and water authorities and privately owned community water systems whose owner serves a combined population of greater than 10,000, with qualified staff and meeting operating criteria developed by the Division may, with prior approval from the Division, approve limited additions to the water system. These additions will be limited to water distribution lines to serve subdivisions, apartment complexes and shopping centers. The review of other additional types of water distribution system additions and/or extensions may be delegated to those water systems that have demonstrated the capability for such reviews. All delegations shall be by written agreement. Additions approved by the water system must be reported annually in a format prescribed by the Division. The report shall be due by July 1 of each year for activities undertaken under this provision in the previous calendar year.

1.2 SUBMISSION OF ENGINEERING DOCUMENTS

For any activity listed in Section 391-3-5-.04 of the Rules, an engineering report, as well as plans and specifications shall be submitted to the Division in accordance with Section 391-3-5-.05 of the Rules. Engineering report and plans and specifications shall be prepared by a professional engineer, licensed in the state of Georgia, and duly qualified and capable of designing water systems and computing flows and pressures in the proposed water system projects. Plans and specifications, along with a completed “Drinking Water Project Submittal” form, shall be submitted to the Division, with additional copies as may be requested, for its review and approval prior to the construction of the project. No construction shall be initiated without prior approval from the Division.

1.3 CONNECTION TO EXISTING WATER SUPPLY

In accordance with Section 391-3-5-.04(4), any person who desires to own or operate or who desires to commence the operation of a public water system must first evaluate connecting to an existing local governmentally owned and operated public water system, provided:

a. the existing public water system is within close proximity (approximately one mile or less) of the proposed water system; and

b. the existing public water system is capable of furnishing the drinking water under adequate water pressure and flow.

1.4 EXCEPTION

The engineering report and/or plans and specifications may be waived by the Director when information submitted by the supplier of water allows an engineering appraisal of the proposed activity to be made by the Division as follows:

a. For minor extensions, additions and/or modification to an existing governmentally owned public water system which does not affect the normal operation of said water system.

b. For new public water systems which are classified as transient non-community water systems (TNCWS) and for additions to existing transient non-community water systems (TNCWS).

1.5 ENGINEERING REPORT

The engineering report shall contain a comprehensive description of the proposed activity including, but not limited to, the following:

a. Scope and description of the proposed activity;

b. A summary of the alternative solutions, if applicable;

c. Recommendations;

d. Where pertinent, the following information should be included in the engineering report:

    1. General description of the existing water system service areas;

    2. Description of the proposed source of water supply, and data concerning the quality of the water, as well as water consumption data;

3. Pertinent information regarding present available sources of water supply, water treatment facilities, and existing public water systems;

4. Sufficient maps, diagrams, charts, tables, calculations, basis of design data and graphs to make the report readily understandable; all sheets shall be descriptively labeled and bound together or folded in a folder attached to the report;

5. Operational and maintenance program description;

6. The known character and depth of the natural earth formations through and from which groundwater sources are to be developed; and

7. Factors which may affect the quality of a source of water supply as determined by the survey of the watershed above the surface water intake or the surrounding area of a groundwater source.

1.6. PLANS AND SPECIFICATIONS

Plans and specifications must be submitted in duplicate for surface water projects and single copy for all other projects (with additional copies as may be requested) to the Division for its review and approval prior to the construction of the project. These plans and specifications must carry the stamp of a professional engineer, licensed and authorized in the State of Georgia and duly qualified and capable of designing water systems and computing flows and pressures in the proposed water system projects. The plans and specifications shall include, but not be limited to the following:

a. Map plans of the area to be served by the public water system, including, but not limited to: geographical location of the project, location of all existing and proposed streets in the area to be served, location of the source of water supply and the treatment facilities, and elevations of the principal parts of the public water system;

b. Detailed plans of the location and the construction of the storage tank, water mains, valves, fire hydrants and appurtenances;

c. Detailed plans of: the location and construction of the water treatment facilities including layout and relationship of the various units of the treatment facility; general piping, pumps, reservoirs, flow measuring devices, controls, points of chemical application, water sampling points, plant control laboratory, chemical feed equipment and chemical storage area. Sufficient dimensions and elevations shall be provided to make all parts of the plans readily understandable;

d. The dimensions of the plan sheets must be within the following limits: twenty (20) to thirty (30) inches in height and twenty-four (24) to forty-two (42) inches in length.

e. Each plan sheet shall have printed thereon the name and location of the public water system, name and registration stamp of the professional engineer, scale, true and magnetic north, and shall be bound together and numbered consecutively;

f. If the plans are solely for extensions to an existing public water system, only such information as is necessary for comprehension of the plans and construction of the project will be required;

g. Specifications will be separate from the plans and shall have printed thereon the name and location of the public water system, name and stamp of the professional engineer, and shall be bound together and numbered consecutively;

h. Specifications for the construction of the public water system shall accompany all plans for new or existing public water systems and shall describe the plans for the whole and for each unit or component of construction of the proposed public water system, including where necessary, testing and disinfection, painting, laboratory equipment, metering and recording devices and related material;

i. The specifications may be omitted for extensions or additions to existing systems provided the proposed construction is in accordance with specifications previously approved and on file with the Division; and

j. Manufacturers' brochures of specifications of materials are not acceptable for purposes of this requirement.

1.7 <u>ADDITIONS AND EXTENSIONS TO PUBLIC WATER SYSTEMS</u>

The following documents (as applicable) should be submitted for projects that do not fall under delegation of authority agreement under Section 1.1.b:

a. Detailed plans and specifications for the construction of the water system project. Engineering plans must be applicable to the project and may include water supply sources [i.e. well(s), spring(s)], treatment, storage, distribution system indicating the size of all water lines, valves, feeder mains, service lines, blow-off valves, booster pump stations, point of tie-in, and any other information pertinent to the project. Specifications should pertain to materials, construction methods, disinfection and pressure testing of water lines, valves, pumps, controls, treatment and appurtenances, as applicable to the project. If previously approved standard specifications apply, a statement to that effect should be included in the submittal cover letter;

b. "basis of design data", as well as "design calculations" and "hydraulic analysis" for the project;

c. "evidence of availability of water";

d. Requests for approval of subdivisions (connecting to existing distribution systems) must include documentation that the project has been coordinated with the supplying water system. A twenty-four-hour pressure test chart and flow information which was taken at a point nearest to the tie-in of the existing system, must be submitted;

e. a copy of the completed form, titled "Drinking Water Project Submittal Form". All applicable information pertinent to the project must be provided on this form; and

f. Additional "specific" requirements may apply to those systems that are proposed for construction in the coastal region of Georgia. For those specific requirements, please contact the Environmental Protection Division Coastal Office.

1.8 CHANGES IN PLANS AND SPECIFICATIONS AFTER APPROVAL

Any significant deviation from the approved plans or specifications affecting capacity, hydraulic conditions, operating units, the functioning of water treatment processes, the quality of water to be delivered, or any provisions stipulated in the Division's original and subsequent letters of approval must receive prior approval by the Division before any construction or installation.

1.9 ENGINEER'S CERTIFICATION

Upon completion of the construction or modification, the water supplier shall submit a statement from the registered professional engineer and affixed with his professional engineering seal stating that construction was completed in accordance with the approved plans and specifications. The statement shall be based upon observations during and upon completion of construction by the engineer or a representative of the engineer's office who is under the engineer's supervision.

PART 2 - PROCEDURES FOR DEVELOPING PUBLIC WATER SYSTEMS THAT ARE USING GROUND WATER (WELLS, SPRINGS) AND/OR PURCHASED SOURCES OF WATER SUPPLY

The documents required for submission to the Division for review and approval are detailed in the following checklists:

- Northern Groundwater and Purchased Water Systems, Water System Review and Permitting Process Checklist.
  - Applies to facilities located in the Mountain and Northeast District areas.
- Southern Groundwater and Purchased Water Systems, Water System Review and Permitting Process Checklist
  - Applies to facilities located in the East Central, West Central, Southwest and Coastal District areas.

The current version of the checklist and the Drinking Water Project Submittal form can be found in the Georgia EPD Website. Please contact the local District office to discuss which portions of each checklist would apply to your specific project.

PART 3 - PROCEDURES FOR DEVELOPING PUBLIC WATER SYSTEMS THAT ARE USING SURFACE WATER OR GROUND WATER UNDER THE INFLUENCE OR IN COMBINATION WITH ANY OTHER SOURCES OF WATER SUPPLY

The documents required for submission to the Division for review and approval are detailed in the following checklists:

- **Checklist #1 –** New Public Water System Review and Permitting process must provide the information described in Checklist #1 for developing new governmentally owned community public water system using surface water.

- **Checklist #2 –** Engineering Report submission required for treatment of surface water as source of drinking water supply.

- **Checklist #3 –** Pilot Plant Study or Treatability Study Plan required for treatment of surface water as source of drinking water supply.

- **Checklist #4 –** Engineering Plans and Specification for construction of surface water treatment plant.

The current version of each checklist and the Drinking Water Project submittal Form can be found on the Georgia EPD website. Please contact the Drinking Water Permitting and Engineering Program to discuss which portions of each checklist would apply to your specific project.

PART 4- GENERAL DESIGN CONSIDERATIONS

4.1 PLANT LAYOUT

System design shall consider:

a. functional aspects of plant layout;

b. provisions for future plant expansion;

c. access roads;

d. site grading;

e. site drainage;

f. walks;

g. driveways and parking;

h. chemical delivery; and

i. provisions for expansion of the plant waste treatment and disposal facilities.

4.2 BUILDING LAYOUT

Design shall provide:

a. adequate ventilation, which is screened for insect protection;

b. adequate lighting;

c. adequate heating and air-conditioning;

d. adequate drainage;

e. dehumidification equipment as needed;

f. accessibility of equipment for operation, servicing, and removal;

g. flexibility and convenience of operation;

h. operator safety, including safety railings;

i. consideration of chemical storage and feed equipment in separate rooms to reduce dust problems; and

j. separate facilities for laboratory procedures and office/lunch activities.

4.3 LOCATION OF STRUCTURES

The Division must be consulted regarding any intake structure which is so located that normal or flood stream flows may be impeded.

4.4 ELECTRICAL CONTROLS

Main switch gear electrical controls shall be located above grade, in areas not subject to flooding. All electrical work shall conform to the requirements of the National Electrical Code or to relevant state and/or local codes.

4.5 STANDBY POWER

Stand-by power generation may be required by the Division so that water may be treated and/or pumped to the distribution system during periods when there is a power outage. Carbon monoxide detectors are recommended when fuel-fired generators are housed.

4.6 EQUIPMENT MAINTENANCE

Adequate facilities shall be available for the maintenance and servicing of automation equipment.

4.7 STORAGE AND SHOP SPACE

Adequate facilities shall be included for shop space and storage consistent with the designed facilities.

4.8 MONITORING

Water treatment plants should be provided with equipment (including recorders, where applicable) to monitor the water as follows:

a. Plants treating surface water and ground water under the direct influence of surface water should have the capability to monitor and record turbidity, free chlorine residual, water temperature and pH at locations necessary to evaluate adequate CT disinfection, and other important process control variables as determined by the Division. Continuous monitoring and recording may be required.

b. Plants treating groundwater using ion removal and/or ion exchange softening should have the capability to monitor and record free chlorine residual.

c. Ion exchange plants for nitrate removal should continuously monitor and record the treated water nitrate level.

4.9 TESTING EQUIPMENT

At a minimum, the following laboratory equipment shall be provided. Consult the Division for any waiver from the requirements listed below.

a. All community water systems which have a surface water source with water treatment facilities and those public water systems having only a ground water source or only a water distribution system and serving a population of more than 12,900 shall provide the necessary facilities for microbiological testing of water from both the treatment plant and the distribution system or have available, the services of a microbiological laboratory certified by the Division to perform microbiological test.

b. Surface water supplies shall have a nephelometric turbidimeter meeting the requirements of Standard Methods for the Examination of Water and Wastewater AWWA, 23rd Edition. 2017.

c. Each surface water treatment plant utilizing flocculation and sedimentation, including those which lime soften, shall have a pH meter, jar test equipment, and titration equipment for both hardness and alkalinity.

d. Each ion-exchange softening plant, and lime softening plant treating only groundwater shall have a pH meter and titration equipment for both hardness and alkalinity.

e. Each iron and/or manganese removal plant shall have test equipment capable of accurately measuring iron to a minimum of 0.1 milligrams per liter, and/or test equipment capable of accurately measuring manganese to a minimum of 0.05 milligrams per liter.

f. Public water supplies which chlorinate shall have test equipment for determining both free and total chlorine residual by methods in Standard Methods for the Examination of Water and Wastewater AWWA, 23rd EDITION 2017.

g. Equipment shall be provided for measuring the quantity of fluoride in the water. Such equipment shall be subject to the approval of the Division.

h. Public water supplies which feed poly and/or orthophosphates shall have test equipment capable of accurately measuring phosphates from 0.1 to 20 milligrams per liter.

4.10 FACILITY WATER SUPPLY

The facility water supply service line and the plant finished water sample tap shall be supplied from a source of finished water at a point where all chemicals have been thoroughly mixed, and the required disinfectant contact time has been achieved. There shall be no cross-connections between the facility water supply service line and any piping, troughs, tanks, or other treatment units containing wastewater, treatment chemicals, raw or partially treated water.

4.11 WALL CASTINGS

Consideration shall be given to provide extra wall castings built into the structure to facilitate future uses whenever pipes pass through walls of concrete structures.

4.12 METERING

All water systems shall have some means of metering the water supplies, raw and finished water, wash water, recycled water and any blended water of different quality. In addition, all new services connected to community and non-transient, non-community water systems shall be metered. Existing services should be metered, if not metered already. In the event existing services are not metered, metering shall be performed when required by the Director of the Environmental Protection Division.

4.13 PIPING COLOR CODE

To facilitate identification of piping in plants and pumping stations it is recommended that the following color scheme be utilized:

Water Lines

Raw or Recycle	Olive Green
Settled or Clarified	Aqua
Finished or Potable	Dark Blue

Chemical Lines

Alum or Primary Coagulant	Orange
Ammonia	White
Carbon Slurry	Black
Caustic	Yellow with Green Band
Chlorine (Gas and Solution)	Yellow
Chlorine Dioxide	Yellow with Violet Band
Fluoride	Light Blue with Red Band
Lime Slurry	Light Green
Ozone	Yellow with Orange Band
Phosphate Compounds	Light Green with Red Band
Polymers or Coagulant Aids	Orange with Green Band

Potassium Permanganate	Violet
Soda Ash	Light Green with Orange Band
Sulfuric Acid	Yellow with Red Band
Sulfur Dioxide	Light Green with Yellow Band

Waste Lines

Backwash Waste	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray

Other

Compressed Air	Dark Green
Gas	Red
Other Lines	Light Gray

For liquids or gases not listed above, a unique color scheme and labeling should be used. In situations where two colors do not have sufficient contrast to easily differentiate between them, a six-inch band of contrasting color should be on one of the pipes at approximately 30-inch intervals. The name of the liquid or gas should also be on the pipe. In some cases, it may be advantageous to provide arrows indicating the direction of flow.

4.14 OPERATION AND MAINTENANCE MANUAL

An operation and maintenance manual including a parts list and parts order form, operator safety procedures and an operational trouble-shooting section shall be supplied to the water works as part of any proprietary unit installed in the facility.

4.15 OPERATOR INSTRUCTION

Provisions shall be made for operator instruction at the start-up of a plant or pumping station.

4.16 SAFETY

Consideration must be given to the safety of water plant personnel and visitors. The design should comply with all applicable safety codes and regulations that may include the Uniform Building Code, Uniform Fire Code, National Fire Protection Association Standards, and state and federal OSHA standards. Items to be considered include noise arresters, noise protection, confined space entry, protective equipment and clothing, gas masks, safety showers and eye washes, handrails and guards, warning signs, smoke detectors, toxic gas detectors and fire extinguishers.

4.17 SECURITY

Security measures are required to help ensure that public water suppliers attain an effective level of security. Design considerations shall address physical infrastructure security and facilitate security related operational practices and institutional controls. Because drinking water systems cannot be made immune to all possible attacks, the design shall address issues of critical asset redundancy, monitoring, response and recovery. All public water supplies shall identify and address security needs in design and construction for new projects and for retrofits of existing drinking water systems.

The following concepts and items shall be considered in the design and construction of new water system facilities and improvements to existing water systems:

a. Security shall be an integral part of drinking water system design. Facility layout shall consider critical system assets and the physical needs of security for these assets. Requirements for submitting, identifying and disclosing security features of the design and the confidentiality of the submission and regulatory review should be discussed with the Division.

b. The design shall identify and evaluate single points of failure that could render a system unable to meet its design basis. Redundancy and enhanced security features should be considered to eliminate single points of failure when possible, or to protect them when they cannot reasonably be eliminated.

c. Consideration shall be made to ensure effective response and timely replacement of critical components that are damaged or destroyed. Critical components that comprise single points of failure (e.g.high-volume pumps) that cannot be eliminated shall be identified during design and given special consideration. Design considerations should include component standardization, availability of replacements and key parts, re-procurement lead times, and identification of suppliers and secure retention of component specifications and fabrication drawings. Readily replaceable components should be used whenever possible and provisions should be made for maintaining an inventory of critical parts.

d. Human access shall be through controlled locations only. Intrusion deterrence measures (e.g., physical barriers such as fences, window grates and security doors; traffic flow and check-in points; effective lighting; lines of sight; etc.) should be incorporated into the facility design to protect critical assets and security sensitive areas. Appropriate and effectively operated detection should be included in the system design to protect critical assets and security sensitive areas. All cameras and alarms installed for security purposes should be connected to SCADA where available and include monitors at manned locations. Alternative methods should be considered for primary use where there is no SCADA or as a SCADA support system.

e. Vehicle access shall be through controlled locations only. Physical barriers such as moveable barriers or ramps should be included in designs to keep vehicles away from critical assets and security sensitive areas. It should be impossible for any vehicle to be driven either intentionally or accidentally into or adjacent to finished water storage or critical components without facility involvement. Designated vehicle areas such as parking lots and drives should be separated from critical assets with adequate standoff distances to eliminate impacts to these assets from possible explosions of material in vehicles.

f. Sturdy, weatherproof, locking hardware shall be included in the design for the access to tanks, vaults, wells, well houses, pump houses, buildings, power stations, transformers, chemical storage, delivery areas, chemical fill pipes, and similar facilities. Hardened protective covers should be considered for padlocks or similar devices. Vent and overflow openings should be placed in secure areas. When not placed in secure areas, they shall be provided with deterrence or intrusion detection equipment.

g. Computer based control technologies such as SCADA shall be secured from unauthorized physical access and potential cyber-attacks. Wireless and network-based communications should be encrypted as deterrence to hijacking by unauthorized personnel. Vigorous computer access and virus protection protocols should be built into computer control systems. Effective data recovery hardware and operating protocols should be employed and exercised on a regular basis. All automated control systems shall be equipped with manual overrides to provide the option to operate manually. The procedures for manual operation including a regular schedule for exercising and ensuring the operator's competence with the manual override systems shall be included in facility operation plans.

h. Real time water quality monitoring with continuous recording and alarms should be considered at key locations to provide early warning of possible contamination events. Facilities and procedures for delivery, handling and storage of chemicals shall be designed to ensure that chemicals delivered to and used at the facility cannot be released, introduced or otherwise used to debilitate a water system, its personnel, or the public. Particular attention should be given to potentially harmful chemicals used in treatment processes (e.g., strong acids and bases, toxic gases and incompatible chemicals) and on maintenance chemicals that may be stored on-site (e.g., fuels, herbicides, paints, solvents).

4.18 FLOOD PROTECTION

Other than surface water intakes, all water supply facilities and water treatment plant access roads shall be protected to at least the 100-year flood elevation or maximum flood of record, as required by the Division. A freeboard factor may also be required by the Division.

4.19 CHEMICALS AND WATER CONTACT MATERIALS

Chemicals and water contact materials shall be approved by the Division or be certified for compliance with ANSI/NSF Standards 60 or 61. Product certification shall be conducted by an ANSI approved entity. All materials used in the construction of a public water supply system must comply with the 2011 Reduction of Lead in Drinking Water Act, as amended.

4.20 OTHER CONSIDERATIONS

Consideration must be given to the design requirements of other federal, state, and local regulatory agencies for items such as energy efficiency, water conservation, environmental impact, safety requirements, special designs for the handicapped, plumbing and electrical codes, construction in the flood plain, freeze protection, etc.

PART 5 - RAW WATER SOURCE AND DEVELOPMENT

5.0 GENERAL

In selecting a source of water to be developed, the design engineer must show, to the satisfaction of the Division, that the source water, which is to be delivered to the consumers, shall meet the state and federal drinking water standards with respect to bacteriological (microbiological), physical, chemical and radiological quality requirements. The Environmental Protection Division shall evaluate and approve proposed new sources before they are placed into service as drinking water sources.

a. All sources of water supply must be adequate to meet anticipated growth. For human consumption in a community water system, one hundred (100) gallons per day for the projected population to be served at the end of the design period shall be considered adequate.

b. Beginning January 1, 1998 all new community public water system with groundwater sources must provide an approved back-up water source, such as an additional well, capable of providing adequate water service if the primary source becomes nonfunctional.

5.1 SURFACE WATER SOURCE

A surface water source includes all tributary streams and drainage basins, natural lakes and artificial reservoirs or impoundments above the point of water supply intake.

5.1.1 QUANTITY

The quantity of water at the source shall:

a. be adequate to supply the water demand of the service area as shown by calculations based on a one in fifty-year drought or the extreme drought of record and should include consideration of multiple year droughts. Requirements for flows downstream of the intake shall comply with requirements of the appropriate Division;

b. provide a reasonable surplus for the anticipated growth over a design period of 20 years;

c. be adequate to compensate for all losses;

d. be adequate to provide ample water for other approved users of the source; and

e. Approval is required from the surface water unit of the Water Supply Program for all surface water withdrawal.

5.1.2 QUALITY

A sanitary survey and study should be made of the factors, both natural and manmade, which will affect quality. Such survey and study, shall include, but shall not be limited to:

a. obtaining samples over a sufficient period of time to assess the bacteriological (microbiological), physical, chemical and radiological characteristics of the water;

b. assessing the degree of hazard to the supply by accidental spillage of materials that may be toxic, harmful or detrimental to the treatment processes. Assessing degree of hazard to the supply posed by agricultural, domestic, industrial, or recreational activities in the watershed, which may generate toxic or harmful substances detrimental to treatment processes;

c. the items listed under 5.1.4 which are considered minimum requirements for determining the acceptability of the proposed surface water source. Additional water quality monitoring, studies, investigations and evaluations should be conducted before selecting and/or designing appropriate treatment processes and technologies;

d. assessing the capability of the proposed treatment process to reduce contaminants to meet safe drinking water maximum contaminants levels (MCL);

e. determining possible future uses of impoundments or reservoirs;

f. determining degree of control of watershed by owner;

g. assessing all waste discharges (point source and non-point sources) and activities that could impact the water supply. The location of each waste discharge shall be shown on a scale map; and

h. consideration of currents, wind and ice conditions, and the effect of combining streams.

5.1.3 <u>SOURCE WATER ASSESSMENT</u>

In accordance with Section 391-3-5-.42 of the Rules for Safe Drinking Water promulgated under the Georgia Safe Drinking Water Act of 1977, the public water system shall develop a Source Water Assessment Plan (SWAP) for every well and surface water intake used by the water system. Contact the Source Water Assessment team of the Drinking Water Program regarding the Division's Source Water Assessment and Protection Implementation Plan for Public Drinking Water Sources.

5.1.4 SOURCE WATER APPROVAL

In accordance with Section 391-3-5-.06 of the Rules for Safe Drinking Water, promulgated under the Georgia Safe Drinking Water Act of 1977, the source of water supply for all public water systems must have the approval of the Environmental Protection Division. Before a proposed new or modified surface water source can be considered for acceptance as a potential source of public water supply, the items below must be addressed to the satisfaction of the Division.

a. A written request to evaluate the water supply as a potential source of public water supply and a map showing the geographical location of the proposed water intake must be submitted to the Division.

b. A survey of the water drainage basin supplying the intake which addresses the current level of watershed protection; the nature of upstream land use; the existing and potential sources of pollution; and, other pertinent conditions which may have an impact on the use of the site as a potential water supply source must be submitted to the Division.

c. One (1) raw water sample must be collected at least every two (2) weeks for six (6) months from a point most representative of the proposed intake location and submitted to the Division's Water Supply Laboratory or other Division approved laboratory for microbiological analysis [total coliform and fecal coliform or Escherichia coli (E. coli)] and turbidity. Additional samples must be collected after each rain event for microbiological and turbidity analysis, and any other parameter that would be considered pertinent due to geographical location of the intake.

d. When required by EPD, one raw water sample shall be collected every month for six (6) months, from a point most representative of the proposed intake location and tested for *Giardia* cysts, *Cryptosporidium* oocysts, and Enteroviruses concentrations.

e. One (1) raw water sample must be collected from the proposed intake location and submitted to a Division approved Radiological Laboratory for radiological analysis. A list of approved laboratories can be found on EPD’s website.

f. Physical and chemical screening of the proposed source water must be performed for at least for two (2) quarters for the following parameters (with the concentrations shown in mg/L, where applicable) and submitted to the Division's Water Supply Laboratory or other Division approved laboratory, and a copy of the results submitted to this office:

pH	Zinc
Alkalinity (as CACO3)	Iron
Hardness (as CACO3)	Manganese
Chloride	Sulfate
Fluoride	Turbidity (NTUs)
Nitrate (as N)	Carbon dioxide
Nitrite (as N)	Color (color units)
Total Nitrate & Nitrite (as N)	Total Dissolved Solids

This "screened" analysis is performed as an interim measure to determine usability of the proposed supply as a potential source of public water supply. Additional tests or in-depth water quality analysis may be required by state and federal drinking water regulations.

g. When required by the Division, raw water samples shall be collected from the proposed intake location for two (2) quarters and tested for Total Organic Carbon (TOC), Total Organic Halide (TOX), Bromide and Ammonia.

h. Contact the Drinking Water Permitting and Engineering Program for any special sampling requirements of the proposed water source for physical and/or chemical analyses.

i. Upon completion of sampling of the proposed water source and water drainage basin survey, tabulate all the laboratory results (with special reference to fluctuations in quality and possible sources of contamination) and other pertinent findings in an engineering report and submit it to EPD along with the engineer's comments and treatment design recommendations. In addition to water source information, this engineering report should be comprehensive enough to include, but not limited to, general project information (i.e. water use, flow requirements, etc.); describe the nature and extent of the proposed water works project; discuss the alternate plans, giving reasons for selecting the one recommended; summarize and establish the adequacy of proposed treatment processes and unit parameters for the treatment of the specific water source under consideration (pilot studies, conducted over a sufficient time to treat under all expected raw water conditions throughout the year, may be necessary to demonstrate satisfactory performance); discuss the various wastes from the water treatment plant, their volume, proposed treatment and points of discharge; discuss the various sites considered and advantages of the recommended ones; summarize planning for future needs and services; etc.

j. Please be reminded, the above outlined testing program is a basic screening process to evaluate the suitability of a surface source proposed for use as a public drinking water supply. Additional water quality testing should be performed to determine treatment characteristics, chemical dosages, primary (and secondary coagulants), pH adjustments, unregulated contaminants per Section 391-3-5-.26 of the Rules for Safe Drinking Water, etc. Information such as these, in conjunction with the source approval data, should be used to select and design appropriate water treatment technologies.

5.1.5 MINIMUM TREATMENT

a. The design of the water treatment plant must consider the worst conditions that may exist during the life of the facility.

b. The minimum treatment required shall be determined by the Division.

c. Filtration preceded by appropriate pretreatment shall be provided for all surface waters. Exemptions may be approved by the Division on a case-by-case basis.

5.1.6 STRUCTURES

Intake structure design shall:

a. provide withdrawal of water from more than one level; if quality varies with depth;

b. provide adequate protection against rupture by dragging anchors, ice, etc.;

c. have motors and electrical controls located above grade and flood level except when submersible pumps are approved;

d. be accessible;

e. be designed against flotation;

f. be equipped with removable or traveling screens before the pump suction well;

g. provide chemical feed facilities (i.e. chlorine, potassium permanganate) for pretreatment and/or raw water transmission main, as necessary for water quality control;

h have intake valves and provisions for backflushing (or cleaning by a mechanical device) and testing for leaks, where practical;

i. have provisions for surges where necessary;

j. have provisions for sand or gravel removal;

k. provide protection against any influence from a sewage outfall (be constructed in a manner to prevent intrusion of contaminants);

l. shall provide for separate facilities for release of less desirable water held in storage;

m. shall provide for inspection of manholes every 1000 feet for pipe sizes large enough to permit visual inspection;

n. shall provide for occasional cleaning of the inlet line;

o. ports located above the bottom of the stream, lake or impoundment, but at sufficient depth to be kept submerged at low water levels;

p. where shore wells are not provided, a diversion device capable of keeping large quantities of fish or debris from entering an intake structure; and

q. when buried surface water collectors are used, sufficient intake opening area must be provided to minimize inlet head loss. Particular attention should be given to the selection of backfill material in relation to the collector pipe slot size and gradation of the native material over the collector system.

5.1.7 SURFACE WATER PUMPING FACILITIES

Refer to section 11 of this document for raw water pumping station requirements.

5.1.8 INTAKE CHEMICAL TREATMENT

If it is determined that chemical treatment is warranted to address taste and odor control or the control of zebra and other mussels and other nuisance organisms at the intake:

a. chemical treatment shall be in accordance with Part 8 of the Minimum Standards for Public Water System and shall be acceptable to the Division;

b. plant safety items, including but not limited to ventilation, operator protective equipment, eyewashes/showers, cross connection control, etc. shall be provided;

c. solution piping and diffusers shall be installed within the intake pipe or in a suitable carrier pipe. Provisions shall be made to prevent dispersal of chemical into the water environment outside the intake. Diffusers shall be located and designed to protect all intake structure components;

d. spare solution line should be installed to provide redundancy and to facilitate the use of alternate chemicals;

e. the chemical feeder shall be interlocked with plant system controls to shut down automatically when the raw water flow stops; and

f. when alternative control methods are proposed, appropriate piloting or demonstration studies, satisfactory to the Division, may be required.

5.1.9 IMPOUNDMENTS AND RESERVOIRS

a. Site preparation should provide for:

1. removal of brush and trees to high water elevation;

2. protection from floods during construction;

3. clearing and grubbing small reservoirs; and

4. abandonment of all wells that will be inundated, in accordance with requirements of the Division.

b. Construction may require:

1. approval, obtained from the Division, of safety features for stability and spillway design of any structures; and

2. a permit for controlling stream flow or the structure on the bed of a navigable stream or interstate water, to be obtained from the appropriate agency.

c. Water Supply Dams

1. approval from the Watershed Protection’s Safe Dams Program; and

2. water supply dams shall be designed and constructed in accordance with the requirements of the appropriate regulatory agency i.e. Georgia Safe Dam Rules.

d. Off-stream raw water storage reservoir for drinking water supply

The off-stream raw water supply shall be constructed to assure that:

1. water quality is protected by controlling runoff into the reservoir;

2. dikes are structurally sound and protected against wave action and erosion;

3. intake structures and devices meet requirements of intake structures Part 5.1.6;

4. point of influent flow is separated from the point of withdrawal;

5. separate pipes are provided for influent to and effluent from the reservoir; and

6. a bypass line is provided around the reservoir to allow direct pumping to the drinking water treatment facilities.

5.2 GROUND WATER

A ground water source includes all water obtained from drilled wells or springs. Dug, bored, or jetted wells are prohibited for all public water systems.

5.2.1 GENERAL

a. The person constructing the well must be a licensed water well contractor in the State of Georgia in accordance with the provisions of the Water Well Standards Act of 1985 (O.C.G.A. 12-5-120, et. seq.). The contractor must maintain accurate driller logs, including material setting and grouting data, complete the results of the pump test, including water level measurements, and must furnish a signed copy of the results to the owner and to the Division on forms provided by the Division.

b. Ground water sources (wells and springs) shall be evaluated for direct influence of surface water, when required by the Division.

c. Two important concerns in the design of water wells must be adequately addressed:

   1. the provision for the proper depth to which the well casing shall be installed as a watertight conduit; and

   2. the provision for positive sealing of the annular space between the outside of the well casing and the well hole to prevent movement of water vertically along the outside of the well casing pipe. The well must be protected from contamination by surface waters and other sources of contamination.

5.2.2 QUANTITY

5.2.2.1 SOURCE CAPACITY

The total developed groundwater source capacity, unless otherwise specified by the Division, shall equal or exceed the design maximum day demand. When multiple wells are used to meet the design maximum daily demand, consideration should be given to locating redundant sources in different aquifers or different locations of an aquifer.

5.2.2.2 BACK UP SOURCES

Beginning January 1, 1998 all new community public water systems with groundwater sources must provide an approved back-up water supply source, such as an additional well, capable of providing adequate water service, if the primary source becomes nonfunctional. The Director may waive this requirement for systems with less than 25 service connections. This requirement does not apply to Non-Transient, Non- community ground water system and Transient, non-community ground water systems.

5.2.2.3 STANDBY POWER

a. To ensure continuous service when the primary power has been interrupted, a standby power supply may be provided through a dedicated portable or in-place auxiliary power supply of adequate capacity and connectivity.

b. When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, design shall assure that the pre-lubrication is provided when auxiliary power is in use.

5.2.3 QUALITY

An assessment should be made of the factors, both natural and man-made, which may affect water quality in the well and aquifer. Such an assessment may include, obtaining samples over a sufficient period of time to assess the microbiological and physical characteristics of the water including dissolved gases, chemical, and radiological characteristics.

5.2.3.1 MICROBIOLOGICAL QUALITY

After disinfection of each new, modified or reconditioned groundwater source, one or more water samples shall be submitted to a laboratory satisfactory to the Division for microbiological analysis with satisfactory results reported to such agency prior to placing the well into service. A list of approved laboratories can be found on EPD website.

5.2.3.2 PHYSICAL, CHEMICAL & RADIOLOGICAL CHARACTERISTICS

a. Every new, modified or reconditioned groundwater source shall be examined for applicable physical, chemical and radiological characteristics as required by the Division by tests of a representative sample in a certified laboratory, with results reported to such authority.

b. Samples shall be collected and analyzed at the conclusion of the test pumping procedure.

c. Field determinations of physical and chemical constituents or special sampling procedures may be required by the Division.

5.2.4 WELL LOCATIONS:

Well shall be located:

a. generally, at the highest point, and as far removed, and in a direction opposite to the ground water flow from any known or probable source of contamination;

b. not less than fifty (50) feet from a septic tank;

c. not less than one hundred (100) feet away from a septic tank absorption field;

d. not less than ten (10) feet away from a sewer;

e. not less than one thousand (1,000) feet away from a solid waste disposal site and not in a direction where ground water flow from the site may be intercepted by the well;

f. as far removed as possible from all open abandoned wells;

g. not in areas of sink holes;

h. not in the flood plain areas, unless adequate protection is provided to prevent submergence of the well casing, pumps and appurtenances;

i. not less than 100 feet from surface water;

j. not less than 50 feet from buildings, mobile homes and permanent structures;

k. not less than 100 feet from animal houses or lots, or cultivated areas to which chemicals are applied;

l. not less than 100 feet from a chemical or petroleum fuel underground storage tank with secondary containment;

m. not less than 50 feet away from storm water drainage ditch that contains water during and shortly after a rain event;

n. the Division may require greater separation distances or impose other protective measures when necessary to protect the well from any potential source of pollution, based upon: the hazard or health risk associated with the source of pollution; the proximity of the potential source to the well; the type of material; facility or circumstance that poses the source or potential source of pollution; the volume or size of the source or potential source of pollution; hydrogeological features of the site which could affect the movement of contaminants to the source water; the effect which well operation might have on the movement of contamination; the feasibility of providing additional separation distances or protective measures; and

o. continued sanitary protection of the well site from potential sources of contamination shall be provided either through ownership, restrictive use zoning, easements or other means acceptable to the Division.

5.2.5 WELL ABANDONMENT

a. Wells not used as sources of water supply shall be filled, plugged and sealed to protect against contamination of the ground water.

b. Wells to be abandoned shall be sealed to prevent undesirable exchange of water from one aquifer to another.

c. Preferably the well hole should be filled with neat cement grout.

d. Have fill materials other than cement grout or concrete, disinfected and free of foreign materials.

e. When filled with cement grout or concrete, these materials shall be applied to the well hole through a pipe, tremie, or bailer.

f. Submission of documentation by a licensed well contractor attesting that well abandonment was completed in accordance with the requirements of this section.

5.2.6 GENERAL WELL CONSTRUCTION

a. All public water supply wells must be constructed in accordance with the requirements of the Georgia Rules for Safe Drinking Water, Chapter 391-3-5, by a water well contractor licensed in the State of Georgia.

b. Pitless adapter wells shall not be constructed for public water supply systems.

c. Wells shall be tested for plumbness and alignment in accordance with the latest edition of AWWA A100 Standard.

d. Drilling fluids must be from an uncontaminated source or must be disinfected.

e. All permanent casing, liners, screens and other manufactured material used in the well installation must be new. Material used shall preferably be wrought iron or steel.

f. All casing and liner pipe joints shall be watertight the entire length in drilled wells. They shall have full circumferential welds or threaded coupling joints.

g. The well casing shall neither terminate below ground nor in a pit.

h. Packers shall be of a material that will not impart, taste, odor, toxic substance or bacterial contamination to the water in the well.

i. The pump house floor shall be at least one foot above the original ground surface and not less than three feet above the highest known flood elevation.

j. Minimum protected depths of drilled wells shall provide watertight construction to such depth as may be required by the Division, to:

   1. exclude contamination, and

   2. seal off formations that are, or may be, contaminated or yield undesirable water.

5.2.6.1 UPPER TERMINAL WELL CONSTRUCTION

a. Permanent casing for all groundwater sources shall project at least 12 inches above the pumphouse, well platform floor or concrete apron surface and at least 18 inches above final ground surface.

b. Protection from physical damage shall be provided as required by the Division.

c. The upper terminal shall be constructed to prevent contamination from entering the well.

d. Where well appurtenances protrude through the upper terminal, the connections to the upper terminus shall be mechanical or welded connections that are watertight.

5.2.6.2 STEEL CASING

a. Steel pipe well casing shall conform to American Society for Testing and Materials (ASTM) Specification A53 or American Petroleum Institute (API) Specification 5L or equal standard and meet the following minimum wall thickness shown below; unless otherwise approved by the Division.

Nominal Casing Diameter (in inches)	Minimum Wall Thickness (in inches)
4	0.237
5	0.258
6	0.280
8	0.322
10	0.365
12	0.375
14	0.375
16	0.375
18	0.375
20	0.375
24	0.500
26	0.500

b. have additional thickness and weight if minimum thickness is not considered sufficient to assure reasonable life expectancy of a well;

c. be capable of withstanding forces to which it is subjected;

d. be equipped with a drive shoe when driven; and

e. have full circumferential welds or threaded coupling joints.

5.2.6.3 PLASTIC/PVC PIPE CASING

a. The use of plastic well casing and screens must be approved by the Division prior to well installation.

b. The plastic well casing and couplings shall meet the requirements of the ASTM Standard F 480 or equal standard and the National Sanitation Foundation standard for use with potable water.

c. Shall not be used at sites where permeation by hydrocarbons or degradation may occur.

d. Shall be properly stored in a clean area free from exposure to direct sunlight.

e. Any approved plastic well casing shall conform to the following minimum wall thickness. However, diameters of 12 inches or greater or deep wells may require greater thickness to meet collapse strength requirements.

Nominal Casing Diameter (in inches)	Minimum Wall Thickness (in inches)
4	0.265
4.5	0.291
6	0.390
8	0.508
10	0.632
12	0.750

f. The plastic well casing and screen shall not extend to a depth of greater than 300 feet below the ground surface.

g. Shall not be driven.

5.2.6.4 OTHER NONFERROUS CASING MATERIALS

a. Approval of the use of any nonferrous material as well casing shall be subject to special determination by the Division prior to submission of plans and specifications.

b. Nonferrous material proposed as a well casing must be resistant to the corrosiveness of the water and to the stresses to which it will be subjected during installation, grouting and operation.

5.2.6.5 PACKERS

Packers shall be of material that will not impart taste, odor, toxic substances or bacterial contamination to the well water. Lead packers shall not be used.

5.2.6.6 CASING DEPTH AND GROUTING

a. The outer, permanent, protective casing shall extend at least five (5) feet into the first solid, unweathered or impervious subsurface rock strata encountered, and shall have a minimum length of twenty-five (25) feet from the ground surface into a well excavated into water-bearing formations in crystalline rocks and fifty (50) feet in a well excavated into sedimentary water-bearing formations.

b. The outer, permanent, protective casing shall be cement grouted its entire length with a cement slurry consisting of not more than six (6) gallons of water to one cubic foot of cement, plus standard additives, when necessary, to facilitate placing or setting. The neat cement shall conform to ASTM Standard C150.

c. The outer protective casing shall be provided with sufficient guides or centralizers attached or welded to the casing to permit unobstructed flow and uniform thickness of grout.

d. The guides or centralizers shall be attached to the bottom of the casing and at intervals not greater than 25 feet.

e. The grout shall be placed under pressure by a positive displacement method, such as pumping, from the bottom of the annular space upward until the grout is extruded at the earth's surface in one continuous operation.

f. Subsurface well construction shall cease for at least twenty-four (24) hours after grouting.

5.2.7 TESTING AND RECORDS

5.2.7.1 YIELD AND DRAWDOWN TESTS

a. The test shall be performed on every production well after construction or subsequent treatment and prior to placement of the permanent pump.

b. The test methods shall be clearly indicated in the project specifications.

c. The test pump should have a capacity at least 1.5 times the flow anticipated at maximum anticipated drawdown.

d. The well shall be test pumped at not less than the desired yield for a period of at least twenty-four (24) hours and shall continue for at least four (4) hours after the pumping level has stabilized.

e. The methods of testing shall include but are not limited to the following:

1. Constant Discharge Method - This type of test is preferred for wells completed in unconsolidated aquifers. It is made by maintaining a constant rate of discharge equal to or greater than the desired yield of the well throughout the entire period of pumping. Measurements of pumping rate and water level shall be made every minute for the first 10 minutes of the test, every 2 minutes for the next 10 minutes, every 5 minutes for the next 40 minutes, every 15 minutes for the next hour, every 30 minutes for the next 3 hours, hourly for the remainder of the pumping period. Recovery water-level measurements shall be made with the same frequency beginning with the cessation of pumping and continuing until complete recovery has occurred or until sufficient data have been collected to extrapolate full recovery.

2. Step Drawdown Method - This method is preferred for wells completed in consolidated rock formations. It involves the wellbeing "step" tested at rates approximately 1/2, 1, and 1-1/2 times the design capacity of the well. Each step should consist of equal periods of pumping except the final step may be continued for a longer period of time if desired by the owner. The pump is operated continuously for the entire period of the test. The discharge must be controlled with a gate valve, if electric driven, or a gate valve and throttle if engine driven. The discharge is controlled and maintained at approximately the desired discharge for each step with an accuracy of + 5 percent. Pump discharge is measured with a meter such as a circular orifice meter that will permit instantaneous determination of the discharge rate. A half-inch I.D. or larger pipe is installed from a point about 2 feet above the pump intake to the well head. The top of the pipe is readily accessible to insert remove and read the depth to water using either a steel tape or 2-wire electric sounder. Measurements of pumping rate and water level are made for each step of the

test according to the schedule given in the constant discharge method. Recovery water-level measurements are made with the same frequency until the well has fully recovered or until sufficient data have been recovered to extrapolate full recovery. The test pump shall be capable of pumping 150 percent of the desired yield of the well.

f. The pumping equipment shall be capable of operating continuously without interruption for the maximum period contemplated for the test.

g. The following data shall be submitted to the Division:

1. test pump capacity-head characteristics;

2. static water level;

3. depth of test pump setting;

4. time of starting and ending each test cycle**;** and

5. the zone of influence for the well or wells.

h. A report shall be submitted which provides recordings and graphic evaluation of the following at one-hour intervals or less as may be required by the Division:

1. pumping rate;

2. pumping water level;

3. drawdown; and

4. water recovery rate and levels.

i. At the discretion of the Division, more comprehensive testing may be required.

5.2.7.2 <u>PLUMBNESS AND ALIGNMENT REQUIREMENTS</u>

a. Every well shall be tested for plumbness and alignment in accordance with current AWWA Standards.

b. The test method and allowable tolerance shall be clearly stated in the specifications.

c. The well fails to meet these requirements, it may be accepted by the engineer if it does not interfere with the installation or operation of the pump or uniform placement of grout.

5.2.7.3 RETENTION OF RECORDS

The owner of each well shall retain all records pertaining to each well, until the well has been properly abandoned.

5.2.7.4 GRAVEL PACK WELLS

a. Gravel pack materials shall be sized based on sieve analysis of the formation and disinfected immediately prior to or during placement.

b. The gravel for gravel-packed wells must be washed, free of organic matter, and composed of well-rounded particles which are 95% siliceous material.

c Gravel pack shall be placed in one uniform continuous operation.

d. Gravel refill pipes, when used, shall be Schedule 40 steel pipe incorporated within the pump foundation and terminated with screwed or welded caps at least 12 inches above the pump house floor or concrete apron.

e. Gravel refill pipes located in the grouted annular opening shall be surrounded by a minimum 1-1/2 inches of grout.

f. Protection from leakage of grout into the gravel pack or screen shall be provided.

g. Gravel pack shall be placed in a manner that prevents segregation and gradation during placement.

h. The annular space between the well screen and the hole shall be adequate to allow proper placement of gravel pack.

5.2.7.5 WELL SCREENS

a. Shall be constructed of material which will not be damaged by the chemical action of ground water or future cleaning operations;

b. Have the size of openings based on sieve analysis of the formation and/or based on the size of gravel if any artificial gravel pack is installed;

c. Have sufficient length and diameter to provide adequate specific capacity and low aperture entrance velocity. Usually, the entrance velocity should not exceed 0.1 feet per second;

d. Be installed so that the pumping water level remains above the screen under all operating conditions;

e. Be designed and installed to permit removal or replacement without adversely affecting the water-tight construction of the well; and

f. Be provided with a bottom plate or washdown bottom fitting of the same material as the screen.

5.2.8 WELL DEVELOPMENT

a. The well shall be properly developed, disinfected, and pump tested by the drilling contractor.

b. Development of the well shall accomplish removal of native silts and clays, drilling mud or finer fraction of the gravel pack, and shall continue until the maximum specific capacity is obtained from the completed well.

c. Where chemical conditioning is required, the specifications shall include provisions for the method, equipment, chemicals, testing for residual chemicals, and disposal of waste and inhibitors.

d. Where blasting procedures may be used, the specifications shall include the provisions for blasting and cleaning. Special attention shall be given to assure that the grouting and casing are not damaged by the blasting.

e. At all times during the progress of work, the contractor shall provide protection to prevent tampering with the well or entrance of foreign materials.

f. During the period of stoppage of the well construction and when the site is unattended, the drilling contractor must have the well opening securely covered to prevent tampering and possible contamination. A welded metal plate is preferred for capping a well.

g. During the well construction, the premises, construction material, tools and equipment must be maintained in a sanitary manner to prevent contamination of the well by the person excavating the well.

5.2.8.1 CAPPING REQUIREMENTS

a. All wells, temporary or permanent, shall be effectively located/sealed against the entrance of water and contaminants.

b. A welded metal plate or a threaded cap shall be used unless otherwise approved by the Division.

5.2.9 WELL DISINFECTION

a. The well must be disinfected prior to the pumping test by the introduction of a chlorine solution into the well under sufficient pressure to overcome the natural flow pressures of all developed water-bearing zones, and in sufficient quantity to produce a minimum chlorine residual of fifty (50) parts per million (mg/L) in six (6) hours after such application.

b. Refer to the Table below to determine chlorine compound necessary to dose 100 feet of water-filled well at 50 mg/L:

Well-Hole or Well-Casing Diameter (in inches)	Volume Per 100 ft Of Water Depth (in gallons)	Amount of Chemical Compound		
		Calcium Hypochlorite (65% avail. Cl_2)	Sodium Hypochlorite (12 trade %)	Liquid Chlorine (100% avail. Cl_2) (in pounds)
4	65.28	0.7 oz	3.5 fl. oz	0.03
6	146.9	1.5 oz	7.8 fl. oz	0.06
8	261.1	2.7 oz	13.9 fl. oz	0.11
10	408.0	4.2 oz	1.4 pt.	0.17
12	587.5	6.0 oz	2.0 pt.	0.25
16	1044.0	10.7 oz	3.5 pt.	0.44
20	1632.0	1 lb. 1 oz	0.7 gal	0.68
24	2350.0	1 lb. 8 oz	1.0 gal	0.98
30	3672.0	2 lb. 6 oz	1.5 gal	1.53

c. After disinfection, the well must be pumped until no trace of chlorine remains in the water, nor in the water samples taken for microbiological analysis. If the water samples submitted are found to be unsatisfactory, the disinfection procedure must be repeated.

d. The permanent pump and pumping equipment shall be disinfected with a chlorine solution prior to being placed into service.

e. Well Disinfection shall be done in accordance with AWWA C654.

5.2.10 WELL APPURTENANCES

a. A concrete slab with a minimum thickness of six (6) inches shall be constructed around the well casing and shall extend at least two (2) feet in all directions, sloping away from the casing.

b. The well casing shall extend at least twelve (12) inches above the concrete slab of the floor.

c. For turbine pump installations, a concrete block to support the pump motor shall be constructed around the outer well casing, shall extend at least twelve (12) inches above the concrete slab, and

   1. the outer casing shall extend at least one (1) inch above the pump motor block;

   2. the well head and pump base shall be sealed to prevent seepage and the casing shall be vented by a screened riser pipe so that the screen opening terminates downward and above any point of back flow of contaminants into the well; and

   3. oil lubricated vertical turbine pumps shall be lubricated with an acceptable turbine oil as prescribed by the pump manufacturer.

5.2.10.1 LINE SHAFT PUMPS

Wells equipped with line shaft pumps shall:

a. have the casing firmly connected to the pump structure or have the casing inserted into a recess extending at least one-half inch into the pump base;

b. have the pump foundation and base designed to prevent water from coming into contact with the joint; and

c. be water lubricated. If oil lubricated pumps are proposed, food grade lubricant shall be used.

5.2.10.2 SUBMERSIBLE PUMPS

Where a submersible pump is used:

a. the pump shall be water lubricated;

b. mercury seals shall not be permitted;

c. the top of the casing shall be effectively sealed against the entrance of water under all conditions of vibration or movement of conductors or cables;

d. the electrical cable shall be firmly attached to the riser pipe at 20-foot intervals or less; and

e. during installation, the well casing shall be provided with a sealed cover plate and, vented by a screened riser pipe so that the screened opening terminates downward at least twelve (12) inches above the top of the casing or ground level.

5.2.10.3 NATURALLY FLOWING WELLS

a. Naturally flowing wells shall require special consideration by the Division where there is an absence of an impervious confining layer.

b. Flow shall be controlled. Overflows shall discharge at least 18 inches above grade and flood level and be visible. Discharge shall be to an effective drainage structure.

c. Permanent casing and grout shall be provided.

d. If erosion of the confining bed appears likely, special protective construction may be required by the Division.

5.2.11 DISCHARGE PIPING

Discharge piping shall:

a. be designed to keep friction losses at minimum;

b. be equipped with a check valve, a shutoff valve, a pressure gauge and a means of measuring flow (water meter);

c. be provided with a raw water sampling tap prior to the well discharge pipe check valve;

d. where applicable, be equipped with an air release-vacuum relief valve located upstream from the check valve, with exhaust/relief piping terminating in a down-turned position at least 18 inches above the floor and covered with a 24-mesh corrosion resistant screen;

e. have an access port of not less than five-eighths (5/8) inch in diameter, with screw cap, for water level measurements; a deep well airline and gauge may also be used in conjunction with the access port;

f. where pneumatic water level measuring equipment is used, it shall be manufactured using corrosion resistant materials attached firmly to the drop pipe or pump column and in such a manner as to prevent the entrance of foreign materials;

g. have all chemical injection ports located downstream from the well discharge pipe check valve;

h. have control valves and appurtenances located above the pumphouse floor;

i. have all exposed piping, valves and appurtenances protected against physical damage or freezing;

j. be properly anchored to prevent movement;

k. be protected against surge or water hammer;

l. be valved or have means of pumping to waste (a blow-off) but shall not be directly connected to a sewer;

m. conform to the latest standards issued by the ASTM, AWWA and ANSI/NSF, where such standards exist;

n. be constructed so that it can be disconnected from the well or well pump to allow the well pump to be pulled; and

o. for submersible, jet and line shaft pumps, the discharge, drop or column piping inside the well shall:

    1. conform to the latest standards issued by the ASTM, AWWA and ANSI/NSF, where such standards exist. Any, fittings, brackets, tape or other appurtenances shall meet ANSI/NSF Standard 61, where applicable; and

    2. be capable of supporting the weight of the pump, piping, water and appurtenances and of withstanding the thrust, torque and other reaction loads created during pumping. The actions of fatigue from repeated starting and stopping of the pump shall be considered when choosing a pipe and fittings.

5.3.0 SPRINGS

a. Springs must be protected by an enclosed structure. The walls of the structure must extend down to bedrock, or into the soil sufficiently to provide for a proper foundation to prevent surface water infiltration.

b. All surface water run-off must be diverted from the spring.

c. The spring must be protected from any entry of surface water.

d. The overflow from the spring's enclosed structure must be designed to prevent entrance of contaminants or animals.

e. A chlorine contact time of at least 30 minutes shall be provided.

f. Continuous turbidity monitoring shall be provided with an automatic cutoff at 1.0 NTU.

g. The pumping and water treatment facilities must be enclosed in shelters that are of weather and vandal-proof construction.

PART 6 - DESIGN CAPACITIES AND WATER DEMANDS

An important factor in the planning and design of a water system is an accurate estimate of the quantities of water which must be supplied to meet water needs. These estimates are pivotal to the entire design including the production of water, pumping, treatment, storage, and the distribution system. Each water system component is designed to meet certain flow requirements and to ensure that water will be available at the various water use points throughout the system in adequate quantities to meet demands. Accordingly, new water systems or existing water systems seeking expansion should:

1. Engage services of Professional Engineer with experience in developing water demand projections and designing water systems in Georgia. The requirements of using the services of a Professional Engineers does not apply to Transient and Non-Transient non community water system.

2. For small water systems serving a few large customers, demand should be estimated based on study of these customer's specific water need.

3. System specific demands should be developed using methodologies outlined in most recent edition of American Water Works Publication "Forecasting Water Demand" (Billings, R Bruce and Clive Vaughn Jones. 2008 currently in its second edition). In estimating demand provision should be made for leaks in the system, fire suppression needs and a reasonable safety factor.

4. Most recent regional water planning data such as those produced from the local Water Planning district should be used in forecasting demands.

5. Past assumption should be periodically reviewed given that pattern of water usage and demands change over time and are reasonably likely to continue changing for the foreseeable future. Provision should also be made for leaks in the system, fire suppression needs and a reasonable safety factor.

6. In the absence of any specific data from the above referenced sources, in accordance with Section 391-3-5-.06 of the Rules, all sources of water supply must be adequate as determined by the Division to meet anticipated growth. For human consumption in a community water system, average daily demand of one hundred (100) gallons per day for the projected population to be served at the end of the design period shall be considered adequate.

6.1 DAILY, HOURLY AND PEAK WATER DEMANDS FOR RESIDENTIAL WATER SYSTEM

Average Daily Demand expresses the quantity of water used in a system in an average day. It is based upon experience from water meter readings in similar water systems over an extended period and reflects the normal seasonal and daily variations. For design purposes, it is usually determined by estimating the population or units of housing or other units and multiplying by an average per person or per unit water consumption derived from past experience. The average daily demand will be exceeded on many days (during peak demands), so it is not appropriate to design merely for the average. The greatest amount of water usage in one day or other period of time must be considered.

The following provides a guide for estimating the average daily demand for various types of establishments, in gallons per day per unit. The unit is persons per day unless otherwise indicated. The values are for normal water requirements and do not include special needs or unusual conditions. Additional allowances should be made for firefighting, lawn watering, swimming pool, industrial or commercial process water and other special uses.

Type of Establishment (The unit is per person unless otherwise stated)	Average Daily Use (gallons per day)
Camps - Children, overnight, central facilities	50
- Construction	50
- Migrant Labor	50
- Day type, no meals served	20
Cottages, season occupancy	50
Clubs - Residential	100
- Nonresidential	25
Parks – Day use (with flush toilets)	5
- Mobile Homes (per unit)	200
- Travel trailers (per unit)	100
Picnic Areas (with flush toilets)	10
Schools – Day, no showers or cafeteria	15
- Day, with cafeteria	20
- Day, with showers and cafeteria	25
- Residential types	100
Residential Communities (Less than 375 connections)	
Single Family Dwelling (per person)	100
- Single Family Dwelling (per house maximum)	400
- Multi-family (per bedroom)	120
- Rooming house/tourist home (per bedroom)	120

a. Maximum Daily Demand expresses the greatest amount of water a system will use in one day. Small residential water systems may experience that their maximum day is 1.5 to 2 times the average day. In general, the smaller the water system, the greater the variation between the average and the maximum day.

b. Maximum Hourly Demand expresses the greatest amount of water which will be used in any hour during the day. This is sometimes referred to as the peak hour demand, although there will be short term peak demand rates lasting for several minutes which will exceed the maximum hourly demand rate. Each type of system exhibits its own maximum hourly and short-term peak demands and the hours of peak occurrence will vary. For example, residential communities may experience two peak hours, about 8:00 a.m. and 6:00 p.m. The maximum hourly demand is often expressed as a ratio of the average daily demand, in gallons per minute. Generally speaking, the smaller the water system, the greater the maximum hour rate in respect to the average daily rate. The peak hourly demand at small residential communities may range about 6 to over 10 times the average daily demand.

e. Peak Demand (instantaneous demand) is the maximum amount of water necessary to meet the peak short-term demand rate which may occur several times during a day, usually occurring during the peak hour period. The instantaneous peak may last for several minutes. The rate is particularly important in considering the sizing of the storage tank in a hydropneumatics system. The effective storage capacity is usually designed to meet these short term peaks. The minimum effective storage volume of pressure tanks, in gallons, shall equal the peak demand, in gallons per minute (gpm), minus the pumping capacity (gpm), multiplied by 20. In the absence of sufficient effective storage to meet extended peak demands, the wells and pumps must be capable of meeting the peak demands. The smaller the water system, the greater the ratio of the peak demand to the average demand.

INSTANTANEOUS (PEAK) DEMAND FOR RESIDENTIAL COMMUNITIES

Number of Connections	Gallons Per Minute
10	40
15	50
20	58
25	66
30	73
35	80
40	85
45	91
50	96
55	101
60	106
70	115
80	124
90	132

INSTANTANEOUS (PEAK) DEMAND FOR RESIDENTIAL COMMUNITIES (CONTINUED)

Number of Connections	Gallons Per Minute
100	140
125	160
150	175
175	195
200	205
250	230
300	255
400	295

Note: It should be noted that fire flow is not included in the definition of average daily and maximum daily demands and should be added if fire protection is desired. Fire flows are usually expressed as gallons per minute to fight a fire of a certain duration and could be designed into a water system for firefighting purposes. Local fire underwriters could provide specific requirements on request.

INSTANTANEOUS (PEAK) DEMAND FOR MOBILE HOME PARK WATER SYSTEMS

Number of Connections	Gallons Per Minute
10	25
15	31
20	37
25	42
30	46
35	50
40	54
45	57
50	60
55	64
60	66
70	72
80	78
90	84
100	88
125	100
150	110
200	128
250	145
300	160

INSTANTANEOUS (PEAK) DEMAND FOR CAMPGROUND & TRAVEL TRAILER WATER SYSTEMS

Number of Connections	Gallons Per Minute
20	25
25	32
40	38
50	43
60	47
80	55
100	60
120	69
140	73
160	80
180	85
200	90
300	110
400	130

PART 7 – CHEMICALS

All chemicals that come into contact with the public water system during drinking water treatment shall be certified for conformance with the NSF Standard 60.

7.1 CHLORINE GAS

a. Enclosed and separated from other operating areas in order to prevent injury to personnel and damage to equipment.

b. Provided with a shatter resistant inspection window installed in an interior wall, to permit viewing of the interior of the room and equipment.

c. Constructed in such a manner that all openings between the chlorine room and the remainder of the plant are sealed.

d. Provided with doors equipped with panic hardware, assuring ready means of exit and opening outward only to the building exterior.

e. Provided with locks to prevent unauthorized entry.

f. Full and empty cylinders of chlorine gas should be:

1. Isolated from operating areas;

2. restrained in position to prevent upset;

3. stored in rooms separate from ammonia storage; and

4. stored in areas not in direct sunlight or exposed to excessive heat.

g. Where chlorine gas is used, the room shall be constructed to provide the following:

1. Each room shall have a ventilating fan with a capacity which provides one complete air change per minute when the room is occupied;

2. the air outlet from the room shall be near the floor level and the point of discharge shall be so located as not to contaminate air inlets to any rooms or structures, or adversely affect the surrounding environment;

3. air inlets should be through louvers near the ceiling, and temperature controlled to prevent adverse effect on chlorinator;

4. louvers for chlorine room air intake and exhaust fan shall facilitate airtight closure;

5. separate switches for the fan and lights shall be located outside of the chlorine room, at the entrance. The exhaust fan should automatically be activated when the door is opened. Outside switches shall be protected from vandalism. A signal light indicating fan operation shall be provided at each entrance when the fan can be controlled from more than one point;

6. vents from feeders and storage shall discharge to the outside atmosphere, above grade;

7. the room location should be on the prevailing downwind side of the building away from entrances, windows, louvers, walkways, etc.;

8. floor drains are discouraged. Where provided, the floor drains shall discharge to the outside of the building and shall not be connected to other internal or external drainage systems;

9. chlorinator rooms should be heated to 60^0 F but should be protected from excessive heat. Cylinders and gas lines should be protected from temperatures above that of the feed equipment;

10. pressurized chlorine feed lines shall not carry chlorine gas beyond the chlorinator room; and

11. gaseous feed chlorine installations shall be equipped with a gas detection device connected to both an audible alarm and warning lights to prevent undetected potentially dangerous leakage of chlorine gas.

h. Chlorine gas feed systems shall be of the vacuum type and include the following:

1. vacuum regulators on all individual cylinders in service or on the manifold when multiple cylinders are manifolded together; and

2. service water to injectors/eductors shall be of adequate supply and pressure to operate feed equipment within the needed chlorine dosage range for the proposed system.

i. Premanufactured chlorine cabinets may be used for retrofit situations only. These cabinets shall have an observation window, fan, air intake, ventilation and light as required in section (g) above for normal chlorine gas rooms. These cabinets should not be placed on the sunny side of the building.

7.2 ACIDS AND CAUSTICS

a. Acids and caustics shall be kept in closed corrosion-resistant shipping containers or storage units.

b. Acids and caustics shall not be handled in open vessels but should be pumped in undiluted form from original containers through suitable hose, to the point of treatment or to day tanks.

c. Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.

d. Liquid caustic (50% sodium hydroxide solution) which is hazardous and may be lost from solution at low temperatures.

7.3 SODIUM CHLORITE

For Sodium Chlorite in chlorine dioxide generation, provisions shall be made for proper storage and handling of sodium chlorite to eliminate any danger of explosion.

a. STORAGE

1. Sodium chlorite shall be stored by itself in a separate room and preferably shall be stored in an outside building detached from the water treatment facility. It must be stored away from organic materials which would react violently with sodium chlorite.

2. The storage structures shall be constructed of noncombustible materials.

3. If the storage structure must be located in an area where a fire may occur, water must be available to keep the sodium chlorite area cool enough to prevent decomposition from heat and the resultant explosive conditions.

b. HANDLING

1. Care should be taken to prevent spillage.

2. An emergency plan of operation should be available for the up of any spillage.

3. Storage drums must be thoroughly flushed prior to recycling or Disposal.

c. FEEDERS

1. Positive displacement feeders shall be provided.

2. Tubing for conveying sodium chlorite or chlorine dioxide solutions shall be Type 1 PVC, polyethylene or materials recommended by the manufacturer.

3. Chemical feeders may be installed in chlorine rooms if sufficient space is provided or facilities meeting the requirements stated in this document shall be provided.

4. Feed lines shall be installed in a manner to prevent formation of gas pockets and shall terminate at a point of positive pressure.

5. Check valves shall be provided to prevent the backflow of chlorine into the sodium chlorite line.

7.4 SODIUM HYPOCHLORITE

Sodium hypochlorite storage and handling procedures should be arranged to minimize the slow natural decomposition process of sodium hypochlorite either by contamination or by exposure to more extreme storage conditions. In addition, feed rates should be regularly adjusted to compensate for this progressive loss in chlorine content.

a. STORAGE

1. Sodium hypochlorite shall be stored in the original shipping containers or in sodium hypochlorite compatible bulk liquid storage tanks.

2. Storage containers or tanks greater than 55 gallons shall be located out of the sunlight in a cool area and shall be vented to the outside of the building.

3. Wherever reasonably feasible, stored sodium hypochlorite shall be pumped undiluted to the point of addition. Where dilution is unavoidable, it is recommended deionized or softened water should be used. Water used for dissolution shall be softened if hardness exceeds 50 mg/L as calcium carbonate.
4. Storage areas, tanks, and pipe work shall be designed to avoid the possibility of uncontrolled discharges and a sufficient amount of appropriately selected spill absorbent shall be stored on-site.

5. Reusable sodium hypochlorite storage containers shall be reserved for use with sodium hypochlorite only and shall not be rinsed out or otherwise exposed to internal contamination.

b. FEEDERS

1. Positive displacement pumps with sodium hypochlorite compatible materials for wetted surfaces shall be used.

2. To avoid air locking in smaller installations, small diameter suction lines shall be used with foot valves and degassing pump heads.

3. In larger installations flooded suction shall be used with pipe work arranged to ease escape of gas bubbles.

4. Calibration tubes or mass flow monitors which allow for direct physical checking of actual feed rates shall be provided.

5. Injectors shall be made removable for regular cleaning where hard water is to be treated.

7.5 AMMONIA

Ammonia for chloramine formation may be added to water either as a water solution of ammonium sulfate, or as aqua ammonia, or as anhydrous ammonia (purified 100% ammonia in liquid or gaseous form). Special provisions required for each form of ammonia are listed below.

7.5.1 AMMONIUM SULFATE

A water solution is made by addition of ammonium sulfate solid to water with agitation. The tank and dosing equipment contact surfaces should be made of corrosion resistant nonmetallic materials. Provision should be made for removal of the agitator after dissolving the solid. The tank should be fitted with an air-tight lid and vented outdoors. The application point should be at the center of treated water flow at a location where there is high velocity movement.

7.5.2 AQUA AMMONIA (AMMONIUM HYDROXIDE)

Aqua ammonia feed pumps and storage shall be enclosed and separated from other operating areas. The aqua ammonia room shall be equipped as in Section 7.1 with the following changes:

a. Corrosion resistant, closed, unpressurized tank shall be used for bulk liquid storage and day tanks, vented through inert liquid traps to a high point outside.

b. An incompatible connector or lockout provisions shall be provided to prevent accidental addition of other chemicals to the bulk liquid storage tank(s).

c. The bulk liquid storage tank(s) shall be designed to avoid conditions where temperature increases cause the ammonia vapor pressure over the aqua ammonia to exceed atmospheric pressure. Such provisions shall include either:

   1. refrigeration or other means of external cooling; and/or;

   2. dilution and mixing of the contents with water without opening the bulk liquid storage tank.

d. An exhaust fan shall be installed to withdraw air from high points in the room and makeup air shall be allowed to enter at a low point.

e. The aqua ammonia feed pump, regulators, and lines shall be fitted with pressure relief vents discharging outside the building away from any air intake and with water purge line leading back to the headspace of the bulk storage tank.

f. The aqua ammonia shall be conveyed direct from a day tank to the treated water stream injector without the use of a carrier water stream unless the carrier stream is softened.

g. The application point should be placed in a region of rapid, preferably turbulent, water flow.

h. Provisions should be made for easy access for removal of calcium scale deposits from the injector.

i. Provision of a modestly sized scrubber capable of handling occasional minor emissions should be considered.

7.5.3 ANHYDROUS AMMONIA

Anhydrous ammonia is readily available as a pure liquefied gas under moderate pressure in cylinders or as a cryogenic liquid boiling at -15°C at atmospheric pressure. The liquid causes severe burns on skin contact.

a. Anhydrous ammonia and storage feed systems (including heaters where required) shall be enclosed and separated from other works areas and constructed of corrosion resistant materials.

b. Pressurized ammonia feed lines should be restricted to the ammonia room and any feed lines located outside the room should be installed in airtight conduit pipe.

c. An emergency air exhaust system, as in Section 7.1 g. 1 but with an elevated intake, shall be provided in the ammonia storage room.

d. Leak detection systems shall be provided in all areas through which ammonia is piped.

e. Special vacuum breaker/regulator provisions must be made to avoid potentially violent results of backflow of water into cylinders or storage tanks.

f. Carrier water systems of soft or pre-softened water may be used to transport ammonia to the application point and to assist in mixing.

g. The ammonia injector should use a vacuum eductor or should consist of a perforated tube fitted with a closely fitting flexible rubber tubing seal punctured with a number of small slits to delay fouling by lime or other scale deposits.

h. Provision should be made for the periodic removal of lime or other scale deposits from injectors and carrier piping.

i. Consideration shall be given to the provision of an emergency gas scrubber capable of absorbing the entire contents of the largest anhydrous ammonia storage unit whenever there is a risk to the public as a result of potential ammonia leaks.

7.6 CALCIUM HYPOCHLORITE AND POTASSIUM PERMANGANATE

Calcium hypochlorite and potassium permanganate may ignite spontaneously on contact with combustible substances. A source of heated water or a heated tank should be available for dissolving potassium permanganate and mechanical mixers shall be provided.

7.7 FLUORIDE

Sodium fluoride, sodium silicofluoride and hydrofluosilicic acid shall conform to the applicable AWWA standards and be ANSI/NSF Standard 60 certified. Other fluoride compounds which may be available must be approved by the Division.

In addition to the requirements listed under “Chemical Application” in this document, the fluoride feed equipment shall meet the following requirements.

a. STORAGE:

1. Fluoride chemicals should be isolated from other chemicals to prevent contamination.

2. Compounds shall be stored in covered or unopened shipping containers and should be stored inside a building.

3. Unsealed storage units for fluosilicic acid should be vented to the atmosphere at a point outside any building. The vents to atmosphere shall be provided with a corrosion resistant 24 mesh screen.

4. Bags, fiber drums and steel drums should be stored on pallets.

b. <u>CHEMICAL FEED EQUIPMENT AND METHODS</u>

1. At least two diaphragm operated anti-siphon devices shall be provided on all fluoride saturator or fluosilicic acid feed systems.

    a. One diaphragm operated anti-siphon device shall be located on the discharge side of the feed pump; and

    b. A second diaphragm operated anti-siphon device shall be located at the point of application unless a suitable air gap is provided.

2. A physical break box may be required in high hazard situations where the application point is substantially lower than the metering pump. In this situation, either a dual head feed pump or two separate pumps are required and the anti-siphon device at the discharge side of the pump may be omitted.

3. Scales, loss-of-weight recorders or liquid level indicators as appropriate for dry or acid chemical feeds, accurate to within five percent of the average daily change in reading shall be provided for chemical feeds.

4. Feeders shall be accurate to within five percent of any desired feed rate. Dry volumetric feeders are to have percent-of cycle timer or variable speed drive. A minimum of 35-gallon dissolver with mechanical mixer shall be used.

5. Fluoride compound shall not be added before lime-soda softening or ion exchange softening.

6. The point of application if into a horizontal pipe, shall be in the lower half of the pipe, preferably at a 45-degree angle from the bottom of the pipe and protrude into the pipe one third of the pipe diameter.

7. Except for constant flow systems, a device to measure the flow of water to be treated is required.

8. Water used for sodium fluoride dissolution shall be softened if hardness exceeds 50 mg/L as calcium carbonate. The dilution water pipe shall terminate at least two pipe diameters above the solution tank.

9. Fluoride solutions shall be injected at a point of continuous positive pressure unless suitable air gap is provided.

10. The electrical outlet used for the fluoride feed pump should have a nonstandard receptacle and shall be interconnected with the well or service pump, or have flow pacing as allowed by the Division.

11. Saturators should be of the upflow type and be provided with a meter and backflow protection on the makeup water line.

12. Fluoridation equipment and chemicals, must be placed in a separate room or facility provided for that purpose.

13. A fluoride solution shall be applied by a positive displacement pump having a stroke rate not less than 20 strokes per minute.

c. SECONDARY CONTROLS

Secondary control systems for fluoride chemical feed devices shall be provided as a means of reducing the possibility for overfeed; these may include flow or pressure switches, break boxes, or other devices.

d. PROTECTIVE EQUIPMENT

Personal protective equipment shall be provided for operator handling fluoride compounds. Deluge showers and eye wash devices shall be provided at all fluosilicic acid installations.

e. DUST CONTROL

1. Provision must be made for the transfer of dry fluoride compounds from shipping containers to storage bins or hoppers in such a way as to minimize the quantity of fluoride dust which may enter the room in which the equipment is installed.

2. The enclosure shall be provided with an exhaust fan and dust filter which places the hopper under a negative pressure. Air exhausted from fluoride handling equipment shall discharge through a dust filter to the outside atmosphere of the building.

3. Provision shall be made for disposing of empty bags, drums or barrels in a manner which will minimize exposure to fluoride dusts.

4. A floor drain should be provided to facilitate the washing of floors.

f. TESTING EQUIPMENT

Equipment shall be provided for measuring the quantity of fluoride in the water. Such equipment shall be subject to the approval of the Division.

g. HYDROFLUOSILICIC ACID

It is extremely corrosive. Fumes or spillage may damage equipment or structures.

7.8 ACTIVATED CARBON (GRANULAR OR POWDERED)

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

7.9 COPPER SULFATE AND OTHER COPPER COMPOUNDS

Continuous or periodic treatment of water supplies (lakes, off-line reservoirs, impoundments) with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of 1.0 milligrams per liter as copper in the plant effluent or distribution system. Care shall be taken to assure an even distribution and to prevent fish kills. A dose at 0.9 lb./acre-foot may be considered for waters with alkalinity less than 50 mg/l and 5.4 lb./acre-foot if alkalinity is greater than 50 mg/L.

7.10 OZONE

7.10.1 DESIGN CONSIDERATIONS

Ozonation systems are generally used for the purpose of disinfection, oxidation and microflocculation. When applied, all of these reactions may occur but typically only one is the primary purpose for its use. The other reactions would become secondary benefits of the installation.

Effective disinfection occurs as demonstrated by the fact that the "CT" values for ozone, for inactivation of viruses and Giardia cysts, are considerably lower than the "CT" values for other disinfectants. In addition, recent research indicates that ozone can be an effective disinfectant for the inactivation of cryptosporidium. Microflocculation and enhanced filterability has been demonstrated for many water supplies but has not occurred in all waters. Oxidation of organic compounds such as color, taste and odor, and detergents and inorganic compounds such as iron, manganese, heavy metals and hydrogen sulfide has been documented. The effectiveness of oxidation has been varied, depending on pH and alkalinity of the water.

These parameters affect the formation of highly reactive hydroxyl radicals, or, conversely the scavenging of this oxidant. High levels of hydroxyl radicals cause lower levels of residual ozone. Depending on the desired oxidation reaction, it may be necessary to maximize ozone residual or maximize hydroxyl radical formation. For disinfection, residual ozone is necessary for development of "CT".

As a minimum, bench scale studies shall be conducted to determine minimum and maximum ozone dosages for disinfection "CT" compliance and oxidation reactions. More involved pilot studies shall be conducted when necessary to document benefits and DBP precursor removal effectiveness. Consideration shall be given to multiple points of ozone addition. Pilot studies shall be conducted for all surface waters. Extreme care must be taken during bench and pilot scale studies to ensure accurate results. Particularly sensitive measurements include gas flow rate, water flow rate, and ozone concentration.

Following the use of ozone, the application of a disinfectant which maintains a measurable residual will be required in order to ensure bacteriologically safe water is carried throughout the distribution system.

Furthermore, because of the more sophisticated nature of the ozone process a higher degree of operator maintenance skills and training is required. The ability to obtain qualified operators must be evaluated in selection of the treatment process. The necessary operator training shall be provided prior to plant startup.

The production of ozone is an energy intensive process: substantial economies in electrical usage, reduction in equipment size, and waste heat removal requirements can be obtained by using oxygen enriched air or 100% oxygen as feed, and by operating at increased electrical frequency.

Use of ozone may result in increases in biologically available organics content of the treated water. Consideration of biologically active filtration may be required to stabilize some treated waters. Ozone use may also lead to increased chlorinated byproduct levels if the water is not stabilized and free chlorine is used for distribution protection.

Other Applications – ozone can be used for algal control, advanced oxidation, and other treatment processes. Contact the Division for other requirements.

7.10.2 FEED GAS PREPARATION

a. GENERAL

Feed gas can be air, oxygen enriched air, or high purity oxygen. Sources of high purity oxygen include purchased liquid oxygen; on site generation using cryogenic air separation; or temperature, pressure or vacuum swing (adsorptive separation) technology. For high purity oxygen-feed systems, dryers typically are not required.

Air handling equipment on conventional low pressure air feed systems shall consist of an air compressor, water/air separator, refrigerant dryer, heat reactivated desiccant dryer, and particulate filters. Some "package" ozonation systems for small plants may work effectively operating at high pressure without the refrigerant dryer and with a "heat-less" desiccant dryer. In all cases the design engineer must ensure that the maximum dew point of -76ºF (-60ºC) will not be exceeded at any time.

b. AIR COMPRESSION

1. Air compressors shall be of the liquid-ring or rotary lobe, oil-less, positive displacement type for smaller systems or dry rotary screw compressors for larger systems.

2. The air compressors shall have the capacity to simultaneously provide for maximum ozone demand, provide the air flow required for purging the desiccant dryers (where required) and allow for standby capacity.

3. Air feed for the compressor shall be drawn from a point protected from rain, condensation, mist, fog and contaminated air sources to minimize moisture and hydrocarbon content of the air supply.

4. A compressed air after-cooler and/or entrainment separator with automatic drain shall be provided prior to the dryers to reduce the water vapor.

5. A back-up air compressor must be provided so that ozone generation is not interrupted in the event of a break-down.

c. AIR DRYING

1. Dry, dust-free and oil-free feed gas must be provided to the ozone generator. Dry gas is essential to prevent formation of nitric acid, to increase the efficiency of ozone generation and to prevent damage to the generator dielectrics. Sufficient drying to a maximum dew point of -76°F (-60°C) must be provided at the end of the drying cycle.

2. Drying for high pressure systems may be accomplished using heatless desiccant dryers only. For low pressure systems, a refrigeration air dryer in series with heat-reactivated desiccant dryers shall be used.

3. A refrigeration dryer capable of reducing inlet air temperature to 40°F (4°C). shall be provided for low pressure air preparation systems. The dryer can be of the compressed refrigerant type or chilled water type.

4. For heat-reactivated desiccant dryers, the unit shall contain two desiccant filled towers complete with pressure relief valves, two four-way valves and a heater. In addition, external type dryers shall have a cooler unit and blowers. The size of the unit shall be such that the specified dew point will be achieved during a minimum adsorption cycle time of 16 hours while operating at the maximum expected moisture loading conditions.

5. Multiple air dryers shall be provided so that the ozone generation is not interrupted in the event of dryer breakdown.

6. Each dryer shall be capable of venting "dry" gas to the atmosphere, prior to the ozone generator, to allow start-up when other dryers are "on-line".

d. AIR FILTERS

1. Air filters shall be provided on the suction side of the air compressors, between the air compressors and the dryers and between the dryers and the ozone generators.

2. The filter before the desiccant dryers shall be of the coalescing type and be capable of removing aerosol and particulates larger than 0.3 microns in diameter. The filter after the desiccant dryer shall be of the particulate type and be capable of removing all particulates greater than 0.1 microns in diameter, or smaller if specified by the generator manufacturer.

e. PREPARATION PIPING

Piping in the air preparation system can be common grade steel, seamless copper, stainless steel or galvanized steel. The piping must be designed to withstand the maximum pressures in the air preparation system.

7.10.3 OZONE GENERATOR

a. CAPACITY

1. The production rating of the ozone generators shall be stated in pounds per day and kWhr per pound at a maximum cooling water temperature and maximum ozone concentration.

2. The design shall ensure that the minimum concentration of ozone in the generator exit gas will not be less than 1 percent (by weight).

3. Generators shall be sized to have sufficient reserve capacity so that the system does not operate at peak capacity for extended periods of time. This can result in premature breakdown of the dielectrics.

4. The production rate of ozone generators will decrease as the temperature of the coolant increases. If there is to be a variation in the supply temperature of the coolant throughout the year, then pertinent data shall be used to determine production changes due to the temperature change of the supplied coolant. The design shall ensure that the generators can produce the required ozone at maximum coolant temperature.

5. Appropriate ozone generator backup equipment must be provided.

b. ELECTRICAL

The generators can be low, medium or high frequency type. Specifications shall require that the transformers, electronic circuitry and other electrical hardware be proven, high quality components designed for ozone service.

c. COOLING

Adequate cooling shall be provided. The required water flow to an ozone generator varies with the ozone production. Normally unit design provides a maximum cooling water temperature rise of 5°F (2.8°C). The cooling water must be properly treated to minimize corrosion, scaling and microbiological fouling of the water side of the tubes. A closed loop cooling water system is often used to ensure proper water conditions are maintained. Where cooling water is treated, cross connection control shall be provided to prevent contamination of the potable water supply in accordance with Section 12.8 b.

d. MATERIALS

To prevent corrosion, the ozone generator shell and tubes shall be constructed of Type 316L stainless steel.

7.10.4 OZONE CONTACTORS

The selection or design of the contactor and method of ozone application depends on the purpose for which the ozone is being used.

a. BUBBLE DIFFUSERS

1. Where disinfection is the primary application a minimum of two contact chambers each equipped with baffles to prevent short circuiting and induce countercurrent flow shall be provided. Ozone shall be applied using porous-tube or dome diffusers.

2. The minimum contact time shall be 10 minutes. A shorter contact time may be approved by the Division if justified by appropriate design and “CT” considerations.

3. For ozone applications in which precipitates are formed, such as with iron and manganese removal, porous diffusers should be used with caution.

4. Where taste and odor control are of concern, multiple application points and contactors shall be considered.

5. Contactors should be separate closed vessels that have no common walls with adjacent rooms. The contactor must be kept under negative pressure and sufficient ozone monitors shall be provided to protect worker safety. Placement of the contactor where the entire roof is exposed to the open atmosphere is recommended.

6. Large contact vessels should be made of reinforced concrete. All reinforcement bars shall be covered with a minimum of 1.5 inches of concrete. Smaller contact vessels can be made of stainless steel, fiberglass or other material which will be stable in the presence of residual ozone and ozone in the gas phase above the water level.

7. Where necessary a system shall be provided between the contactor and the off-gas destruct unit to remove froth from the air and return the other to the contactor or other location acceptable to the Division. If foaming is expected to be excessive, then a potable water spray system shall be placed in the contactor head space.

8. All openings into the contactor for pipe connections, hatchways, etc. shall be properly sealed using welds or ozone resistant gaskets such as Teflon or Hypalon.

9. Multiple sampling ports shall be provided to enable sampling of each compartment's effluent water and to confirm “CT” calculations.

10. A pressure/vacuum relief valve shall be provided in the contactor and piped to a location where there will be no damage to the destruction unit.

11. The diffusion system should work on a countercurrent basis such that the ozone is fed at the bottom of the vessel and water is fed at the top of the vessel.

12. The depth of water in bubble diffuser contactors should be a minimum of 18 feet. The contactor should also have a minimum of 3 feet of freeboard to allow for foaming.

13. All contactors shall have provisions for cleaning, maintenance and drainage of the contactor. Each contactor compartment shall also be equipped with an access hatchway.

14. Aeration diffusers shall be fully serviceable by either cleaning or replacement.

b. OTHER CONTACTORS

Other contactors, such as the venturi or aspirating turbine mixer contactor, may be approved by the Division provided adequate ozone transfer is achieved and the required contact times and residuals can be met and verified.

7.10.5 OZONE DESTRUCTION UNIT

a. A system for treating the final off-gas from each contactor must be provided in order to meet safety and air quality standards. Acceptable systems include thermal destruction and thermal/catalytic destruction units.

b. In order to reduce the risk of fires, the use of units that operate at lower temperatures is encouraged, especially where high purity oxygen is the feed gas.

c. The maximum allowable ozone concentration in the discharge is 0.1ppm (by volume).

d. At least two units shall be provided which are each capable of handling the entire gas flow.

e. Exhaust blowers shall be provided in order to draw off-gas from the contactor into the destruct unit.

f. Catalysts must be protected from froth, moisture and other impurities which may harm the catalyst.

g. The catalyst and heating elements shall be located where they can easily be reached for maintenance.

7.10.6 PIPING MATERIALS

Only low carbon 304L and 316L stainless steels shall be used for ozone service with 316L the preferred.

7.10.7 JOINTS AND CONNECTIONS

a. Connections on piping used for ozone service are to be welded where possible.

b. Connections with meters, valves or other equipment are to be made with flanged joints with ozone resistant gaskets, such as Teflon of Hypalon. Screwed fittings shall not be used because of their tendency to leak.

c. A positive closing plug or butterfly valve plus a leak-proof check valve shall be provided in the piping between the generator and the contactor to prevent moisture reaching the generator.

7.10.8 INSTRUMENTATION

a. Pressure gauges shall be provided at the discharge from the air compressor, at the inlet to the refrigeration dryers, at the inlet and outlet of the desiccant dryers, at the inlet to the ozone generators and contactors and at the inlet to the ozone destruction unit.

b. Electric power meters should be provided for measuring the electric power supplied to the ozone generators. Each generator shall have a trip which shuts down the generator when the wattage exceeds a certain preset level.

c. Dew point monitors shall be provided for measuring the moisture of the feed gas from the desiccant dryers. Because it is critical to maintain the specified dew point, it is recommended that continuous recording charts be used for dew point monitoring which will allow for proper adjustment of the dryer cycle. Where there is potential for moisture entering the ozone generator from downstream of the unit or where moisture accumulation can occur in the generator during shutdown, post-generator dew point monitors shall be used.

d. Air flow meters shall be provided for measuring air flow from the desiccant dryers to each of other ozone generators, air flow to each contactor and purge air flow to the desiccant dryers.

e. Temperature gauges shall be provided for the inlet and outlet of the ozone cooling water and the inlet and outlet of the ozone generator feed gas, and, if necessary, for the inlet and outlet of the ozone power supply cooling water.

f. Water flow meters shall be installed to monitor the flow of cooling water to the ozone generators and, if necessary, to the ozone power supply.

g. Ozone monitors shall be installed to measure zone concentration in both the feed-gas and off-gas from the contactor and in the off-gas from the destruct unit. For disinfection systems, monitors shall also be provided for monitoring ozone residuals in the water. The number and location of ozone residual monitors shall be such that the amount of time that the water is in contact with the ozone residual can be determined.

h. A minimum of one ambient ozone monitor shall be installed in the vicinity of the contactor and a minimum of one shall be installed in the vicinity of the generator. Ozone monitors shall also be installed in any areas where ozone gas may accumulate.

7.10.9 ALARMS

The following alarm/shutdown systems should be considered at each installation:

a. Dew point shutdown/alarm- This system should shut down the generator in the event the system dew point exceeds -76°F (-60°C).

b. Ozone generator cooling water flow shutdown/alarm - This system should shut down the generator in the event that cooling water flows decrease to the point that generator damage could occur.

c. Ozone power supply cooling water flow shutdown/alarm - This system should shut down the power supply in the event that cooling water flow decreases to the point that damage could occur to the power supply.

d. Ozone generator cooling water temperature shutdown/alarm - This system should shut down the generator if either the inlet or outlet cooling water exceeds a certain preset temperature.

e. Ozone power supply cooling water temperature shutdown/alarm - This system should shut down the power supply if either the inlet or outlet cooling water exceeds a certain preset temperature.

f. Ozone generator inlet feed-gas temperature shutdown/alarm - This system should shut down the generator if the feed-gas temperature is above a preset value.

g. Ambient ozone concentration shutdown/alarm - The alarm should sound when the ozone level in the ambient air exceeds 0.1 ppm or a lower value chosen by the water supplier. Ozone generator shutdown should occur when ambient ozone levels exceed 0.3 ppm (or a lower value) in either the vicinity of the ozone generator or the contactor.

h. Ozone destruct temperature alarm - The alarm should sound when temperature exceeds a preset value.

7.10.10 SAFETY

a. The maximum allowable ozone concentration in the air to which workers may be exposed must not exceed 0.1 ppm (by volume).

b. Noise levels resulting from the operating equipment of the ozonation system shall be controlled to within acceptable limits by special room construction and equipment isolation.

c. High voltage and high frequency electrical equipment must meet current electrical and fire codes.

d. Emergency exhaust fans must be provided in the rooms containing the ozone generators to remove ozone gas if leakage occurs.

e. A portable purge air blower that will remove residual ozone in the contactor prior to entry for repair or maintenance should be provided.

f. A sign shall be posted indicating “No smoking, oxygen in use” at all entrances to the treatment plant. In addition, no flammable or combustible materials shall be stored within the oxygen generator areas.

7.10.11 CONSTRUCTION CONSIDERATIONS

a. Prior to connecting the piping from the desiccant dryers to the ozone generators the air compressors should be used to blow the dust out of the desiccant.

b. The contactor should be tested for leakage after sealing the exterior. This can be done by pressurizing the contactor and checking for pressure losses.

c. Connections on the ozone service line should be tested for leakage using the soap- test method.

PART 8 CHEMICAL APPLICATIONS

All chemicals that come into contact with the drinking water during its treatment shall be certified for conformance with the NSF Standard 60.

8.1 DESCRIPTION

Plans and specifications describing the water treatment plants (new, modified or expanded) shall include the chemicals and chemical feed equipment to be used in the treatment process. Plans and Specifications shall include:

a. descriptions of feed equipment, including maximum and minimum feed ranges;

b. location of feeders, piping layout and points of application;

c. storage and handling facilities;

d. specifications for chemicals to be used;

e. operating and control procedures including proposed application rates;

f. descriptions of testing equipment and procedures; and

g. all tanks with capacities, (with drains, overflows, and vents), transfer pumps, valves, backflow prevention devices, air gaps, secondary containment, and safety eye washes and showers.

8.2 CHEMICAL APPLICATION

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

a. assure maximum efficiency of treatment and good mixing of the chemicals with the water;

b. assure maximum safety to consumer and the operators;

c. provide maximum flexibility of operation through various points of application when appropriate; and

d. prevent backflow or back-siphonage at all feed points.

8.3 GENERAL EQUIPMENT DESIGN AND CAPACITY

General equipment design shall be such that:

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

b. feeders are adjustable to handle all plant flow rates;

c. chemical-contact materials and surfaces are resistant to the aggressiveness of the chemical solution;

d. corrosive chemicals are introduced in such a manner as to minimize potential for corrosion;

e. chemicals that are incompatible are not stored or handled together;

f. all chemicals are conducted from the feeder to the point of application in separate conduits;

g. chemical feeders are as near as practical to the feed point;

h. chemicals are fed by gravity where practical, and shall not be siphoned into the water supply;

i. service water supply shall be protected from contamination by the chemical solutions. It should be equipped with backflow prevention devices or an air gas should be provided between the supply line and the solution tank;

j. no direct connection shall exist between any sewer and drain or overflow from the feeder or solution chamber or tank. All drains shall terminate at least six inches or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle;

k. Dry Chemical Feeders shall:

    1. measure chemicals volumetrically or gravimetrically;

    2. provide adequate solution water and agitation of the chemical in the solution pot;

    3. provide gravity feed from solution pots; and

    4. completely enclose chemicals to prevent emission of dust to any of the operating areas.

l. Positive Displacement Solution Pumps shall be used to feed liquid chemicals but shall not be used to feed chemical slurries. Pumps must be sized to match or exceed maximum head conditions found at the point of injection;

m. Calibration tubes or mass flow monitors which allow for direct physical measurement of actual feed rates should be provided;

n. A pressure relief valve should be provided on the pump discharge line; and

o. Liquid Chemical Feeders shall be such that chemical solutions cannot be siphoned into the water supply, by assuring discharge at a point of positive pressure, or providing vacuum relief, or providing a suitable air gap, or other suitable means or combinations as necessary.

8.4 CHEMICAL INFORMATION

For each chemical the information submitted shall include:

a. documentation that the chemical is NSF/ANSI Standard 60 approved;

b. specifications for the chemical to be used;

c. purpose of the chemical;

d. proposed minimum non-zero, average and maximum dosages, solution strength or purity (as applicable), and specific gravity or bulk density;

e. method for independent calculation of amount fed daily; and

f. chemical hazards class, if any, and regulatory workplace health/safety and chemical exposure standards listed in Safety Data Sheets (SDS).

8.5 FEED EQUIPMENT

a. NUMBER OF FEEDERS:

Where chemical feed is essential for the production of safe drinking water, or necessary for continuous operation and for the protection of the water supply:

1. a minimum of two feeders shall be provided;

2. a standby unit or a combination of units of sufficient capacity should be available to replace the largest unit during shutdowns; and

3. where a booster pump is required, duplicate equipment should be provided and, when necessary, a standby power.

b. ADDITIONAL CONSIDERATIONS:

A separate feeder must be used for each chemical applied. In addition, spare parts should be available for all feeders to replace part which are subject to wear and damage.

8.6 LOCATION OF CHEMICAL FEED EQUIPMENT

Chemical feed equipment shall:

a. be located in a separate room to reduce hazards and dust problems;

b. be conveniently located near points of application to minimize length of feed lines;

c. be readily accessible for servicing, repair, calibration and observation of operation;

d. be located such that the flow to the rapid mix is by gravity; and

e. shall be located, and protective curbing provided (containment), so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water through conduits, treatment or storage basins, or result in hazardous or unpermitted discharge.

8.7 FEEDER CONTROLS

a. Feeders may be manually or automatically controlled, with automatic controls being designed so as to allow override by manual controls.

b. Process must be manually started following shutdowns.

c. At automatically operated facilities, chemical feeders shall be electrically interconnected with the well or service pump and should be provided a nonstandard electrical receptacle.

d. Chemical feed rates shall be proportional to flow.

e. A means to measure water flow must be provided in order to determine chemical feed rates.

f. Provisions shall be made for measuring the quantities of chemicals used.

8.8 CROSS-CONNECTION CONTROL

Cross-connection control shall be provided to assure that:

a. the service water lines discharging to liquid storage tanks shall be properly protected from backflow as required by the Division;

b. chemical solutions or slurries cannot be siphoned through liquid chemical feeders into the water supply;

c. no direct connection exists between any sewer and a drain or overflow from the liquid chemical feeder, liquid storage chamber or tank by providing that all drains terminate at least six inches or two pipe diameters, whichever is greater, above the overflow rim of a receiving sump, conduit or waste receptacle; and

d. in the absence of other cross connection control measures, separate day tanks and feeders shall be provided for chemical feed systems that have feed points at both unfiltered and filtered water locations such that all unfiltered water feed points are fed from one day tank and feeder, and that all filtered water feed points are fed from another day tank and feeder.

8.9 WEIGHING SCALES

a. shall be provided for weighing cylinders, at all plants utilizing chlorine gas;

b. shall be provided to measure fluoride solution feed from supply drums or carboys;

c. should be provided for volumetric dry chemical feeders; and

d. should be accurate to measure increments of 0.5 % of load.

8.10 IN-PLANT WATER SUPPLY

Service water supply shall be:

a. only from a safe, approved source. It can be obtained from a location sufficiently downstream of any chemical feed point to assure adequate mixing;

b. ample in quantity and adequate in pressure;

c. provided with means for measurement when preparing specific solution concentrations by dilution;

d. Where a booster pump is required, duplicate equipment should be provided and, when necessary, standby power;

e. properly treated for hardness, when necessary; and

f. properly protected against backflow, by appropriate mean such as:

1. an air gap between fill pipe and maximum flow line of solution or dissolving tank equivalent to 2 pipe diameters but not less than 6 inches;

2. an approved reduced pressure backflow preventer, consistent with the degree of hazard, aggressiveness of chemical solution, back pressure sustained, and available means for maintaining and testing the device; or

3. a satisfactory vacuum relief device.

8.11 STORAGE OF CHEMICALS

a. Space should be provided for:

1. at least 30 days of chemical supply;

2. convenient and efficient handling of chemicals;

3. dry storage conditions;

4. a minimum storage volume of 1-1/2 truckloads where purchase is by truckload lots; and

5. protection against excessive, damaging or dangerous extremes in temperature.

b. Storage tanks and pipelines for liquid chemicals shall be specific to the chemicals and not for alternates.

c. Chemicals shall be stored in covered or unopened shipping containers, unless the chemical is transferred into an approved storage unit.

d. Offloading areas shall be clearly labeled to prevent accidental cross-contamination.

e. Liquid chemical storage tanks must:

1. have a liquid level indicator;

2. have an overflow and a receiving basin or drain capable of receiving accidental spills or overflows; and

3. provide for protection against freezing and/or loss from solution due to temperature drop.

8.12 SOLUTION TANKS

a. A means which is consistent with the nature of the chemical solution shall be provided in a solution tank to maintain a uniform strength of solution.

b. Continuous agitation shall be provided to maintain slurries in suspension.

c. Two solution tanks of adequate volume may be required for a chemical to assure continuity of supply in servicing a solution tank.

d. Each tank shall be provided with a drain:

   1. No direct connection between any tank or drain and a sewer shall be allowed;

   2. Any drain must terminate at least 2 pipe diameters above the overflow rim of a receiving sump, conduit or waste receptacle; and

   3. Each tank shall be provided with a valve drain and protected against backflow.

e. Means shall be provided to indicate the solution level in the tank.

f. Make-up water shall enter the tank above the maximum solution level, providing an air gap of 2 pipe diameters but not less than 6 inches, or shall be protected with an approved backflow prevention device.

g. Chemical solutions shall be kept covered. Large tanks with access openings shall have such openings curbed and fitted with overhanging covers.

h. Subsurface locations for solution tanks shall:

   1. be free from sources of possible contamination; and

   2. assure positive drainage for groundwaters, accumulated water, chemical spills and overflows.

i. Overflow pipes, when provided, should:

   1. be turned downward, with the end screened;

   2. have a free fall discharge; and

   3. be located where noticeable.

j. Acid storage tanks must be vented to the outside atmosphere, but not through vents in common with day tanks.

k. Solution tanks shall be located, and protective curbing provided so that chemicals from equipment failure, spillage or accidental drainage shall not enter the water in conduits, treatment or storage basins.

l. Secondary containment volumes shall be able to hold the volume of the largest storage tank. Piping shall be designed to minimize or contain chemical spills in the event of pipe ruptures.

8.13 DAY TANKS

a. Day tanks shall be provided where bulk storage of liquid chemical is provided, however the Division may allow chemicals to be fed directly from shipping containers no larger than 330 gallons.

b. Day tanks should hold no more than a 30-hour supply.

c. Day tanks shall be scale-mounted, or have a calibrated gauge painted or mounted on the side if liquid level can be observed in a gauge tube or through translucent sidewalls of the tank. In opaque tanks, a gauge rod extending above a reference point at the top of the tank, attached to a float may be used. The ratio of the area of the tank to its height must be such that unit readings are meaningful in relation to the total amount of chemical fed during a day.

d. Except for fluosilicic acid, Hand pumps may be provided for transfer from a carboy or drum. A tip rack may be used to permit withdrawal into a bucket from a spigot. Where motor driven transfer pumps are provided, a liquid level limit switch and an over-flow from the day tank, must be provided.

e. A means which is consistent with the nature of the chemical solution shall be provided to maintain uniform strength of solution in a day tank. Continuous agitation shall be provided to maintain chemical slurries in suspension.

f. Tanks shall be properly labeled to designate the chemical contained.

8.14 CHEMICAL FEED LINES

a. should be as short as possible, and:

1. of durable, corrosion-resistant material;

2. easily accessible throughout the entire length;

3. protected against freezing;

4. easily cleaned;

5. lime feed lines should be designed so that they can be easily replaced; and

6. avoid sharp bends when possible.

b. should slope upward from the chemical source to the feeder when conveying gases;

c. should introduce corrosive chemicals in such manner as to minimize potential for corrosion;

d. shall be designed consistent with scale-forming or solids depositing properties of the water, chemical, solution or mixtures conveyed;

e. shall not carry chlorine gas beyond chlorine storage and feeder room(s) except under vacuum; and

f. should be color coded.

8.15 HANDLING OF CHEMICALS

a. Carts, elevators and other appropriate means shall be provided for lifting chemical containers to minimize excessive lifting by operators.

b. Provisions shall be made for disposing of empty bags, drums or barrels by an approved procedure which will minimize exposure to dusts.

c. Provision must be made for the proper transfer of dry chemicals from shipping containers to storage bins or hoppers, in such a way as to minimize the quantity of dust which may enter the room in which the equipment is installed. Control should be provided by use of:

1. vacuum pneumatic equipment or closed conveyor systems;

2. facilities for emptying shipping containers in special enclosures; and/or

3. exhaust fans and dust filters which put the hoppers or bins under negative pressure.

d. Provision shall be made for measuring quantities of chemicals used to prepare feed solutions and for easy calibration of solution pumps measured from the suction side.

e. Storage tanks and pipelines for liquid chemicals shall be specific to the chemicals and not for alternates.

f. Chemicals that are incompatible shall not be fed, stored or handled together.

g. Precautions shall be taken with electrical equipment to prevent explosions, particularly in the use of sodium chlorite and activated carbon.

h. Acids shall be kept in closed, acid resistant shipping containers or storage units Acids shall not be handled in open vessels but should be pumped in undiluted form from original containers, through suitable hose, to the point of treatment or to a covered day tank.

8.16 HOUSING

a. Structures, rooms and areas accommodating chemical feed equipment shall provide convenient access for servicing, repair and observation of operation.

b. Floor surfaces shall be smooth and impervious, slip-proof and well drained with 2.5 % minimum slope.

c. Vents from feeders, storage facilities and equipment exhaust shall discharge to the outside atmosphere above grade and remote from air intakes.

d. Open basins, tanks and conduits shall be protected from chemical spills or accidental drainage.

8.17 CHEMICALS

a. Chemical containers shall be fully labeled to include:

   1. chemical name, purity and concentration;

   2. supplier name and address; and

   3. expiration date where applicable.

b. Chemicals shall be listed as meeting NSF Standard 60 and shall meet AWWA specifications, where applicable.

c. Provisions should be made for assay of chemicals delivered.

d. Chemicals shall not impart any toxic material to the water under recommended dosages.

8.18 OPERATOR SAFETY

a. Gases from feeders, storage and equipment exhausts shall be conveyed to the outside atmosphere, above grade and remote from air intakes.

b. Special provisions shall be made for ventilation of chlorine feed and storage rooms. See the *applicable section in this document.*

c. Respiratory protection equipment, meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled. It shall be stored at a convenient location that is easily accessible to the operator, but not inside any room where chlorine is used or stored. The units shall use compressed air and have at least a 30-minute capacity. Provision of a 30-minute backup cylinder is urged to prevent loss of utility while the primary air cylinder is being refilled or tested. It is preferred that the unit be compatible with or exactly the same as units used by the fire department responsible for the plant.

d. A bottle of ammonium hydroxide, 56 % ammonia solution, shall be available for chlorine leak detection.

e. Where ton containers are used, a leak repair kit approved by the Chlorine Institute must be provided.

f. At least one pair of rubber gloves, a dust respirator of a type certified by NIOSH for toxic dusts, an apron or other protective clothing like rubber boots and goggles face mask shall be provided for each operator in any shift who will handle dry chemicals, preparing chemical solutions, or cleaning up spills.

g. A deluge shower and/or eye washing device should be installed where strong acids and alkalis are used or stored. A water holding tank that will allow water to come to room temperature should be installed in the water line feeding the deluge shower and eye washing device, as necessary.

h. Other protective equipment and facilities should be provided as necessary.

PART 9- TREATMENTS

All proposed treatment or modification to existing water treatment facilities including any chemical changes must take into consideration the source of raw water, and the acceptable recommended methods for achieving the finished water maximum contaminated levels (MCLs) as specified in Georgia Rules for Safe Drinking Water 391-3-5.-18 and 391-3-5.-19.

The ability to respond to seasonal variations of quality of raw water source depends on the designing a treatment process involving: Conventional Treatment; Copper Sulphate and Other Copper Compounds; Pre-sedimentation; Potassium Permanganate; Pre-chlorination; Zebra mussel control; Softening; Aeration; Sequestration for Iron and Manganese Treatment; Corrosion Control; Taste and Odor Control; Flocculation/Sedimentation; Tube or Plate Settlers; Activated Carbon (Granular and Powdered); Ozonation; Iron Adsorption; Ion Exchange; Chemical Feed; Membrane; and Other Approved Technologies Methods.

The design of chemical and physical water treatment facilities requires submissions of engineering reports, pilot study or treatability documentation and plans and specifications.

9.1 CONVENTIONAL TREATMENT

a. The design of treatment of surface water and or ground water sources processes and devices depend on evaluation of the nature and quality of the particular water to be treated and the desired quality of the finished water. However, the constructed facilities and the quality of the finished water must consistently and reliably meet the applicable state and federal drinking water standards.

b. All those water systems that are using surface water sources or ground waters determined to be under the direct influence of surface waters shall be designed and constructed to assure compliance of the finished water quality with the current state and federal regulations that are in effect concerning the treatment, removal, and inactivation of the applicable chemical, physical and biological contaminants.

c. The quality of the raw water, the quality desired in the finished water and other factors may require installation of multiple-stage treatment facilities and/or pre-sedimentation facilities.

d. Water treatment plants processing surface water sources shall include, but not limited to, means for rapid mixing, flocculation, sedimentation, filtration and disinfection. They shall preferably be of conventional type design.

    1. Pressure filtration systems shall not be installed to treat surface water supply sources.

2. The treatment plant shall be of such construction to allow units to be taken out of service without disrupting the operation and required treatment processes.

e. At its discretion, the Division may accept new and alternate treatment means, methods and technologies, provided the following are demonstrated to the satisfaction of the Division:

1. The treatment method has been thoroughly tested in full scale comparable installations by an acceptable third party, in accordance with protocol and standards acceptable to the Division; and

2. Has been thoroughly tested in a plant approved by the Division, by an acceptable third party, in accordance with protocol and standards acceptable to the Division and operated for a period that shall demonstrate the effectiveness and reliability of the proposed treatment system during changes in seasonal and climatic conditions.

9.2 MICROSCREENING

Microscreening is a mechanical treatment process capable of removing suspended matter and organic loading from surface water by straining. It shall not be used in place of filtration or coagulation.

9.2.1 DESIGN

a. consideration shall be given to the:

1. nature of the suspended matter to be removed;

2. corrosiveness of the water;

3. effect of chemicals used for pre-treatment;

4. duplication of units for continuous operation during equipment maintenance; and

5. provision of automated backwashing.

b. shall provide:

1. a durable, corrosion -resistant screen;

2. provisions to allow for by-pass of the screen;

3. protection against back-siphonage when potable water is used for backwashing; and

4. proper disposal of backwash waters.

9.3 CLARIFICATION

Plants designed for processing surface waters should:

a. provide a minimum of two units each for flocculation and sedimentation;

b. permit operation of the units either in series or parallel where softening is performed and should permit series or parallel operation where plain clarification is performed;

c. be constructed to permit units to be taken out of service without disrupting operation, and with drains or pumps sized to allow dewatering in a reasonable period of time;

d. Provide a means of measuring and modifying the flow to each train or unit unless otherwise approved by the Division;

e. provide multiple-stage treatment facilities when required by the Division;

f. be started manually following shutdown; and

g. minimize hydraulic head losses between units to allow future changes in processes without the need for repumping.

9.3.1 PRESEDIMENTATION

Waters containing high turbidity may require pretreatment, usually sedimentation either with or without the addition of coagulation chemicals.

a. Basin design – Presedimentation basins should have hopper bottoms or be equipped with continuous mechanical sludge removal apparatus and provide arrangements for dewatering. Ponds used for presedimentation should be designed to hold maximum 3-day usage. A means of maintaining and cleaning basins without interruption shall be provided.

b. Inlet – Incoming water shall be dispersed across the full width of the line of travel as quickly as possible; short-circuiting must be prevented.

c. Bypass – Provisions for bypassing presedimentation basins shall be included.

d. Detention Time – Three (3) hours detention is the minimum period recommended. Greater detention may be necessary and is preferred.

9.3.2 RAPID MIX/COAGULATION

Rapid mix shall mean the rapid dispersion of chemicals throughout the water to be treated, usually by violent agitation. The engineer shall submit the design basis for the velocity gradient (G value) selected, considering the chemicals to be added and water temperature, color and other related water quality parameters. The velocity gradient should not be less than 750 (ft/sec)/ft.

a. Equipment – Basins should be equipped with mechanical mixing devices; other arrangements, such as baffling, in-line mixers may be acceptable and should be capable of providing adequate mixing for all treatment flow rates. Static mixing should only be considered where the flow is relatively constant and will be high enough to maintain the necessary turbulence for complete chemical reactions.

b. Mixing – The detention period should be not more than thirty (30) seconds.

c. Location – The rapid mix and flocculation basin shall be as close together as possible.

d. SCD – Install a streaming current detector for continuous monitoring of coagulant dosage to assist in optimizing the coagulation process.

9.3.3 FLOCCULATION

Flocculation shall mean the agitation of water at low velocities for long periods of time.

a. Basin Design – Inlet and outlet design shall prevent short-circuiting and destruction of floc. Series compartments are recommended to further minimize short-circuiting and to provide decreasing mixing energy with time. Basins shall be designed so that individual basins may be isolated without disrupting plant operation. A drain and/or pumps shall be provided to handle dewatering and sludge removal.

b. Detention – The flow-through velocity shall be not less than 0.5 nor greater than 1.5 feet per minute with a detention time for floc formation of at least 30 minutes with consideration to using tapered (i.e. diminishing velocity gradient) flocculation.

c. Equipment – Agitators shall be driven by variable speed drives with the peripheral speed of paddles ranging from 0.5 to 3.0 feet per second for paddle wheel type agitators and greater than 6 feet per second for hydrofoil type agitators. The speed of each successive agitator should be less than the previous one. External, non-submerged motors are preferred.

d. Piping – Flocculation and sedimentation basins shall be as close together as possible. The velocity of flocculated water through pipes or conduits to settling basins shall be not less than 0.5 nor greater than 1.5 feet per second. Allowances must be made to minimize turbulence at bends and changes in direction.

e. Other Designs – Baffling may be used to provide for flocculation in small plants only after consultation with the Division. The design should be such that the flow-through velocity shall be not less than 0.5 nor greater than 1.5 feet per minute with a detention time for floc formation of at least 30 minutes as noted above.

f. To assist in observing floc formation, effective size, and density, consideration should be given to providing adequate lighting.

g. Consideration should be given to the need for additional chemical feed in the future.

9.3.4 SEDIMENTATION

Sedimentation shall follow flocculation. The detention time for effective clarification is dependent upon a number of factors related to basin design and the nature of the raw water. The plant shall have a minimum of two (2) basins. Under optimal operation conditions, the design must allow the operator to be able to achieve a settled water turbidity of not more than 1 NTU prior to the filtration.

The following criteria apply to sedimentation units:

a. Even Flow – Flow shall be evenly distributed to each basin from the flocculation chamber(s).

b. Detention Time – Shall provide a minimum of four (4) hours of settling time. This may be reduced to two hours for lime-soda softening facilities treating only groundwater. Dependent upon the basin design and raw water quality, reduced sedimentation time may also be approved when equivalent effective settling is demonstrated or when the overflow rate is not more than 0.5 gpm per square foot (1.2 m/hr.) (i.e. plate settlers); however, provisions should be made for more frequent removal of sludge from the basins than is required for conventional sedimentation.

c. Ratio – Rectangular basins shall have a length to width ratio of 4:1 with an average depth of 8 feet. However, calculations using surface area, overflow rate and detention time should be used to determine the depth.

d. Inlet Devices – Inlets shall be designed to distribute the water equally and at uniform velocities. Open ports, submerged ports, and similar entrance arrangements are required. A baffle should be constructed across the basin close to the inlet end and should project several feet below the water surface to dissipate inlet velocities and provide uniform flows across the basin. This velocity should not exceed 0.25 ft/sec.

e. Outlet Devices – Outlet devices shall be designed to maintain velocities suitable for settling in the basin and to minimize short-circuiting. The use of submerged orifices is recommended in order to provide a volume above the orifices for storage when there are fluctuations in flow. The entrance velocity through the submerged orifices shall not exceed 5 feet per second.

f. Overflow Rate – The rate of flow over the outlet weir or through the submerged orifices shall not exceed 20,000 gallons per day per foot of weir length (250m3/day/m) of the outlet launder or orifice circumference. The overflow weir should be installed which will establish the maximum water level desired on top of the filters. They shall not be flooded. Adjustable V-notch weirs are preferred. Where submerged orifices are used as an alternate for overflow weirs, they should be not lower than three feet below the flow line with flow rates equivalent to weir loadings.

g. Velocity – The velocity through settling basins shall not exceed 0.5 feet per minute. The basins must be designed to minimize short-circuiting. Fixed or adjustable baffles must be provided as necessary to achieve the maximum potential for clarification. Not applicable if tube or plate settlers are used.

h. Overflow – An overflow weir (or pipe) should be installed which will establish the maximum water level desired on top of the filters. It shall discharge by gravity with a free fall at a location where the discharge will be noted.

i. Sludge Collection – Mechanical sludge collection equipment should be provided.

j. Drainage – Basins must be provided with a means for dewatering. Basin bottoms should slope toward the drain not less than one foot in twelve feet where mechanical sludge collection equipment is not required.

k. Flushing Lines – Flushing lines or hydrants shall be provided and must be equipped with backflow prevention devices acceptable to the Division.

l. Safety – Permanent ladders or handholds should be provided on the inside walls of basins above the water level. Guard rails should be included. Compliance with other applicable safety requirements, such as OSHA, shall be required.

m. Sludge Removal – Sludge removal design shall provide that:

1. sludge pipes shall be not less than three inches in diameter and so arranged as to facilitate cleaning;

2. entrance to sludge withdrawal piping shall prevent clogging;

3. valves shall be located outside the tank for accessibility; and

4. the operator may observe, and sample sludge being withdrawn from the unit.

n. Sludge Disposal – must be accomplished in accordance with the applicable rules in effect.

9.3.5 SOLIDS CONTACT UNIT

Units are generally acceptable for combined softening and clarification where water characteristics, especially temperature, do not fluctuate rapidly, flow rates are uniform, and operation is continuous. Before such units are considered as clarifiers without softening, the Division should be contacted before the design has started. Clarifiers should be designed for the maximum uniform rate and should be adjustable to changes in flow which are less than the design rate and for changes in water characteristics. A minimum of two (2) units are required for surface water treatment. The following are design criteria for consideration, but any design shall be submitted in detail to be reviewed on a case-by-case basis.

a. Installation of Equipment – Supervision by a representative of the manufacturer shall be provided with regard to all mechanical equipment at the time of:

1. installation; and

2. initial operation.

b. Operating Equipment – The following shall be provided for plant operation:

1. a complete outfit of tools and accessories;

2. necessary laboratory equipment; and

3. adequate piping with suitable sampling taps so located as to permit the collection of samples of water from critical portions of the units. Sampling taps should be located at the sludge withdrawal level and preferably spaced at two-foot intervals from the basin bottom to two feet below the effluent level.

c. Chemical Feed – Chemicals shall be applied at such points and by such means as to ensure satisfactory mixing of the chemicals with the water. Interference between treatment chemicals and optimum locations and sequences for feeding different chemicals shall be considered.

d. Mixing – A rapid mix device or chamber ahead of solids contact units may be necessary to assure proper mixing of the chemicals applied. Mixing devices employed shall be so constructed as to:

1. provide good mixing of the raw water with previously formed sludge particles; and

2. prevent deposition of solids in the mixing zone.

e. Flocculation - Flocculation equipment:

1. shall be adjustable (speed and/or pitch);

2. must provide for coagulation in a separate chamber or baffled zone within the unit; and

3. should provide the flocculation and mixing period to be not less than 30 minutes.

f. Sludge Concentrators - The equipment should provide either internal or external concentrators in order to obtain a concentrated sludge with a minimum of waste water. Large basins should have at least two (2) sumps for collecting sludge with one (1) sump located in the central flocculation zone.

g. Sludge Removal - Sludge removal design shall provide that:

1. sludge pipes shall be not less than three (3) inches in diameter and so arranged as to facilitate cleaning;

2. entrance to sludge withdrawal piping shall prevent clogging;

3. valves shall be located outside the tank for accessibility;

4. operator may observe, and sample sludge being withdrawn from the unit;

5. backflow from sanitary sewer systems be impossible; and

6. provide permanent fittings to allow flushing or unplugging of the blow-off lines.

h. Cross-Connections

1. Blow-off outlets and drains must terminate and discharge at places satisfactory to the Division.

2. Cross-connection control must be included for the potable water lines used to backflush sludge lines.

i. Detention Period – The detention time shall be established on the basis of the raw water characteristics and other local conditions that affect the operation of the unit. Based on design flow rates, the detention time should be:

1. Two to four hours for suspended solids contact clarifiers and softeners treating surface water; and

2. One to two hours for the suspended solids contact softeners treating only ground water.

j. Suspended Slurry Concentrate - Softening units should be designed so that continuous slurry concentrates of one percent or more, by weight, can be satisfactorily maintained.

k. Water Losses - Units shall be provided with suitable controls for sludge withdrawal.

1. Total water losses should not exceed five percent (5%) for clarifiers, and three percent (3%) for softening units.

2. Solids concentration of sludge bled to waste should be three percent (3%) by weight for clarifiers, and five percent (5%) by weight for softeners.

l. Weirs or Orifices - The units should be equipped with either overflow weirs or orifices constructed so that water at the surface of the unit does not travel over 10 feet horizontally to the collection trough. Weirs shall be:

1. Adjustable, and at least equivalent in length to the perimeter of the tank;

2. Weir loading shall not exceed:

   a. 10 gallons per minute per foot of weir length for units used for clarifiers;

   b. 20 gallons per minute per foot of weir length for units used for softeners; and

   c. Where orifices are used, the loading rates per foot of launder rates should be equivalent to weir loadings. Either shall produce uniform rising rates over the entire area of the tank.

m. Upflow Rates - Unless supporting data is submitted to the Division to justify rates exceeding the following, rates shall not exceed:

   1. 1.0 gallon per minute per square foot of area at the sludge separation line for units used for clarifiers; and

   2. 1.75 gallons per minute per square foot of area at the slurry separation line for units used for softeners.

9.3.6 TUBE OR PLATE SETTLERS

Proposals for settler unit clarification must include pilot plant and/or full-scale demonstration satisfactory to the Division prior to the preparation of final plans and specifications for approval. Settler units consisting of variously shaped tubes or plates which are installed in multiple layers and at an angle to the flow may be used for sedimentation, following flocculation.

The following criteria apply to Tube or Plate Settlers:

a. Inlet and Outlet Considerations - Design to maintain velocities suitable for settling in the basin and to minimize short-circuiting. Inlets to plate settlers shall be designed to evenly distribute the water across the units.

b. Drainage - Drain piping from the settler units must be sized to facilitate a quick flush of the settler units and to prevent flooding other portions of the plant.

c. Protection from Freezing - Although most units will be located within a plant, outdoor installations must provide sufficient freeboard above the top of settlers to prevent freezing in the units. A cover or enclosure is strongly recommended.

d. Application Rate for tubes - A maximum rate of 2 gal/ft^2/min of cross-sectional area (based on 24-inch long 60 degree tubes or 39.5-inch long 7 ½ degree tubes, 4.8m/hr.), unless higher rates are successfully shown through pilot plant or in-plant demonstration studies.

e. Application rates for plates - A maximum plate loading rate of 0.5 gpm per square foot (1.2m/hr.) based on 80 percent of the projected horizontal plate area.

f. Flushing Lines - Flushing lines shall be provided to facilitate maintenance and must be properly protected against backflow or back siphonage.

g. Placement - Modules should be placed:

1. In zones of stable hydraulic conditions; or

2. In areas nearest effluent launders for basins not completely covered by the Modules.

h. Inlets and Outlets - Inlets and outlets shall conform to Section 9.3.4 d and Section 9.3.4 e.

i. Support - The support system shall be able to carry the weight of the modules when the basin is drained plus any additional weight to support maintenance personnel and Equipment.

j. Cleaning - Provisions should be made to allow the water level to be dropped, and a water or air jet system for cleaning the modules.

9.4 FILTRATION OF TREATED WATER FROM THE SEDIMENTATION BASIN

Acceptable filters shall be upon the discretion of the Division. The application of any one type must be supported by water quality data representing a reasonable period of time to characterize the variations in water quality. Experimental (pilot) treatment studies may be required to demonstrate the applicability of the method of filtration proposed. Filtration rates greater than 5 gpm/ft^2 are not recommended and may not be approved. All filters shall have provisions for filtering to waste. The design of the filter must allow the water operator to achieve a filtered water effluent of 0.1 NTU or less at each filter under optimal operating conditions.

9.4.1 RAPID RATE GRAVITY FILTERS

a. Pretreatment - The use of rapid rate gravity filters shall require pretreatment.

b. Number - At least two (2) units shall be provided. Where only two units are provided, each shall be capable of meeting the plant design capacity (normally the projected maximum daily demand) at the approved filtration rate. Where more than two filter units are provided, the filters shall be capable of meeting the plant design capacity at the approved filtration rate with one filter removed from service. Where declining rate filtration is provided, the variable aspect of filtration rates, and the number of filters must be considered when determining the design capacity for the filters.

c. Rate of Filtration - The permissible rate of filtration shall be determined through consideration of such factors as raw water quality, degree of pretreatment provided, filter media, water quality control parameters, competency of operating personnel and other factors as required by the Division. The normal rate shall be 2 gpm/ft^2 and should not exceed 5 gpm/ft^2 of filter area, for turbidity removal plants.

d. High Rate Filtration - Filtration rates for turbidity or iron removal plants of up to 4 gpm/ft are acceptable with the following:

1. Mixing flocculation, and sedimentation must meet the requirements of this document.

2. Dual or mixed filter media must be used. Mixed filter media configuration is preferred.

3. Full compliance with the current Surface Water Treatment Rules must be assured.

4. Additional instrumentation and monitoring devices may be required for those plants with filter rates greater than 2 gpm/ft^2.

5. Any proposal to operate a conventional plant with a filtration rate greater than 4 gpm/ft^2 shall require performance of a high-rate pilot study, in accordance with the protocols acceptable to the Division. Filtration rates greater than 5 gpm/ft^2 may be considered on a case by case basis, but generally rates greater than 5 gpm/ft^2 are not recommended for surface water sources and may not be approved. Unconventional or package type water treatment plants using surface water sources shall not operate at filtration rates greater than 5 gpm/ft^2.

GUIDELINES FOR HIGH-RATE CONSIDERATION FOR FILTER RATES BETWEEN 2 AND 4 GPM/FT^2

Prior to the Division's approval of increased filter rates between 2 and 4 gpm/ft^2, the following items must be addressed and submitted for review and approval:

(A) A demand for the extra water must be documented by indicating current water usage, unaccounted for water, water conservation guidelines, accurate population projections, and future water demands;

(B) Complete and submit the "**High Rate Study Data Submittal Form".** The current version of the form can be found on Georgia EPD Website;

(C) Turbidity and/or particle count data on the raw or filter influent water and/or filtered effluent water should be available for EPD inspection (for existing plants, at least one year of data should be available);

(D) The results of a simulated CT study at the proposed flow conditions must be provided. Please be reminded the required log inactivation *of Giardia* cysts must be achieved at the proposed plant flow capacity;

(E) Baffling of the clearwell and sedimentation basin is required. Installation of plate or tube settlers in the sedimentation basin is preferred;

(F) An application to increase the water withdrawal permit must be submitted to the Division's Water Resources Program;

(G) Plans and specifications for any necessary modifications to the treatment plant must be submitted for review and approval; and

(H) After the above items have been submitted and concurred with, the Division may reduce or waive the requirement for an in-depth pilot study based on the submitted information and an onsite plant evaluation. A completed "Application to Operate a Public Water System" will be required in order to increase plant rates. The current version of the form can be found on the Georgia EPD Website.

HIGH-RATE PILOT STUDY GUIDELINES FOR FILTER RATES ABOVE 4 GPM/FT^2

In order to be approved to perform a high-rate pilot study, at filter rates above 4 gpm/ft^2 on treatments plants a detailed plant evaluation and a high-rate study plan which addresses the items listed in this sections must be submitted by a Registered Professional Engineer in the State of Georgia for review and concurrence.

(A) A demand for the extra water must be documented by indicating current water usage, unaccounted for water, water conservation guidelines, accurate population projections, and future water demands;

(B) A complete engineering evaluation, by a professional engineer licensed in the State of Georgia, of the existing facilities and unit process components, the proposed high-rate study plan, as well as the pertinent schematic drawings indicating the proposed flow rates through the unit processes. The evaluation must address the current treatment train and processes which includes flow rates, chemical addition points, sample points, weir overflow rates, simulated CT study, filter media configurations, plant storage, backwash water rates, sludge handling and pumps;

(C) Verification of the availability of additional raw water must be provided. Please contact the Water Resources Management Program of the Division for water withdrawal requirements;

(D) When required by the Division, turbidity and/or particle count data on the raw, settled or filter influent water and/or filtered effluent water for a duration of one year and;

(E) An unconventional or package type water treatment plant using surface water with a proposed filtration rate 5 gpm/ft^2 will be required to have a Certified Class I Water Plant Operator in responsible charge while the plant is in operation.

(F) After concurrence of the plant evaluation and the high-rate study plan (a through e above), the high-rate pilot study shall be conducted as follows:

1) The study must be conducted a minimum of 180 days, covering at least two seasons, including a period of cold weather;

2) The performance and results must be conducted under the supervision of a professional engineer licensed in the State of Georgia;

3) At least two (2) daily (or one per shift) coliform bacteria or standard plate count analysis of the filtered water from the pilot test filter(s) and the non-test filter(s) shall be performed by a Division approved laboratory and tabulated for comparison. Water sample taps shall be available on the effluent line from each filter;

4) In addition to the turbidity measurements required for normal plant operations, turbidity measurements of the raw water must be made at least once (1) a shift and settled water [goal is 1. 0 NTU or less] and the pilot test filter(s) and non-test filter(s) effluents [goal is 0.1 NTU or less] must be made and recorded at least at two (2) hour intervals while the plant is in operation. During the study, the combined filter effluent should not exceed 0.3 NTU.

5) Any failure to comply with the current Drinking Water Standards during the pilot test period and/or if the combined filter effluent at the plant reaches or exceeds 1.0 NTU, the study must be terminated.

6) Tests shall be performed during the pilot study to determine the actual detention time in the pilot test sedimentation basin(s) along with an evaluation of short-circuiting and weir loading rates;

7) During the pilot study of the higher filtration rate, calculate and record the daily theoretical CT value, but report the lowest daily CT value calculated during each month and the corresponding log inactivation for *Giardia;*

8) With a particle counting device, record and report the number (particles/ml of particles in the test and non-test filter(s) effluents at two (2) hour intervals, while the plant is in operation, in the size range between 3 and 15 microns;

9) Tests shall be performed every month for Total Organic Carbon (TOC) concentration from the effluent of the pilot test filter(s) and non-test filter(s) for comparison, prior to the point of continuous disinfectant application; and

10) Simulated Distribution System (SDS) samples shall be collected every quarter from the effluent of the pilot test filter(s) and non-test filter(s) for total trihalomethanes (TTHMs) and total haloacetic acids (THAAs) analysis, to be performed by a private laboratory. The collected samples should be stored in a dark place and incubated at the same temperature and pH typically found in the distribution system for a reaction time comparable to the maximum detention time in the distribution system.

11) At the completion of the pilot study, the results from the above items along with any other pertinent findings (as well as recommendation) must be tabulated and submitted in a report form by the professional engineer.

12) Some plant design features may require additional evaluation or additional treatment studies (i.e. polymer and/or ferric chloride feed, enhanced coagulation, GAC, plate settlers, pre-settling units, deeper filter media configurations, or pilot plants) and/or a longer pilot study.

(G) Upon completion of a successful pilot study, the following minimum improvements must be completed at the water plant prior to the final approval and modification of the system’s operating permit:

1) Based upon the results, submit engineering design plans and specifications for the necessary plant modifications, for Division’s review and approval;

2) For filtration rates exceeding 4 gpm/ft^2 mixed media or deep-bed dual-media, with an acceptable agitation system, must be provided in all filters;

3) The system must currently be in compliance with the Federal Surface Water Treatment Regulations (SWTR), as adopted by Georgia;

4) Provisions to filtering to waste after a filter backwash cycle;

5) Provisions for continuous sludge removal in each sedimentation basin;

6) Adequate settled solids facilities to treat basin sludge and backwash water;

7) The operator in responsible charge of the water plant must be Class I Certified;

8) Modification of the Surface Water or Groundwater Withdrawal Permit;

9) Assurances that adequate wastewater treatment facilities will be available to treat the additional wastewater generated by the increased water plant capacity; and

10) Additional improvements identified during the pilot study or as deemed necessary by the Division, may be required.

9.4.2 FILTER STRUCTURAL DETAILS AND HYDRAULICS

The filter structure shall be designed to provide for:

a. vertical walls within the filter;

b. no protrusion of the filter walls into the filter media;

c. cover by superstructure as determined necessary under local climate;

d. head room to permit normal inspection and operation;

e. minimum depth of filter box of 8-1/2 feet;

f. minimum water depth over the surface of the filter media of three (3) feet;

g. trapped effluent to prevent backflow of air to the bottom of the filters;

h. prevention of floor drainage to the filter with a minimum 4-inch curb around the filters;

i. prevention of flooding by providing overflow;

j. maximum velocity of treated water in pipe and conduits to filters of two feet per second;

k. cleanouts and straight alignment for influent pipes or conduits where solids loading is heavy, or following lime-soda softening;

l. washwater drain capacity to carry maximum flow;

m. walkways around filters, to be not less than 24 inches wide;

n. safety handrails or walls around filter areas adjacent to normal walkways; and

o. construction to prevent cross connections and common walls between potable and non-potable water.

9.4.3 WASHWATER TROUGHS

Wash water troughs should be constructed to have:

a. the bottom elevation above the maximum level of expanded media during washing;

b. a two-inch freeboard at the maximum rate of wash. At a minimum, the troughs should be sized to accommodate backwash flow rates of 20 gpm/ft^2 without flooding;

c. the top edge level and all at the same elevation;

d. spacing so that each trough serves the same number of square feet of filter area; and

e. maximum horizontal travel of suspended particles to reach the trough not to exceed three (3) feet.

9.4.4 FILTER MATERIAL

Installation of media shall be in accordance with the current AWWA Standards. The media shall be clean silica sand or other natural or synthetic media free from detrimental chemical or bacterial contaminants, approved by the Division, and having the following characteristics:

a. a total depth of not less than 24 inches and generally not more than 30 inches;

b. a uniformity coefficient of the smallest material not greater than 1.65; and

c. a minimum of 12 inches of media with an effective size range no greater than 0.45 mm to 0.55 mm.

TYPES OF FILTER MEDIA

A. SAND FILTER – Sand shall have the following characteristics:

1. an effective size range of the 0.45mm to 0.55mm;

2. specific gravity greater than 2.5;

3. acid Solubility less than 5 percent; and

4. a uniformity coefficient of the smallest material not greater than 1.65.

B. ANTHRACITE – Anthracite shall consist of hard, durable anthracite coal particles of various sizes. Blending of non-anthracite is not acceptable. Anthracite shall have an:

1. effective size of 0.45 mm – 0.55 mm with a uniformity coefficient not greater than 1.65 when used alone;

2. effective size of 0.8 mm – 1.2 mm with a uniformity coefficient not greater than 1.75 when used as a cap;

3. effective size for anthracite uses as a single media on potable groundwater for iron and manganese removal only shall be a maximum of 0.8 mm (effective sizes greater than 0.8 mm may be approved based upon onsite pilot studies or other demonstration acceptable to Division;

4. Specific gravity greater than 1.4;

5. a Mho's scale hardness greater than 2.7; and

6. acid Solubility less than 5 percent.

C. HIGH DENSITY SAND - High Density sand shall consist of hard durable, and dense grain garnet, ilmenite, hematite, magnetite, or associated minerals of those ores that will resist degradation during handling and use, and shall:

1. an effective size range of the 0.2 mm to 0.3 mm;

2. contain at least 95 percent of the associated material with a specific gravity greater than 3.8 or higher;

3. acid Solubility less than 5 percent; and

4. a uniformity coefficient of not greater than 1.65.

D. GRANULAR ACTIVATED CARBON (GAC) - Granular activated carbon as single media may be considered for filtration only after pilot or full-scale testing and with prior approval of the Division. The design shall include the following:

1. The media must meet the basic specifications for filter media as given in this document except that larger size media may be allowed by the Division where full-scale tests have demonstrated that treatment goals can be met under all conditions.

2. There must be provisions for a free chlorine residual and adequate contact time in the water following the filters and prior to distribution.

3. There must be means for periodic treatment of filter material for control of bacterial and other growth.

4. Provisions must be made for replacement or regeneration by monitoring for filter break through at the outlet of the GAC.

E. OTHER MEDIA - Other media may be considered based on experimental data and operating experience.

TYPES OF SUPPORT MEDIA

F. TORPEDO SAND - A three-inch layer of torpedo sand should be used as a supporting media for filter sand where supporting gravel is used, and should have:

1. effective size of 0.8 mm to 2.0 mm; and

2. uniformity coefficient not greater than 1.7.

G. GRAVEL - Gravel, when used as the supporting media shall consist of hard, durable, rounded silica particles and shall not include flat or elongated particles.

1. The coarsest gravel shall be 2 ½ inches in size when the gravel rests directly on a lateral system and must extend above the top of the perforated laterals.

2. Not less than four layers of gravel shall be provided in accordance with the following size and depth distribution when used with perforated laterals:

Size	Depth
3/16 to 1/2 inches	2 to 3 inches
1/2 to 3/4 inches	3 to 5 inches
3/4 to 1 1/2 inches	3 to 5 inches
1 1/2 to 2 1/2 inches	5 to 8 inches

3. Reduction of gravel depths may be considered upon justification when proprietary filter bottoms are specified.

4. The depth of any gravel layer should not be less than 2 inches or less than twice the largest gravel size for that layer, whichever is greater. The bottom layer should be thick enough to cover underdrain laterals, strainers, or other irregularities in the filter bottom. The total depth of gravel above the underdrains should not be less than ten (10) inches.

9.4.5 FILTER BOTTOMS AND STRAINER SYSTEMS

Departures from these standards may be acceptable for high rate filters and for proprietary bottoms. Porous plate bottoms shall not be used. The design of manifold-type collection systems shall be such as to:

a. minimize loss of head in the manifold and laterals;

b. assure even distribution of washwater and even rate of filtration over the entire area of the filter;

c. provide the ratio of the area of the final openings of the strainer systems to the area of the filter at about 0.003;

d. provide the total cross-sectional area of the laterals at about twice the total area of the final openings; and

e. provide the cross-sectional area of the manifold at 1-1/2 to 2 times the total area of the laterals.

9.4.6 SURFACE WASH OR SUBSURFACE WASH

Surface or subsurface wash facilities are required except for filters used exclusively for iron or manganese removal and may be accomplished by a system of fixed nozzles or a revolving-type apparatus. All devices shall be designed to ensure maximum agitation over the entire filter area and include:

a. provision for water pressures of at least 45 psi; Higher pressures of 65-100 psi may be necessary for the proper operation of the revolving-type surface wash apparatus depending upon the diameter of the arms;

b. arms of the revolving-type surface wash apparatus should be placed about 2 inches above the surface of the unexpanded filter media;

c. a properly installed vacuum breaker or other approved device (i.e. double check valve or reduced pressure zone backflow preventer) to prevent back siphonage if connected to the treated water system; and

d. rate of flow of 2.0 gpm/ft^2 of filter area with fixed nozzles or 0.5 gpm/ft^2 with revolving arms.

9.4.7 AIR SCOURING

Air scouring can be considered in place of surface wash.

a. air flow for air scouring the filter must be 3-5 standard cubic feet per minute per square foot of filter area when the air is introduced in the underdrain; a lower air rate must be used when the air scour distribution system is placed above the underdrains;

b. a method for avoiding excessive loss of the filter media during backwashing must be provided;

c. air scouring must be followed by a fluidization wash sufficient to restratify the media;

d. air must be free from contamination;

e. air scour distribution systems should be placed below the media and supporting bed interface; if placed at the interface the air scour nozzles shall be designed to prevent media from clogging the nozzles or entering the air distribution system;

f. piping for the air distribution system shall not be flexible hose which will collapse when not under air pressure and shall not be a relatively soft material which may erode at the orifice opening with the passage of air at high velocity;

g. air delivery piping shall not pass down through the filter media nor shall there be any arrangement in the filter design which would allow short circuiting between the applied unfiltered water and the filtered water;

h. consideration should be given to maintenance and replacement of air deliver piping;

i. the backwash delivery system must be capable of 15 gallons per minute per square foot of filter surface area; however, when air scour is provided the backwash rate must be variable and should not exceed 8 gallons per minute per square foot unless operating experience shows that a higher rate is necessary to remove scoured particles from filter surfaces;

j. the filter underdrains shall be designed to accommodate air scour piping when the piping is installed in the underdrain; and

k. the provisions for backwash, as stated in Section 9.4.9, shall be followed.

9.4.8 APPURTENANCES

The following shall be provided for every filter:

a. influent and effluent sampling taps;

b. an indicating loss of head gauge;

c. an indicating rate-of flow control. A modified rate controller which limits the rate of filtration to a maximum rate may be used. However, equipment that simply maintains a constant water level on the filters is not acceptable, unless the rate of flow onto the filter is properly controlled;

d. a turbidimeter with continuous turbidity reading in NTUs and a recorder;

e. a sensor on the effluent pipe connected to an online continuous particle counting device (and data processing system) for counting particles in a size range between 3 and 15 microns;

f. wall sleeves providing access to the filter interior at several locations for sampling or pressure sensing;

g. a 1 to 1-1/2 inch pressure hose and storage rack at the operating floor for washing filter walls. The hose connection shall be protected with a vacuum breaker;

h. provisions for filtering to waste with appropriate measures for backflow prevention;

i a throttling valve used to reduce rates below normal during adverse raw water conditions; and

j. evaluation of the need for body feed, recirculation and any other pumps in accordance with this document.

9.4.9 BACKWASH

Provisions shall be made for washing filters as follows:

a. a minimum rate of 15 gallons per minute per square foot, consistent with water temperatures and specific gravity of the filter media. A rate of 20 gallons per minute per square foot or a rate necessary to provide for a 50 percent expansion of the filter bed is recommended. A reduced rate of 10 gallons per minute per square foot may be acceptable for full depth anthracite or granular activated carbon filters;

b. filtered water provided at the required rate by washwater tanks, a washwater pump, from the high service main, or a combination of these;

c. washwater pumps in duplicate unless an alternate means of obtaining washwater is available;

d. water supply to backwash one filter for not less than 15 minutes at the design rate of wash;

e. a washwater regulator or valve on the main washwater line to obtain the desired rate of filter wash with the washwater valves on the individual filters open wide;

f. a rate-of-flow indicator, preferably with a totalizer, on the main washwater line located so that it can be easily read by the operator during the washing process;

g. after washwater pumps are turned off and influent line opened, a rewash cycle shall be performed or use other backwash approaches like Extended Terminal Subfluidization Wash (ETSW) or other techniques, during which period the water is filtered to waste until the turbidity is stabilized at approximately 0.3 NTU. Piping must be provided for this purpose to assure that the water is filtered to waste at a rate equivalent to the permitted filtration rate; and

h. design to prevent rapid changes in backwash water flow.

9.4.10 <u>MISCELLANEOUS</u>

Roof drains shall not discharge into the filters or basins and conduits preceding the filters. Preferably, all filters be enclosed.

9.5 <u>PRESSURE FILTERS</u>

The normal use of these filters is for iron and manganese removal. Pressure filters shall not be used in the filtration of surface or other polluted waters or following lime-soda softening.

Minimum criteria relative to number, rate of filtration, structural details and hydraulics, filter media, etc., provided for rapid rate gravity filters also apply to pressure filters where appropriate. Preferably, the rate shall not exceed three (3) gallons per minute per square foot of filter area.

9.5.1 <u>DETAILS OF DESIGN</u>

The filters shall be designed to provide for:

a. loss of head gauges on the inlet and outlet pipes of each filter;

b. an easily readable meter or flow indicator on each battery of filters. A flow indicator is to be installed for each filtering unit;

c. filtration and backwashing of each filter individually with an arrangement of piping as simple as possible to accomplish these purposes;

d. minimum side wall shell height of five feet. A corresponding reduction inside wall height is acceptable where proprietary bottoms permit reduction of the gravel depth;

e. the top of the washwater collectors to be at least 18 inches above the surface of the media;

f. the underdrain system to efficiently collect the filtered water and to uniformly distribute the backwash water at a rate not less than 15 gallons per minute per square foot of filter area;

g. backwash flow indicators and controls that are easily readable while operating the control valves;

h. an air release valve on the highest point of each filter;

i. an accessible manhole to facilitate inspection and repairs;

j. means to observe the wastewater during backwashing; and

k. construction to prevent cross-connection.

9.6 DIATOMACEOUS EARTH FILTRATION

The use of these filters may be considered for application to surface waters with low turbidity and low bacterial contamination and may be used for iron removal for groundwaters provided the removal is effective and the water is of satisfactory sanitary quality before treatment.

9.6.1 CONDITIONS OF USE

Diatomaceous earth filters are expressly excluded from consideration for the following conditions:

a. bacteria removal;

b. color removal;

c. turbidity removal where either the gross quantity of turbidity is high, or the turbidity exhibits poor filterability characteristics; and

d. filtration of waters with high algae counts.

9.6.2 PILOT PLANT STUDY

Installation of a diatomaceous earth filtration system shall be preceded by a pilot plant study on the water to be treated.

a. Conditions of the study such as duration, filter rates, head loss accumulation, slurry feed rates, turbidity removal, bacteria removal, etc., must be approved by the Division prior to the study.

b. Satisfactory pilot plant results must be obtained prior to preparation of final construction plans and specifications.

c. The pilot plant study must demonstrate the ability of the system to meet applicable drinking water standards at all times.

9.6.3. TYPES OF FILTERS

Pressure or vacuum diatomaceous earth filtration should be considered. However, the vacuum type is preferred for its ability to accommodate a design which permits observation of the filter surfaces to determine proper cleaning, damage to a filter element, and adequate coating over the entire filter area.

9.6.4 TREATED WATER STORAGE

Treated water storage capacity in excess of normal requirements shall be provided to:

a. allow operation of the filters at a uniform rate during all conditions of system demand at or below the approved filtration rate; and

b. guarantee continuity of service during adverse raw water conditions without by-passing the system.

9.6.5 NUMBER OF UNITS

At least two (2) units shall be provided.

9.6.6 PRECOAT

The precoat shall conform to following:

a. Application - A uniform precoat shall be applied hydraulically to each septum by introducing a slurry to the tank influent line and employing a filter-to-waste or recirculation system.

b. Quantity - Diatomaceous earth in the amount of 0.1 pounds per square foot of filter area or an amount sufficient to apply a 1/16 inch coating should be used with recirculation. When precoating is accomplished with a filter-to-waste system, 0.15 to 0.2 pounds per square foot of filter area is recommended.

9.6.7 BODY FEED

A body feed system to apply additional amounts of diatomaceous earth slurry during the filter run is required to avoid short filter runs or excessive head losses.

a. Quantity - Rate of body feed is dependent on raw water quality and characteristics and must be determined in the pilot plant study.

b. Operation and maintenance can be simplified by providing accessibility to the feed system and slurry lines.

c. Continuous mixing of the body feed slurry is required.

9.6.8 FILTRATION

a. The settled raw water entering the filtration system shall contain turbidity level less than 1.0 NTU and total organic compound (TOC) less than 1.0 ppm.

b. Rate of Filtration - The recommended nominal rate is 1.0 gallon per minute per square foot of filter area with a recommended maximum of 1.5 gallons per minute per square foot. The filtration rate shall be controlled by a positive means.

c. Head Loss - The head loss shall not exceed 30 psi for pressure diatomaceous earth filters, or a vacuum of 15 inches of mercury for a vacuum system.

d. Recirculation - A recirculation or holding pump shall be employed to maintain differential pressure across the filter when the unit is not in operation in order to prevent the filter cake from dropping off the filter elements. A minimum recirculation rate of 0.1 gallon per minute per square foot of filter area shall be provided.

e. Septum or Filter Element - The filter elements shall be structurally capable of withstanding maximum pressure and velocity variations during filtration and backwash cycles and shall be spaced such that no less than one inch is provided between elements or between any element and a wall.

f. Inlet Design - The filter influent shall be designed to prevent scour of the diatomaceous earth from the filter element.

9.6.9 BACKWASH

A satisfactory method to thoroughly remove and dispose of spent filter cake shall be provided.

9.6.10 MONITORING

An on-line continuous particle counting device and a continuous monitoring turbidimeter with recorder on the filter effluent is required for plants treating surface water.

9.7 DECLINING RATE FILTRATION

This is a design where no rate-of-flow controllers are installed. The rate of flow through the filter media is greatest when the media has just been back washed and gradually declines as the media becomes filled with contaminants.

a. The design must include means to ensure that the water level during operation will not fall below the level of the top of the media.

b. The filtration rate must not exceed 6 gpm/ft^2 when the filter is clean (immediately following backwash) and uses dual or mixed media.

c. This design is normally appropriate only when four (4) or more filters are used in the plant.

9.8 DIRECT FILTRATION

Direct filtration, as used herein, refers to the filtration of a surface water without prior settling. The nature of the treatment process will heavily depend upon the raw water quality. A full-scale direct filtration plant shall not be constructed without prior pilot studies which are acceptable to the Division. Where direct filtration is proposed, an engineering report shall be submitted prior to conducting pilot plant.

a. Will be considered on a case-by basis.

b. However, all filters shall have dual or mixed media and be operated at a rate between 2 and 5 gpm/ft^2.

c. Flash mix and flocculation basins shall be provided.

9.8.1 ENGINEERING REPORT

In addition to the items previously stated in this document under "Engineering Report", the report should include a historical summary of meteorological conditions and of raw water quality with special reference to fluctuations in quality, and possible sources of contamination. The following raw water parameters should be evaluated in the report:

a. color;

b. turbidity;

c. microbiological/pathogen concentration;

d. microscopic biological organisms;

e. temperature;

f. total solids;

g. general inorganic, organic chemical and radiological characteristics; and

h. additional parameters as may be required by the Division.

The report should also include a description of methods and work to be done during a pilot plant study or where appropriate an in-plant demonstration study.

9.8.2 PILOT PLANT/TREATABILITY/TRANSFER TECHNOLOGIES STUDIES

Submission of an engineering report is required for approval before conducting pilot plant, treatability study and transfer of technologies for new and/or modification of a public water system. This requirement depends on the proposed water plant treatment changes. After approval of the engineering report, the Division will provide the next step in approval process.

a. The study must be conducted over a sufficient time to treat all expected raw water conditions throughout the year.

b. The study shall emphasize but not be limited to, the following items:

1. chemical mixing conditions including shear gradients and detention periods;

2. chemical feed rates;

3. use of various coagulants and coagulant aids;

4. flocculation conditions;

5. filtration rates;

6. filter gradation, types of media and depth of media;

7. filter breakthrough conditions; and

8. adverse impact of recycling backwash water due to solids, pathogens, algae, disinfection by-products formation and similar problems.

c. Prior to the initiation of design plans and specifications, a final report including the engineer's design recommendations shall be submitted to the Division for review and approval.

d. The pilot plant filter must be of a similar type and operated in the same manner as proposed for full scale operation.

e. The pilot study must demonstrate the minimum contact time necessary for optimum filtration for each coagulant proposed.

9.8.3 PRETREATMENT

Rapid mix and flocculation - The final rapid mix and flocculation basin design should be based on the pilot plant or in-plant demonstration studies augmented with applicable portions of this document.

9.8.4 FILTRATION

Filters should be rapid rate gravity filters with dual or mixed media. The final filter design should be based on the pilot plant or in-plant demonstration studies augmented by applicable portions and in conformance with this document. Pressure filters or single media sand filters shall not be used.

9.8.5 CONTROL AND OPERATION

An online continuous particle counting device equipped with dual sensors and data processing system to demonstrate continuous removal of particles in a size range between 3 and 15 microns shall be installed. A continuous recording turbidimeter shall also be installed on each filter effluent line and on the composite filter effluent line. Additional continuous monitoring equipment, such as a streaming current detector, shall be provided to assist in control of coagulant dosage in optimizing the coagulation process.

9.8.6 SITING REQUIREMENTS

The plant design and land ownership surrounding the plant shall allow for the installation of conventional sedimentation basins should it be found that such are necessary.

9.9 DISINFECTION

An engineering report submission is a requirement for the demonstration of the optimization of chlorination of finished drinking water by continuous disinfection treatment using any of the following treatment techniques: Chlorination; Chloramination; Chlorine Dioxide; Ozonation; Mixed Oxidant Types; Ultraviolet Disinfection and other approved methods.

Chlorine is the disinfecting agent commonly used. Chlorination may be accomplished with liquid chlorine, calcium or sodium hypochlorite or chlorine dioxide. Other disinfecting agents will be considered, providing reliable application equipment is available and testing procedures for a residual are recognized in "Standard Methods for the Examination of Water and Wastewater," latest edition.

9.9.1 CHLORINATION EQUIPMENT

a. Type - Solution-feed gas chlorinators or hypochlorite feeders of the positive displacement type are acceptable.

b. Capacity - The chlorinator capacity shall be such that a free chlorine residual of at least two (2) milligrams per liter (mg/L) can be maintained in the water after contact time of at least 30 minutes when maximum flow rate coincides with anticipated maximum chlorine demand. The equipment shall be of such design that it will operate accurately over the desired feeding range.

c. Standby Equipment - Where chlorination is required for protection of the supply, standby equipment of sufficient capacity shall be available to replace the largest unit. Spare parts shall be made available to replace parts subject to wear and breakage. If there is a large difference in feed rates between routine and emergency dosages, a gas metering tube should be provided for each dose range to ensure accurate control of the chlorine feed.

d. Automatic Switchover - Automatic switchover of chlorine cylinders should be provided, where necessary, to assure continuous disinfection. All surface water treatment plants must comply with this requirement.

e. Automatic Proportioning - Automatic proportioning chlorinators will be required where the rate of flow or chlorine demand is not reasonably constant or where the quality of the water is subject to rapid changes.

f. Eductor - Each eductor must be selected for the point of application with particular attention given to the quantity of chlorine to be added, the maximum injector waterflow, the total discharge back pressure, the injector operating pressure and the size of the chlorine solution line. Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor should be provided.

g. Injector/Diffuser – The chlorine solution injector/diffuser must be compatible with the point of application to provide a rapid and thorough mix with all the water being treated. The center of a pipeline is the preferred application point.

9.9.2 CONTACT TIME (CT) AND POINT OF APPLICATION

Due consideration shall be given to the contact time of the chlorine in water with relation to pH, ammonia, taste-producing substances, temperature, bacterial quality, trihalomethanes formation potential and other pertinent factors. Chlorine should be applied at a point which will provide adequate contact time. All basins used for disinfection must be designed to minimize short circuiting.

a. Water must be continuously chlorinated to maintain a detectable residual of free chlorine in all parts of the distribution system in the recommended amount of at least 0.2 parts per million.

b. As a minimum, at plants treating groundwater, provisions should be made for applying chlorine to the detention basin inlet and water entering the distribution system.

c. Water from a spring shall be disinfected and retained in a detention tank for a minimum of thirty (30) minutes unless otherwise approved by the Division; and such additional water treatment as the Division may require for the drinking water to comply with the rules.

d. Chemical feed equipment shall be of such design and capacity to accurately supply, at all times, the treatment chemicals required.

e. At plants treating surface water, provisions should be made for applying chlorine to the raw water, settled water, filtered water and water entering the distribution system. The contact time (CT) as required by the Division must be provided after filtration to achieve the level of inactivation of *Giardia* cysts and viruses through disinfection. The required CT shall be determined by conducting tracer studies as outlined in this section.

f. Contact Time (CT) shall be conducted per Section 9.9.9.

g. If a new disinfectant is proposed or change in rate of disinfection, a new CT shall be conducted.

9.9.3 RESIDUAL CHLORINE

If primary disinfection is accomplished using ozone, ultraviolet light (UV), or some other chemical that does not provide a residual disinfectant, then chlorine must be added to provide a residual disinfectant. Minimum free chlorine residual in a water distribution system should be at least 0.2 mg/L. minimum chloramine residuals, where chloramination is practiced, should be 1.0 mg/L at different points in the distribution system.

9.9.4 PROCEDURES FOR CONDUCTING TRACER STUDIES

The effectiveness of *Giardia* inactivation in a water treatment plant can be demonstrated through "CT" studies. The Surface Water Treatment Rule (SWTR) Guidance Manual defines CT as the residual disinfectant value multiplied by the minutes of available contact time. The time is measured from the disinfectant application point to the point where the residual is measured. For the inactivation of *Giardia* to meet SWTR requirements, only contact time prior to the first customer can be counted. Contact time, T_{10} (detention time for the calculation of CT), is defined as the point where 90% of the flow passing through a unit (clearwell, wetwell, storage tank, etc.) is retained within the unit. Flow through a pipe is calculated as plug flow and the total volume is included in the CT determination. That means to determine the contact time in minutes in a pipeline, calculate the volume of the pipeline in gallons and divide it by the maximum flow rate in gallons per minute.

Detention time established by tracer tests may be used to estimate "CT" with flow rates less than or equal to the tracer test flow. For this reason, use of worst case evaluations can provide reliable CT value determinations under all permitted operating conditions. This may eliminate the need for conducting multiple studies at several different plant flows. Once CT has been calculated (remember CT is the product of the retention time (T,,) in minutes and the disinfectant residual in mg/L measured at the exit/end of the unit or pipeline) , the log inactivation of *Giardia* can be determined using the "CT Table" that corresponds to the water temperature and pH.

The Guidance Manual (GM) describes two procedures for determining contact time using tracer materials. Both procedures involve measuring tracer concentrations versus time. The step-dose procedure is readily adaptable to most Georgia water plants because existing equipment can be utilized with minimal modifications. The slug-dose procedure may require some plant modifications and offers no advantage over the former procedure. Only the step-dose procedure for conducting a tracer study to determine T_{10} is outlined in this document.

Recommended tracer materials are fluoride compounds due to availability, cost and compatibility with existing plant equipment. In addition, fluoride concentration is easily measured with routine laboratory analyses using existing equipment. Depending on baseline concentrations, application of 3 mg/L of fluoride should be adequate. The maximum fluoride level should not exceed 4.0 mg/L. To ensure accurate results, the selected test method should be conducted maintaining constant plant flow rates (at maximum or worst case) and plant finished water storage volume representing no more than 30% of capacity. During the study, finished water outflow (pumped or gravity flow) should equal or exceed plant inflow to provide conservative CT value estimates.

Using the recommended step-dose method, a constant tracer addition is started and timed until the concentration stabilizes at the sampling point. If the fluoride addition is then discontinued, the receding fluoride values may be monitored and used for verification purposes. In contrast, the slug-dose method requires an instantaneous tracer addition and measurement at the sampling point over time. Successful use of this method is directly related to post chemical mixing efficiency to avoid distortions associated with density currents.

Before attempting a tracer test, the plant supervisor should develop a plan to ensure proper coordination of all system components. The planning must provide a system balance while conducting the test, which precludes activities, such as filter backwashing, which could significantly distort test results. Some plants may have site specific features that require modification to properly conduct a tracer test. Please call the Drinking Water Program for information if there are questions concerning areas not listed in the attached procedures.

a. <u>TRACER TEST PROCEDURES</u>

1. Select tracer chemical. Fluoride compounds are used in virtually all surface water treatment plants in Georgia and are the recommended choice.

2. The total fluoride concentration should not exceed 4 mg/L. Remember to verify the available fluoride content of the product being used for your study. Sodium silicofluoride usually contains about 60% available fluoride, while sodium fluoride contains about 44% fluoride.

3. Discontinue routine fluoride application 24 to 48 hours prior to the scheduled tracer study. This will allow the fluoride level in the water in the clearwell to drop to background (baseline concentration).

4. Determine the tracer (fluoride) background level by testing filtered water prior to fluoride addition. Do not start the study until the fluoride concentration in the water leaving the plant is the same as the background level.

5. Provide a bypass flush connection to waste on the fluoride solution line just prior to its application (injection) point.

6. Adjust the fluoride output to the desired application rate (this value is referred to as C_0) and verify by weighing output several times, especially if using a volumetric feeder. Verify the feed rate again about midway and at the conclusion of the test. (If significant output variations are noted, a repeat test may be required.) After obtaining the desired feed output, operate the feeder for 30 minutes while discharging the fluoride solution to waste at the application (injection point). This procedure will allow the fluoride concentration to stabilize in the feeder solution chamber and pipe.

   Example: Using sodium silicofluoride as the selected tracer, the amount of chemical required is determined as follows:

   1. Assume 60% fluoride concentration
   2. Application (dosage) rate of 3 mg/L (C_0)
   3. 1 MGD plant flow

Calculation:

$$\frac{8.34 \ \text{x} \ 1.0 \text{ MGD} \ \text{x} \ 3 \text{ mg/L}}{0.60} = 41.7 \text{ lbs.}$$

$$\frac{41.7 \text{ lbs.} \ \text{x} \ 454 \text{ grams/lb.}}{1440} = 13.1 \text{ grams/min } Na_2SiF_6 \text{ required from the feeder}$$

7. The sampling point should represent direct discharge into the distribution system. Excessively long sample lines or taps from plant service water lines can distort actual detention values and must be avoided. In some cases, installation of representative sampling tap(s) may be necessary.

8. Close the bypass flush valve and start allowing the fluoride solution into the filtered water through the injection point. Note and record the time (a stopwatch is recommended) and begin sampling the finished water leaving the clearwell/plant at 3 to 5 minute intervals using clean, clearly marked sampling containers. Continue sampling until the fluoride concentration in the finished water has stabilized for several sampling intervals. The stabilized fluoride concentration should be approximately equal to the fluoride dose applied (3 mg/L in the previous example) plus the background (baseline) concentration contained in the filtered water prior to fluoride addition. Note: if your clearwell has a large theoretical retention time (greater than 4 hours), sampling may be conducted at 10 minute intervals for the first 30 minutes, or until a tracer concentration above baseline is first detected. Once a concentration change is first observed, immediately change to the 3 to 5 minute sampling interval. For verification of the test, the tracer (fluoride) feed should be discontinued, and the receding fluoride concentration at the effluent should be sampled and monitored at the same frequency (3 to 5 minute intervals) until the fluoride concentration returns to background. The time at which the fluoride feed is stopped is time zero for the receding tracer test and must be noted. The receding tracer test will provide a replicate set of measurements which can be compared with data derived from the rising tracer concentration versus time curve.

9. Fluoride analyses should be conducted using standardized instrumentation, fresh reagents and clean glassware. Fluoride levels exceeding about 2.0 mg/L must be accurately diluted with distilled water before calorimetric analysis.

10. During the tracer test, the analytical results versus time should be tabulated in the columns on the "Step-Dose Tracer Test Data" form and used to determine T_{10} as shown in the following example taken from the SWTR Guidance Manual. The current version of these forms can be found on the Georgia EPD Website.

11. For each tracer study performed, a completed copy of the "Tracer Study Report" form, the "Step-Dose Tracer Test Data" form and a copy of the graphical analysis for determining T_{10} (see Figure C-1, a graph of C/C_0 vs. Time) must be submitted to the Division. The current version of these forms can be found on the Georgia EPD Website.

EXAMPLE from U.S.EPA SWTR Guidance Manual:

Step-Dose Method Test

For the step-dose test a constant fluoride dosage of 2.0 mg/L was added to the clear-well inlet. Fluoride levels in the clearwell effluent were monitored and recorded every 3 minutes. The raw tracer study data, along with the results of further analyses are shown in Table C-1.

TABLE C-1

CLEARWELL DATA-STEP-DOSE TRACER TEST(1,2,3)

	Fluoride Concentration		
t , minutes	Measured, mg/L	Tracer, mg/L	Dimensionless, C/C_0
0	0.20	0	0
3	0.20	0	0
6	0.20	0	0
9	0.20	0	0
12	0.29	0.09	0.045
15	0.67	0.47	0.24
18	0.94	0.74	0.37
21	1.04	0.84	0.42
24	1.44	1.24	0.62
27	1.55	1.35	0.68
30	1.52	1.32	0.66
33	1.73	1.53	0.76
36	1.93	1.73	0.86
39	1.85	1.65	0.82
42	1.92	1.72	0.86
45	2.02	1.82	0.91
48	1.97	1.77	0.88
51	1.84	1.64	0.82
54	2.06	1.86	0.93
57	2.05	1.85	0.92
60	2.10	1.90	0.95
63	2.14	1.94	0.96

1. Baseline concentration = 0.2 mg/L, fluoride dose = 2.0 mg/L , [C_0 = 2.0 mg/L]
2. Measured concentration = Tracer concentration + Baseline concentration
3. Tracer concentration.= Measured concentration - Baseline concentration

The steps in evaluating the raw data shown in the first column of Table C-1 are as follows. First, the baseline fluoride concentration, 0.2 mg/L, is subtracted from the measured concentration to give the fluoride concentration resulting from the tracer study addition alone. For example, at elapsed time = 39 minutes, the tracer fluoride concentration, C, is obtained as follows:

$C = C_{measured} - C_{baseline}$
C = 1.85 mg/L - 0.2 mg/L
C = 1.65 mg/L

This calculation was repeated at each time interval to obtain the data shown in the third column of Table C-1. As indicated, the fluoride concentration rises from 0 mg/L at t = 0 minutes to the applied fluoride dosage of 2 mg/L, at t = 63 minutes.

The next step is to develop dimensionless concentrations by dividing the tracer concentrations in the second column of Table C-1 by the applied fluoride dosage, Co = 2 mg/L. For time = 39 minutes, C/Co is calculated. as follows:

C/Co = (1.65 mg/L)/(2.0 mg/L)
C/C_0 = 0.82

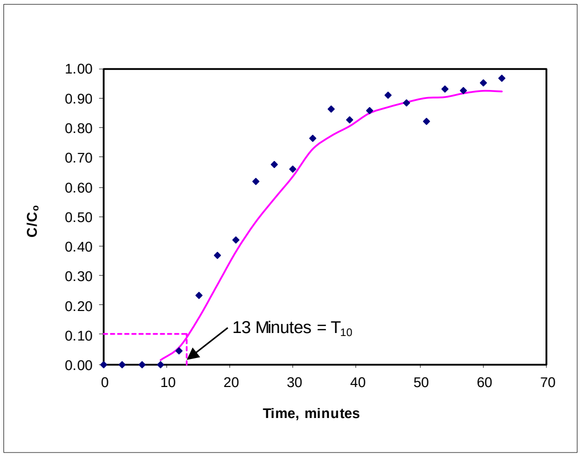
The resulting dimensionless data, presented in the fourth column of Table C-1, is the basis for completing the determination of T_{10} by either the graphical or numerical method.

In order to determine T_{10} by the graphical method, a plot of C/Co vs. time should be generated using the data in Table C-1. A smooth curve should be drawn through the data as shown on Figure C-1.

T_{10} is read directly from the graph at a dimensionless concentration (C/Co) corresponding to the time for which 10 percent of the tracer has passed at the effluent end of the contact basin (T_{10}). For step-dose method tracer studies, this dimensionless concentration is C/Co = 0.10.

T_{10}.should be read directly from Figure C-1 at C/Co = 0.1 by first drawing a horizontal line (C/Co = 0.1) from the Y-axis (t = 0) to its intersection with the smooth curve drawn through the data. At this point of intersection, the time read from the X-axis is T_{10} and may be found by extending a vertical line downward to the X-axis. These steps were performed as illustrated on Figure C-1, resulting in a value for T_{10} of approximately 13 minutes.

FIGURE C-1 - C/C_0 vs. Time (Graphical Analysis for T_{10})



CT Values Tables: CT Values for Inactivation of *Giardia* cysts by Free Chlorine at 5^0 C.

Chlorine Concentration (mg/L)	pH < = 6.5 Log Inactivation 0.5	1.0	1.5	2.0	2.5	3.0
< = 0.4	20	39	59	78	98	117
0.6	20	40	60	80	100	120
0.8	20	41	61	81	102	122
1	21	42	63	83	104	125
1.2	21	42	64	85	106	127
1.4	22	43	65	87	108	130
1.6	22	44	66	88	110	132
1.8	23	45	68	90	113	135
2	23	46	69	92	115	138
2.2	23	47	70	93	117	140
2.4	24	48	72	95	119	143
2.6	24	49	73	97	122	146
2.8	25	49	74	99	123	148
3	25	50	76	101	126	151

Chlorine Concentration (mg/L)	pH = 7.0 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0
< = 0.4	23	46	70	93	116	139
0.6	24	48	72	95	119	143
0.8	24	49	73	97	122	146
1	25	50	75	99	124	149
1.2	25	51	76	101	127	152
1.4	26	52	78	103	129	155
1.6	26	53	79	105	132	158
1.8	27	54	81	108	135	162
2	28	55	83	110	138	165
2.2	28	56	85	113	141	169
2.4	29	57	86	115	143	172
2.6	29	58	88	117	146	175
2.8	30	59	89	119	148	178
3	30	61	91	121	152	182

Chlorine Concentration (mg/L)	pH < = 7.5 Log Inactivation					
	0.5	1.0	1.5	2.0	2.5	3.0
< = 0.4	28	55	83	111	138	166
0.6	29	57	86	114	143	171
0.8	29	58	88	117	146	175
1	30	60	90	119	149	179
1.2	31	61	92	122	153	183
1.4	31	62	94	125	156	187
1.6	32	64	96	128	160	192
1.8	33	65	98	131	163	196
2	33	67	100	133	167	200
2.2	34	68	102	136	170	204
2.4	35	70	105	139	174	209
2.6	36	71	107	142	178	213
2.8	36	72	109	145	181	217
3	37	74	111	147	184	221

9.9.5 CHLORINE TESTING EQUIPMENT

a. Chlorine residual test equipment recognized in the latest edition of Standard Methods for the Examination of Water and Wastewater shall be provided and should be capable of measuring residuals to the nearest 0.01 mg/L in the range below 1.0 mg/L, to the nearest 0.1 mg/L between 1.0 mg/L and 2.5 mg/L and to the nearest 0.2 mg/L above 2.5 mg/L. It is recommended that all systems, as a minimum, use an instrument with a digital readout.

b. Automatic chlorine residual recorders should be provided where the chlorine demand varies appreciably over a short period of time.

c. All treatment plants having a capacity of 0.5 million gallons per day or greater should be equipped with recording chlorine analyzers monitoring water entering the distribution system.

d. All surface water treatment plants that serve a population greater that 3300 must have equipment to measure chlorine residuals continuously entering the distribution system.

e. Systems that rely on chlorination for inactivation of bacteria or other microorganisms present in the source water shall have continuous chlorine residual analyzers and other equipment that automatically shut down the facility when chlorine residuals are not met unless otherwise approved by the Division.

f. All continuously recording chlorine residual analyzers must be compatible with the requirements of EPA Method 334.0 or ChloroSense (Palintest).

g. Public water supplies with a chloramine residual shall have test equipment for ammonia, nitrite, nitrate, total chlorine, and free chlorine, with consideration given for the possible interference of chloramines.

9.9.6 CHLORINATOR PIPING

a. The chlorinator water supply piping shall be designed to prevent contamination of the treated water supply by sources of questionable quality.

b. At all facilities treating surface water, pre- and post-chlorination systems must be independent to prevent possible siphoning of partially treated water into the clearwell. A check valve should be provided for the pre-chlorination line near the eductor.

c. The water supply to each eductor shall have a separate shut-off valve. No master shut-off valve will be allowed.

d. The pipes carrying elemental liquid or dry gaseous chlorine under pressure must be Schedule 80 seamless steel tubing or other materials recommended by the Chlorine Institute (never use PVC). Rubber, PVC, polyethylene or other materials recommended by the Chlorine Institute must be used for chlorine solution piping and fittings. Nylon products are not acceptable for any part of the chlorine solution piping system.

9.9.7 HOUSING FOR CHLORINATION EQUIPMENT

Adequate housing must be provided for the chlorination equipment and for storing the chlorine.

In addition to the applicable items stated in Part 8, in this document, the following must be included:

a. Gas chlorination equipment and cylinders must be housed in a separate room or facility provided for that purpose and be separated from the other treatment facilities and chemicals. Hypochlorite feeders are not required to be placed in a separate room or facility.

b. Chlorine cylinders stored or used outdoors must be protected from the direct rays of the sun by shading and additionally protected to prevent unauthorized tampering.

c. Chlorine cylinders must be secured from accidental tipping or movement.

d. A chlorine gas mask or self-contained gas mask (air pack) must be provided outside the gas chlorine room or facility or otherwise made available and be readily accessible to the operator for repairs or emergencies.

e. Forced air ventilation, placed near floor level and near the cylinders, must be provided to exhaust any leaking chlorine gas. Exhaust fumes must be directed away from the entrance to the room or facility. The fan must be activated by an outside switch or start automatically when the door is opened.

f. A small bottle of fresh ammonia solution shall be provided for testing for chlorine gas leaks.

g. There must be sufficient space for chemical storage.

9.9.8 CHLORAMINE DISINFECTION

Chlorine combines with ammonia to form chloramine compounds. The ammonia may be naturally occurring or may be added to the water usually after the chlorine injection point. Chloramines are a weaker disinfectant and typically are used for secondary disinfection. Chloramine, which is less powerful than free chlorine, may be suitable for disinfection of some ground water supplies but it is inadequate in strength for primary disinfection of surface waters. In the distribution system, they are more persistent and better at controlling biofilms than free chlorine. Monochloramine has less taste and odor issues than free chlorine.

a. CHLORAMINE FORMATION

Chloramine formation is dependent on temperature, pH, mixing, organics, and chlorine to ammonia-nitrogen weight ration. The chlorine to ammonia-nitrogen weight ratio is based upon chlorine residual not chlorine dose. The desired chloramine compound is monochloramine. The chlorine to ammonia-nitrogen weight ratio for monochloramine formation is between 3:1 to 5:1. Typically, the desired ratio is 4:5:1. A higher ratio can lead to formation of dichloramine and trichloramine and the production of undesirable taste and odors. Too low of a ratio will result in excess free ammonia and possible nitrification in the distribution system.

b. FEED SYSTEM DESIGN

1. Chemical feed systems shall meet the requirements of Part 8 (Chemical application). Specific chemical requirements for chlorine gas, sodium hypochlorite, ammonium sulfate, aqua ammonia, and anhydrous ammonia are in Section 7 (Specific Chemicals).

2. Ammonia and ammonia compounds shall be stored in a separate room for chlorine because of potential explosive or violent reactions that could occur.

3. Both chlorine and ammonia must be mixed thoroughly and rapidly in the main plant stream to prevent formation of dichloramine and trichloramine.

4. A method to maintain the desired chlorine to ammonia-nitrogen weight ratio shall be provided. An automated, continuous instrument control method is recommended.

c. CHLORAMINE CONCENTRATION

The required chloramine concentration at each entry point depends on the size of the distribution system and the decay rate. Typically, the initial chloramine concentration is 2 mg/L or higher. A chloramine residual of at least 1 mg/L should be maintained throughout the distribution system.

d. CHLORAMINE BOOSTER SYSTEM

Booster chlorination of chloraminated water in the distribution system can be used to reform monochloramine from the ammonia released during the decay process. Booster chloramination (adding chlorine and ammonia) may be necessary in certain situations.

e. MONITORING

1. Public water supplies with a chloramine residual shall have test equipment for ammonia, nitrite, nitrate, total chlorine, and free chlorine, with consideration given for the possible interference of chloramines.

2. A monitoring program shall be established for each entry point, booster chlorination station and throughout the distribution system to verify proper chloramine formation and for determination of nitrification occurrence.

f. NITRIFICATION

1. Free ammonia concentration should be kept below 0.1 mg/L.

2. A nitrification control plan that includes flushing and the temporary use of a free chlorine residual should be prepared along with the triggering criteria for implementation.

g. CORROSION CONTROL

1. Switching from free chlorine to chloramines may increase lead solubility in water. An evaluation of the corrosion control strategy is required prior to making this switch.

2. The type of chlorine and ammonia chemicals used can affect the finished water pH. An evaluation of the corrosion control strategy is required prior to changing chemicals.

h. PUBLIC WATER SUPPLY INTERCONNECTIONS

Blending water supplies that contain both free chlorine and chloramines should be avoided except in an emergency.

i. PUBLIC NOTICE

Chloramines in water present risks to kidney dialysis patients and fish aquariums. Provide public notice prior to changing the type of chlorine residual.

9.9.9 CHLORINE DIOXIDE

Chlorine dioxide may be considered as a primary and residual disinfectant, a pre-oxidant to control tastes and odors, to oxidize iron and manganese, and to control hydrogen sulfide and phenolic compounds. It has been shown to be a strong disinfectant which does not form THMs or HAAs.

When choosing chlorine dioxide, consideration must be given to formation of the regulated byproducts, chlorite and chlorate.

a. CHLORINE DIOXIDE GENERATORS

Chlorine dioxide generation equipment shall be factory assembled pre-engineered units with a minimum efficiency of 95 percent. The excess free chlorine shall not exceed three percent of the theoretical stoichiometric concentration required.

b. FEED AND STORAGE FACILITIES

Chlorine gas and sodium chlorite feed and storage facilities shall comply with sections 7.1 and 7.3, respectively. Sodium hypochlorite feed and storage facilities shall comply with section 7.4.

c. OTHER DESIGN REQUIREMENTS

1. The design shall comply with all applicable portions of sections 9.9.1, 9.9.2, 9.9.3, and 9.9.8.

2. The minimum residual disinfectant level shall be established by the Division.

d. PUBLIC NOTIFICATION

Notification of a change in disinfection practices and the schedule for the changes shall be made known to the public; particularly to hospitals, byproducts may have similar effects as chloramines.

9.9.10 OZONE DISINFECTION

U.S.E.P.A. Guidance Manual Alternative Disinfectants and Oxidants: April 1999.

9.9.11 ULTRAVIOLET DISINFECTION

See: U.S.E.P.A. Office of Water (4601) EPA 815-D-03-007 Ultraviolet Disinfection Guidance Manual: June 2003: UV Disinfection Guidance Manual for the Final LT2ESWTR November 2006.

9.9.12 OTHER DISINFECTING AGENTS

Proposals for use of disinfecting agents other than chlorine such as iodine treatment may be approved by the Division prior to preparation of final plans and specifications.

9.10 RAW WATER SOFTENING TREATMENT

9.10.0 GENERAL

The softening process selected must be based upon the mineral qualities of the raw water and the desired finished water quality in conjunction with requirements for disposal of sludge or brine waste, cost of plant, cost of chemicals and plant location. Applicability of the process chosen shall be demonstrated through treatability study of the raw water.

a. Lime or Lime-Soda Process - For design standards for rapid mix, flocculation and sedimentation, refer to the applicable sections in this document. Additional consideration must be given to the following process elements.

   Hydraulics: When split treatment is used, the bypass line should be sized to carry total plant flow, and an accurate means of measuring and splitting the flow must be provided.

b. Aeration - Determinations should be made for the carbon dioxide (CO_2) content of the raw water. When concentrations exceed 10 milligrams per liter, the economics of removal by aeration as opposed to removal with lime should be considered if it has been determined that dissolved oxygen in the finished water will not cause corrosion problems in the distribution system.

c. Chemical Feed Point - Lime and recycled sludge should be fed directly into the rapid mix basin.

d. Rapid Mix - Rapid mix basins must provide not more than 30 seconds detention time with adequate velocity gradients to keep the lime particles dispersed.

e. Stabilization - Equipment for stabilization of water softened by the lime or lime-soda process is required.

f. Sludge Collection - Mechanical sludge removal equipment should be provided in the sedimentation basin. Sludge recycling to the rapid mix should be provided.

g. Sludge Disposal - Provisions must be included for proper disposal of softening sludges.

h. Disinfection - The use of excess lime shall not be considered an acceptable substitute for disinfection.

i. Plant Start-Up - The plant processes must be manually started following shut-down.

j. Cation Exchange Process - Alternative methods of hardness reduction should be investigated when the sodium content and dissolved solids concentration is of concern.

k. Pre-Treatment Requirements - Iron, manganese, or a combination of the two, should not exceed 0.3 milligrams per liter in the water as applied to the ion exchange resin. Pre-treatment is required when the content of iron, manganese or a combination of the two, is one milligram per liter or more. Waters having 5 units or more turbidity should not be applied directly to the cation exchange softener.

l. Design - The units may be of pressure or gravity type, of either an upflow or downflow design. Automatic regeneration based on volume of water softened should be used unless manual regeneration is justified (suggested for small plants). A manual override shall be provided on all automatic controls.

m. Exchange Capacity - The design capacity for hardness removal should not exceed 20,000 grains per cubic foot when resin is regenerated with 0.3 pounds of salt per kilogram of hardness removed.

n. Depth of Resin - The depth of the exchange resin should not be less than three (3) feet.

o. Flow Rates - The rate of softening should not exceed seven gallons per minute per square foot of bed area (7 gpm/ft^2) and the backwash rate should be six to eight gallons per minute per square foot of bed area (6 gpm/ft^2). Rate-of-flow controllers or the equivalent must be installed for the above purposes.

p. Freeboard - The freeboard will depend upon the specific gravity of the resin and the direction of water flow. Generally, the washwater collector should be 24 inches above the top of the resin on downflow units.

q. Underdrains and Supporting Gravel - The bottoms, strainer systems and support for the exchange resin shall conform to criteria provided for rapid rate gravity filters. Refer to applicable sections in this document.

r. Brine Distribution - Facilities should be included for even distribution of the brine over the entire surface of both upflow and downflow units.

s. Cross-Connection Control - Backwash, rinse and air relief discharge pipes should be installed in such a manner as to prevent any possibility of back-siphonage.

t. By-Pass Piping and Equipment - A bypass must be provided around softening units to produce a blended water of desirable hardness. Totalizing meters must be installed on the bypass line and on each softener unit. The bypass line must have a shutoff valve and should have an automatic proportioning or regulating device. In some installations, it may be necessary to treat the bypassed water to obtain acceptable levels of iron and/or manganese in the finished water.

u. Additional Limitations - Silica gel resins should not be used for waters having a pH above 8.4 or containing less than six milligrams per liter silica and should not be used when iron is present. When the applied water contains a chlorine residual, the cation exchange resin shall be a type that is not damaged by residual chlorine. Phenolic resin should not be used.

v. Sampling Taps - Smooth-nose sampling taps must be provided for the collection of representative samples. The taps shall be located to provide for sampling of the softener influent, effluent and blended water. The sampling taps for the blended water shall be at least 20 feet downstream from the point of blending. Petcocks are not acceptable as sampling taps. Sampling taps should be provided on the brine tank discharge piping.

9.10.1 BRINE AND SALT STORAGE TANKS

a. Salt dissolving or brine tanks and wet salt storage tanks must be covered and must be corrosion resistant.

b. The make-up water inlet must be protected from back-siphonage. Water for filling the tank should be distributed over the entire surface by pipes above the maximum brine level in the tank. The tanks should be provided with an automatic declining level control system on the make-up water line.

c. Tanks must be equipped with manholes or hatchways for access and filling. Openings must be provided with raised curbs and watertight covers having overlapping edges similar to those required for finished water reservoirs. Each cover shall be hinged on one side and shall have locking device.

d. Overflows, where provided, must be protected with corrosion resistant screens and must terminate with either a turned down bend having a proper free fall discharge or a self-closing flap valve.

e. Two wet salt storage tanks or compartments designed to operate independently should be provided.

f. The salt shall be supported on graduated layers of gravel placed over a brine collection system.

g. Alternative designs which are conducive to frequent cleaning of the wet salt storage tank may be considered.

9.10.2 SALT AND BRINE STORAGE CAPACITY

Total salt storage should have sufficient capacity to store in excess of 150 percent of delivery volume of salt and provide for at least 30 days of operation. Brine storage should be adequate to regenerate the softeners for 24 hours of operation without being replenished.

9.10.3 BRINE PUMP OR EDUCTOR

An eductor may be used to transfer brine from the brine tank to the softeners. If a pump is used, a brine measuring tank or means of metering should be provided to obtain proper dilution.

9.10.4 STABILIZATION

Stabilization for corrosion control shall be provided.

9.10.5 WASTE DISPOSAL

Acceptable disposal must be provided for the brine waste. Where the volume of spent brine must be reduced, consideration may be given to using a part of the spent brine for a subsequent regeneration.

9.10.6 CONSTRUCTION MATERIALS

Pipes and contact materials must be resistant to the aggressiveness of salt. Plastic and red brass are acceptable piping materials. Steel and concrete must be coated with a non-leaching protective coating which is compatible with salt and brine.

9.10.7 HOUSING

Bagged salt and dry bulk salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

9.11 FINISHED WATER AERATION TREATMENT

Aeration may be used to help remove offensive tastes and odors due to dissolved gases from decomposing organic matter, or to reduce or remove objectionable amounts of carbon dioxide, hydrogen sulfide, etc., and to introduce oxygen to assist in iron and/or manganese removal. The packed tower aeration process is an aeration process applicable to removal of volatile organic contaminants.

a. A by-pass shall be provided for all aeration units.

b. The aggressiveness of the water after aeration should be determined and corrected by additional treatment, if necessary.

9.11.1 NATURAL DRAFT AERATION

Design shall provide:

a. perforations in the distribution pan 3/16 to 1/2 inches in diameter, spaced 1 to 3 inches on centers to maintain a six inch water depth;

b. for distribution of water uniformly over the top tray;

c. discharge through a series of three or more trays with separation of trays not less than 12 inches;

d. loading at a rate of 1 to 5 gallons per minute for each square foot of total tray area;

e. trays with slotted, heavy wire (1/2 inch openings) mesh or perforated bottoms;

f. construction of durable material resistant to aggressiveness of the water and dissolved gases;

g. protection from loss of spray water by wind carriage by enclosure with louvers sloped to the inside at an angle of approximately 45 degrees;

h. air intake protection with 24-mesh screen and cover, e.g., louver or shroud, accessible for maintenance and inspection; and

i. for continuous disinfection feed shall be provided after aeration.

9.11.2 FORCED OR INDUCED DRAFT AERATION

Devices shall be designed to:

a. include a blower with a weatherproof motor in a tight housing and screened enclosure;

b. ensure adequate counter current of air through the enclosed aerator column;

c. exhaust air directly to the outside atmosphere;

d. include a down-turned and 24-mesh screened air outlet and inlet;

e. be such that air introduced in the column shall be as free from obnoxious fumes, dust and dirt as possible;

f. be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room;

g. provide loading at a rate of 1 to 5 gallons per minute for each square foot of total tray area;

h. ensure that the water outlet is adequately sealed to prevent unwarranted loss of air;

i. discharge through a series of five or more trays with separation of trays not less than six inches;

j. provide distribution of water uniformly over the top tray;

k. be of durable material resistant to the aggressiveness of the water and dissolved gases; and

l. provide for continuous disinfection feed after aeration.

9.11.3 SPRAY AERATION

Design shall provide:

a. A hydraulic head of between 5 – 25 feet;

b. nozzles, with the size, number, and spacing of the nozzles being dependent on the flowrate, space, and the amount of head available;

c. nozzle diameters in the range of 1 to 1.5 inches to minimize clogging;

d. an enclosed basin to contain the spray. Any openings for ventilation, etc., must be protected with 24-mesh screen and cover, e.g., louver or shroud, and be accessible for maintenance and inspection; and

e. for continuous disinfection feed after aeration.

9.11.4 PRESSURE AERATION

Pressure aeration may be used for oxidation purposes only if pilot plant study indicates the method is applicable. It is not acceptable for removal of dissolved gases. Filters following pressure aeration must have adequate exhaust devices for release of air. Pressure aeration devices shall be designed to:

a. provide thorough mixing of compressed air with water being treated; and

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

9.11.5 PACKED TOWER AERATION

Packed tower aeration (PTA) which is also known as air stripping involves passing water down through a column of packing material while pumping air counter-currently up through the packing. PTA is used for the removal of volatile organic chemicals, trihalomethanes, carbon dioxide and radon. Generally, PTA is feasible for compounds with a Henry's Constant greater than 100 (expressed in atm mol/mol) at 12^0C), but not normally feasible for removing compounds with a Henry's Constant less than 10. For values between 10 and 100, PTA may be feasible but should be extensively evaluated using pilot studies.

a. PROCESS DESIGN

1. Process design methods for PTA involve the determination of Henry's Constant for the contaminant, the mass transfer coefficient, air pressure drop and stripping factor. The project shall provide justification for the design parameters selected (i.e. height and diameter of unit, air to water ratio, packing depth, surface loading rate, etc.). Pilot plant testing shall be provided. The pilot test shall evaluate a variety of loading rates and air to water ratios at the peak contaminant concentration. Special consideration should be given to removal efficiencies when multiple contaminations occur. Where there is considerable past performance data on the contaminant to be treated and there is a concentration level similar to previous projects, the Division may consider approval of the process design based on use of appropriate calculations without pilot testing. The proposals of this type must be discussed with the Division prior to preparation of the design plans and specifications.

2. The tower shall be designed to reduce contaminants to below the maximum contaminant level (MCL) and to the lowest practical level.

3. The ratio of the column diameter to packing diameter should be at least 7:1 for the pilot unit and at least 10:1 for the full-scale tower. The type and size of the packing used in the full-scale unit shall be the same as that used in the pilot work.

4. The minimum volumetric air to water ratio at peak water flow should be 25:1. The maximum air to water ratio for which credit will be given is 80:1.

5. The design should consider potential fouling problems from calcium carbonate and iron precipitation and from bacterial growth. It may be necessary to provide pretreatment.

6. Disinfection capability shall be provided prior to and after PTA.

7. The effects of temperature should be considered since a drop in water temperature can result in a drop in contaminant removal efficiency.

b. MATERIALS OF CONSTRUCTION

The tower can be constructed of stainless steel, concrete, aluminum, fiberglass or plastic. Uncoated carbon steel is not recommended because of corrosion. Towers constructed of light-weight materials should be provided with adequate support to prevent damage from wind. Packing materials shall be resistant to the aggressiveness of the water, dissolved gases and cleaning materials and shall be suitable for contact with potable water.

c. WATER FLOW

Water should be distributed uniformly at the top of the tower using spray nozzles or orifice-type distributor trays that prevent short-circuiting. In addition:

1. A mist eliminator shall be provided above the water distributor system.

2. A side wiper-redistribution ring should be provided at least every 10 feet in order to prevent water channeling along the tower wall and short circuiting.

3. Sample taps shall be provided in the influent and effluent piping.

4. The effluent sump, if provided, shall have easy access for cleaning purposes and be equipped with a drain valve. The drain shall not be connected directly to any storm or sanitary sewer.
5. A blow-off line should be provided in the effluent piping to allow for discharge of water/chemicals used to clean the tower.

6. The design shall prevent freezing of the influent riser and effluent piping when the unit is not operating. If piping is buried, it shall be maintained under positive pressure.

7. The water flow to each tower shall be metered.

8. An overflow line shall be provided which discharges 12 to 14 inches above a splash pad or drainage inlet. Proper drainage shall be provided to prevent flooding of the area.

d. AIR FLOW SYSTEM

1. The air inlet to the blower and tower discharge vent shall be protected with a noncorrodible 24-mesh downturned screen to prevent contamination from extraneous matter.

2. The air inlet shall be in a protected location.

3. An air flow meter shall be provided on the influent air line or an alternative method to determine the air flow shall be provided.

4. A backup motor for the air blower must be readily available.

e. OTHER FEATURES TO BE PROVIDED

1. A sufficient number of access ports with a minimum diameter of 24 inches to facilitate inspection, media replacement, media cleaning and maintenance of the interior.

2. A method of cleaning the packing material when iron, manganese or calcium carbonate fouling may occur.

3. Tower effluent collection and pumping wells constructed to clearwell standards.

4. Provisions for extending the tower height without major reconstruction.

5. An acceptable alternative supply must be available during periods of maintenance and operation interruptions. No bypass shall be provided unless specifically approved by the Division.

6. Disinfection application points both ahead of and after the tower to control biological growth.

7. Disinfection and adequate contact time after the water has passed through the tower and prior to the distribution system.

8. Adequate packing support to allow free flow of water and to prevent deformation with deep packing heights.

9. Operation of the blower and disinfectant feeder equipment during power failures.

10. Adequate foundation to support the tower and lateral support to prevent overturning due to wind loading.

11 Fencing and locking gate to prevent vandalism.

12. An access ladder with safety cage for inspection of the aerator including the exhaust port and de-mister.

13. Electrical interconnection between blower, disinfectant feeder and well pump.

f. ENVIRONMENTAL FACTORS

1. The applicant must contact the Division's Air Quality Branch to determine if permits are required under the Clean Air Act.

2. Noise control facilities should be provided on PTA systems located in residential areas.

9.11.6 OTHER METHODS OF AERATION

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

9.11.7 PROTECTION OF AERATORS FROM CONTAMINATION

All aerators except those discharging to lime softening or clarification plants shall be protected from contamination by birds, insects, wind borne debris, rainfall and water draining off the exterior of the aerators.

9.11.8 DISINFECTION

Groundwater supplies exposed to the atmosphere by aeration must receive disinfection treatment as the minimum additional treatment.

9.11.9 BY-PASS

A by-pass shall be provided for all aeration units.

9.11.10 CORROSION CONTROL

The aggressiveness of the water after aeration should be determined and corrected by additional treatment, if necessary. (See section 9.13)

9.11.11 QUALITY CONTROL

Equipment should be provided to test for DO, pH, and temperature to determine proper functioning of the aeration device. Equipment to test for iron, manganese, and carbon dioxide should also be considered.

9.11.12 REDUNDANCY

Redundant equipment shall be provided for units installed to comply with Safe Drinking Water Act primary contaminants, unless otherwise approved by the Division.

9.12 IRON AND MANGANESE CONTROL TREATMENT

Iron and manganese control, as used herein, refers solely to treatment processes designed specifically for this purpose. The treatment process used will depend upon the character of the raw water. The selection of one or more treatment processes must meet specific local conditions as determined by engineering investigations, including chemical analyses of representative samples of water to be treated, and receive the approval of the Division. It may be necessary to operate a pilot plant in order to gather all information pertinent to the design. Consideration should be given to adjusting pH of the raw water to optimize the chemical reaction. Testing equipment and sampling taps shall be provided as outlined in this document.

9.12.1 REMOVAL BY OXIDATION, DETENTION AND FILTRATION

a. OXIDATION

Oxidation may be by aeration, as outlined in this document, or by chemical oxidation with chlorine, potassium permanganate, ozone or chlorine dioxide.

b. DETENTION

A detention time of at least 30 minutes shall be provided following aeration to ensure that the oxidation reactions are as complete as possible. This minimum detention may be omitted only where a pilot plant study indicates no need for detention. The detention basin should be designed as a holding tank with no provisions for sludge collection but with sufficient baffling to prevent short-circuiting. Sedimentation basins shall be provided when treating water with high iron and/or manganese content, or where chemical coagulation is used to reduce the load on the filters. Provisions for sludge removal shall be made.

c. FILTRATION

Filters shall be provided and shall be in conformance with this document. Filtration rate normally should not exceed 4 gpm/ ft^2 of filter area.

9.12.2 REMOVAL BY THE LIME-SODA SOFTENING PROCESS

See applicable Section in this document.

9.12.3 REMOVAL BY MANGANESE GREENSAND FILTRATION

This process consists of a continuous feed of potassium permanganate to the influent of a manganese greensand filter.

a. The permanganate should be applied as far ahead of the filter as practical.

b. Other oxidizing agents or processes such as chlorination or aeration may be used prior to the permanganate feed to reduce the cost of the chemical.

c. Anthracite media cap of at least six inches shall be provided over manganese treated greensand.

d. Normal filtration rate is 4 gpm/ ft^2 of filter area.

e. Typical wash rate is 8 to 10 gallons per minute per square foot (20 - 24 m/hr.) with manganese greensand and 15 to 20 gallons per minute per square foot (37 - 49 m/hr.) with manganese coated media.

f. Air washing should be provided.

g. Sample taps shall be provided at the following locations:

1. prior to application of permanganate;

2. immediately ahead of filtration;

3. at points between the anthracite media and the manganese treated greensand media;

4. halfway down the manganese treated greensand media; and

5. at the filter effluent.

9.12.4 REMOVAL BY ION EXCHANGE

This process of iron and manganese removal should not be used for water containing more than 0.3 milligrams per liter of iron, manganese or combination thereof. This process is not acceptable where either the raw water or wash water contains dissolved oxygen.

9.12.5 SEQUESTRATION BY POLYPHOSPHATES

This process is generally suitable only for low contents of iron and manganese where iron, manganese or combination thereof does not exceed 1.0 milligrams per liter. The total phosphate applied should not exceed 10 milligrams per liter as PO_4 or as recommended by the product supplier in accordance with the NSF Standard 60 listing. Where phosphate treatment is used, satisfactory chlorine residuals shall be maintained in the distribution system. In addition, a systematic flushing program shall be established and maintained for the distribution system.

a. Feeding equipment shall be as outlined in this document.

b. Stock phosphate solution must be kept covered and disinfected by carrying approximately 10 milligrams per liter free chlorine residual. Phosphate solutions having a pH of 2.0 or less may also be exempted from this requirement by the Division.

c. Polyphosphates shall not be applied ahead of iron and manganese removal treatment. The point of application shall be prior to any aeration, oxidation or disinfection if no iron or manganese removal treatment is provided.

d. Phosphate compounds used must be certified for conformance with NSF Standard 60. The phosphate feed point shall be located as far ahead of the oxidant feed point as possible.

9.12.6 SEQUESTRATION BY SODIUM SILICATES

Sodium silicate sequestration of iron and manganese is appropriate only for groundwater supplies prior to air contact. On-site pilot tests are required to determine the suitability of sodium silicate for the particular water and the minimum feed needed. Rapid oxidation of the metal ions such as by chlorine or chlorine dioxide must accompany or closely precede the sodium silicate addition. Injection of sodium silicate more than 15 seconds after oxidation may cause detectable loss of chemical efficiency. Dilution of feed solutions much below five percent (5%) silica as SiO_2 should also be avoided for the same reason.

a. Sodium silicate addition is applicable to waters containing up to 2 mg/l of iron, manganese or combination thereof.

b. Chlorine residuals shall be maintained throughout the distribution system to prevent biological breakdown of the sequestered iron.

c. The amount of silicate added shall be limited to 20 mg/l as SiO_2 but the amount of added and naturally occurring silicate shall not exceed 60 mg/l as SiO_2.

d. Feeding equipment shall be as outlined in this document.

e. Sodium silicate shall not be applied ahead of iron or manganese removal treatment.

f. Liquid sodium silicate must be certified for conformance with NSF Standard 60.

9.12.7 SAMPLING TAPS

Smooth-nosed sampling taps shall be provided for control purposes. Taps shall be located on each raw water source, each treatment unit influent and each treatment unit effluent.

9.12.8 TESTING EQUIPMENT

Testing equipment shall be provided for all plants. The equipment should have the capacity to accurately measure the iron content to a minimum of 0.1 milligrams per liter and the manganese content to a minimum of 0.05 milligrams per liter. Where polyphosphate sequestration is practiced, appropriate phosphate testing equipment shall be provided.

9.13 CORROSION CONTROL

9.13.0 GENERAL

All treated water shall be evaluated to ensure that water quality parameters and characteristics are optimized to obtain the desired water stability throughout the distribution systems of a water supply.

The primary approaches to internal corrosion control in drinking water systems are to modify the water chemistry to make it less corrosive and to encourage formation of passivating films on the contacting surface. This is typically accomplished through pH and/or alkalinity adjustment or through the addition of a corrosion inhibitor. Most corrosion control treatment will be beneficial for reducing corrosion of lead, copper, iron, steel and galvanized pipe.

Where adjustments to water quality parameters such as chlorine residual, pH, alkalinity or carbonate buffer strength prove insufficient to control corrosion rates, the use of corrosion inhibitors should be considered. Orthophosphate is particularly effective for this purpose in most situations.

To control corrosion, certain basic approaches can be utilized:

a. Using pipe materials and designing the system so it is not corroded by a given water;

b. Modifying the water quality so it is not corrosive to the pipe material; and

c. Placing a protective barrier or lining between the water and the pipe.

9.13.1 <u>CORROSION CONTROL STUDY</u>

A corrosion control study is required for change in source water and treatment changes that could alter the water quality. EPA's "Optimal Corrosion Control Treatment Evaluation for Primary Agencies and Public Water System" shall be used as a guide in developing such study. The study should include:

A sample site location plan for water quality parameter monitoring. Entry point and distribution system samples shall be collected for water quality data and other system information pertinent to achieving optimum corrosion control. The frequency of sampling and number of sites shall be determined by the Division. The water quality parameters include:

pH	Conductivity
Temperature	Hardness
Alkalinity	Iron
Calcium Manganese	Sulfate Aluminum
Ammonia	Dissolved Oxygen
Total Phosphorus	Natural Organic Matter
Chloride	Total and Free Chlorine
Corrosion Control Inhibitors (Orthophosphate, Silica)	Total & Free Chlorine

a. A summary of all water quality parameter monitoring results. These results should be evaluated considering the location of sample sites within the distribution system and used as the basis for considering corrosion control treatment options.

b. A desktop evaluation utilizing corrosion control computer modeling or regulatory guidance. The evaluation shall recommend optimal corrosion control treatment and water quality parameter performance requirements for the selected treatment.

d. Identification of possible limitations and secondary impacts for treatment options.

9.13.2 SYSTEM DESIGN

a. Choose compatible materials throughout the system where possible to avoid forming galvanic cells;

b. Avoid dead ends and stagnant areas;

c. Reduce mechanical stress, sharp turns and elbows;

e. Provide adequate insulation and avoid uneven heat distribution; and

f. Eliminate grounding of electrical circuits to system.

9.13.3 INSTRUMENTATION

Monitoring/testing equipment shall be provided for determining the effectiveness of stabilization treatment and the chemical residuals at the entry point and in the distribution system, including an acceptable pH probe that utilizes three standards for calibration.

9.13.4 CARBON DIOXIDE ADDITION

Recarbonation basin design should follow these guidelines:

a. Provide a total detention time of twenty minutes.

b. Be composed of two compartments, with a depth that will provide a diffuser submergence of not less than 7.5 feet nor greater than recommended by the manufacturer. The two compartments shall be as follows:

1. mixing compartment having a detention time of at least three minutes; and

2. reaction compartment.

c. In lieu of meeting items 1 and 2 above, the Division may allow shorter detention times and reduced mixing compartment volumes for alternative feed systems.

d. Discourage the practice of on-site generation of carbon dioxide.

e. Where liquid carbon dioxide is used, take adequate precautions to prevent carbon dioxide from entering the plant from the recarbonation process. In addition, consideration should be given to the installation of a carbon dioxide alarm system with light and audio warning, especially in low areas.

f. House recarbonation tanks outside or seal and vent the tanks to the outside with adequate seals and adequate purge flow of air to ensure workers safety.

g. Make provisions for draining the recarbonation basin and removing sludge.

9.13.5 CATHODIC PROTECTION

Metal tanks and reservoirs should be considered for protection from corrosion by this method.

9.13.6 MODIFICATION OF WATER QUALITY

pH adjustment by the addition of lime, caustic soda or soda ash in order to stabilize the water with regard to calcium carbonate. Advantages of aeration for iron, H_2S or CO_2 removal should be balanced against the fact that dissolved oxygen is a corrosive agent.

9.13.7 USE OF INHIBITORS

These may be used as appropriate.

a. Addition of lime or alkalinity increases the tendency of water to deposit $CaCO_3$ forming a protective coating inside of pipe.

b. A phosphate compound which not only masks the symptoms of red water due to iron, but also reduces corrosion can be selected.

c. Sodium silicate can be effective in water with low hardness, alkalinity, and pH less than 8.4 under relatively high velocity conditions.

9.13.8 ACID ADDITION

a. Feed equipment shall conform to Part 8.

b. Adequate precautions shall be taken for operator safety (See Sections 8.18), such as not adding water to concentrated acid.

9.13.9 PHOSPHATES

The feeding of phosphates may be applicable for sequestering iron and manganese, for corrosion control, and in conjunction with alkali feed.

a. ORTHOPHOSPHATE

Orthophosphate acts as a corrosion inhibitor by forming a protective film on the interior of pipes. This film protects the pipe material from the corrosive effects of water, which reduces or eliminates the potential for lead and copper leaching into the water. Phosphates containing zinc will help protect cement and cement mortar-lined pipes at low alkalinity/hardness/pH conditions.

b. BLENDED PHOSPATES

Blended phosphates contain some proportion of orthophosphate and polyphosphate. The orthophosphate portion is beneficial for corrosion control while the polyphosphate sequesters hardness, iron, or manganese. It is possible that blended phosphates can provide both sequestration of metals and reduce metals release. The orthophosphate to polyphosphate ratio is very important to assure sufficient orthophosphate residual to control the lead or copper release.

c. DESIGN PHOSPHATE SYSTEMS:

1. Shall have chemical feed equipment that conforms to Section 8.

2. Shall have a chemical feed system capable of maintaining an orthophosphate residual of at least 1.0 mg/L as P (3.0 mg/L as PO_4) throughout the distribution system.

3. Shall be designed to operate within the optimum pH range and alkalinity concentration.

4. Should follow manufacturer’s specifications for handling, storage, and use.

5. Shall keep stock phosphate solution covered and disinfected by carrying approximately 10 mg/L free chlorine residual unless the phosphate is being fed from the covered shipping container. Phosphate solutions having a pH of 2.0 or less may also be exempted from this requirement by Division.

6. Shall operate with disinfectant residuals of at least 0.2 mg/L of free chlorine or 1.0 mg/L of total chlorine throughout the distribution system to ensure bacteriological safety of the water.

7. Shall have testing equipment that utilizes an EPA accepted method and is equipped with a digital display for monitoring the phosphate residual.

8. Should consider a 6-month higher dose period to establish the desired residual.

9. Should not operate until the distribution system has been cleaned by flushing or with hydraulic pigs.

Phosphates can have secondary impacts that limit their use. Two factors that shall be evaluated prior to the installation of these corrosion control systems are (1) reactions with aluminum, and (2) impacts on wastewater treatment plants.

9.13.10. pH/ALKALINITY ADJUSTMENT

pH/Alkalinity adjustment includes adding a base or similar chemical to the water to increase pH to a level where the practical lead or copper solubility lowers, acids are neutralized, and less soluble metal compounds are formed on the pipes. Treatment shall be designed to operate within the optimum pH range and alkalinity concentration.

a. CHEMICALS

1. CAUSTIC SODA

Caustic soda (sodium or potassium hydroxide) will increase the pH with minimal effect on alkalinity and dissolved inorganic carbon (DIC). A stable pH is very difficult to provide when using caustic soda on water having low alkalinity. Caustic soda can cause severe burns and damage the eyes.

2. SODA ASH

Soda ash (sodium or potassium carbonate) will increase the alkalinity, DIC, and moderately increase the pH. Soda ash is relatively safe to handle compared to caustic soda.

3. LIME

Lime (calcium hydroxide) will increase the pH, alkalinity, DIC, and hardness. A stable pH is very difficult to provide when using lime on water having low alkalinity. Some types of lime can cause an increase in turbidity.

4. SODIUM BICARBONATE

Sodium bicarbonate substantially increases the alkalinity and DIC, while minimally increasing the pH. It will not increase the pH above 8.3.

b. SIMULTANEOUS COMPLIANCE

Alkalinity, pH, and DIC can have secondary impacts that limit the use of caustic soda, soda ash, lime and sodium bicarbonate. The following secondary impacts shall be evaluated:

1. Optimal pH for all other processes, particularly disinfection;
2. Calcium carbonate precipitation pH;
3. Oxidation of iron and manganese; and
4. Disinfection byproducts (DBP) formation (trihalomethanes).

c. ALKALINITY/pH ADJUSTMENT SYSTEMS

1. Shall be capable of providing a stable pH.
2. Should have chemical feed injection points located after all the disinfection log inactivation requirements are achieved.
3. Shall have chemical feed equipment that conforms to Part 8.
4. Shall produce treated water with an alkalinity of at least 20 mg/L as $CaCO_3$.

A pH/alkalinity feed system shall be provided for all systems utilizing anion-exchange treatment except when exempted by the Division.

9.13.11 SPLIT TREATMENT

Under some conditions, a lime softening water treatment plant can be designed using "split treatment" in which raw water is blended with lime-softened water to partially stabilize the water prior to secondary clarification and filtration. Treatment plants designed to utilize "split treatment" should also contain facilities for further stabilization by other methods.

9.13.12 AERATION

a. Aeration can increase the pH and reduce excess DIC by removing carbon dioxide. Aeration is most effective when there is an adequate carbon dioxide concentration in the water.

b. The carbon dioxide content of aggressive water may be reduced by aeration. Aeration devices shall conform to Section 9.11.

9.13.13 COATINGS AND LININGS

Metal distribution system components' surfaces in contact with water shall be protected by being coated or lined. Coatings and linings used must be certified for conformance with NSF Standard 61.

9.13.14 OTHER TREATMENTS

Other treatment for controlling corrosive waters by the use of sodium silicate may be used where necessary. Any proprietary compound must receive the specific approval of the Division before use. Chemical feeders shall be as required in Part 8.

9.13.15 WATER UNSTABLE DUE TO BIOCHEMICAL ACTION IN DISTRIBUTION SYSTEM

Unstable water resulting from the bacterial decomposition of organic matter in water (especially in dead end mains), the biochemical action within tubercles and the reduction of sulfates to sulfides should be prevented by the maintenance of a free chlorine residual throughout the distribution system.

9.13.16 CHLORIDE TO SULFATE MASS RATIO

Using or changing to chloride base coagulant, utilizing anion exchange treatment, and runoff from road salt can increase the lead solubility. The CSMR is calculated by the effluent chloride result divided by the effluent sulfate results. The CSMR value of the water can be an indicator of potential lead release.

9.14 TASTE AND ODOR CONTROL TREATMENT

9.14.0 GENERAL

a. Provision shall be made for the control of taste and odor at all water treatment plants.

b. Chemicals shall be added sufficiently ahead of other treatment processes to assure adequate contact time for an effective and economical use of the chemicals.

c. Where severe taste and odor problems are encountered, in-plant and/or pilot plant studies may be required.

9.14.1 FLEXIBILITY

Plants treating water that is known to have taste and odor problems should be provided with equipment that makes several of the control processes available so that the operator will have flexibility in operation.

9.14.2 CHLORINATION

Chlorination can be used for the removal of some objectionable odors. Adequate contact time must be provided to complete the chemical reactions involved. Excessive potential trihalomethane production through this process should be avoided by adequate bench-scale testing prior to design.

9.14.3 CHLORINE DIOXIDE

Chlorine dioxide has been generally recognized as a treatment for tastes caused by industrial wastes, such as phenols. However, chlorine dioxide can be used in the treatment of any taste and odor that is treatable by an oxidizing compound. Provisions shall be made for proper storing and handling of the sodium chlorite, so as to eliminate any danger of explosion.

9.14.4 POWDERED ACTIVATED CARBON

a. Powdered activated carbon should be added as early as possible in the treatment process to provide maximum contact time. Flexibility to allow the addition of carbon at several points is preferred. Activated carbon should not be applied near the point of chlorine application.

b. The carbon can be added as a pre-mixed slurry or by means of a dry-feed machine as long as the carbon is properly “wetted”.

c. Continuous agitation is necessary to keep the carbon from depositing in the mixing tank.

d. Provision shall be made for adequate dust control.

e. The required rate of feed of carbon in a water treatment plant depends upon the tastes and/or odors involved, but provision should be made for adding from 0.1 mg/L to at least 40 mg/L.

f. Powdered activated carbon shall be handled as a potentially combustible material in accordance with AWWA Standard B600. It should be stored in a building or compartment as nearly fireproof as possible. Other chemicals should not be stored in the same compartment. A separate room should be provided for carbon feed installations. Carbon feeder rooms should be equipped with explosion-proof electrical outlets, lights and motors.

9.14.5 GRANULAR ACTIVATED CARBON

See Section under "Filters" for application within filters. Rates of flow shall be consistent with the type and intensity of the problem. The design used must be supported by the results of pilot plant studies when granular activated carbon units are used for organic removal. Replacement of anthracite with GAC may be considered as a control measure for geosmin and 2-methylisoborneol (MIB) for taste and odors issues from algae blooms. Demonstration studies may be required by the Division.

9.14.6 COPPER SULFATE AND OTHER COPPER COMPOUNDS

Continuous or periodic treatment of water supplies with copper compounds to kill algae or other growths shall be controlled to prevent copper in excess of 1.0 milligrams per liter as copper in the plant effluent or distribution system. Care shall be taken to assure an even distribution and to prevent fish kills. A dose at 0.9 lb./acre-foot may be considered for waters with alkalinity less than 50 mg/L, and 5.4 lb./acre-foot if alkalinity is greater than 50 mg/L. Necessary approval and/or permits shall be obtained prior to application, if required. Consult the Watershed Protection Branch NPDES Program before making applications to public Waters.

9.14.7 AERATION

See section 9.11 in this document.

9.14.8 POTASSIUM PERMANGANATE

Application of potassium permanganate may be considered, providing the treatment shall be designed so that the products of the reaction are not visible in the finished water. It must be applied as early in the treatment as possible to provide adequate contact time and must be prior to filtration.

9.14.9 OZONE

Ozonation can be used as a means of taste and odor control. Adequate contact time must be provided to complete the chemical reactions involved. Ozone is generally more desirable for treating water with high threshold odors.

9.14.10 ADVANCED OXIDATION PROCESSES

The UV/H2O2 ((ultra-violet/hydrogen peroxide) system is an advanced oxidation process (AOP) in which hydrogen peroxide is added in the presence of ultraviolet light to generate hydroxyl radicals (OH). This process has been shown to be effective in the treatment of taste and odor compounds such as 2-methylisoborneol (MIB) and geosmin.

9.14.11 OTHER METHODS

The decision to use any other methods of taste and odor control should be made only after careful laboratory and/or pilot plant tests and on consultation with the Division.

9.15 ANION EXCHANGE TREATMENT

Anion exchange treatment can be used to treat for a variety of contaminants, including arsenic, nitrates, organics, sulfides, uranium, and taste and odor compounds and others.

9.15.1 PRE-TREATMENT REQUIREMENTS

Pre-treatment may be required for contaminant specific resins. Iron, manganese or a combination of the two, should not exceed 0.3 mg/L in the water as applied to the ion exchange resin. Pretreatment is required when a combination of iron and manganese exceeds 0.5 mg/L.

9.15.2 DESIGN

a. Anion exchange units are typically of the pressure type, down flow design. Automatic regeneration based on volume of water treated should be used unless manual regeneration is justified and is approved by the Division. A manual override shall be provided on all automatic controls.

b. If a portion of the water is bypassed around the units and blended with treated water, the maximum blend ratio allowable must be determined based on the highest anticipated raw water level of the contaminant of concern. If bypassing is provided, a totalizing meter and a proportioning or regulating device or flow regulating valves must be provided on the bypass line.

9.15.3 EXCHANGE CAPACITY

The design capacity of the regeneration process should be in accordance with the specifications of the resin manufacturer. For nitrate removal, the design capacity should not exceed 10,000 grains per cubic foot (23 g/L) when the resin is regenerated at 15 pounds of salt per cubic foot (240 g/L) of resin.

9.15.4 NUMBER OF UNITS

For community water systems treating acute contaminants, at least two units shall be provided. The treatment capacity must be capable of producing the maximum day water demand at a level below the MCL for the contaminant of concern with one exchange unit out of service.

9.15.5 TYPE OF RESIN

Unless otherwise approved by the Division, the anion exchange resin must have high selectivity for the contaminant of concern.

9.15.6 FLOW RATES

For the contaminant of concern, the treatment flow rate should not exceed the manufacturer's recommendation for the selected resin.

9.15.7 FREEBOARD

Adequate freeboard must be provided to accommodate the backwash flow rate of the unit. The freeboard will depend on the size and specific gravity of the resin. Generally, the wash water collector should be 24 inches above the top of the resin on downflow units.

9.15.8 MISCELLANEOUS APPURTENANCES

a. The treatment equipment shall be designed to include an adequate underdrain and support system and brine distribution system.

b. Sample taps, brine and salt storage, salt and brine storage capacity and brine pump or educator shall be as required in sections 9.10.0.v, 9.10.1, 9.10.2, and 9.10.3 of these standards.

9.15.9 CROSS CONNECTION CONTROL

Regeneration, rinse, and air relief discharge pipes shall be installed with an air gap between the discharge and the disposal point to prevent back-siphonage.

9.15.10 CONSTRUCTION MATERIALS

Pipes and contact materials must be resistant to the aggressiveness of the regenerant. Steel and concrete must be coated with a non-leaching protective coating which is compatible with salt and brine. or other regenerants.

9.15.11 HOUSING

Bagged salt and dry bulk salt storage shall be enclosed and separated from other operating areas in order to prevent damage to equipment.

9.15.12 PRE-CONDITIONING OF THE RESIN

Prior to start-up of the equipment, the resin must be regenerated with no less than two bed volumes of water containing sodium chloride, or other appropriate regenerant followed by an adequate rinse.

9.15.13 WASTE DISPOSAL

Suitable disposal must be provided for brine waste (See Section 13.2).

9.15.14 WATER QUALITY TEST EQUIPMENT

Appropriate test equipment must be provided to determine treatment effectiveness.

9.16 REQUIREMENTS FOR THE USE OF NON-CONVENTIONAL WATER TREATMENT PLANTS OR ALTERNATIVE TECHNOLOGIES

9.16.1 PACKAGE TREATMENT PLANTS

These will be reviewed on a case-by-case basis based on pilot study demonstrated performance criteria. Membranes Technologies (Reverse Osmosis (RO), **Nanofiltration (NF), Ultrafiltration (UF), Microflitration (MF),** Cartridge filters and other alternative technologies may be considered at the discretion of the Division based on pilot study results and quality of the raw water supply.

a. Package plants using surface water sources shall meet the water treatment standards, procedures and instrumentation stated in this document.

b. Withdrawal of water directly from a surface source (i.e. river, stream, creek, lake, etc.) shall not be allowed.

c. A pre-sedimentation treatment as discussed under "Pre-sedimentation" section in the document and/or a plant reservoir with at least three-day storage capacity that would provide equivalent treatment shall be provided for the water entering the package treatment plant.

d. The turbidity concentration of the raw water entering the plant shall be consistently low (preferably not more than 10 NTU). In any case, it is preferred that the raw water supply source experience not more than a 20 NTU variation within any given 24 hour period.

e. Due to compressed treatment times, the operation of package treatment plants is even more critical than for conventional treatment plants.

f. The package plants should not operate in total automation mode without a qualified certified water operator available at all times to make the necessary treatment adjustments.

g. It is necessary that the operators of package plants are fully trained by the plant manufacturer's representatives.

9.16.2 PILOT PLANT STUDIES FOR ALTERNATIVE WATER TREATMENT TECHNOLOGIES.

a. Pilot plant studies shall be performed to demonstrate that the specific technology, in combination with the disinfection treatment, shall accomplish the required level of log removal of *Giardia* cysts and viruses and/or *Cryptosporidium* cysts, as specified by the drinking water standards.

b. The following stages of evaluation shall be performed:

1. The first stage is to determine if the process effectively removes/inactivates the contaminants of concern;

   The alternative filtration technology, in combination with disinfection treatment must consistently achieve a minimum of 99.9 percent removal and/or inactivation *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses, and a minimum of 99 percent removal of *Cryptosporidium* oocysts.

2. The second stage is to determine if the individual system can effectively operate the process and to assess site-specific considerations that can affect the technology's performance.

c. In order to assure influent water quality within the designed criteria, pretreatment may be necessary with certain waters.

d. The level of water treatment operator skills and qualifications must be compatible with each piece of unit technology specified.

9.17 FILTER BACKWASH RECYCLING

The Filter Backwash Recycling Rule (FBRR) establishes regulatory provisions governing the way that certain recycle streams are handled within the treatment processes of conventional and direct filtration water treatment systems. The FBRR also establishes reporting and recordkeeping requirements for recycle practices that will allow States and EPA to better evaluate the impact of recycle practices on overall treatment plant performance. The FBRR published in the Federal Register (66 FR 31086, June 8, 2001) presents the specific regulatory requirements that must be met by affected systems. The FBRR document has been developed to provide operators with the practical guidance and relevant information to assist them in complying with the FBRR provisions. It outlines detailed methods for complying with each portion of the FBRR, and provides other useful information regarding recycle practices and filter backwashing not specifically required by the FBRR Refer to Filter Backwash recycling Rule Technical Guidance Manual of EPA, 2002, for more details.

PART 10 - FINISHED WATER STORAGE

The materials and designs used for finished water storage structures shall provide stability and durability, as well as protect the quality of the stored water. Steel structures shall follow the current American Water Works Association standards concerning steel tanks, standpipes, reservoirs, clearwells and elevated tanks wherever they are applicable. Materials of construction are acceptable when properly designed to meet the requirements of this part. All products in contact with drinking water shall be certified for compliance with ANSI/NSF Standard 61.

10.1 LOCATION

a. The bottom of ground-level reservoirs should be placed at the normal ground surface and above maximum flood level. They should be placed above the 100 years flood elevation or the highest flood of record, whichever is higher, and at least two feet above the groundwater table.

b. Where the bottom must be below normal ground surface, it should be placed above the ground water table.

c. Sewers, drains, standing water, and similar sources of contamination must be kept at least 50 feet from the reservoir. Gravity sewer constructed of water main quality pipe, pressure tested in place to 50 psi without leakage, may be used at distances of less than 50 feet, but no closer than 20 feet.

d. The top of a ground-level reservoir should not be less than 2 feet above normal ground surface and any possible flood level. Clearwells constructed under filters may be exempted from this requirement when the total design gives the same protection.

10.2 PROTECTION

a. All new finished water storage structures shall have suitable watertight roofs or covers which exclude birds, animals, insects, and excessive dust.

b. Protection from Trespassers: Fencing, locks on access manholes, and other necessary precautions shall be provided to prevent trespassing, vandalism and sabotage.

10.3 DRAINS

No drain on a water storage structure may have a direct connection to a sewer or storm drain. Splash pad and drainage channel shall be provided to prevent erosion. The outlet of the drain shall be provided with a twenty-four mesh non-corrodible screen or a flap valve. The design shall allow draining the storage facility for cleaning or maintenance without causing loss of pressure in the distribution system.

10.4 TURNOVER OF WATER

Water quality degradation in distribution system storage facilities such as loss of disinfectant residual, microbial growth, formation of disinfection byproducts, nitrification, and taste and odor problems result from incomplete mixing, or high-water age, or a combination of both.

a. Distribution system storage facilities shall be designed to eliminate short-circuiting and stratification and achieve adequate mixing.

b. Designs with single inlet/outlet pipe should be avoided.

c. Consideration should be giving to mixing system to avoid stagnation.

d. Finished water should be designed to facilitate fire flow and pressure requirements and meet average daily demand while maximizing daily volume turnover to minimize water age.

e. If the storage reservoir is sized larger than required for initial demand and there is more than 2 days storage, provisions shall be made for turnover of the water in the tank and/or booster chlorination.

f. Storage structures should be designed to ensure water age does not exceed five days.

10.5 OVERFLOW

a. The overflow pipe of a water storage structure shall be brought down to an elevation between 12 and 24 inches above the ground surface and discharged over a drainage inlet structure or a splash plate and flow onto a drainage ditch which is rip-rapped or otherwise protected to minimize erosion.

b. No overflow shall be connected directly to a sewer or storm drain or be not visible to sight.

c. When an internal overflow pipe is used, it shall be located in the access tube. For vertical drops on other types of storage facilities, the overflow pipe should be located on the outside of the structure.

d. The overflow of a ground-level structure shall be high enough above normal or graded ground surface to prevent the entrance of surface water.

e. The overflow shall be protected with a twenty-four mesh non-corrodible screen and/or a flap valve. The screen shall be installed within the overflow pipe at a location least susceptible to damage by vandalism. A mesh-fitted mechanical flap valve is acceptable provided the flapper is supplied with non-corroding and non-seizing hinges. The flap valve shall be spring loaded or counterweighted, so it closes and forms a tight seal after the overflow event.

f. Use of a solid flapper or duckbill valve should be considered to minimize air movement in the tank. When a solid flapper is used, a screen shall be provided inside the overflow. If a duckbill valve is used, a screen is not required. Provisions must be included to prevent the flapper or duckbill from freezing shut.

g. The outlet of the overflow shall always be visible.

h. The overflow pipe shall be of sufficient diameter to permit waste of water in excess of the maximum filling rate.

10.6 ACCESS

a. Finished water storage structures shall be designed with reasonably convenient access to the interior for cleaning and maintenance.

b. Manholes above the waterline:

1. At least two manholes should be provided.

2. On elevated storage or doom roof structures, at least one of the access manholes shall be framed at least 4 inches, and preferably 6 inches, above the surface of the roof at the opening.

3. On ground-level structures, manholes should be elevated 24 to 36 inches above the top or covering sod;

4. shall be fitted with a solid watertight cover which overlaps the framed opening and extends down around the frame at least 2 inches;

5. should be hinged at one side;

6. shall have a locking device; and

7. shall be a minimum of 20 inches in diameter or equivalent.

10.7 VENTS

a. Finished water storage structures shall be vented by separate special vent structures.

b. Overflow pipe or any other opening constructed between the side wall and the roof is not permissible to be used as vents.

c. The vents:

1. shall prevent the entrance of surface water and rainwater;

2. shall exclude birds and animals;

3. should exclude insects and dust, as much as this function can be made compatible with effective venting;

4. shall, on ground-level structures, terminate in an inverted U construction, the opening of which is 24 to 36 inches above the roof or sod and is covered with 24-mesh non-corrodible screen. The screen shall be installed within the pipe at a location least susceptible to vandalism; and

5. Shall, on elevated tanks and standpipes, open downward and be fitted with twenty-four mesh non-corrodible screen in combination with an automatically resetting pressure-vacuum relief mechanism.

10.8 ROOF AND SIDEWALL

The roof and sidewalls of all structures must be watertight with no openings except properly constructed vents, manholes, overflows, risers, drains, pump mountings, control ports or piping for inflow and outflow.

a. Any pipe running through the roof or sidewall of a finished water storage structure must be welded or properly gasketed in metal tanks, or should be connected to standard wall castings which were poured in place during the forming of a concrete structure; these wall castings should have flanges embedded in the concrete.

b. Openings in a storage structure roof or top, designed to accommodate control apparatus or pump columns, shall be curbed and sleeved with proper additional shielding to prevent the access of surface or slope water to the structure.

c. Valves and controls should be located outside the storage structure so that valve stems and similar projections will not pass through the roof or top of the reservoir.

d. For reservoirs with concrete roofs, if a minimum slope of 1.5% is not provided, reservoir roof must be made watertight with the use of a waterproof membrane or similar product.

e. When earthen cover is used on concrete reservoirs, it shall be sloped to facilitate drainage.

f. The roof or cover of the storage structure should be well drained, but downspout pipes shall not enter or pass through the reservoir, parapets or similar construction which would tend to hold water and snow on the roof will not be approved unless adequate waterproofing drainage are provided.

10.9 CONSTRUCTION MATERIALS

The material used in construction of reservoirs shall be acceptable to the Division. Porous materials, including wood and concrete block, are not suitable for potable water contact applications.

10.10 SAFETY

The safety of employees must be considered in the design of the storage structure. As a minimum, such matters shall conform to pertinent laws and regulations.

a. Ladders, ladder guards, balcony railings, and safe location of entrance hatches shall be provided where applicable. Access to roof hatches and vents shall be provided. When a fixed ladder is used, the bottom shall be located at least 12 feet above ground (refer to OSHA standard) to prevent the entrance of unauthorized personnel.

b. Elevated tanks with riser pipes over 8 inches in diameter shall have protective bars over the riser openings inside the tank.

c. Railings or handholds shall be provided on elevated tanks where persons must transfer from the access tube to the water compartment. Fall protection shall be provided in accordance with OSHA standards.

d. Confined space entry requirements shall be considered for all water tanks.

10.11 FREEZING

All finished water storage structures and their appurtenances, especially the riser pipes, overflows and vents, shall be designed to prevent freezing which will interfere with proper functioning. Equipment used for freeze protection that will come into contact with the potable water shall meet ANSI/NSF Standards 61 or be approved by the Division. If a water circulation system is used, it is recommended that the circulation pipe be located separately from the riser pipe.

10.12 INTERNAL CATWALK

Every catwalk over finished water in a storage structure shall have a solid floor with sealed raised edges, designed to prevent contamination from shoe scrapings and dirt.

10.13 SILT STOP

The discharge pipe of the reservoir shall be located in a manner that will prevent the flow of sediment into the distribution system. Either a permanent or removable silt stop shall be provided at least 4 inches above the bottom of the storage structure.

10.14 GRADING

The area surrounding a ground-level structure shall be graded in a manner that will prevent surface water from standing within 50 feet of the structure.

10.15 PAINTING AND/OR CATHODIC PROTECTION

Proper protection should be given to metal surfaces by paints or other protective coatings, by cathodic protective devices or by both.

a. Paint systems shall be consistent with the current American Water Works Association (AWWA) standards and all paint coatings must be certified for conformance with NSF Standard 61 for contact with potable water. After curing, the coating should not transfer any substance to the water which will be toxic or cause taste or odor problems. Prior to placing in service, an analysis for volatile organic compounds is advisable to establish that the coating is properly cured. Consideration should be given to 100 percent solids coatings.

b. Wax coatings for the tank interior shall not be used on new tanks. Recoating with a wax system is strongly discouraged. Old wax coating must be completely removed before using another tank coating.

c. Cathodic protection should be designed and installed by competent technical personnel and a maintenance contract should be provided.

10.16 DISINFECTION OF STORAGE TANKS

a. Finished water storage structures shall be disinfected in accordance with the latest edition of AWWA Standard C652 before being placed into or restored to service.

b. The forms of chlorine that may be used during disinfection are high-test calcium hypochlorite, sodium hypochlorite solution or liquid chlorine.

c. Only potable water shall be used as the water supply during the disinfecting operations.

d. One of the three following methods of disinfection shall be used:

1. <u>First Method</u>: After the storage tank has been thoroughly dried, it shall be filled slowly to the overflow level with potable water to which enough chlorine is added to provide a free chlorine residual in the full facility of not less than 10 mg/L at the end of the 24-hour period. After the 24-hour retention period, the highly chlorinated water in the storage tank shall be completely emptied (by applying a reducing agent to the wasted water to thoroughly neutralize the chlorine residual in the water), and then refilled with potable water. After refilling, samples of water shall be taken from the storage tank and tested to demonstrate that the water in the tank is microbiologically satisfactory in accordance with the Georgia Rules for Safe Drinking Water, Chapter 391-3-5, before the tank is placed in or restored to regular service.

2. <u>Second Method</u>: The walls and bottoms of storage tanks shall be thoroughly cleaned to remove all dirt and loose material. A strong chlorine solution (at least 200 mg/L) shall be applied to the surface of all parts of the storage facility, including the inlet and outlet piping, that would be in contact with water when the storage facility is full to the overflow elevation. The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 minutes, after which potable water shall be admitted. After that, the highly chlorinated water in the tank shall be disposed in an acceptable manner, as stated above, and then refilled with potable water to its overflow level. After refilling, samples of water shall be taken from the storage tank and tested to demonstrate that the water in the tank is microbiologically satisfactory in accordance with the Georgia Rules for Safe Drinking Water, Chapter 391-3-5, before the tank is placed in or restored to regular service.

3. <u>Third Method</u>: Water containing a minimum of 50 mg/L chlorine shall be placed in the storage tank to such depth that, when the storage tank is filled with potable water to the overflow level and held full for a period of at least 24 hours, there will be a free chlorine residual of not be less than 2 mg/L. The full storage tank must be allowed to stand for 24 hours. All highly chlorinated water shall then be purged from the drain piping. Samples of water shall be taken from the storage tank and tested to demonstrate that the water in the tank is microbiologically satisfactory in accordance with the Georgia Rules for Safe Drinking Water, Chapter 391-3-5. The storage tank may be put into service without draining the remaining water in the tank.

10.17 <u>SAMPLING</u>

A suitable sampling tap should be provided on all storage structures and be protected from public access. Smooth-nosed sampling tap(s) shall be provided to facilitate collection of water samples for both bacteriological and chemical analyses. The sample tap(s) shall be easily accessible.

10.18 TREATMENT PLANT STORAGE

10.18.1 PLANT STORAGE

The applicable design standards of this document shall be followed for the plant storage.

10.18.2 FILTER WASHWATER TANKS

If filter wash water tanks are used, they shall be sized in conjunction with available pump units and finished water storage to furnish the backwash water required. In the design, consideration must be given to the possibility of having to wash more than one filter at a time or several filters in succession.

10.18.3 CLEARWELL

Clearwell storage should be sized in conjunction with distribution system storage to relieve the filters from having to follow fluctuations in water use to meet peak demands, including filter backwash water.

a. The design shall include features (i.e. baffles) to minimize short circuiting.

b. It shall be sized to provide the required contact time for chlorine (CT), to achieve required level of inactivation of *Giardia* cysts and viruses (or any other pathogen that may be required under the current Surface Water Treatment Rules) through disinfection under worst case conditions.

c. A drain and an overflow shall be provided for the clearwell.

d. It shall be vented.

e. A minimum of two clearwell compartments shall be provided.

10.18.4 ADJACENT COMPARTMENTS

Finished water must not be stored or conveyed in a compartment adjacent to unsafe water when the two compartments are separated by a single wall.

10.18.5 BASINS AND WET-WELLS

Receiving basins and pump wet-wells for finished water shall be designed as finished water storage structures.

10.18.6 OTHER TREATMENT PLANT STORAGE TANKS

Tanks are exempted from this requirement if they contain water that will receive full treatment for which the plant is designed, such as a pre-sedimentation basin at a surface water treatment plant, or water that will not be returned to the treatment process and is separated from the treatment plant by appropriate cross-connection control measures.

10.19 HYDROPNEUMATIC TANKS (PRESSURE TANKS)

Hydropneumatic tanks, when provided as the only water storage are acceptable only in very small water systems. Systems serving more than 150 living units should have ground or elevated storage designed in accordance with section 10.18. Hydropneumatic tank storage is not to be permitted for fire protection purposes unless specifically permitted by local fire and zoning regulations.

a. Location- Hydropneumatic (pressure) storage tanks should be located above normal ground surface and either be completely housed, or one end be projected into an operating house to prevent freezing of the control units.

b. Bypass - Tanks should have bypass piping to permit operation of the system while the tank is being repaired or painted.

c. Paint systems shall be consistent with the current American Water Works Association (AWWA) Standards and all paint coatings must be certified for conformance with NSF Standard 61 for contact with potable water.

d. Disinfection – Pressure tanks shall be disinfected in accordance with the latest edition of AWWA Standard C652 before being placed into service.

e. Sampling - A suitable sampling tap should be provided on all pressure tanks and be protected from public access.

f. Protection from Trespassers – Fencing and other necessary precautions shall be provided to prevent unauthorized entry, vandalism, and sabotage.

g. Appurtenances - Each pressure tank shall have cut off valves, a drain, and control equipment consisting of a pressure gauge, water sight glass, automatic or manual air blow-off, mechanical means for adding air, and pressure-operated start-stop controls for the pumps. Each pressure tank should have an access manhole when practical; the access manhole should be 24-inch in diameter.

h. Sizing - The hydropneumatic tanks must be properly sized to supply the required peak demand for a period of at least twenty (20) minutes. In the design, it is assumed that a combination of hydropneumatic storage and pumping will be utilized. The Effective Volume of the tank is considered to be the volume of water discharged between the high and low pressure settings.

Required Effective Volume (gal) = [Peak Demand (gpm) - Pumping Capacity (gpm)] x 20 minutes

For example, a mobile home system that serves 50 spaces will require an instantaneous (peak) demand flow of 60 gpm (see the tables provided in this document). If this system has a well with a pumping capacity of 30 gpm, then the required effective volume for the system is 600 gallons:

Required Effective Volume = (Peak Demand - Pumping Capacity) x 20 Minutes

= (60 gpm – 30 gpm) x 20 minutes

= 600 gallons

The actual size of the pressure storage tank necessary to furnish the 600 gallons effective volume depends upon the pressure settings, air-water volume controls, etc. A system without an air-water control system would require the largest tank, whereas a system with an air charging device and automatic air-water volume controls would require a much smaller tank. As indicated above, all pressure storage tanks must be equipped with mechanical means for adding air, and pressure-operated start-stop controls for the pumps. In general, it is assumed that a properly designed pressure tank with an air charging system with automatic air-water volume controls, would be able to discharge up to 25 % of the tank volume during a typical 60-40 psi pressure cycle. Then the total tank volume necessary to furnish the required effective volume in this case would be:

$$\text{Total Tank Volume (gallons)} = \frac{\text{Required Effective Volume (gallons)}}{25\%}$$

$$= \frac{600 \text{ gallons}}{0.25}$$

= 2,400 gallons

i. Auxiliary power – It is highly recommended that auxiliary power with an automatic takeover capability be provided when the pressure tank system includes an air charging device and automatic air-water volume control.

PART 11 - PUMPING FACILITIES

11.0 PUMPING FACILITY DESIGN/GENERAL

a. Pumping facilities shall be designed to maintain the sanitary quality of pumped water.

b. Subsurface pits or pump rooms and inaccessible installations should be avoided.

c. No pumping station shall be subject to flooding.

11.1 LOCATION

The pumping station shall be so located that the proposed site will meet the requirements of the sanitary protection of the water quality, hydraulics of the system and be protected against interruption of service by fire, flood or any other hazard.

The station shall be:

a. elevated to a minimum of three feet above the 100-year flood elevation, or three feet above the highest recorded flood elevation, whichever is higher, or protected to such elevations;

b. accessible at all times unless permitted to be out of service for period of inaccessibility;

c. graded around station so as to divert surface drainage away from the station;

d. protected to prevent vandalism and entrance by unauthorized persons or animals; and

e. labeled such that the pumps and valves in the station are tagged to correspond to the maintenance record and for proper identification.

11.2. SURFACE WATER FACILITIES

Pump stations normally associated with surface water sources, either as raw or finished water pump stations shall:

a. have adequate space for the installation of additional units if needed. and for the safe servicing of all equipment;

b. be of durable character, fire and weather resistant and with outward opening doors;

c. have floor elevation of at least 6 inches above finished grade;

d. have underground structure waterproofed;

e. have all floors drained without impairing the quality of water being handled and if equipment is contained on the floor, the floor shall have sufficient slope to drain adequately; and

f. provide suitable outlet for drainage from pump glands without discharging onto the floor.

11.2.1 SUCTION WELL

Suction wells shall:

a. be watertight;

b. have floors sloped to permit removal of water and entrained solids;

c. be covered or otherwise protected against contamination, including pump lubricant; and

d. have two pumping compartments or other means to allow the suction well to be taken out of service for inspection maintenance or repair.

11.2.2 EQUIPMENT SERVICING

Pump facilities shall be provided with:

a. crane-ways, hoist beams, eye bolts or other adequate facilities for servicing or removal of pumps, meters or heavy equipment;

b. openings in floors, roofs or wherever else needed for removal of heavy or bulky equipment; and

c. a convenient tool board or other facilities as needed for proper maintenance of the equipment.

11.2.3 STAIRWAYS AND LADDERS

Stairways or ladder shall:

a. be provided between all floors in pits or compartments which must be entered;

b. have handrails on both sides and treads of non-slip material; and

c. stairs are preferred in areas where there is frequent traffic or where supplies are transported by hand. They shall have risers not exceeding 9 inches and treads wide enough for safety.

11.2.4 HEATING

Provision shall be made for adequate heating for:

a. comfort of the operator;

b. the safe and efficient operation of the equipment; and

c. in pump houses not occupied by personnel, only enough heat need be provided to prevent freezing of equipment or treatment process and to allow proper operation of equipment and treatment processes.

11.2.5 VENTILATION

Adequate ventilation shall be provided for all pumping stations for operator comfort and dissipation of excess heat from the equipment. Ventilation shall conform to relevant state and/or local codes. Forced ventilation of at least 6 changes of air per hour shall be provided for:

a. all confined rooms, compartments, pits and other enclosures below grade floor; and

b. any area where unsafe atmosphere may develop or where excessive heat may be built up.

11.2.6 DEHUMIDIFICATION

In areas where excess moisture could cause hazards for operator safety or damage to equipment means for dehumidification shall be provided.

11.2.7 LIGHTING

Pump stations shall be adequately lighted to deter vandalism and facilitate maintenance. All electrical work shall conform to the requirements of the related agencies and to relevant State and/or local codes.

11.2.8 SANITARY AND OTHER CONVENIENCES

Pumping stations which are manned for extended periods shall be provided with potable water, lavatory and toilet facilities. Plumbing must be so installed as to prevent contamination of a public water supply. Wastes shall be discharged in accordance with Part 13.

11.3 PUMPS

11.3.1 GENERAL

a. At least 2 pumping units shall be provided. Each pumping unit shall be capable of carrying the peak demand. If more than 2 units are installed, they shall have sufficient capacity so that any one pump can be taken out of service and the remaining pumps are capable of carrying the peak demand.

b. The pumping units shall:

   1. have ample capacity to supply the peak demand without dangerous overloading;

   2. be driven by a prime mover able to operate against the maximum head and air temperature which may be encountered;

   3. have spare parts and tools readily available.

11.3.2 SUCTION LIFT

Suction lift pumps shall be considered on an individual basis based on justification of the design engineer.

Suction lift shall:

a. be avoided, if possible; and

b. be within allowable limits, preferably less than 15 feet.

If suction lift is necessary, provision shall be made for priming the pumps.

11.3.3 PUMP PRIMING

Prime water must not be of lesser sanitary quality than that of the water being pumped. Means shall be provided to prevent either backpressure or back siphonage backflow. When an air-operated ejector is used, the screened intake shall draw clean air from a point at least 10 feet above the ground or other source of possible contamination, unless the air is filtered by an apparatus approved by the Division. Vacuum priming may be used.

11.4 BOOSTER PUMPS

Booster pumps shall be located or controlled so that:

a. they will not produce negative pressure anywhere in the distribution system;

b. the pressure in the suction line shall be maintained at or above 20 psi by the use of a pressure sustaining valve or low pressure cutoff device. Pumps installed in the distribution system shall maintain inlet pressure as required under all operating conditions. Pumps taking suction from storage tanks shall be provided adequate net positive suction head;

c. automatic or remote control devices shall have a range between the start and cutoff pressure which will prevent excessive cycling. Automatic shutoff or low pressure controller shall maintain at least 20 psi (140 kPa) in the suction line under all operating conditions, unless otherwise acceptable to the Division. Pumps taking suction from ground storage tanks shall be equipped with automatic shutoffs or low pressure controllers as recommended by the pump manufacturer; and

d. a bypass is available.

11.4.1 DUPLICATE PUMPS

Each booster pumping station shall contain not less than two pumps with capacities such that peak demand can be satisfied with the largest pump out of service.

11.4.2 METERING

All booster pumping stations shall be fitted with a flow rate indicator and totalizer meter.

11.4.3 IN-LINE BOOSTER PUMPS

In addition to the other requirements of this section, in-line booster pumps shall be accessible for servicing and repairs.

11.4.4 FIRE PUMPS

The criteria in this section also apply to fire pumps.

11.5 AUTOMATIC AND REMOTE CONTROLLED STATIONS

All automatic stations shall be provided with automatic signaling apparatus which will report when the station is out of service. All remote-controlled stations shall be electrically operated and controlled and shall have signaling apparatus of proven performance. Installation of electrical equipment shall conform with the acceptable and applicable codes.

11.6 APPURTENANCES

11.6.1 VALVES

a. Pumps shall be adequately valved to permit satisfactory operation, maintenance and repair of the equipment. If foot valves are necessary, they shall have a net valve area of at least 2 ½ times the area of the suction pipe and they shall be screened.

b. Each pump shall have a positive acting check valve on the discharge side between the pump and shutoff valve.

c. Surge relief valves or slow acting check valves shall be designed to minimize hydraulic transients.

11.6.2 PIPING

In general, piping shall:

a. be designed so that friction head will be minimized;

b. not be subject to contamination;

c. have watertight joints;

d. be protected against surge or water hammer and provided with suitable restraints where necessary; and

e. be such that each pump has an individual suction line, or the lines shall be so manifolded that they will ensure hydraulic and operation conditions.

11.6.3 GAUGES AND METERS

Each pump shall:

a. have a standard pressure gauge on its discharge line;

b. have a compound gauge on its suction line;

c. have recording gauges in larger stations;

d. have a means for measuring the discharge;

e. have sampling taps; and

f. the station shall have a flow rate indicator and totalizing meter, and a method of recording the total water pumped.

11.6.4 WATER SEALS

Water seals shall not be supplied with water of a lesser sanitary quality than that of the water being pumped. Where pumps are sealed with potable water and are pumping water of lesser sanitary quality, the seal shall:

a. be provided with either an approved reduced pressure principle backflow preventer or a break tank open to atmospheric pressure; and

b. where a break tank is provided, have an air gap of at least six inches or two pipe diameters, whichever is greater, between the feeder line and the flood rim of the tank.

11.6.5 CONTROLS

Pumps, their prime movers and accessories, shall be controlled in such a manner that they will operate at rated capacity without dangerous overload. Where two or more pumps are installed, provision shall be made for proper alternation. Provision shall be made to prevent operation of the pump during the backspin cycle. Electrical controls shall be located above grade. Equipment shall be provided or other arrangements made to prevent surge pressures from activating controls which switch on pumps or activate other equipment outside the normal design cycle of operation.

11.6.6 POWER

When power failure would result in cessation of minimum essential service, power supply shall be provided from at least two independent sources or standby or auxiliary source shall be provided or be available. If standby power is provided by onsite generators or engines, the fuel storage and fuel line must be designed to protect the water supply from contamination.

11.6.7 AUXILIARY POWER SUPPLY

When automatic pre-lubrication of pump bearings is necessary, and an auxiliary power supply is provided, then the pre-lubrication line shall be provided with a valved by-pass around the automatic control. Design shall assure that pre lubrication is provided when auxiliary power is in use, or that bearings can be lubricated manually before the pump is started.

11.6.8 OIL OR GREASE LUBRICATION

All lubricants which come into contact with the potable water shall meet NSF International Standard H1, 3H, or H3.

11.7 GROUND WATER PUMPING FACILITIES

Where pumping facilities are used, wells and springs shall be vented by properly hooded and screened pipe extending at least 12 inches above the pump floor. Where necessary, provision shall be made for lubricating the pump from a point at least 6 inches above the top of the well cover by means which will prevent contamination of the water supply.

11.7.1 DRILLED WELLS

Pumping stations located over drilled wells shall:

a. have riser pipe or casing ex-tending at least 12 inches above the floor and be equipped with flange or suitable stuffing box;

b. have riser pipe or casing firmly connected to the pump structure to provide a water tight connection;

c. have base of pump not less than 6 inches above pump room floor; and

d. have pump foundation and base designed to prevent water from coming into contact with the joint.

PART 12 – FINISHED WATER AND DISTRIBUTION SYSTEMS

Water distribution systems shall be designed to sustain EPD's standards for safe drinking water quality. Special consideration should be given to distribution main sizing, providing for design of multidirectional flow, adequate valving for distribution system control, and provisions for adequate flushing. Distribution systems should be designed to maximize turnover and to minimize residence times while delivering acceptable pressures and flows.

12.1 MATERIALS

a. All materials that come into contact with the drinking water during its treatment, storage, transmission or distribution shall not adversely affect drinking water quality and public health and must be certified for conformance with American National Standards Institute/ National Sanitation Foundation Standard 61 (ANSI/NSF Standard 61).

b. The pipe, fittings, valves and fire hydrants selected shall conform with the latest AWWA Standards. In the absence of such standards, pipe meeting applicable ASTM and ANSI criteria and acceptable to the Division may be selected.

c. Special attention shall be given to selecting pipe materials which will protect against both internal and external corrosion.

d. Used water mains that meet these standards may be used again after the pipe has been thoroughly cleaned and restored practically to its original condition.

e. Pipe having mechanical joints or slip-on joints with rubber gaskets shall be used. Lead-tip gaskets shall not be used.

f. In general, packing and jointing materials used must meet the latest edition of the AWWA Standards. Joints shall conform to AWWA Standard C111.

g. Ductile iron and cast iron pipe shall meet the latest edition of ANSI/AWWA Standard C106 or C108 for cast iron pipe and C151 for ductile iron pipe.

h. Pipe and fittings shall be cement lined in accordance with the latest edition of AWWA Standard C104.

i. Fittings shall be ductile iron and shall conform to the latest edition of AWWA Standard C110 or C153.

j. Concrete pipe shall meet the latest edition of AWWA Standard C300.

k. Any pipe material which is not specifically stated in this section shall be considered on an individual basis.

l. Fire Hydrants shall meet the current AWWA Standard C502.

12.1.1 PVC PIPE (2 inch through 60 inch)

a. PVC pipe meeting the standards set forth in AWWA C-900 (latest edition) shall be acceptable for those working pressures as designated by class. (Note that C-900 refers to 4-inch through 60-inch pipe.)

b. The pipe shall meet all the requirements set forth in ASTM Standard D 2241, with a minimum pressure class rating of Class 200. The pipe must bear the seal of approval for potable water use and for conformance with NSF Standard 61.

c. Provisions must be made for contraction and expansion at each joint with flexible ring gaskets made from rubber or other suitable material. Gasket materials shall meet the requirements established in ASTM F477.

d. All fittings such as tees, ells, etc. using welded joints shall be factory welded and shall meet the same specifications as the welded bell section.

e. Lubricants shall be non-toxic, shall not promote biological growth, and shall be certified for conformance with NSF Standard 61.

f. Solvent cemented joints are not allowed for buried pipes.

g. Detection tape shall be placed along all PVC water mains.

12.2 SYSTEM DESIGN

The water distribution system must be designed to meet the requirements of Rule Section 391-3-5-.10.

12.2.1 MINIMUM PIPE SIZE

a. The water distribution system must be designed and the water lines sized to furnish at all times the instantaneous demand flow of water required and to maintain at all times a pressure of twenty (20) pounds per square inch at each service connection in the distribution system under all conditions of flow.

b. The minimum size of pipe for principal water mains and for water mains where fire hydrants are to be attached shall be 6-inch diameter. Larger size mains will be required if necessary, to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psi (140 kPa).

c. The minimum size water main shall be 2-inch in nominal diameter. However, the size of water mains shall be justified by hydraulic analysis, performed by a professional engineer. The 2-inch water mains shall be considered for short cul-de-sacs and permanent dead-ends where future growth is not feasible. (Any departure from minimum requirements shall be justified by the hydraulic analysis and future water use, and can be considered only in special circumstances.)

d. Generally, not more than 20, or the equivalent of 20, residences shall be connected to a 2-inch diameter water line, unless the main is looped or otherwise supplied from two connections with mains of adequate capacities. A looped 2-inch main shall serve no more than 40 residences, or the equivalent water demand of 40 residences. A 2-inch diameter main shall not exceed 1000 feet in length.

e. All water mains, including those not designed to provide fire protection, shall be sized after a hydraulic analysis based on flow demands and pressure requirements has been completed.

f. The system must be designed to maintain a minimum pressure of 20 psi (140 kPa) at each service connection and at all points in distribution system under all conditions of flow. The normal working pressure in the distribution system should be approximately 60 to 80 psi) (410-550 kPa) and shall not be less than 35 psi.

g. Wide variations in pressure above the minimum requirement of 20 psi may be inherent in the design of a distribution system but pressures no greater than 100 psi should be delivered to the customer (unless higher pressures are requested). The 100 psi maximum pressures can be met by pressure reducing valves in vicinity of each customer's source line, or by designing the distribution system to limit the maximum pressure.

h. All assumptions and any flow data used must be clearly documented and submitted with the hydraulic analysis. If actual flow data is not available, theoretical calculations shall be based on all storage facilities half-full and the Hazen-Williams friction factor appropriate for type of pipe being used but in no case greater than 130.

i. Water mains and distribution systems should be sized to meet instantaneous peak demand flows. When fire protection is to be provided, system design should consider the recommendations of Insurance Underwriters organization.

12.2.2 DEAD ENDS

a. Dead ends should be minimized by making appropriate tie-ins whenever practical.

b. Where dead-end mains occur, they shall be provided with a fire hydrant, when fire flows are available, or with an acceptable flushing hydrant or blow-off for flushing purposes. The blow-off shall be at least 2 inches in diameter but must be appropriately sized to provide flushing velocities of 2.5 feet per second or greater in the water main being flushed.

c. No flushing device shall be directly connected to any sewer nor be subjected to flooding or plugging.

12.3 VALVE, AIR RELIEF, METER AND BLOW-OFF CHAMBERS

a. Sediment accumulations may be removed through a standard fire hydrant. In addition, compressed air and pumping may be used for dewatering mains through hydrants.

b. At high points in water mains where air can accumulate, provisions shall be made to remove the air by means of hydrants or air relief valves. Automatic air relief valves shall not be used in areas where flooding of the manhole or chamber may occur.

c. The open end of an air relief pipe from automatic valves shall be extended to at least one (1) foot above grade and provided with a screened, downward-facing elbow. The pipe from a manually operated valve should be extended to the top of the pit.

d. Wherever possible, chambers, pits or manholes containing valves, blow-offs, meters, or other such appurtenances to a distribution system, shall not be located in areas subject to flooding or in areas of high groundwater. Such chambers or pits should drain to the ground surface, or to absorption pits underground. The chambers, pits and manholes shall not connect directly to any storm drain or sanitary sewer. Blow-offs shall not connect directly to any storm drain or sanitary sewer.

e. Valves are to be placed at all intersections of water mains. Valves should be located at not more than 500 feet intervals in commercial districts and at not more than one block or 800 feet intervals in other districts. Where systems serve widely scattered customers, the valve spacing should not exceed 4000 feet.

f. Valves shall meet the current AWWA Standards.

12.4 DISTRIBUTION STORAGE

The applicable design standards of this document shall be followed for distribution storage.

a. The purpose of system storage is to have sufficient water available to provide adequate flow and pressure at peak demand as well as to provide for fire flows when needed. For most water systems a satisfactory rule-of-thumb to meet these needs is to provide at least the average 24-hour demand in elevated storage. An engineering study should be performed to determine the system's actual elevated storage capacity needs.

b. Pressure Variation - System pressure variation on account of changes in level of water in storage structures should be minimized. Elevated storage tanks or large diameter ground tanks located on high ground should be the usual choices. Normally, standpipes should not be considered for distribution storages, unless completely justified. The maximum variation between high and low levels in storage structures providing pressure to a distribution system should not exceed 30 feet. The minimum working pressure in the distribution system should be 20 psi and the normal working pressure should be approximately 60 to 80 psi. When static pressure exceeds 100 psi, pressure reducing devices should be provided on mains or as part of the meter setting on individuals service lines in the distribution system.

c. Drainage - Storage structures which float on the distribution system should be designed to drain for cleaning or maintenance without necessitating loss of pressure in the distribution system. The drains should discharge to the ground surface with no direct connection to a sewer or storm drain. A nearby fire hydrant may be considered as a drain as long as service is not interrupted, and suitable erosion protection is provided.

d. Level Controls - Adequate controls shall be provided to maintain levels in distribution system storage structures.

   1. Telemeter equipment should be used when pressure-type controls are employed, and any appreciable head loss occurs in the distribution system between the source and the storage structure.

   2. Altitude valves or equivalent controls may be required for a second and subsequent structures on the system.

   3. Overflow and low-level warnings or alarms should be located at places in the community where they could be under responsible surveillance on a 24 hour basis.

e. For more details please refer to Part 10 Finished Water Storage of this document.

12.5 INSTALLATION OF MAINS

a. Water lines must not be installed in contaminated areas such as sanitary landfill or dump areas.

b. No water main or pipe shall pass through or come into contact with any part of a sewer or sewer manhole.

c. A continuous and uniform bedding shall be provided in the trench for all buried pipe.

d. Backfill material shall be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect pipe.

e. Thrust restraint shall be provided at all points where hydraulic thrust may develop. This will include providing reaction blocking, tie rods or joints designed to prevent movement to all bends, tees, valves, plugs, hydrants and other points where thrust may develop. Additional restraints may be necessary on fusible pipe at the connection to appurtenances or transitions to different pipe materials to prevent separation of joints. The restraint may be provided in the form of an anchor ring encased in concrete or other methods as approved by the Division.

f. Whenever a state route or heavily traveled off-system road or a railroad is crossed, the agency that has jurisdiction over the road or the railroad must be notified, prior to the installation of the mains. At the crossing, a steel casing with sufficient diameter must be jacked and bored to accommodate the carrier pipe. Any free boring at low traffic city streets and county roads must conform to the applicable local and/or state requirements.

g. Installation of water lines and appurtenances along highways, streets and roadways must comply with the applicable regulations of, and permits issued by, the Georgia Department of Transportation, local County and Municipality with reference to construction operations, safety, traffic control, road maintenance and repair.

h. When non-metallic pipe is installed, detection tape shall be installed.

i. Any pipe, pipe fittings, plumbing fittings or fixtures, solder, or flux used in the installation or repair of a public water system must meet the new definition of lead free meaning: (a) not containing more than 0.2 percent lead when used with respect to solder; and (b) not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures.

j. If soils are found to be aggressive, the water main shall be protected by encasement in polyethylene, the provision of cathodic protection (in very severe instances), or the use of corrosion resistant water main materials.

12.5.1 ROCK EXCAVATION

Stones found in the trench shall be removed for a depth of at least six (6) inches below the bottom of the pipe.

12.5.2 COVER

All distribution mains shall be provided with sufficient earth and other suitable cover to prevent freezing. This shall be not less than 24 inches measured above the top of pipe.

12.5.3 HYDROSTATIC TESTS

a. Pressure and leakage tests shall be performed in accordance with the latest edition of AWWA Standard C600.

b. The test pressure of the installed pipe shall be a minimum 1.5 times the working pressure, but not less than 150 psi, whichever is greater.

d. For DIP: Allowable leakage shall be no greater than as calculated in $L=SD(P)^{1/2}/133{,}200$ where L is allowable leakage in gallons/hour, S is the length of pipe tested in feet, D is the nominal diameter of the pipe in inches and P is average test pressure during the leakage test in pounds per square inch (psi gauge).

d. For PVC: Allowable leakage shall be no greater than as calculated in $L=ND(P)^{1/2}/7{,}400$ where L is allowable leakage in gallons/hour, N is the number of joints in the length of pipe tested, D is the nominal diameter of the pipe in inches and P is average test pressure during the leakage test in pounds per square inch (psi-gauge).

12.5.4 DISINFECTION OF NEWLY INSTALLED WATER MAINS

a. All new water mains shall be disinfected before they are placed in or returned to service.

b. Disinfection of the new mains and the disposal of the heavily chlorinated water, following the disinfection, shall be accomplished in accordance with the latest edition of AWWA Standard C651.

c. The “tablet method” of disinfection which consists of placing calcium hypochlorite granules or tablets in the water main as it is being installed and then filling the main with potable water when installation is complete is not allowed.

d. Before the main is chlorinated, it shall be filled to eliminate air pockets and shall be flushed to remove particulates. A flushing velocity of not less than 2.5 feet/second is usually maintained in pipe sizes less than 24 inches in diameter. For larger diameter mains, an alternative to flushing, such as broom-sweeping of the main, is acceptable prior to chlorinating the main.

e. During disinfection of the water mains, an appropriate cross-connection control device, consistent with the degree of hazard, shall be provided for backflow protection of the active distribution system.

f. The quality of the water used during the disinfection procedures shall meet the required drinking water standards.

g. The chlorine solution used for the "continuous feed" method of disinfection of water mains shall have a free chlorine residual concentration not less than 25 mg/L. This heavily chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants shall be operated to ensure disinfection of the appurtenances. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L free chlorine. Re-chlorinate if required results are not obtained on all samples.

h. After the applicable retention period, the heavily chlorinated water must not be disposed in a manner that will harm the environment. Neutralizing chemicals, such as Sulfur Dioxide, Sodium Bisulfite, Sodium Sulfite or Sodium Thiosulfate can be used to neutralize the chlorine residual remaining in the water to be wasted.

i. Flush all lines until residual is equal to existing system. After final flushing and before the water main is placed into service, water samples shall be collected from the main and tested for microbiological quality in accordance with the Georgia Rules for Safe Drinking Water, Chapter 391-3-5. The laboratory results must show the absence of coliform organisms in the water. Reflush and redisinfect the lines, as necessary, until satisfactory bacteriological results are obtained.

12.5.5 <u>DISINFECTION WHEN CUTTING INTO OR REPAIRING EXISTING MAINS</u>

a. All water mains that are depressurized and/or wholly or partially dewatered shall be disinfected in accordance with the current AWWA C651 Standards, including swabbing with hypochlorite solution, flushing, and/or slug chlorination as appropriate.

b. Bacteriological testing shall be performed after the repairs are complete. However, depending upon the circumstances, the water main may be returned to service prior to completion of testing to minimize the time the customers are out of service.

c. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure may require no disinfection.

12.5.5.1 AMOUNT OF CHLORINE NECESSARY FOR DISINFECTION

a. Chlorine required to produce 25 mg/L concentration in 100 feet of pipe by diameter:

Pipe Diameter	100% Chlorine		1% Chlorine Solution	
(inches)	(lbs.)	(g)	(gal)	(L)
4	0.013	5.9	0.16	0.6
6	0.030	13.6	0.36	1.4
8	0.054	24.5	0.65	2.5
10	0.085	38.6	1.02	3.9
12	0.120	54.4	1.44	5.4
16	0.217	98.4	2.60	9.8

Note: 1% chlorine solution may be prepared with sodium hypochlorite (contains 5% to 15% available chlorine) or calcium hypochlorite (contains approximately 65% available chlorine by weight). To prepare 1% chlorine solution using calcium hypochlorite, add one (1) pound (454 grams) of calcium hypochlorite in approximately 8 gallons of water.

b. Amounts and types of chemicals advised to be used for neutralizing various residual chlorine concentration in 100,000 gallons of water

Residual Chlorine Concentration	Chemicals							
	Sulfur Dioxide (SO_2)		Sodium Bisulfate ($NaHSO_3$)		Sodium Sulfite (Na_2SO_3)		Sodium Thiosulfate ($Na_2S_2O_3.5H_2O$)	
Mg/L	Lb.	Kg	Lb.	Kg	Lb.	Kg	Lb.	Kg
1	0.8	0.36	1.2	0.54	1.4	0.64	1.2	0.54
2	1.7	0.77	2.5	1.13	2.9	1.32	2.4	1.09
10	8.3	3.76	12.5	5.67	14.6	6.62	12.0	5.44
50	41.7	18.91	62.6	28.39	73.0	33.11	60.0	27.22

12.6 SEPARATION OF WATER MAINS (RECLAIMED AND POTABLE) AND SEWERS

12.6.0 GENERAL

The following factors should be considered in providing adequate separation:

a. materials and type of joints for water and sewer pipes;

b. soil conditions;

c. service and branch connections into the water main and sewer line;

d. compensating variations in the horizontal and vertical separations;

e. space for repair and alterations of water and sewer pipes;

f. off-setting of pipes around manholes; and

g. water mains and sanitary or storm sewers shall not be laid in the same trench.

12.6.1 PARALLEL INSTALLATION

a. Water mains and water service lines (before the curb stop and customer meter) owned by the public water systems shall be laid at least ten (10) feet horizontally from any existing or proposed sanitary sewer, storm sewer, septic tank, subsoil treatment system or sewer manhole. The distance shall be measured edge-to-edge.

b. When local conditions prevent a horizontal separation of 10 feet, the water main may be laid closer to a sewer (on a case-by-case basis) provided the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer. It is advised that the sewer be constructed of materials and with joints that are equivalent to water main standards of construction and be pressure tested to assure water-tightness prior to backfilling.

12.6.2 CROSSINGS

a. Water mains and water service lines (before the curb stop and customer meter) owned by the public water systems crossing house sewers, storm sewers or sanitary sewers shall be laid to provide a minimum vertical separation of at least 18 inches between the bottom of the water main and the top of the sewer. At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

b. When local conditions prevent a vertical separation of 18 inches, the sewer passing over or under water mains shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

c. When water mains and water service lines (before the curb stop and customer meter) owned by the public water systems cross under sewers, additional measures shall be taken by providing:

1. a vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;

2. adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the water mains;

3. that the length of water pipe be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer; and

4. both the sewer and the water main shall be constructed of water main materials extending on each side of the crossing until at least 10 feet separates the two pipes and subjected to hydrostatic tests, as prescribed in this document. Other options that are acceptable include:

   -Encasement of the water main or sewer in a carrier pipe constructed of water main materials, extending on each side of the crossing until at least 10 feet separates the two pipes.

   -The sewer has a structural lining that meets ASTM F1216 extending on each side of the crossing until at least 10 feet separates the two pipes.

d. Maximum obtainable separation of reclaimed water lines and potable water lines shall be practiced. A minimum horizontal separation of three (3) feet (outside of pipe to outside of pipe) shall be maintained between reclaimed water lines and either potable water mains or sewage collection lines. A minimum of 18 inches shall be provided between the bottom of any potable water supply line and the top of the reuse line.

12.7 SURFACE WATER CROSSINGS

Surface water crossings, both over and under water, may present special concerns and should be discussed with the Division before the final plans are prepared.

a. At above water crossings, the pipe shall be adequately supported and anchored, protected from vandalism, damage and freezing, and accessible for repairs or replacement.

b. At underwater crossings, a minimum of 3 feet of cover shall be provided over the pipe.

c. The installation of ductile iron pipe with restrained push-on joints and encased in concrete, may be considered with the prior approval of the Division. Otherwise, when crossing water courses which are greater than 15 feet in width, only pipes of special construction, having flexible, watertight joints shall be installed.

d. Valves shall be provided at both ends of water crossings so that the section can be isolated for testing or repair; valves shall be easily accessible and not subject to flooding.

e. Sampling taps shall be installed at each end of the crossing, and permanent taps shall be made for testing and determining leaks.

12.8 CROSS CONNECTION

There shall be no physical connection between the distribution system and any pipes, pumps, hydrants, or tanks whereby unsafe water and other contaminating materials may be discharged or drawn into the system.

a. The approval of the Division shall be obtained for interconnections between potable water supplies.

b. Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply.

12.9 WATER SERVICES AND PLUMBING

a. Water services and plumbing should conform to relevant local and/or state plumbing codes, or to the Standard Plumbing Code, as applicable within the jurisdiction in which the system is located.

b. The product that is used for the service line must be listed as being certified for conformance with the NSF Standard 61.

c. All new and existing services connected to community and non-transient noncommunity water systems shall be individually metered.

d. Individual booster pump(s) shall not be allowed for any individual residential service from the public water supply mains. Where permitted for other types of services, booster pumps shall be designed in accordance with AWWA standards.

12.10 WATER LOADING STATIONS

Water loading stations present special problems since the fill line may be used for filling both potable water vessels and other tanks or contaminated vessels. To prevent contamination of both the public supply and potable water vessels being filled, the following principles shall be met in the design of water loading stations:

a. there shall be no backflow to the public water supply;

b. the piping arrangement shall prevent contaminant being transferred from a hauling vessel to others subsequently using the station; and

c. hoses shall not be contaminated by contact with the ground.

PART 13 - WASTE HANDLING AND DISPOSAL

13.0 GENERAL

Thorough consideration must be given to the waste streams that are generated by treatment equipment and treatment technologies that are chosen. Wastes that discharge to municipal sewer systems may impact the ability of the wastewater treatment facility to meet discharge permit limits. Alternative methods of water treatment and chemical use should be considered as a means of reducing waste volumes and the associated handling and disposal problems. All waste discharges shall be in accordance with all federal, state and/or local laws and ordinances. The requirements outlined herein must, therefore, be considered minimum requirements as federal, state, and/or local water pollution control authorities may have more stringent requirements.

Provisions must be made for proper disposal of water treatment plant wastes such as sanitary and laboratory wastes, clarification sludge, softening sludge, iron sludge, filter backwash water, backwash sludge, and brines (including softener and ion exchange regeneration wastes and membrane and reverse osmosis wastes). In locating sewer lines and waste disposal facilities, consideration shall be given to preventing potential contamination of the water supply.

The appropriate federal, state, and local officials should be notified when designing treatment facilities to ensure that the local sanitary sewer system and wastewater treatment facility can accept the anticipated wastes.

Backflow prevention measures as approved by the Division must be provided as needed to protect the public water supply.

All waste discharges shall be governed by Georgia EPD requirements.

13.1 SANITARY WASTE

The sanitary waste from water treatment plants, pumping stations, and other waterworks installations must receive treatment. Waste from these facilities must be discharged directly to a sanitary sewer system, when available and feasible, or to an adequate on-site waste disposal facility providing suitable treatment.

13.2 BRINE WASTE

The disposal method proposed must receive prior approval from the Division. Waste from ion exchange, demineralization, and membrane plants, or other plants which produce brine, must be treated or discharged in accordance with all federal, state, and local rules. When discharging to a sanitary sewer, an equalization basin or tank may be required to prevent the overloading of the sewer and/or interference with the waste treatment processes. The effect of brine discharge to sewage lagoons may depend on the rate of evaporation from the lagoons.

13.3 LIME SOFTENING SLUDGE

Methods of treatment and disposal of sludge from plants using lime are as follows:

13.3.1 LAGOONS

Design should provide:

a. Temporary lagoons which must be cleaned periodically should be designed on the basis of 0.7 acres per million gallons per day per 100 milligrams per liter of hardness removed based on a usable lagoon depth of 5 feet. This should provide about 2-1/2 years storage. At least two but preferably more lagoons must be provided in order to give flexibility in operation. An acceptable means of final sludge disposal must be provided. Provisions must be made for convenient cleaning.

b. Permanent lagoons should have a volume of at least 4 times that for temporary lagoons.

c. The design of both temporary lagoons and permanent lagoons should provide for:

   1. location free from flooding;

   2. when necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoons;

   3. a minimum usable depth of 5 feet;

   4. adequate freeboard of at least 2 feet;

   5. adjustable decanting devices;

   6. effluent sampling point;

   7. adequate safety provisions;

   8. parallel operation; and

   9. subsurface infiltration may be acceptable if approved by the Division.

13.3.2 FARMLAND APPLICATION

The application of liquid lime or dewatered lime sludge to farmland may be considered as a method of disposal. Prior to land application, a chemical analysis of the sludge including calcium and heavy metals shall be conducted. and disposal must have been registered with the Georgia Department of Agriculture as liming material. When this method is selected, the following provisions should be considered:

a. Transport of sludge by vehicle or pipeline should incorporate a plan or design which prevents spillage or leakage during transport.

b. Interim storage areas at the application site should be kept to a minimum and facilities should be provided to prevent runoff of sludge or flooding of the facilities.

c. Sludge should not be applied at times when runoff from the land could be expected or on sloping land unless provisions are made, for suitable land, to immediately incorporate the sludge into the soil.

d. Trace metals loading should be limited to prevent significant increases in trace metals in the food chain, phytotoxicity or water pollution.

e. Each area of land to receive lime sludge should be considered individually and a determination made.

13.3.3 DISCHARGE

Discharge of lime sludge to sanitary sewers should be avoided since it may cause both liquid volume and sludge volume problems at the sewage treatment plant. This method should be used only when the sewerage system has the capability to adequately handle the lime sludge.

13.3.4 MIXING

Mixing of lime sludge with activated sludge waste may be considered as a means of co-disposal.

13.3.5 DISPOSAL

Disposal at a landfill can be done as either a solid or liquid if the landfill can accept such waste, in conformance with the Division requirements.

13.3.6 MECHANICAL DEWATERING

Mechanical Dewatering of sludge may be considered. Pilot studies on a particular plant waste may be required.

13.3.7 CALCINATION

Calcination of sludge may be considered. Pilot studies on a particular plant waste are required.

13.3.8 LIME SLUDGE DRYING BEDS

Lime sludge drying beds are not recommended.

13.4 ALUM SLUDGE

13.4.0 GENERAL

a. Lagoon may be used as a method of handling alum sludge. Lagoon size can be calculated using total chemicals used plus a factor for turbidity.

b. Mechanical concentration may be considered. A pilot plant study may be required before the design of a mechanical dewatering installation.

c. Freezing changes the nature of alum sludge so that it can be used for fill. Acid treatment of sludge for alum recovery may be a possible alternative.

d. Alum sludge can be discharged to a sanitary sewer. However, initiation of this practice will depend on obtaining approval from the owner of the sewer system as well as from the Division before final designs are made.

e. Lagoons should be designed to produce an effluent satisfactory to the Division and should provide for:

1. location free from flooding;

2. where necessary, dikes, deflecting gutters or other means of diverting surface water so that it does not flow into the lagoon;

3. a minimum usable depth of 5 feet;

4. adequate freeboard of at least 2 feet;

5. adjustable decanting device;

6. effluent sampling point;

7. adequate safety provisions; and

8. a minimum of two cells, each with appropriate inlet/outlet structures to facilitate independent filling/dewatering operations.

13.4.1 MECHANICAL DEWATERING

a. It is recommended that a pilot study on the particular plant waste be conducted.

b. Mechanical dewatering shall be preceded by sludge concentration and chemical pretreatment.

13.4.2 LAND APPLICATION

Alum sludge may be disposed of by land application as long as it is not mixed with any other wastes, and disposal has been registered with the Georgia Department of Agriculture as soil amendment.

13.5 RED WATER WASTE

Waste filter wash water from iron and manganese removal plants can be disposed of as follows:

a. SAND FILTERS

Sand filters should have the following features:

1. Total filter area, regardless of the volume of water to be handled, should be no less than 100 square feet. Unless the filter is small enough to be cleaned and returned to service in one day, two or more cells are required.

2. The "red water" filter shall have sufficient capacity to contain, above the level of the sand, the entire volume of wash water produced by washing all of the production filters in the plant, unless the production filters are washed on a rotating schedule and the flow through the production filters is regulated by true rate of flow controllers. Then sufficient volume must be provided to properly dispose of the wash water involved.

3. Sufficient filter surface area should be provided so that, during any one filtration cycle, no more than 2 feet of backwash water will accumulate over the sand surface.

4. The filter shall not be subject to flooding by surface runoff or flood waters. Finished grade elevation shall be established to facilitate maintenance, cleaning and removal of surface sand as required. Flash boards or other non-watertight devices shall not be used in the construction of filter side walls.

5. The filter media should consist of a minimum of 12 inches of sand, 3 to 4 inches of supporting small gravel or torpedo sand, and 9 inches of gravel in graded layers. All sand and gravel should be washed to remove fines.

6. Filter sand should have an effective size of 0.3 to 0.5 mm and a uniformity coefficient not to exceed 3.5. The use of larger sized sands shall be justified by the designing engineer to the satisfaction of the Division.

7. The filter should be provided with an adequate under-drainage collection system to permit satisfactory discharge of filtrate.

8. Provision shall be made for the sampling of the filter effluent.

9. Overflow devices from "red water" filters shall not be allowed.

10. Where freezing is a problem, provisions should be made for covering the filters during the winter months.

11. "Red water" filters shall comply with the common wall provisions contained in this document, which pertain to the possibility of contaminating treated water with an unsafe water.

12. The Division must be contacted for approval of any arrangement where a separate structure is not provided.

b. LAGOONS

Lagoons shall have the following features:

1. be designed with a volume 10 times the total quantity of wash water discharged during any 24-hour period;

2. a minimum usable depth of 3 feet;

3. length 4 times width, and the width at least 3 times the depth, as measured at the operating water level;

4. outlet to be at the end opposite the inlet;

5. a weir overflow device at the outlet end with weir length equal to or greater than depth;

6. velocity to be dissipated at the inlet end; and

7. subsurface infiltration lagoons may be acceptable if approved by the Division.

c. DISCHARGE TO COMMUNITY SANITARY SEWER

Red water can be discharged to a community sewer if the owner of the sewage system and the Division give approval before final designs are made. An equalization basin or tank is recommended to prevent overloading the sewers. Design shall prevent cross connections and there shall be no common walls between potable and non-potable water compartments.

d. DISCHARGE TO SURFACE WATER

The water treatment plant must have appropriate permits, including an NPDES (National Pollutant Discharge Elimination System) permit, if the design calls for the disposal of backwash water into surface water.

e. RECYCLING "RED WATER" WASTES

Recycling of supernatant or filtrate from "red water" waste treatment facilities to the head end of an iron removal plant may be allowed by the Division. Backwash reclaim tanks for plants treating groundwater shall be constructed to finished water storage tank standards and sized to contain the total backwash waste volume from two consecutive backwash cycles at a minimum. Backwash reclaim tanks may not be directly connected to a sewer or a storm drain. It is recommended that the recycled water be returned at a rate of less than 10 percent of the instantaneous raw water flow entering the plant.

13.6 FILTER BACKWASH WASTEWATER

13.6.0 GENERAL

Suspended solids in the backwash wastewater from surface water treatment and lime softening plants should be reduced prior to recycling to the head of the plant.

a. Waste filter wash water from surface water treatment or lime softening plants should have suspended solids reduced to a level acceptable to the Division in accordance with the issued NPDES permit, before being discharged.

b. The plants should construct appropriate holding tanks or other facilities for this purpose. The holding tank should be of such a size that it will contain the anticipated volume of waste wash water produced by the plant when operating at design capacity.

13.6.1 THE BACKWASH RECLAIM TANK MUST CONTAIN

a. The anticipated volume of waste water produced by the plant when operating at design capacity;

b. the total volume of waste wash water from both filters using 15 minutes of backwashing at a rate of 20 gallons per minute per square foot for a plant that has two filters; and

c. a volume that takes into account the number of filters and the anticipated backwash frequency and volume using 15 minutes of backwashing at a rate of 20 gallons per minute per square foot for a plant with more than two filters.

13.6.2 RECYCLING OF BACKWASH WASTEWATER

The Division may approve the recycling of filter backwash wastewater, thickener supernatant, and other liquids to the head of the plant under the following conditions:

a. Reclaimed water should be returned at a rate of less than 10 percent of the instantaneous raw water flow rate entering the plant;

b. Reclaiming filter backwash water should be avoided if there is increased risk to treated water quality. Reclaimed water should not be recycled when the raw and/or reclaimed water contains excessive algae, algal toxins, excessive turbidity, or when finished water taste and odor are problematic. Consideration should be given to the presence of protozoans such as *Giardia and Cryptosporidium* concentrating in the wastewater stream; and

c. Pre-treatment of filter backwash wastewater prior to recycling may be required to reduce pathogen populations and to improve coagulation.

13.7 RADIOACTIVE MATERIALS

Radioactive materials may be found in the following waste streams, including, but not limited to:

a. granulated activated carbon (GAC) used for radon removal;

b. radium adsorptive filter media;

c. ion-exchange regeneration waste water;

d. manganese greensand backwash solids from manganese removal systems;

e. precipitative softening sludge; and

f. reverse osmosis concentrates.

The buildup of radioactive decay products shall be considered, and adequate shielding, ventilation, and other safeguards shall be provided in the plant design to protect water operators and visitors. Some materials may require disposal as radioactive waste in accordance with Nuclear Regulatory Commission regulations. Approval shall be obtained from the Land Protection Branch, Solid Waste Permitting Program prior to disposal of all wastes.

13.8 ARSENIC WASTE RESIDUALS

Arsenic-bearing wastes may be found in the following waste streams and may be considered hazardous, including but not limited to:

a. filter backwash wastewater and sludge;

b. lime softening sludge;

c. reverse osmosis reject water; and

d. adsorptive filter media.

Under the Resource Conservation and Recovery Act (RCRA) residual wastes from an arsenic water treatment facility may be defined as being hazardous waste if it exhibits a Toxicity Characteristic Leaching Procedure (TCLP) result higher than the thresholds set in rule. The Solid Waste Division of EPD must be contacted and must grant approval prior to disposal of arsenic residual wastes.

PART 14 - LABORATORY FACILITIES

14.0 GENERAL

a. Laboratory equipment and facilities shall be compatible with the raw water source, intended design of the treatment plant, daily monitoring and the complexity of the treatment process involved.

b. Recognized laboratory procedures must be utilized, and the testing equipment shall be acceptable to the Division.

c. Laboratory facilities and any other part of the water treatment plant should not be used for activities and/or purposes that are not pertinent to the operation of the plant or in the execution of the duties of the operator and/or the laboratory analyst.

14.1 LABORATORY SPACE AND FACILITIES

a. Laboratory facilities shall be located in a separate room from office/lunch activities and from the treatment units. Facilities shall be isolated by doors and not be located in the main traffic pattern.

b. Sufficient bench space, adequate ventilation, adequate lighting, storage room, laboratory sink, and auxiliary facilities shall be provided.

c. The bacteriological laboratory, if provided, shall be acceptable to the Division. It shall have adequate counter space and shall be located in a separate room or area.

14.2 SAMPLE TAPS

Sample taps shall be provided so that water samples can be obtained from each water source and from appropriate locations in each unit operation of treatment. Taps shall be consistent with sampling needs and not be of petcock type. Sample lines and pumps where applicable shall be sized to minimize time lag between point of sampling and point of sample collection.

14.3 RECORDS MAINTENANCE

14.3.1 GENERAL

Daily records of the operation of the water treatment facility and water distribution system, including the amount of water treated daily, results of the performance of daily tests pertinent to the control of the water treatment processes, jar tests, disinfectant residuals, tests performed in the water distribution system, and any test results and records as may be required by the Division shall be maintained by the water supplier. These records shall be kept on the premises or at a convenient location near the water plant. Based on the complexity of the water treatment process, the quality of water source, and the size of the system, the Division may establish less frequent maintenance of record requirements for small groundwater system.

14.3.2 RECORDS MAINTENANCE DURATION

a. Microbiological: Records of microbiological analyses shall be kept for not less than five (5) years.

b. Chemicals: Records of chemical analyses shall be kept for not less than ten (10) years.

c. Lead/ Copper: Original records of all lead and copper sampling data, analyses, reports, surveys, letters, evaluations, schedules, Division determinations, and any other related information shall be kept for not less than twelve (12) years.

d. Individual Filter Monitoring: Records of individual filter monitoring results that are taken under Rules for Safe Drinking Water, Chapter 391-3-5-.20(9)(c) shall be maintained for at least three (3) years.

e. Violations: Records of action taken by the system to correct violations of the Rules for Safe Drinking Water, Chapter 391-3-5, shall be kept for a period of not less than three (3) years after the last action taken with respect to the particular violation.

f. Inspections/Sanitary Survey Reports: Copies of any written reports, summaries or communications relating to sanitary surveys of the system conducted by the system itself, by a private consultant, or by any local, state or federal agency, shall be kept for a period not less than ten (10) years after completion of the sanitary survey involved.

g. Variance/ Exemption: Records concerning a variance or exemption granted to the system shall be kept for a period ending not less than five (5) years following the expiration of such variance or exemption.

14.4 AVAILABLE LABORATORIES FOR SAMPLING AND TESTING

For chemical, microbiological and radiological analysis of raw and finished water, the water systems must use one of the following laboratories:

a. EPD laboratories; or

b. EPD approved laboratories. (See EPD's website for the list of approved labs.)

-END –