Consecutive Water System
Guidance Document
For Navy Installations

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Introduction/Overview

Maintaining a safe potable water supply on Navy installations is essential to mission readiness in the Navy. Many Navy water systems purchase their water already treated from a primary supplier and therefore are classified as consecutive water systems. This guidance document recommends procedures and defines the efforts and responsibilities for maintaining the supply, distribution and monitoring of safe drinking (potable) water via a consecutive system at a Navy installation.

The purpose of water supply systems is to provide a safe and pleasant drinking water that is free of disease causing organisms and toxic substances. Historically, water supply systems focused on the control of turbidity, iron, manganese, taste & odors, and color; primarily for aesthetic reasons. Disinfection focused on the control of coliform organisms and generally consisted of the addition of chlorine somewhere within the treatment process in addition to maintaining a disinfectant residual within the distribution system. This approach to water supply, treatment, and distribution, though somewhat simplistic by today's standards, was sufficient to help eliminate the major outbreaks of cholera and typhoid in this country.

The new and pending drinking water regulations have significantly shifted the focus of water supply systems. For example:

- The concept of microbial control has been expanded to include not only coliform organisms, but other, more difficult to control microorganisms such as *Giardia*, *Cryptosporidium*, viruses, etc.

- The role of turbidity or particle removal has been expanded to function as a surrogate indicator of microbial removal and as an indicator of interference with disinfection.

- The Surface Water Treatment Rule (SWTR) formally established the multiple barrier approach to microbial control including removal by coagulation and filtration, and included primary disinfection as defined by the contact time or "CT" concept for maintenance of microbial control in the distribution system.

- The Ground Water Disinfection Rule (GWDR) that is currently under development by the USEPA will, like the SWTR, establish multiple barrier microbial control requirements for systems that rely on ground water. The need for a GWDR is based on the fact that, the use of untreated, contaminated ground waters still accounts for a significant number of the waterborne disease outbreaks in this country.

- The Total Coliform Rule (TCR) focused on microbial control in the distribution system for both ground and surface water systems.

- The Lead and Copper Rule, for the first time, moved the point of compliance to the consumer's tap.

- The current regulations on Trihalomethanes (THMs) and the new Disinfectant/Disinfection By-Products (D/DBPs) regulations, being developed by the USEPA, focus on the control of constituents that are suspected of having a chronic health impact over a 70-year life span.

In many cases, these new regulations pose conflicting requirements. For example:

- Increasing the chlorine dose and/or contact time to improve disinfection may also result in an increase in THMs and other DBPs.

- Increasing the pH for corrosion control may increase THMs and decrease the disinfection efficiency of free chlorine.

Consequently, the traditional approach to conventional water supply, treatment and distribution is no longer sufficient to meet the new requirements. Providing an acceptable drinking water is becoming more sophisticated and costly.

In addition, many installations present a unique set of challenges for maintaining water quality control. Due to physical changes at the installations, changes in mission and in occupants as well as the needs of the various users, often there is too much storage, storage that is locked out of the system, oversized transmission lines, distribution system valves that are closed, etc. This is true of both permitted and non-permitted systems. These challenges are exacerbated by the fact that at each installation, there may be different organizations that are responsible for operating, maintaining and monitoring the water supply system.

One of the more effective methods of meeting the new requirements is through a systems approach recognizing that all components of the water supply system are inter-related and that what impacts one may also impact the others. As installations work to comply with these drinking water regulations, there is a need to focus on the multiple requirements and not on the individual regulations as has been done in the past. There is also a need for the various organizations that have responsibility for the water supply system to work together and coordinate the activities that impact the system.

OPNAVINST 5090.1B "Environmental and Natural Resources Protection Manual" establishes the minimum regulatory or policy requirements, however additional actions may need to be taken to ensure adequate water quality control. For any given installation the distribution system may well contain any number of elements that can accelerate water quality deterioration within the installation. These problem areas may include:

- Dead ends where the water remains stagnant for extended periods of time;

- Tanks that are hydraulically locked out of the system;

- Tanks that are not turning over due to minimal demands within the proximity;
- Oversized pipes where demands existed in the past or as a result of a change in flow patterns;
- Artificial dead ends created by closed valves that should be open;
- Areas within the system that still contain unlined cast iron pipe;
- Areas within the system where it is difficult to maintain a disinfectant residual or that are prone to positive coliforms or Heterotrophic Plate Count (HPC) organisms;

The typical problems encountered by consecutive water systems include:

- Insufficient disinfectant residual in the water being delivered from the primary supplier to the installation;
- Loss of disinfectant residual within the installations system;
- For installations receiving chloraminated water, excess free ammonia in the water delivered from the primary supplier to the installation;
- Bacterial regrowth;
- The growth of nitrifying bacteria in chloraminated water;
- Excessive levels of THMs and/or other DBPs;
- Inadequate or ineffective corrosion control treatment;
- Discolored water; and
- Taste and odor problems.

For these systems, there may be a need to go beyond the minimum requirements in order to ensure the delivery of a safe and acceptable drinking water supply.

Being a consecutive system does not offer much flexibility from a source control and/or a treatment perspective. For some consecutive water systems, when a problem occurs with the water being delivered to the installation, negotiations with the primary supplier may be sufficient to alleviate the problem. For example, one consecutive water system that was purchasing chloraminated water from a primary supplier found that there was bacterial regrowth in the distribution system as well as the growth of nitrifying bacteria. Upon analysis of the water, they

discovered that they were receiving chloraminated water that would often contain 0.5 to 1.0 mg/L of free ammonia (as N). After negotiating with the primary supplier, the ammonia feed system controls were upgraded and the problem was resolved.

Unfortunately, negotiations are not always successful. At a Naval installation that was receiving chlorinated water, the THMs entering the installation were routinely greater than the current Maximum Contaminant Limit (MCL) of 100 ug/L. Despite repeated meetings and negotiations, the supplier was unwilling to accelerate its planned conversion to chloramines that was scheduled for the year 2000.

Even more than their suppliers, consecutive water systems need to focus on water quality control within their distribution systems to minimize any further degradation. The available tools include:

- An initial distribution system survey;
- Implementation of a cross-connection control and backflow prevention program;
- Water quality monitoring and through sampling;
- Documentation and evaluation of customer complaints;
- Unidirectional flushing;
- Implementation of a distribution system Code of Practice; and
- Establishment of routine coordination meetings with the supplier.

The need for an initial distribution system survey is due to the fact that the traditional focus in designing, operating and maintaining distribution systems has been on public safety requirements, or hydraulic objectives involving flow and pressure many of which can have a negative impact on water quality. The purpose of the initial survey is to identify all potential problems areas within the system including dead ends, oversized pipes, closed valves, storage tanks that are hydraulically locked out or not turning over, etc.

Following this initial survey, one system found a large number of fire hydrants that were not indicated on any of the distribution system maps. Another system found several closed interconnections that should have been open. Whatever is found, the results of this survey can be used to develop a comprehensive plan to correct the deficiencies within the system to improve overall water quality control.

In order to prevent degradation of water quality it is essential that a cross-connection control and backflow prevention program be implemented. The possibility of backflow due to improper piping/configuration layout within facilities is especially significant because such cross-connections may easily result in the contamination of the drinking water system. These situations may result in the drinking water system becoming a transmitter of pathogenic organisms, toxic materials, or other hazardous substances which can adversely affect public health and welfare. The only protection against such occurrences is the elimination of cross-connections or the protection of the drinking water system by proper application of backflow prevention procedures.

The quality of water in a consecutive system can best be guaranteed through the use of regular monitoring and sampling. Problems in water furnished by suppliers, as well as distribution system deficiencies, can often be identified before compliance problems arise. Chapter 9 of this User's Guide outlines Navy recommended monitoring procedures.

In addition to sampling and monitoring, documentation and evaluation of customer complaints is a valuable tool that can be used to solve problems as they arise. Customer complaints or monitoring and sampling results may indicate the need for corrective action such as system flushing.

Of all the available tools, flushing is the single most powerful tool available to consecutive water systems in their effort to maintain water quality control. Flushing techniques fall into two broad categories: conventional flushing and unidirectional flushing. Conventional flushing is the most commonly used method and it consists of opening hydrants in a specified area of the distribution system until improvements in color, residual disinfectant, etc. are observed. No valve isolation is used, and water to the hydrant often flows from several mains with the resultant velocity in each individual main remaining low. Although this type of flushing does promote water flow in the pipes and expels some of the poor quality water from the system, it generally does not result in dislodging of biofilms or other accumulated debris due to the low velocities. Moreover, because water used to flush a main may not originate from the segment that has already been flushed, (as would result from *unidirectional flushing*), the cleaning efficiency of conventional flushing is not maximized. Conventional flushing is most useful for restoring a disinfectant residual to a pipe segment in the distribution system.

Unidirectional flushing consists of isolating a particular pipe section or loop, typically through closing appropriate valves, and exercising the hydrants in an organized, sequential manner to produce velocities of 6 feet per second (fps) or more. These high velocities are sufficient to produce a scouring action, removing any accumulated debris, biofilms and/or corrosion products.

Unidirectional flushing can be used on a spot basis (in response to a specific water quality complaint) or as a comprehensive system-wide flushing effort (to avoid or reduce water quality problems). This flushing technique is typically more effective than conventional flushing in providing long-term water quality benefits.

Although water quality in the distribution system can be maintained through proper flushing of lines, Consecutive water systems have traditionally flushed in response to immediate water quality problems. More recently, however, flushing has been implemented as a preventative measure to avoid regulatory related water quality problems and customer complaints. The benefits of a well-defined, unidirectional flushing program include both hydraulic and water quality improvements including: reduced bacterial regrowth potential; restoration of a disinfectant residual; color/turbidity control; corrosion control; and restoration of flow and pressure.

Overall, a successful unidirectional flushing program will not only help to maintain acceptable water quality throughout the distribution system, but also prevent the degradation of water quality that often occurs between the interconnections with the primary supplier and the

customer's tap.

Although implementation of a unidirectional flushing program will provide a number of significant benefits, by itself, it will not correct other deficiencies or problems in the system. Therefore, the flushing program should be incorporated into an overall Code of Practice that, in addition to flushing, includes:

- Routine tank maintenance and cleaning;
- Operation of the tank to prevent stagnation (generally, provide for the turnover of at least 1/3 of the water in the tank every day);
- Ensuring that the repair crews are disinfecting and flushing line repairs/replacements;
- A valve exercise program to assure that all of the valves that should be open are, in fact, open;
- Effective corrosion control treatment;
- Enhanced monitoring including the use of Heterotrophic Plate Counts (HPCs) using the R2A media (as presented in Reference 17) to provide an early warning system for localized water quality degradation; and, if possible,
- Modeling of the system to provide a tool for better operational control and planning.

As part of this effort, it has been beneficial for consecutive water systems to establish monthly or quarterly coordination meetings with their suppliers. These meetings help to avoid the unpleasant surprises that occur from construction activities, equipment failures, process modifications or upsets, etc.

Appendix A provides guidance for developing a unidirectional flushing program and Appendix B provides information on storage. Appendix C includes a discussion of the use of HPCs as a monitoring tool for distribution systems, and Appendix D includes a discussion on modifying the sampling plan for the Total Coliform Rule to provide a more representative picture of microbial control in the distribution system.

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1.0 PURPOSE

This guidance document recommends procedures and defines the efforts and responsibilities for maintaining the supply, distribution, and monitoring of safe drinking (potable) water via a consecutive system at a Navy installation. Installations are encouraged to use this document to develop installation instructions.

2.0 SCOPE

2.1 System Application

The provisions of this guidance document apply to Navy installations that meet the definition of "consecutive water system."

2.2 Consecutive Water Systems

A consecutive water systems is a public water system that has no water production or source facilities of its own and obtains all of its water from another water system.

3.0 CANCELLATION

Not applicable.

4.0 GENERAL INFORMATION

4.1 Safe Drinking Water Act (SDWA)

"The Act" (Reference 1) promulgated requirements to assure that public water supply systems meet minimum National Standards for the protection of the public health. The Act delegates to the Environmental Protection Agency (EPA) the responsibility to set the national drinking water standards which were later promulgated in Reference 2. States administer these via specific state regulations (see Reference 3 for Your State).

4.2 Primary and Secondary Regulations

The drinking water regulations consist of:

(a) Primary regulations - aimed at protecting public health by establishing maximum contaminant levels in drinking water (see Appendix E).

(b) Secondary regulations - aimed at protecting public welfare, deal with taste, odor, and appearance of drinking water (see Appendix F).

5.0 POLICY

Comply with applicable Federal, state, and local Safe Drinking Water Regulations and Navy policy relative to consecutive water systems as contained in Reference 4.

6.0 DEFINITIONS

For the purpose of this document, definitions of terms are presented:

(a) General - Definitions are provided as an enhancement tool for more efficient use of this document. The words and terms herein have meanings as set forth unless the context within the document clearly requires a different meaning.

(b) Specific -

(1) Air Gap Separation - The unobstructed vertical distance through free atmosphere between the lowest opening from any pipe or faucet conveying water or waste to a tank, plumbing fixture, receptor, or other assembly and the flood level rim of the receptacle. These vertical, physical separations must be at least twice the diameter of the water supply outlet, but never less than 1 inch (25 mm). Local codes and regulations may have more stringent requirements.

(2) Approved - Material, equipment, workmanship, process, or method that has been accepted by the (Your State) Waterworks Regulatory Agency as suitable for the proposed use.

(3) Backflow - The flow of water or other liquids, mixtures, or substances into the distribution piping of a waterworks from any source or sources other than its intended source.

(4) Backflow Prevention Device - Any approved device, method, or type of construction intended to prevent backflow into a waterworks.

(5) Bacteriological Analysis - Refers to analysis of the water for members of the Total Coliform Group.

(6) Chloramines - disinfectant generated by the addition of ammonia to a water that contains free chlorine and is sometimes referred to as total combined chlorine residual.

(7) Chlorine – Chlorine is the most commonly used disinfectant in water supplies. Unless otherwise indicated, the word chlorine, whenever used, refers to any form of chlorine both gaseous and hypochlorites.

(8) Chlorine Solution (Chlorine Water) - A solution of chlorine in water. Note: The term chlorine solution is sometimes used to describe hypochlorite solutions. This use of the

term is incorrect. A chlorine solution may be gaseous, solid hypochlorites, or hyprochlorite solutions mixed with water.

(9) Coliform - A group of bacteria found in the intestines of warm-blooded animals (including humans) and also in plants, soil, air, and water.

(10) Community Public Water System - A water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

(11) Consecutive Water Systems – A public water system which has no water production or source facility of its own and which obtains all of its water from another water system.

(12) Contaminant - Any physical, chemical, biological, or radiological substance or matter in water.

(13) Corrosion - Corrosion is an electrochemical reaction that deteriorates a metal or an alloy. Corrosion also includes the dissolving of other water system materials through contact with water or soil.

(14) Corrosive Water - Water that causes corrosion.

(15) Cross-Connection - Any connection or structural arrangement, direct or indirect, to the waterworks whereby backflow can occur. For more information, review References 5 and 6.

(16) Dechlorination - The partial or complete reduction of residual chlorine in water by any chemical or physical process. For more information refer to References 5 and 6.

(17) Degree of Hazard - This is a term derived from an evaluation of the potential risk to health and the adverse effect upon the waterworks.

(18) Disinfectant - Any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or the distribution process for the purpose of killing or inactivating pathogenic micro-organisms.

(19) Exemption - An exemption is a conditioned waiver of a specific primary maximum contaminant level (PMCL) regulation which is granted to a specific waterworks.

(20) Fecal Coliform - Fecal coliform are a specific class of bacteria which only inhabit the intestines of warm-blooded animals. The presence of coliform bacteria is an indication that the water is polluted and may contain pathogenic (disease-causing) organisms.

(21) Free Available Chlorine - That portion of the total residual chlorine remaining in water at the end of a specified contact period which will react chemically and biologically as hypochlorous acid or hypochlorite ion.

(22) Halogen - One of the chemical elements fluorine, chlorine, bromine, or iodine.

(23) Health Regulations - Health regulations include all primary maximum contaminant levels (PMCLs) and all operation regulations, the violation of which would jeopardize the public health.

(24) Heterotrophic Plate Count (HPC) - These microorganisms represent a class of non-coliform bacteria commonly found in drinking water. Though not yet regulated, their presence in any given sample location at densities greater than 500 colonies per ml indicates poor microbial control, the presence of conditions that are favorable towards bacterial regrowth and the potential to interfere with the coliform measurement. In addition, some types of HPC bacteria are considered to be opportunistic pathogens that pose a health risk to the very young, the elderly and those with suppressed or compromised immune systems. Additional information regarding HPCs can be found in Appendix C.

(25) Hypochlorite - A solution of hypochlorite, usually sodium hypochlorite. The term liquid chlorine is sometimes used to describe a hypochlorite solution often employed for swimming pool sanitation. This use of the term is incorrect.

(26) Liquid Chlorine - A liquefied, compressed gas as shipped in commerce. Note: The term liquid chlorine is sometimes used to describe a hypochlorite solution often employed for swimming pool sanitation. This use of the term is incorrect.

(27) Maximum Contaminant Level (MCL) - The maximum permissible level of contaminant in water which is delivered to any user of a public water system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition. Maximum contaminant level may be either "primary" (based on health) or "secondary" (based on aesthetics).

(28) Maximum Total Trihalomethane Potential (MTP) - The maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after 7 days at a temperature of $25^{o}C$ or above.

(29) Most Probable Number (MPN) - The number of organisms per unit volume that, in accordance with statistical theory, would be more likely than any other number to yield the observed test result or that would yield the observed test result with greatest frequency. Expressed as density of organisms per 100 milliliters. Results are computed from the number of positive findings of coliform-group organisms resulting from multiple-portion decimal-dilution plantings.

(30) Non-Community Water System - A waterworks that is not a community water system.

(31) Non-Potable Water - Water not classified as potable (drinking) water.

(32) Non-Transient Non-Community Water System - A public water system that is not a community water system and that regularly serves at least 25 of the same persons over 6 months per year.

(33) One Hundred (100) Year Flood Level - The flood elevation which will, over a long period of time, be equaled or exceeded on the average once every 100 years.

(34) Owner - An individual, group of individuals, partnership, firm, association, institution, corporation, municipal corporation, or the Federal Government which supplies water to any person within a state from or by means of any waterworks.

(35) Person - An individual, corporation, company, association, partnership, state, municipality, or Federal agency.

(36) Pollution - The presence of any foreign substance (chemical, physical, radiological, or biological) in water that tends to degrade its quality so as to constitute an unnecessary risk or impair the usefulness of the water.

(37) Pollution Hazard - A condition through which an aesthetically objectionable or degrading material may enter the waterworks or a consumer's water system.

(38) Primary Drinking Water Regulation - A regulation which:

a) Applies to public water systems;

b) Specifies contaminants which, in the judgment of the (Your State) Waterworks Regulatory Agency, may have any adverse effect on the health of persons;

c) Specifies for each such contaminant either -

1) A maximum contaminant level, if, in the judgment of the (Your State) Waterworks Regulatory Agency, it is economically or technologically feasible to achieve the level of such contaminant in water in public water systems, or

2) A treatment technique requirement which specifies for a contaminant a specific treatment technique(s) which leads to a reduction in the level of such contaminant sufficient to comply with the requirements of 40 CFR 141.

d) Contains criteria and procedures to assure a supply of drinking water which dependably complies with such maximum contaminant levels; including quality control and testing procedures to ensure compliance with such levels, and to ensure proper operation and

maintenance of the system, and requirements as to the minimum quality of water which may be taken into the system.

e) Contains requirements for reporting, record keeping, and public notification.

(39) Process Fluids - Any fluid or solution that may be chemically, biologically, or otherwise contaminated or polluted which would constitute a health, pollution, or system hazard if introduced into the waterworks. This includes, but is not limited to:

a) Polluted or contaminated water

b) Industrial process waters

c) Used waters, originating from the waterworks which may have deteriorated in sanitary quality

d) Cooling waters

e) Contaminated natural waters taken from wells, lakes, streams, or irrigation systems

f) Chemicals in solution or suspension

g) Oils, gases, acids, alkalis, and liquid and gaseous fluid used in industrial or other processes, or for firefighting purposes

(40) Potable Water - Water fit for human consumption and domestic use which is sanitary and normally free of minerals, organic substances, and toxic agents in excess of reasonable amounts for domestic usage in the area served, and normally adequate in supply for the minimum health requirements of the persons served.

(41) Public Water System - A system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals. Such a term includes:

a) Any collection, treatment, storage, and distribution facilities under the control of the operator of such a system and used primarily in connection with such a system.

b) Any collection or pretreatment storage facilities not under such control which are used primarily in connection with such a system.

The definition of a Public Water System is based on population served by the system, not by the type of ownership. Navy operated systems providing water to 25 or more personnel, or serving greater than 15 service connections, are classified as a Public Water System.

A public water system is either a "community water system" or a "noncommunity water system." There are two types of non-community water systems: transient and non-transient.

(42) Reduced Pressure Zone Backflow Prevention Device - A device containing a minimum of two independently acting check valves together with an automatically operated pressure differential relief valve located between the two check valves. During normal flow and at the cessation of normal flow, the pressure between these two checks shall be less than the supply pressure. In case of leakage of either check valve, the differential relief valve, by discharging to the atmosphere, shall operate to maintain the pressure between the check valves at less than the supply pressure. The unit must include tightly closing shut-off valves located at each end of the device, and each device shall be fitted with properly located test cocks. These devices must be the approved type.

(43) Sanitary Survey - An outside review of the water source, facilities, equipment, operation, and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water.

(44) Secondary Drinking Water Regulation - A regulation which applies to public water systems and which specifies the maximum contaminant levels which, in the judgment of the (Your State) Waterworks Regulatory Agency, are requisite to protect the public welfare. Such regulations may apply to any contaminant in drinking water which: (a) may adversely affect the odor or appearance of such and consequently may cause a substantial number of the persons served by the public water system providing such water to discontinue its use, or (b) may otherwise adversely affect the public welfare. Such regulations may vary according to geographic and other circumstances.

(45) Service Connection - The terminal end of a service line from the waterworks. If a meter is installed at the end of the service, then the service connection means the downstream end of the meter.

(46) Sewer - Any sanitary or combined sewer used to convey municipal or industrial water.

(47) Standard Sample - That portion of finished drinking water that is examined for the presence of coliform bacteria.

(48) Supplier of Water - Any person who owns or operates a public water system.

(49) System Hazard - A condition posing actual, or threat of, damage to the physical properties of the waterworks or a consumer's water system.

(50) Treatment Technique Requirement - A requirement that specifies for a contaminant a specific treatment technique(s) demonstrated to the satisfaction of the Waterworks

Regulatory Agency to lead to a reduction in the level of such contaminant sufficient to comply with applicable water system regulations.

(51) Total Trihalomethane (TTHM) - The sum of the concentrations of the trihalomethane expressed in milligrams per liter (mg/L) and rounded to two significant figures. TTHMs consist of trichloromethane (chloroform), dibromochloromethane, bromodichloromethane, and tribromomethane (bromoform).

(52) Trihalomethane (THM) - One of the family of organic compounds, named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure.

(53) Variance - A variance is a conditional waiver of specific regulation which is granted to a specific waterworks. A PMCL variance is a variance to a primary maximum contaminant level, including prescribed treatment techniques. An operational variance is a variance to an operational regulation.

(54) Water Purveyor - An individual, group of individuals, partnership, firm, association, institution, corporation, municipal corporation, or the Federal government which supplies water to any person within a state from or by means of any waterworks.

(55) Water Supply - Water that has been taken into a waterworks from all wells, streams, springs, lakes, and other bodies of surface waters (natural or impounded), and the tributaries thereto, and all impounded groundwater. The term "water supply" shall not include any waters above the point of intake of a waterworks.

(56) Water Supply Main - The principal water supply line which feeds one or more branch lines.

(57) Waterworks - Means a system that serves piped water for drinking or domestic use to: (1) the public, (2) at least 15 connections, or (3) an average of 25 individuals for at least 60 days out of the year. The term waterworks shall include all structures, equipment, and appurtenances used in the storage, collection, purification, treatment, and distribution of potable water, except the piping and fixtures inside the building where such water is delivered.

7.0 RESPONSIBILITIES

7.1 Environmental Management

Environmental management shall be responsible for the following:

(a) Provide overall technical control for implementation of the drinking (potable) water program.

(b) Notify the appropriate personnel (e.g., Public Works Officer, the duty officer, medical personnel, state regulatory agencies, etc.) whenever the potable water system becomes contaminated.

(c) Ensure personnel involved in work on the potable water system are properly trained and are aware of potable water program requirements.

(d) Review and approve plans and directives which may potentially impact the quality of the potable water system.

(e) As appropriate, develop and submit projects as necessary to comply with References 1, 2, 3, 4, 7 and 8.

(f) Ensure that existing or upgraded systems are designed in compliance with drinking water regulations.

(g) As appropriate, ensure that work requests for potable water system requirements are processed as expeditiously as possible, especially when it involves a potential risk to the public's health.

7.2 Operations

Operations shall be responsible for the following:

(a) Perform routine potable water system operations using qualified operators and technical personnel.

(b) Obtain potable water samples as required by References 2 and 4.

(c) Review and approve plans and directives which may potentially impact the quality of the potable water system.

(d) Ensure personnel involved in work on the potable water system are properly trained and are aware of potable water program requirements.

(e) Ensure that existing or upgraded systems are designed in compliance with drinking water regulations. Provide applicable plans and specifications to environmental personnel for review.

(f) Prepare specific job orders for inspections, alterations, monitoring and repairs of potable water system components. Ensure that adequate funding is available for all required projects and repairs.

(g) As appropriate, ensure that work requests for potable water system requirements are processed as expeditiously as possible, especially when it involves a potential risk to the public's health.

7.3 Maintenance

Maintenance shall be responsible for the following:

(a) Ensure maintenance (major preventive, routine, and emergency) is performed as required by a written potable water maintenance program. Update applicable portions of the program as necessary with input from environmental and operational personnel.

(b) Advise environmental and operational personnel when maintenance work causes system outages or other impacts to the potable water system so that appropriate actions, such as public notification or water sampling, can be taken.

(c) Ensure fabrication, installation, and repair of system components as necessary to comply with the potable water maintenance program.

(d) Ensure personnel involved in work on the potable water system are properly trained and are aware of potable water program requirements.

(e) Ensure proper decontamination/disinfection action is taken after maintenance work is performed.

(f) Prepare specific job orders for inspections, alterations, and repairs of potable water system components. Ensure that adequate funding is available for all required projects and repairs.

7.4 Contracting Officer

The Contracting Officer or designated representative shall be responsible for ensuring that all contracts require contractors to comply with drinking (potable) water regulations and/or procedures as designated by Federal, state, local, and Navy personnel.

7.5 Temporary Services/Waterfront Operations Director

The Temporary Services/Waterfront Operations Director or designated representative shall be responsible for the following:

(a) Implement this program relative to temporary service/waterfront operations maintenance functions.

(b) Inform temporary service maintenance personnel of the need to observe proper precautions when making temporary connections to potable water distribution systems.

(c) Ensure potable water distribution equipment used for temporary connections is maintained in an adequately clean and sanitary fashion.

(d) Ensure that all temporary service/waterfront operations technical documents include provisions to prevent the contamination of the potable water system by cross connections. Provide environmental and operational personnel with plans, specifications, and/or shop drawings of any production equipment that will directly or indirectly connect to the potable water system.

(e) Regularly inspect waterfront potable water connection locations and initiate necessary action to correct any problems when these connections are found to be in noncompliance with potable water program requirements.

(f) Ensure that temporary service/maintenance personnel are properly trained and are aware of potable water program requirements.

7.6 BUMED

BUMED or its designated representative shall be responsible for the following:

(a) Assist potable water program, operational and/or maintenance personnel, as required, to decontaminate potable water systems.

(b) Review plans and directives involving potable water systems that may impact the health of Navy personnel.

(c) Periodically inspect potable water system temporary service connections and waterfront equipment for maintenance of adequate sanitary requirements relative to potable water system quality.

8.0 PROGRAM REQUIREMENTS

8.1 Operation and Maintenance Requirements

All operations, maintenance, and monitoring tasks as outlined in Section 9 shall be performed as per prescribed procedures. These procedures must be in accordance and consistent with References 1, 2, 3, 4, 8, and 9. All routine and/or recurring tasks shall be performed within the guidelines of written procedures. All other tasks will be performed per written or verbal instructions at the discretion of the Public Works and/or Environmental Director or designated individual(s). Procedures will be kept on file, and all personnel involved in the Potable Water Program will have copies of the procedures contained within, or have access to these files. Once each year, all procedures will be reviewed for needed changes and updates. This will be performed by the Public Works Officer, and/or the Environmental Director, or designated individual(s).

8.2 Construction Permit General Requirements

Most state drinking water regulations (Reference 3) require that the water system owner shall not cause or allow the construction or change in the manner of storage, purification, or treatment of any waterworks or water supply without a written construction permit from the state. All contracts for construction or repairs to the potable water system shall be reviewed by the Public Works Officer, and/or the Environmental Director, or designated individual(s) before being finalized.

8.3 Design Specifications and Plan Requirements

Most states (Reference 3) further expand permit requirements: permits are not usually required for the extension of water pipes for the distribution of water; however plans and specifications are usually submitted for system extensions designed to serve more than fifteen (15) residential connections unless the owner has adapted and has on record with the state agency approved general specifications and plan details covering water line design and construction. All design specifications and plans shall be submitted to the Public Works Officer and/or Environmental Director or designated individual for review and concurrence early in the development phase (no later than 35 percent).

8.4 Compliance Provision for Construction/Improvement Projects

All construction projects involving the change, improvement, and/or extension of the Navy installation's potable water system shall comply with permit, specification, and plan submittal requirements as required by state and/or local regulations. All contracts and guide specifications shall require that all contractor work comply with the latest edition of applicable state and local regulations.

8.5 Potable Water System Design

Design requirements of potable water systems for Navy facilities are published in References 8 and 10.

8.6 Waterfront Requirements for Potable Water Systems

Reference 7 requires all potable water outlets on piers and wharves to have a reduced pressure type backflow prevention device. All such outlets shall be identified via a permanent metal tag labeled "potable water." All non-potable outlets shall be colored different than the white potable outlets and shall be identified "Unfit for Drinking" by a permanent metal tag. All potable water outlets and backflow preventers along the waterfront must be located above grade except for those specifically exempted by (Your State) regulatory officials.

8.7 Potable Water Operation and Maintenance Program Plan

Section 9 outlines general program requirements to be followed for operation and maintenance of potable water consecutive (distribution) systems. Additionally, Reference 8 should be consulted for technical guidance and/or recommended procedures for situations not specifically addressed in this guidance document. Water treatment and distribution system personnel shall be familiar with the contents of Section 9 and Reference 8.

8.8 Cross-Connection Control and Backflow Prevention Program

Reference 4 paragraph 8-5.4 requires that Navy water system owners establish and enforce a program of cross-connection control and backflow prevention. A Cross Connection Control and Backflow Prevention Program should be established and implemented in accordance with Reference 5. Special attention is directed to the requirement for the use of a reduced pressure type backflow preventer any time the potable water system is connected to a non-potable source and that source cannot be eliminated or protected by an air gap. Refer to References 5 and 10 for further guidance.

8.9 Facilities Disinfection Procedure and Requirements

Water systems can become contaminated during construction and/or repair; before such systems are placed into service, they must be disinfected per Sections 9 and 10. References 11 and 12 should be consulted and followed for work not specifically addressed by this guidance document. All newly installed and/or repaired water mains, distribution lines, and service lines must be disinfected, thoroughly flushed, and tested for bacteriological contamination, before being placed into service. In emergency situations, when consumers must begin using the water before bacteriological quality is known, Appendix H should be filled out by all contractors and Navy personnel and submitted to the Public Works Officer and/or Environmental Director or designated individual. It should be noted that a minimum of two consecutive bacteriological samples, collected a minimum of 24 hours apart, must be absent of total coliform bacteria to meet most state regulatory requirements. All personnel involved in disinfection, sampling, and analysis shall be properly trained.

8.10 Ship Related Potable Water System Provisions

Reference 13 provides a uniform method and standard for cleaning and disinfecting ship related potable (fresh) water tanks and systems. Also, Section 10.3 outlines Reference 9 requirements for potable water hose stowage and ship-to-shore potable water supply connections.

8.11 Temporary Connections/Mobile Supply Provisions

All temporary and/or mobile supplies of potable water shall be delivered per Reference 14 requirements. Reference 9 and 13 standards require that all potable water transferred from shore to ship contain at least 0.2 parts per million (PPM) free available chlorine residual. For systems utilizing chloramines for disinfection, the minimum total combined chlorine residual should be 2.0 PPM. This generally will be no problem; however, waivers of this requirement can only be obtained from the Navy Bureau of Medicine by special request via the chain of command. Such requests normally apply to activities with a natural source of potable water and do not chlorinate. Requests shall contain historical data and other relevant documentation which prove consistent water potability.

8.12 Potable Water Preventative Maintenance Program (PWPMP)

The Public Works Department (PWD)/Centers (PWCs) are responsible for maintaining most of the major components of Navy potable water systems. The appropriate PWD/PWC shop or division shall develop and maintain all preventive maintenance and repair records, and will establish and keep updated all procedures pursuant to same.

8.13 Notification of Potable Water System Work

Appendix I should be filled out by all persons involved in potable water system work. No planned work should be performed on the system before the appropriate representative has completed the form and forwarded it to the Public Works Officer and/or Environmental Director or designated individual. When emergency repairs must be made, maintenance personnel should notify the Duty Officer who should then notify environmental personnel.

8.14 Waterworks Operation Permit

Potable water systems shall be operated and maintained per the applicable (Your State) Waterworks Operation Permit, as required (see Reference 3).

8.15 Operator Qualifications

Waterworks operators responsible and in charge (ORIC) shall be qualified per the requirements of the applicable (Your State) Waterworks Regulations.

(a) Job descriptions for new or vacant waterworks operator billets shall require a state certification or license as a condition of employment per Reference 4.

(b) A comprehensive training program for operators, technicians, and supervisors of water treatment and distribution facilities shall be developed and implemented. Minimum requirements are set forth in Reference 4.

8.16 Sampling and Analysis

Potable water samples shall be collected and analyzed as required by References 2, 3, and 9. Minimum requirements are set forth in Reference 4. Specific guidance regarding sampling of drinking water is provided in Reference 15. Section 9 contains a recommended schedule.

8.17 Laboratory Certification

Analysis performed for monitoring compliance with State or Local Health Department regulations shall be performed by a state certified laboratory. The laboratory chosen for such work shall be certified for each specific drinking water analysis that is performed. Analysis performed for purposes other than monitoring compliance can be completed by an uncertified but accredited laboratory per Reference 4, Chapter 25 requirements.

8.18 Reporting and Recordkeeping

(a) Results of tests, analyses, and measurements required for compliance shall be forwarded within prescribed time frames to the appropriate regulatory agency.

(b) Records of bacteriological analyses shall be retained for 5 years, chemical/physical analyses 10 years. However, Lead and Copper Rule analysis must be kept for 12 years.

8.19 Noncompliance Monitoring and Reporting

The Navy shall report to the appropriate state regulatory agency instances of noncompliance(s) with primary national drinking water standards, variances or exemptions, including failure to comply with sampling or drinking water monitoring requirements. Noncompliance conditions shall also be reported to all persons served by the water system(s), per Reference 4.

8.20 Site Inspections

(a) Authorized Environmental Protection Agency, state, or local regulatory officials upon written notice, and presentation of proper credentials, shall be allowed to enter Navy installations to examine records, system equipment (including monitoring equipment), controls and processes, and to sample/test the water system. Appropriate notification up the chain of command is required for all site visits/inspections by regulatory personnel.

(b) Inadequately cleared personnel shall not be allowed access to classified areas. Where such entry may become necessary, access by a representative with appropriate security clearances should be negotiated with the requesting agency.

8.21 Underground Injection

The Safe Drinking Water Act provides for regulation of fluid injections into the ground to prevent the degradation of underground sources of drinking water. For more information refer to Reference 2 (Parts 144, 145 and 146).

9.0 RECOMMENDED MONITORING AND OPERATIONS PROGRAM

These recommendations do not supersede any permit requirements.

9.1 Daily

(a) Check and record the quality of the water as it enters the Navy installation. Sampling and analysis will be performed in accordance with References 4 and 15. Minimally test for pH, chlorine residual and color.

(b) Read and record the values of the flow meters of all entrance mains. Tabulate and record the consumption for each meter (usually performed by Public Works Department/Center personnel). Fluctuations in normal usage can indicate water main breaks or leaks.

(c) Recirculate the water in ground storage tanks.

(d) Turnover at least one-third of the water in elevated storage tanks.

9.2 Weekly

(a) Perform bacteriological sampling in accordance with a written Bacteriological Sample Siting Plan and References 2 (Parts 141.21 Coliform Sampling), 4 and 15. Samples shall be analyzed by a state certified laboratory. Additional guidance for developing a bacteriological sampling plan is provided in Appendices C and D.

(b) Check and record the water quality of all storage facilities, both elevated and ground storage tanks. Sampling and analysis will be performed in accordance with Reference 4 and 15. Minimally test for chlorine residual and color.

(c) Check and record the overall condition of the potable water system. This will include, but is not limited to, entrance mains, storage facilities, pumps, chlorinators, and on-line monitoring equipment.

(d) Check and record the quality and pressure of the water at the risers where ships are located. Sampling and analysis will be performed in accordance with References 4 and 15. Minimally test for chlorine residual and color.

9.3 Bi-weekly (every 2 weeks)

(a) A minimum of once every 2 weeks, all on-line potable water storage facilities that do not "float" on the system will have potable water added to them, and will be rechlorinated as necessary. A 1.0 PPM chlorine residual should be maintained in all storage facilities.

(b) The entrance main backflow preventers will be thoroughly flushed and strainers cleaned of debris following manufacturers recommended proceedures.

9.4 Monthly

On a monthly basis additional sampling and analysis may need to be performed as a means of verifying the effectiveness of the potable water program. Sampling and analysis will be in conformance with References 4 and 15. Monthly sampling and analysis plans should be designed to determine the presence of contaminants of concern. If there are no contaminants of concern, monthly sampling and analysis may not be necessary.

All installations have, by necessity, numerous groups responsible for a portion of the operation and maintenance of the water supply system. There is a need to bring these groups together and to have them cooperate and integrate their activities in order to ensure optimal water quality. This should include monthly meetings among these groups as well as with the installation’s primary supplier.

9.5 Quarterly

(a) The installation's water systems within buildings will be checked to determine whether the service lines need to be flushed. Buildings with low water usage or near "dead ends" are particularly vulnerable to poor water quality. The absence of chlorine residual, the presence of discoloration, or the presence of Heterotrophic Plate Counts (HPC) using the R2A media at greater than 500 colonies per milliliter is an indicator that flushing is needed. Sampling and analysis will be in accordance with References 2, 4, and 15. If spot flushing is required, it is recommended that the high velocity unidirectional type of flushing be used.

(b) Research has shown that Point-of Use (POU) water filters can foster the growth of bacteria, especially filters containing activated carbon. Within 30 days, there can be sufficient growth to begin sloughing into the product water. After 30 days, the non-coliform bacteria counts for HPCs can range from a 100 cfu/mL to as high as 30,000 cfu/mL. Although most of the bacteria that are detected by the HPC method are not pathogenic, some of these microorganisms are considered to be opportunistic pathogens and may pose a health risk to the very young, the elderly or those individuals with suppressed or compromised immune systems. POU water filters should only be used when and where there has been a demonstrated need. If a POU filter is installed, it should be replaced quarterly. At no time should replacement occur less than

semiannually regardless of the manufacturers recommendation unless sampling and testing indicate more frequent change out is needed.

9.6 Yearly

(a) System Flushing - Water systems will be flushed to prevent bacteriological problems and sediment buildup, and to check flows throughout the system. The system should be flushed twice a year. Depending on installation water conservation efforts the system may be flushed less frequently, however in no case shall flushing be performed less frequently than once a year. Guidance for conducting unidirectional flushing is provided in Appendix F.

(b) Test entrance mains and storage facility valves. Ensure all appropriate valves are in the open position. Repair valves as necessary.

(c) Evaluate the potable water system for maintenance of at least 20 pounds per square inch (psi) of water pressure throughout. Water pressure should consistently be at or above 20 psi from the entrance main(s) to the farthest connection.

(d) Review of primary system analyses - minimally, once a year review the results of water quality testing performed by the water purveyor. Test results to review include bacteriological, Lead and Copper Rule, and National Primary Drinking Water Standards (NPDWS) parameters required to be analyzed by the purveyor's permit. For each NPDWS parameter in the primary system monitoring report that exceeds 50% of its respective MCL, the affected shore installation shall monitor from a representative point in the installation's system those parameters at a frequency equal to that of the primary water purveyor. This requirement is to ensure that water quality has not degraded to above the MCL for that parameter within the distribution system. Sampling shall be in accordance with References 4 and 15. Analyses shall be performed by a laboratory that is state certified for the analytes of concern. Report any results that are above the maximum contaminant level(s) to the water purveyor.

9.7 Sub-Programs

(a) Cross Connection Control Program - All aspects of this program shall be in accordance with References 1, 3, and 5.

(b) Water Quality Complaint Program - A system shall be employed to document all water quality complaints. Minimally, documentation must include: the complainant, the nature of the complaint, the location of the complaint, and how the complaint was resolved. Water quality complaints are a valuable tool for finding systemic water quality problems. Any sampling and analysis will be in accordance with References 2, 4 and 15. It is recommended that the water system be analyzed at least twice a year, at representative points, for the physical parameters in Appendix B. Levels of these contaminants above the maximum contaminant level (MCL) may trigger customer complaints.

(c) Lead In Drinking Water Program - Water fountains, service lines, faucets, and any other components of the drinking (potable) water system suspected of lead contamination shall

be sampled and any analysis that confirms lead contamination shall be sufficient to have that component immediately removed from service and replaced in as expeditious a fashion as possible. All sampling and analysis will be in accordance with References 2, 4, 15, 16, and 19.

(d) Lead and Copper Rule Monitoring Program - Consecutive water systems that are served by primary systems must determine the susceptibility of the water to lead and copper contamination above the lead and copper action levels as contained within the Lead and Copper Rule. If approved by the State or EPA Regulatory Agency, shore installations can include their consecutive public water systems monitoring plan as part of the supplier's plan, instead of treating each as a separate system. The lead action level is exceeded if the concentration of lead in more than 10 percent of water samples collected during any monitoring period, conducted in accordance with 40 CFR 141.86 is greater than 0.015 PPM. The copper action level is exceeded if the concentration of copper in more than 10 percent of tap water samples collected during any monitoring period, conducted in accordance with 40 CFR 141.86 is greater than 1.3 PPM. Navy consecutive systems, receiving corrosive water, that were not included in the primary system's sampling pool (at the time the primary system performed Lead and Copper Rule monitoring) shall be sampled for lead and copper. The number and location of samples should be sufficient to be representative of the system and in conformance with Lead and Copper Rule requirements. The owner of the primary system will be notified of the results and requested to take corrective action as applicable. Navy installations operating consecutive water systems can seek waivers from CNO (N45) via their Major Claimants for this requirement if they can document their water purveyor passed their lead and copper rule monitoring and that the water being supplied to them is non-corrosive.

(e) Potable Water Preventative Maintenance/Repair Program - All aspects of this program will comply with References 3, 4, and 8 and will be reviewed minimally once a year by the Public Works Officer and/or Environmental Director or designated individual and the Public Works Officer or designated individual.

(f) Sanitary Survey Program – In many instances, a State may require treatment plants or public water systems that are experiencing compliance problems, particularly with microbial pathogens to perform a sanitary survey. Refer to Reference 4 for sanitary survey content requirements.

10.0 DISINFECTION

10.1 Disinfection-Flushing and Sampling Procedure for Water Mains

(a) Disinfection - Disinfection of all water lines used to transport water for human consumption must be in compliance with a State approved method, and shall be in accordance with AWWA Standard C-651 (Reference 11). All newly installed pipes must be adequately flushed before (if dirt or debris has entered the line) and after chlorination. If necessary, before chlorination, flush the pipe until the water is completely clear of all discoloration and debris. After chlorination, flush until the chlorine residual is within 1.0 part per million (PPM) of the closest entrance main's chlorine residual. If this is unknown, flush until a chlorine residual no

greater than 3.0 PPM exists. When making a repair (not replacement, e.g., installing a utility clamp) of existing water lines that do not come in contact with either the ground or internal flooring, flushing is sufficient without chlorination. However, the interior of all pipe and fittings (particularly couplings and sleeves) used to make a repair must be thoroughly swabbed or sprayed with a 1 percent chlorine solution. When disinfecting a section of pipe too long (usually anything longer than 10 feet) to be swabbed or sprayed, the slug method (see AWWA C-651) can be used (this is only for a repair, not installation of new line).

(b) Flushing of the Water Line - The water line directly upstream of the repair and the closest water line downstream of the repair must be flushed for a minimum of 30 minutes or until all water is clear. A minimum of 0.6 PPM chlorine residual shall exist (unless it is known that the water entering the system is below 0.6 PPM).

(c) Analysis, Potable Water Samples - Immediately after disinfecting and flushing, take the water samples and have them analyzed by a state certified laboratory to ensure that the water is safe for human consumption. The first sample should be collected immediately after the repair (at a representative point downstream of the repair), and a second sample must follow 24 hours later. Unless absolutely necessary, the water should not be returned to service until the results of the first sample are known (usually 24 hours after the sample is taken). If the water service must be resumed before that time, verify in writing, using Appendix H, that correct disinfection and flushing procedures were followed. If either the first or second bacteriological sample is positive, notify the Public Works Officer and/or Environmental Director, or designated individual, immediately, in order to coordinate corrective action. The designated individuals will control all actions until two consecutive non-positive bacteriological samples are achieved. The laboratory being used must contact sampling personnel immediately upon knowledge of a positive result. Sampling personnel must immediately notify the Public Works Officer and/or Environmental Director, or designated individuals. They shall receive a copy of the analysis in as expeditious a fashion as possible. When bacteriological sample results will not be known, within 24 hours of the repair, and/or samples cannot be delivered to a laboratory, as previously discussed, the following steps must be taken:

(1) Chlorinate the affected portion of the system.

(2) Flush the affected lines for at least 30 minutes (or longer if needed to obtain clear water).

(3) Fill out the Chlorination/Flushing Verification Form (see Appendix H) and forward to the Public Works Officer and/or Environmental Director or designated individual the first work day following the repair.

(4) Take bacteriological samples the first normal work day and immediately deliver to a certified laboratory. It is emphasized that in all cases of repair, as a minimum, water lines and valves must be rinsed with a hypochlorite solution and flushed until clear water is obtained. Major repairs (replacement of several feet of piping, etc.) require chlorination and flushing per an approved method.

(d) General

(1) As noted above, when installing new water lines (as part of a repair, not a new installation) 1/2 inch in diameter or larger and 10 feet or greater in length, the slug method of chlorination should be used. This means a slug of chlorine solution (usually 300 to 500 PPM) will be flushed through the pipe to the atmosphere (open end of pipe). When this is done it is important to flush all the super-chlorinated water out of the line. For most jobs on lines 1/2 inch to 2 inches in diameter, 2 to 4 ounces of calcium hypochlorite will be enough. This can be added dry or mixed with 1 to 2 quarts of water. For lines 2-1/2 to 4 inches in diameter, 4 to 6 ounces (mixed with 2 to 4 quarts of water) will be sufficient. This is for lengths of pipe from 10 to 25 feet in length. For repairs of water lines larger than 4 inches in diameter and/or more than 25 feet in length, use the Quick Chart for Potable Water Piping Disinfection (see Appendix C), or if uncertain, contact the Public Works Officer and/or Environmental Director or designated individual for recommended chlorine dosages.

(2) When installing water lines for new installations (no service existed before) chlorine must be added to the line to bring the residual up to 25 PPM. The chlorinated water must be held for 24 hours; at the end of 24 hours the chlorine residual must be checked, and must be at least 10 PPM. If the chlorine residual is at least 10 PPM after 24 hours, the flushing and bacteriological sampling phases begin. If the residual is less than 10 PPM, the line must be rechlorinated. When this process must be performed, use the Quick Chart for Potable Water Piping Disinfection (see Appendix G), or if uncertain, contact the Public Works Officer and/or Environmental Director or designated individual for chlorine measurement and coordination.

(3) When chlorinating with a 1 percent chlorine solution, add 1.5 ounces of calcium hypochlorite for every gallon of water.

(4) When chlorinating, the system not affected by the repair or the new installation must be isolated from the work. This is to ensure that the part of the system still being used by customers will not become contaminated or subject to super-chlorinated water (which can cause extreme illness).

(5) Make sure all necessary valves are closed and holding. Isolate as little of the unaffected portion of the system as is necessary to get the job done.

(6) It is preferable to add the chlorine to the line to be chlorinated before the line is closed. When this is not possible, a temporary tap must be installed in the line to add the chlorine (and plugged after the chemical has been added). Temporary taps can also be installed to flush a line (and plugged when flushing and sampling is complete). This is done when a convenient flushing location (e.g., hydrant, faucet, etc.) is not readily available.

(7) When dirt and/or debris must be flushed from a line, before chlorination can begin, potable water must be used. Depending on the size of the line, use a garden hose or hydrant hose connected to a potable water source (not a part of the repair or installation area) to clear the line(s).

10.2 Disinfection, Flushing and Sampling Procedure for Water Storage Facilities

(a) Disinfection - Disinfection of all water storage facilities used to store water for human consumption must be in compliance with a state approved method, and shall be in accordance with AWWA Standard D-105-80 (Reference 12). All new water storage facilities or those taken out of service for inspection, repairing, painting, cleaning, or other activities which might lead to contamination of the water, shall be disinfected before they are returned to service. Before chlorination remove all rags, buckets, etc., used for cleaning the tank, and thoroughly flush the tank to remove all rust and sediment. This can be done by running potable water hoses into the tank or opening the fill valve. One of the following methods will be employed to disinfect all water storage facilities:

(1) Method One - The water storage facility will be filled to the overflow level with potable water. Enough chlorine will be added to provide a free chlorine residual in the full tank of not less than 10 parts per million (PPM), at the end of a waiting period of not less than 6 hours and up to 24 hours (this will be at the discretion of the Public Works Officer and/or Environmental Director or designated individual). After the holding period, the highly chlorinated water will be either neutralized before draining to waste via a method approved by the Public Works Officer and/or Environmental Director or designated individual, or drained directly to waste as approved by the Public Works Officer and/or Environmental Director or designated individual.

(2) Method Two - A minimum 200 PPM chlorine solution shall be applied (via brushes or spray equipment) to all internal surfaces (including inlet, outlet, and drain piping) and then the tank will be filled to overflow level. When the tank is filled, the chlorine residual must be a minimum of 10 PPM; if not, the tank must be drained and the process repeated, or the tank must be disinfected via another method. NOTE: Wait 30 minutes to 1 hour before filling the tank. After the holding period, the highly chlorinated water will be disposed of in the same manner as in Method One.

(3) Method Three - Water will be added to the storage facility so that it equals 5 to 10 percent of the total tank volume at the overflow point. Chlorine will be added so that the solution in the tank will be a minimum of 50 PPM. The 50 PPM solution must sit for a minimum of 6 hours. At the end of that period fill the tank to overflow. The residual must be a minimum of 2.0 PPM but not more than 3.5 PPM. If the residual is not at least 2.0 PPM, Method Three must be repeated until 2.0 PPM is achieved or another method must be used. With this method the tank must sit an additional 24 hours before pulling bacteriological samples.

(b) Flushing the Tank - After completing either Method One or Method Two, refill the storage tank. Open the drain to waste valve and allow the tank to flush for a minimum of 15 minutes and a maximum of 30 minutes (then close the drain valve). The water should be clear and a strong chlorine odor should not exist. The chlorine residual should be a minimum of 2.0 PPM and a maximum of 3.5 PPM. If Method Three was used, this flushing step is not necessary as long as the water is CLEAR and the chlorine residual is between 2.0 PPM and 3.5 PPM. If

there is any discoloration, or the chlorine residual is above 3.5 PPM, the tank must be flushed in the same manner as prescribed above.

(c) Bacteriological Analysis - Immediately after chlorinating and flushing the storage facility, water samples must be taken and analyzed by a state certified laboratory. The first sample must be collected immediately after the flushing process is completed, and a second sample must be taken a minimum of 24 hours later. Unless absolutely necessary, the tank must not be returned to service until the results of the first sample are known (usually 24 hours after the sample is taken). If the tank (existing) must be placed into service, verify in writing, using Appendix H, that correct disinfection and flushing procedures were followed. New tanks will not be placed into service until the results of both bacteriological samples are known. If either the first or second sample is positive (indicates contamination) the chlorination/flushing process must be repeated and two consecutive bacteriological samples pulled (24 hours apart). The sequence of events will continue until two consecutive non-positive bacteriological sample results are achieved. The laboratory must contact sampling personnel immediately upon a positive result, and the sampling personnel must in turn immediately notify the Public Works Officer and/or Environmental Director or designated individual. Sampling personnel shall provide a copy of the analysis to the Public Works Officer and/or Environmental Director or designated individual in as expeditious a fashion as possible.

(d) General

(1) The storage facility must remain off-line during all of the processes noted above. This means the outlet valve(s) (at least one on the discharge side of the tank) must remain closed until the bacteriological results are known.

(2) When using hypochlorite in either granular or tablet form (tablets must be broken into 1/4-inch pieces), it must be added before the filling process begins unless a recirculation pump will be employed.

(3) When feeding either liquid chlorine, hypochlorite, or chlorine solution, it can be added simultaneously with the water.

10.3 Disinfection and Handling of Potable Water Hoses (for Ship-to-Shore Connections and other Necessary Purposes)

(a) Hoses used for transferring potable water between the shore system and a ship shall be disinfected before each use (Reference 21).

(b) Before disinfecting thoroughly flush the hose.

(c) Use the slug method described in Section 10.1. The super-chlorinated water must stay in the hose for at least 2 minutes.

(d) Fittings and connections shall be immersed in a chlorine solution of at least 100 PPM prior to being connected.

(e) Before making final connections, potable water hoses must be flushed to waste for 2 to 3 minutes (or as long as needed to achieve clear water).

(f) If contamination of a hose is suspected, the hose must not be used until it has been adequately disinfected. Repeat steps (b) through (d) or discard hose in an appropriate manner.

(g) General

(1) Potable water hoses must not be used for any other purpose. If used for water from an unapproved source, the hoses must be disinfected or discarded in an appropriate manner.

(2) Hoses shall be labeled "POTABLE WATER ONLY," Hoses will be kept in good condition at all times. They shall be examined routinely and removed from use when cracks in the exterior lining develop.

(3) Potable water hoses will be protected from contamination by storing with the ends coupled or closed with screw-type caps. They shall be stored in vermin proof lockers or cabinets.

(4) Printed instructions outlining the method of disinfection for potable water hoses shall be posted in a conspicuous location in the hose storage area.

10.4 Conversion to Chloramines

The USEPA is currently in the process of promulgating a new regulation that will, among other things, reduce the MCL for THMs from the current level of 100 ug/L to 80 ug/L. In addition, this new regulation will establish a new MCL for 5 of the Haloacetic Acids (HAAs). In an effort to control disinfection by-products (DBPs) and meet the requirements of this new regulation, it is anticipated that a significant percentage of the water suppliers in this country will convert to chloramines for residual disinfection in the distribution system.

Effective use of chloramines requires establishing a program that takes advantage of the benefits of chloramines while minimizing the drawbacks associated with its use. Specifically:

(a) For the primary supplier:

(1) Selection of the point of ammonia addition downstream of the primary disinfection with free chlorine.
(2) Design of the ammonia feed facilities and controls to minimize the amount of free ammonia leaving the treatment plant and entering the distribution system.

(b) For the Installations:

(1)Maintaining an adequate chloramine residual within the distribution system.

(2) Focus on eliminating conditions within the distribution system that promote the decay of chloramines and the subsequent liberation of ammonia.
(3) Implementation of a distribution system Code of Practice (discussed on the next page) to provide positive control and feedback on water quality within the distribution system.
(4) Development and implementation of a public notification/information program to avoid potential adverse effects on special water users such as kidney dialysis patients , tropical fish, etc.

Point of Ammonia Addition: Installations should confirm that, if their primary supplier is planning to convert to chloramines, the addition of ammonia to the finished water will be downstream of the clearwells to provide for adequate primary disinfection with free chlorine prior to the addition of the ammonia.

Design and Control: The most common problem associated with the use of chloramines has been excess free ammonia in the finished water leaving the treatment plant. This free ammonia is a nutrient and can help promote the growth of nitrifying bacteria within the distribution system. Therefore, it is essential to select the appropriate chlorine to ammonia ratio to maximize the production of monochloramines while minimizing the amount of free ammonia in the finished water. In addition, the control system must be designed to maintain the target chlorine to ammonia ratio under varying water quality conditions.

Minimum Disinfectant Residual: The Total Coliform Rule allows for a "detectable disinfectant residual" at the selected sampling locations in the distribution system. However, recognizing that chloramines are a weaker disinfectant as compared to free chlorine, as well as the potential to create nitrifying bacteria, it is prudent to establish a minimum residual goal that provides adequate microbial control and inhibits nitrification. Within the water industry, maintaining a minimum total chlorine residual of 2 mg/L within the distribution system appears to satisfy these requirements.

Chloramine Decay: There are two factors that can promote chloramine decay;

- Time, and
- Chloramine demanding substances.

Even in a clean environment, after 4 or 5 days of detention time chloramines begin to exhibit exponential decay. As a result, areas within the distribution system that provide for long detention times may also provide sufficient time for chloramine decay. This excessive detention time tends to occur in:

- Oversized transmission lines;
- Real dead ends;
- Artificial dead ends created by closed valves that should be open;
- Tanks with low turnover; and
- Tanks that are not turning over due to being locked out of the system.

Therefore, prior to converting to chloramines, there is a benefit in conducting a survey of the distribution system to identify these areas of concern and to implement a corrective action program to alleviate, or at least to minimize, the detention times related to these issues.

In addition, any accumulation of debris, corrosion products, biofilms, etc. tend to exert a chloramine demand. These chloramine demanding substances also tend to occur in the same areas that have excessive detention time. The most effective method of removing this material from the distribution system is through the use of a high velocity Unidirectional Flushing Program. This comprehensive cleanup should be accomplished prior to the conversion to chloramines and repeated every 12 to 18 months thereafter.

Code of Practice: The Code of Practice includes operational changes that are designed to provide positive, proactive control of the water quality within the distribution system. With Unidirectional Flushing as the cornerstone of this Code of Practice, the program also includes:

- Operational changes to ensure adequate turnover in the tanks;
- A valve exercise program to eliminate artificial dead ends;
- Ensuring that the repair crews are adequately disinfecting main repairs;
- An effective cross connection control and backflow prevention program to minimize the chances for contamination from external sources;
- Modification of the existing Total Coliform Sampling Plan to provide a more accurate picture of water quality changes in the distribution system; and
- Periodic reconversion to free chlorine for a period of 4 to 6 weeks.

This last item is generally performed as part of the unidirectional flushing program.

Public Notification/Information: If not adequately removed, chloramines are toxic to patients on kidney dialysis machines and to tropical fish. Therefore, as part of the conversion effort, it is essential to develop and implement a public notification/information program that targets potentially affected users prior to the conversion to chloramines. This will ensure that they have adequate time to make the changes necessary to dechloraminate the water prior to its use.

Collectively, these actions will allow installations to take full advantage of the benefits of chloramination while minimizing the disadvantages that some utilities have experienced. In general, once the complete program has been developed it requires up to two years to fully implement.

11.0 REFERENCES

1. PL 93-523, Safe Drinking Water Act (SDWA) as amended 1986, and the Safe Drinking Water Amendments of 1996 (PL 104-182);

2. Title 40, Code Federal Regulations, Parts 141, 142, 143, 144, 145 and 146;

3. (YOUR STATE) "Waterworks Regulations" (latest addition);

4. OPNAVINST 5090.1 B "Environmental and Natural Resources Program Manual", Chapters 1, 3, 8, 20, 24, and 25, of 2 Feb 1998;

5. Naval Facilities Engineering Service Center: *Cross-Connection Control and Backflow Prevention Program Implementation at Navy Shore Facilities*, User's Guide UG-2029-ENV, May 1998;

6. AWWA M14, Recommended Practice for Backflow Prevention and Cross-Connection Control, 1990;

7. MIL-HDBK 1025/6 General Criteria for Waterfront Construction, May 1988;

8. MIL-HDBK 1164, Operations and Maintenance of Water Supply Systems, March 1997;

9. NAVMED P5010-5 - Water Supply Ashore, 1992;

10. MIL-HDBK 1005/7 Water Supply Systems, Nov 1988;

11. ANSI/AWWA C651-86 - Standard for Disinfecting Water Mains;

12. ANSI/AWWA D105-80 - Standard for Disinfection of Water Storage Facilities;

13. UMS 0533-310 Potable Water System, Disinfection of 28 Aug 79;

14. NAVSEA S9086-SE-STM-010 0901-LP-533-0030 Potable Water Systems 15 March 1995;

15. Navy Environmental Compliance Sampling and Field Testing Procedures Manual, NAVSEA T0300-AZ-PRO-010;

16. EPA 812/B-94-002, Lead in Drinking Water in Schools and Non-Residential Buildings; April 1994.

17. Standard Methods for the Examination of Water and Wastewater, 19th Edition;

18. Great Lakes-Upper Mississippi River Board of State Sanitary Engineers, *Recommended Standards for Water Works (Ten States Standards)* (1997);

19. NAVFAC ltr 5090/980043/ENV-EQ/RS of 22 July 1998 *Lead in Drinking Water Program Update –98*;

20. U.S. EPA/State Joint Guidance on Sanitary Surveys (December 1995).

21. NAVMED P-5010-6, Water Supply Afloat, 1990.

APPENDIX A

UNIDIRECTIONAL FLUSHING

Background

With the introduction of the Surface Water Treatment Rule (SWTR), the concept of a multiple barrier approach (source protection, treatment, disinfection, and maintenance of microbial control in the distribution system) was formally established with the distribution system being the last barrier which serves to ensure a successful microbial control program. In response, a comprehensive approach to dealing with preserving/improving water quality within the distribution system must be adopted. Such an approach encompasses a variety of operations and maintenance programs including a review of storage needs with the goal of eliminating unneeded storage, frequent tank exercising to ensure turnover, periodic tank cleaning and maintenance, adequate disinfection practices during all main repairs and replacement, an effective corrosion control program, a comprehensive cross connection control program, an active valve and hydrant exercise program and enhanced water quality monitoring. A unidirectional flushing (UDF) program is the corner stone for this type of approach.

Unidirectional Flushing

Unidirectional flushing consists of isolating a particular pipe section or loop, typically through closing appropriate valves, and exercising the hydrants in an organized, sequential manner. It is carefully engineered with consideration to flushing crew size, duration of flushing, equipment availability, and location of water sources such as water treatment plant, storage tanks, booster stations, etc. UDF can be implemented on a spot basis (in response to a specific water quality complaint) or as a comprehensive system-wide flushing effort (to prevent water quality deterioration).

For flushing to be effective for biofilm removal and the removal of corrosion products and other debris attached to the pipe walls, two criteria must govern. First, the flow velocity in the pipes must be 6 ft/sec or greater, and second, the system must be flushed in a systematic manner to ensure all pipe sections are completely flushed, and that residue/debris is not simply moved from one part of the system to another. UDF relies on both of these criteria.

Benefits

Considering the minimum cost associated with the design and implementation of a UDF, the benefits are enormous. A well-designed UDF can result in both water quality and hydraulic improvements and can result in capital savings. The water quality and hydraulic benefits include:

- Restoring disinfectant residual,
- Reducing bacterial growths,
- Dislodging biofilms,

- Removing sediments/deposits,
- Corrosion control,
- Restoring flows and pressures,
- Effective elimination of taste and odor problems, and
- Reduced disinfectant demand throughout the distribution system.

Once the UDF program has been implemented, the capital savings that can be realized from the annual use of UDF can come from:

- A reduction in the number of hours required to oversee program implementation since all the needed information is presented on the flushing maps and accompanying technical instructions,
- Allowing for simultaneous implementation of preventive maintenance (PM) activities,
- A reduction in trouble shooting efforts due to searches for closed valves that are supposed to be open.
- Allowing chloraminated systems to quickly and effectively implement flushing during the annual conversion to free chlorine.

Overall, a successful unidirectional flushing program will not only maintain acceptable water quality throughout the distribution system, but also will help to minimize degradation of water quality that often occurs between the treatment plant and the customer's tap.

Program Development

The development of a UDF program requires a strong hydraulic background, particularly in the absence of a hydraulic model, and a thorough familiarity with the distribution system components such as water sources, pump stations, storage tanks/reservoirs, type of piping materials and age, etc. First and foremost the person(s) developing the program must review distribution system maps and models, if available, to gain an understanding of normal water flow paths/directions throughout the distribution system under average-day conditions. A key element to becoming familiar with the normal flow direction is to understand the depletion/replenishment patterns of all storage tanks under the same conditions. Further, in the case of distribution systems with multiple pressure zones, learning the function of pressure regulating valves (PRVs) and booster stations becomes essential.

The next task is to divide the distribution system into individual loops. These are sections within the distribution system, starting at the water source(s) and ending at the system's periphery, to be flushed in sequence. Each loop consists of a manageable section, the size of which is determined with consideration to flushing crew size, duration of flushing, equipment availability, and location of water sources such as water treatment plant, storage tanks, booster stations, etc. The goal is to complete flushing each individual loop or multiple loops within the crew's predetermined work shift. This will allow for reopening all valves used for isolation while flushing the particular loop which avoids having to keep normally-open valves from being closed for extended periods.

Following loop delineation, desired flushing velocities must be determined. Ideally, flushing velocities throughout the system must be greater than 6 ft/sec. However, due to some systems' existing configurations, this flushing velocity might not be attainable.

The next task in developing a UDF program is to prepare step-by-step flushing procedures, which provide precise instructions with regards to the sequence of valve and hydrant opening and closing. For each loop, an average of ten to twelve steps can be developed. Each step will then be complemented with an individual map which clearly illustrates, in color, the valve and hydrant status (open or closed) during each step. This will result in approximately ten to twelve individual maps for each loop to be laminated and used by the flushing crew.

The final step is program implementation. This should be carried out with consideration to public and flushing crew safety. An effective UDF program requires not only good design but also proper execution.

APPENDIX B

STORAGE

With recent regulations placing even more emphasis on distribution systems being the final barrier for protecting water quality prior to reaching the consumer, it is imperative that the distribution system be considered equally as important as the water treatment plant. With that in mind, a comprehensive approach to dealing with maintaining water quality within the distribution system must be adopted. Such an approach encompasses, but is not limited to:

- The elimination of excess storage;
- Frequent tank exercising to ensure turnover:
- Periodic tank cleaning and maintenance;
- Good disinfection practices during pipe repair/replacement;
- A unidirectional flushing program;

Tank exercising to ensure timely turnover is possible if storage volume is adequate. However, if storage is excessive this task is nearly impossible and the drawbacks are significant.

Historically, distribution storage has been designed with little regard to water quality concerns. The driving mechanism was strictly based on hydraulic issues such as pressures and flows, largely due to restrictions imposed for maintaining fire fighting readiness and in part to provide the customer with assurances that the water supply will not be interrupted.

Regulations such as the Total Coliform Rule, the Surface Water Treatment Rule, the THM Rule, etc., which can impact storage operation and maintenance either directly or indirectly, were not in place and as a result adverse effects from excessive storage went unnoticed. Further, storage was and still is designed to be strategically located throughout the distribution system. However, what used to be strategic is no longer the case for many installations, particularly with the continuing change in missions which often leads to prompt relocation of a large number of personnel/tenants. These challenges among others warrant an installation's reevaluation of the entire system storage capacity.

Regulations throughout the U.S., as enforced by the local health departments, specify storage requirements ranging from one half to one times the annual average daily demand. The Recommended Standards for Waterworks adopted by many northeastern and central states (Reference 18), stipulates that the minimum storage shall be equal to the average daily consumption. This requirement may be reduced when the source and treatment facilities have sufficient capacity with standby power to supplement peak demands of the system. The problem stems from the fact that, even when applicable, most systems overlook the second sentence and in fact some installations maintain several times the volume of storage needed. Although excess storage may be justified when in areas prone to earthquakes, overall the cost in terms of water quality deterioration is severe. It has been well documented that microbial, chemical, and physical problems can occur as a result of long detention time in storage tanks.

Even in a clean distribution system, the disinfectant residual will begin to decay after 3 to 5 days. As a minimum, this loss of residual can result in bacterial regrowth. With systems that utilize chloramines as the residual disinfectant, the decay of the disinfectant residual also liberates ammonia, a nutrient, and can result in the growth of nitrifying bacteria. It is not uncommon for storage tanks that are not being turned over or that are hydraulically locked out of the system, to become incubators for bacteria. These bacteria then seed the system whenever the water in these tanks is introduced into the distribution system piping. As a result, effective use of storage is essential for maintaining water quality control in the distribution system.

In addition to routine maintenance and cleaning, providing for effective use of storage may encompass one or more of the following elements:

- The elimination of excess or unneeded storage;
- Isolating storage that is only needed for fire protection and the installation of a recirculating chlorine feed system to maintain the bacteriological quality of the stored water; and
- Routine turnover of approximately 1/3 of the water in the on-line storage tanks.

It should be noted, that providing for routine turnover of a storage tank that is hydraulically locked out of the system, may require the installation of a pumping station.

APPENDIX C

HETEROTROPHIC PLATE COUNTS

Water supply production invokes interrelated aspects of source water quality, treatment strategy and maintaining integrity of the distribution system. These interrelated aspects cannot be isolated into separate entities. While coliform measurements may provide vital information on treatment effectiveness with respect to meeting basic issues of engineering process operation and the delivery of potable water to the consumer, there are other microbial issues that need recognition. These include consumer concerns with not only the ingestion of a safe water supply but also the risks associated with inhalation and skin contact in bathing. These latter concerns are of particular concern to a sub-population of consumers: infants and seniors citizens with weakened immune systems; AIDS patients who are at risk from the loss of protective immunities; and others such as patients in the hospital environment. The organisms in question are included in the heterotrophic bacterial population of water and are frequently described as opportunistic pathogens.

Characterizing the occurrences of these diverse organisms can best be done with a sensitive measurement of the heterotrophic bacterial population and formulating a realistic density limit. These microorganisms represent a class of non-coliform bacteria commonly found in drinking water. Though not yet regulated, their presence in any given sample location at densities greater than 500 colonies per milliliter indicates poor microbial control, the presence of conditions that are favorable towards bacterial regrowth and the potential to interfere with the coliform measurement. As previously indicated, some types of Heterotrophic Plate Count (HPC) bacteria are considered to be opportunistic pathogens that pose a health risk to the very young, the elderly and those with suppressed or compromised immune systems.

A description of the sampling and analytical methods associated with the HPC test can be found in the 19th Edition of Standard Methods of Water and Wastewater Analyses (Reference 17). Systems electing to include the HPC analyses as part of their monitoring program are encouraged to use the R2A media at 20 to 25 C incubation temperature and 5 to 7 days of incubation. Samples should be collected from the same locations as those used for the Total Coliform Rule as well as any dead-ends and storage tanks.

The use of the HPC analyses with the R2A media provides a sensitive measure of the effectiveness of the microbial control efforts within the distribution system and the results can be used to develop a site-specific response plan to help control water quality deterioration. An example of a response plan is:

HPCs (#/ml)	**Response**
➢ 100	Resample within 2 weeks
➢ 250	Resample within 1 week
➢ 500	Spot Flush within 2 weeks
➢ 1000	Spot Flush within 1 week
➢ 5000	Spot Flush within 48 hours

Because HPCs are currently unregulated, these response numbers are not written in stone. Installations are encouraged to develop their own response plan.

APPENDIX D

SAMPLING FOR THE TOTAL COLIFORM

Location of Sampling Sites

The intent of the Total Coliform regulations is to ensure the timely identification of biological contamination within public water systems. Sampling site locations should be selected in order to provide an accurate representation of conditions throughout the distribution system, and should be chosen with considerations to the following criteria:

- First customer
- Locations of previous coliform occurrences
- Densely populated residential areas
- Hospital areas
- Child care centers
- Most distant customer
- Locations along aging water mains
- Dead ends
- Potential cross-connections or loops
- Distribution reservoirs
- Storage tanks
- Distinct hydraulic locations

In addition, if multiple sources of water are used, each source must be adequately characterized.

Sampling Tap and Sample Handling Considerations

Proper sampling procedures for total coliforms are essential to ensure that contamination and false-positive samples do not occur. Sample bottles must be carefully cleaned, rinsed, and sterilized. Collect samples that are representative of the water being tested. Flush or disinfect sample ports, and use aseptic techniques to avoid contamination. Keep the sample bottle closed until it is to be filled. When removing the cap, make sure not to contaminate the inner surface of the cap or the neck of the sample bottle. Fill the container without rinsing and replace the cap immediately.

The condition of the sampling location and tap is also important to ensure accurate sampling results. Samples should be taken from cold water taps, preferably from those having individual hot and cold spigots. Prior to sampling, remove faucet attachments such as screens, aerators, o-rings, and splash guards as these areas provide a potential habitat for colonies of microorganisms. Open the tap fully and let water run to waste for 2 to 3 minutes or for a time sufficient to permit clearing of the service line. Reduce water flow to permit filling sample bottle without splashing. If tap cleanliness is questionable, apply a solution of sodium hypochlorite (bleach) to the faucet before sampling or, alternatively, use other methods approved by your local health department. Let the water run for an additional 2 to 3 minutes

after treatment prior to taking samples. Do not sample from leaking taps that allow water to flow over the outside of the tap.

APPENDIX E

NATIONAL PRIMARY DRINKING WATER STANDARDS

Inorganic Contaminants	MCL (mg/L)
Antimony	0.006
Arsenic	0.05
Asbestos	7 million fibers/liter
Barium	2
Beryllium	.004
Cadmium	0.005
Chromium	0.1
Copper	1.3
Cyanide (as free Cyanide)	0.2
Fluoride	4.0
Lead	0.015
Mercury	0.002
Nickel	0.1
Nitrate	10 (as Nitrogen)
Nitrite	1 (as Nitrogen)
Total Nitrate + Nitrite	10 (as Nitrogen)
Selenium	0.05
Thallium	0.002

Note: Lead and copper as a result of the Lead and Copper Rule Amendments to the Safe Drinking Water Act are action levels not MCLs.

APPENDIX E (CONTINUED)

Synthetic Organic Contaminants	MCL (mg/L)
Alachlor	0.002
Aldicarb	0.003
Aldicarb sulfoxide	0.004
Aldicarb sulfone	0.003
Altrazine	0.003
Carbofuran	0.04
Chlordane	0.002
Dibromochloropropane	0.0002
2,4-D	0.07
Ethylene dibromide	0.00005
Heptachlor	0.0004
Heptachlor epoxide	0.0002
Lindane	0.0002
Methoxychlor	0.041
Polychlorinated biphenyls	0.0005
Pentachlorophenol	0.001
Toxaphene	0.003
2,4,5-TP	0.05
Benzoapyrene	0.0002
Dalapon	0.2
Di(2-ethylexyl) adipate	0.4
Di(2-ethylexyl) phtahalate	0.006
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Glyphosate	0.7
Hexacholorbenzene	0.001
Hexachlorocyclopentadiene	0.05
Oxamyl (Vydate)	0.2
Picloram	0.5
Simazine	0.004
2,3,7,8-TCDD (Dioxin)	3×10^{-8}

APPENDIX E (CONTINUED)

Organic Contaminants	MCL (mg/L)
Vinyl chloride	0.002
Benzene	0.005
Carbon tetrachloride	0.005
1,2-Dichloroethane	0.005
Trichloroethylene	0.005.
para-Dichloroethane	0.075
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.2
cis-1,2-Dichloroethylene	0.07
1,2-Dichloropropane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
Styrene	0.1
Tetrachloroethylene	0.005
Toluene	1
trans-1,2 Dichloroethylene	0.1
Xylenes (total)	10
Dichloromethane	0.005
1,2,4-Trichloro-benzene	0.07
1,1,2-Trichloro-ethane	0.005
Total Trihalomethanes	0.10

APPENDIX E (CONTINUED)

Physical Quality

Parameter	Maximum Contaminant Level	Concentration
*Turbidity		1.0 ntu

* NTU applies to surface water sources or groundwater sources under the direct influence of surface water which have slow sand filtration or diatomaceous earth filtration treatment facilities. Surface water sources or groundwater sources under the direct influence of surface water which have conventional or direct filtration treatment facilities must have turbidity levels (of representative samples of the system's filtered water) less than or equal to 0.5 NTU in at least 95% of the measurements taken per month. (Reference 1)

Microbiological Contaminants	MCL
** Total Coliform	zero
***Giardia lamblia	zero
***Viruses	zero
***Legionella	zero

** Compliance with Total Coliform is based on presence-absence.
*** Routine test methods unavailable, therefore these contaminants not usually part of NPDWS analyses.

The MCL is based on the presence or absence of total coliforms in a sample, rather than coliform density:

(1) For a system which collects at least 40 samples per month, if no more than 5.0 percent of the samples collected during a month are total coliform-positive, the system is in compliance with the MCL for total coliforms.

(2) For a system which collects fewer than 40 samples/month, if no more than one sample collected during a month is total coliform-positive, the system is in compliance with the MCL for total coliforms.

Any fecal coliform-positive repeat sample or E. coli-positive repeat sample, or any total coliform-positive repeat sample following a fecal coliform-positive or E. coli-positive routine sample constitutes a violation of the MCL for total coliforms.

APPENDIX F

NATIONAL SECONDARY DRINKING WATER STANDARDS

Inorganic Contaminants	MCL (mg/L)
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Silver	0.1 mg/L
Sulfate	250 mg/L
Zinc	5 mg/L

Physical Quality

Parameter	Maximum Contaminant Level	Concentration
Color	Secondary	15 Color Units
Odor	Secondary	3 Threshold Odor Number
pH	Secondary	6.5 - 8.5
Total Dissolved Solids	Secondary	500 mg/L

APPENDIX G

QUICK CHART FOR POTABLE WATER PIPING DISINFECTION

Chlorine required to produce 25 PPM residual in 100 feet of pipe:

PIPE DIAMETER	65% CALCIUM HYPOCHLORITE (DRY)	1% CHLORINE SOLUTION (LIQUID)
4	0.02 lbs (0.30 oz.)	0.16 gal. (10 oz.)
6	0.05 lbs (0.8 oz.)	0.3 gal. (23 oz.)
8	0.08 lbs (1.3 oz.)	0.65 gal. (41 oz.)
10	0.1 lbs (1.6 oz.)	1.02 gal. (65 oz.)
12	0.2 lbs (3.2 oz.)	1.44 gal. (92 oz.)

Chlorine required to produce 500 PPM residual in 100 feet pipe:

PIPE DIAMETER	65% CALCIUM HYPOCHLORITE (DRY)	1% CHLORINE SOLUTION (LIQUID)
4	0.4 lbs (6.4 oz.)	3.2 gal.
6	1.0 lbs (16.0 oz.)	7.2 gal.
8	1.6 lbs (26.0 oz.)	13.0 gal.
10	2.0 lbs (32.0 oz.)	20.0 gal.
12	4.0 lbs (64.0 oz.)	29.0 gal.

For pipe sizes that are less than 4 inches in diameter, use a standard two tablespoons of 66 percent available calcium hypochlorite to achieve a 25 PPM residual (in 100 feet or less); use 3 ounces of calcium hypochlorite to achieve a 500 PPM residual.

APPENDIX H

SAMPLE CHLORINATION/FLUSHING VERIFICATION FORM

1. Job Title: _____

2. Description of Work (25 Words or Less): _____
_____
_____

3. Building Number and/or Location: _____

4. Was chlorine added, if yes; amount and chlorine residual, if no; explain why:
_____
_____
_____
_____

5. Was the system flushed, if yes, how long? Was all discoloration removed, chlorine residual after flush? If system not flushed, explain why:
_____
_____
_____

6. Give estimated date and time bacteriological samples will be delivered to a state certified laboratory. Please note if the first bacteriological sample will be collected 24 or more hours after the repair:
_____
_____

SIGNATURE:_____DATE: _____

Give Company Position/Shop or Code and Supervisor's Name.

Forward a copy of this sheet to the Public Works Officer and/or Environmental Director or designated individual any time bacteriological sample results will not be issued within 24 hours of a repair. However, the above action is not a substitute for bacteriological sampling and analysis which must still be performed.

APPENDIX I

SAMPLE POTABLE WATER IMPACT STATEMENT SHEET

*From:
To: INSTALLATION ENVIRONMENTAL OR PUBLIC WORKS DIRECTOR

Subj: POTABLE WATER SYSTEM IMPACT STATEMENT SHEET

The following information is provided regarding a function which could affect the potable water system:

1. Job Title: _____

2. Description of Work (25 Words or Less): _____
_____
_____
_____

3. Building Number and/or Location: _____

4. Contract or Control Number: _____
_____
_____

5. Has job begun, if yes, has the potable water system been encroached? If yes, give date and time: _____

6. Will chlorination and/or flushing take place, if yes, give approximate date, amount of chlorine to be used, method of chlorination, and estimated flush time: _____
_____
_____

7. Will bacteriological samples be collected if yes, by whom (give name, code, and extension):
_____
_____
_____

SIGNATURE_____

DATE_____

*Give Code, Name, Extension