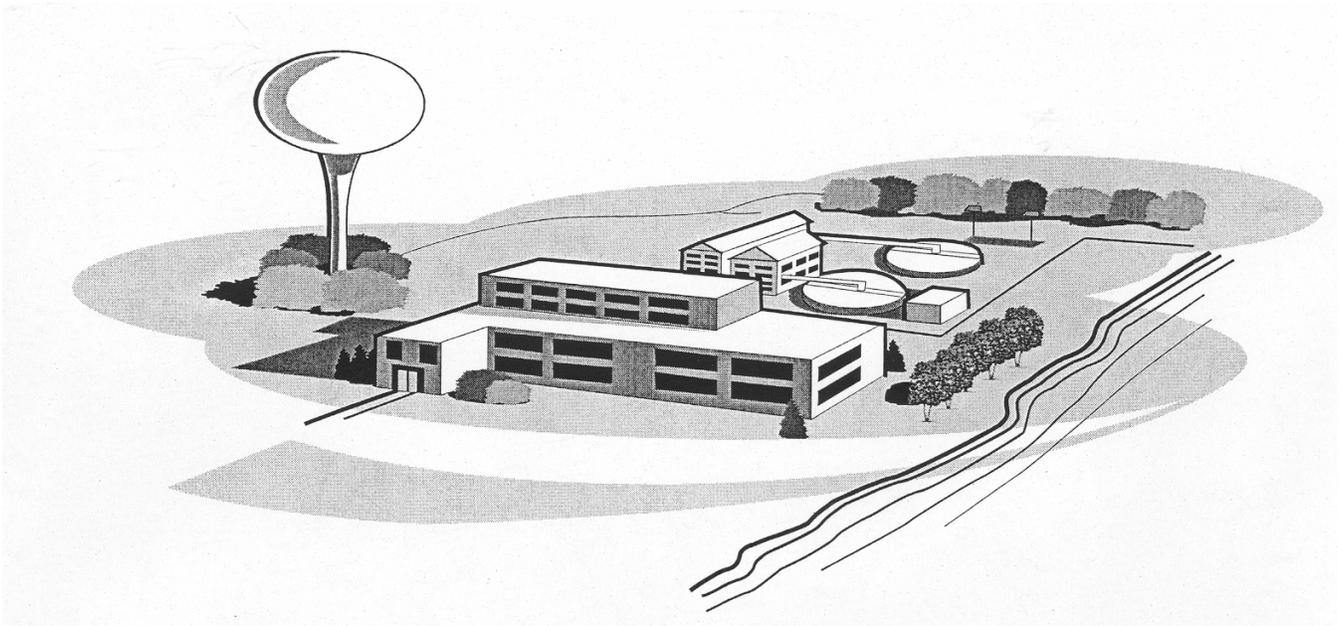


Reuse of Treated Wastewater Guidance Manual

362-0300-009



pennsylvania

DEPARTMENT OF ENVIRONMENTAL PROTECTION

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Water Standards and Facility Regulation

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TITLE: Reuse of Treated Wastewater Guidance Manual

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

POLICY: To reduce the demand on potable water supplies from groundwater and surface waters in the Commonwealth by reusing treated wastewater where appropriate.

PURPOSE: To provide guidance to Department of Environmental Protection (DEP) staff and the public for reusing treated wastewater in an environmentally protective manner in accordance with DEP regulations.

APPLICABILITY: This guidance applies to the reuse of treated wastewater from domestic wastewater treatment facilities.

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

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

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List of Acronyms

BOD	Biochemical Oxygen Demand
DEP	PA Department of Environmental Protection
EV	Exceptional Value Water
HQ	High Quality Water
mg/L	milligrams per liter
mJ/cm ²	milliJoules per square centimeter
NTU	Nephelometric Turbidity Units
TOC	Total Organic Carbon
TOX	Total Organic Halides
TSS	Total Suspended Solids
UV	Ultraviolet

I. INTRODUCTION

Water reuse is the reclamation of treated wastewater for a beneficial use, such as agricultural irrigation and industrial cooling. Reuse has been and continues to be an important component of Pennsylvania's water management toolbox. Industries have been reusing water within their facilities for decades to reduce operating costs. Many municipal and industrial wastewater treatment plants discharge treated water to streams and lakes, or land apply reclaimed water for additional treatment prior to recharging a groundwater aquifer. In many of these cases, the reclaimed water becomes a portion of the source water for a potable drinking water supply.

Pennsylvania recognizes that all water is a valuable resource, and should be allocated to the highest practical use. In an effort to conserve and promote reuse of this resource, guidance regarding reuse activities is provided in this manual.

A. Activities Covered by this Manual

This manual was developed to assist in planning, designing, and implementing a program to reuse treated domestic wastewater. The approval of any activity listed in this manual may only occur under the authority of a permit issued by DEP.

B. Activities Not Covered by this Manual

This manual does not cover land application of wastewater for the purpose of soil treatment. For information on land application of wastewater for the purposes of additional treatment, see DEP's technical guidance document *Manual for Land Treatment of Wastewater*, DEP ID: 362-2000-009, available on DEP's Web site at www.depweb.state.pa.us.

This manual does not cover the reuse or recycling of industrial wastewater within the same facility that it was generated.

C. Information Contained in this Manual

This manual includes planning, design, operation and maintenance guidelines for wastewater systems treating domestic wastewater for beneficial reuse. Using this manual, treatment plant owners can establish flexible designs and sound engineering practices for managing wastewater in an environmentally friendly manner. The manual is also intended to ensure that reclaimed water discharges are free from substances that pose a serious threat to public health, safety and welfare.

This manual also includes:

- Permissible types of reuse
- Treatment guidelines for various reuse applications
- Details on the documents and reports needed to receive reuse approval from DEP
- An explanation of the approval process, the operations protocol process and the report review

D. Benefits of Water Reuse

- Reuse reduces demands on valuable water supplies used for drinking water and irrigation
- Reuse replenishes groundwater and surface water sources
- Reuse helps reduce pollutant loading to surface waters
- Reuse may postpone costly investment for development of new water sources
- Reuse can save money and can provide aesthetic value
- Reuse can allow for nondischarge alternatives which are especially useful in Special Protection Watersheds

E. Definitions

Reclaimed water – Treated wastewater used in accordance with applicable guidelines for a beneficial purpose as a substitute for water withdrawn from a surface or groundwater source. The term “reclaimed water” includes both recycled water and reused water.

Recycled water – Treated wastewater obtained from an application or process that is intended to be used again in the same application or process.

Reused water – Treated wastewater obtained from one application or process that is intended for use in another application or process.

II. PLANNING GUIDELINES FOR BENEFICIAL REUSE SYSTEMS

In planning for a beneficial water reuse system, it is important that the project sponsor consider a variety of technical and administrative issues. These considerations may include:

A. Sources of Treated Effluent for Reuse

For the purposes of this guidance, the source of treated effluent will be from domestic wastewater treatment facilities. This will not address reuse from industrial processes if the water is reused within the same facility that generated it.

Existing sources must be characterized to establish the effluent's suitability for reclamation. To compare the quality and quantity of available reclaimed water with requirements of potential users, information on the operation and performance of the existing domestic wastewater treatment facilities and related facilities should be examined. Important factors to consider in this preliminary stage of reuse planning are:

1. Reclaimed water quality

The beneficial reuse of reclaimed water requires that the quality of the reclaimed water be appropriate for the reuse application. Uses such as irrigation of publicly accessible lands, irrigation of food crops, groundwater recharge, or surface water augmentation require a higher degree of treatment than water used in access controlled areas such as fenced pastures, farm fields, forest, or surface waters where access is controlled.

2. Reclaimed water quantity (daily and seasonal average, maximum and minimum flows)

It is important for the project sponsor to identify all possible demands for the reclaimed water, and compare the demand with the supply of reclaimed water. If the demand does not equal or exceed the supply, other methods of accommodating the excess reclaimed water, such as storage or stream augmentation should be considered in addition to the beneficial reuse purposes.

Reclaimed water should be applied for irrigation purposes at limited rates. Application rates may vary by season. Irrigation demand may be estimated by determining the total irrigable acreage, along with the estimated weekly irrigation rates.

Demands for uses other than irrigation, such as commercial and recreational uses, should also be considered.

B. Industrial Wastewater Contributions to Flow

Many domestic wastewater treatment facilities have industries that contribute flows to the wastewater. Some industries have pretreatment standards that regulate the maximum rate at which industrial contaminants may be discharged to the sanitary sewer system. The project sponsor must carefully evaluate the industrial contributions to the wastewater. Wastewater treatment facilities that receive large amounts of industrial wastes may not be eligible for some types of reuse applications, or may require additional treatment.

C. System Reliability

The treatment facility should take steps to ensure the reliability of the system to prevent the distribution of inadequately treated reclaimed water due to circumstances such as power outage, process upset, or equipment failure.

Reliability can be ensured by provisions such as backup power supplies, redundant equipment, and storage of excess or off-spec water until it can be adequately treated.

If the reclaimed water supply must be uninterrupted, the system may consider other options in addition to the above. Another alternative may include satellite treatment plants or additional storage in case of an upset at the treatment facility.

D. Supplemental Facilities (e.g., storage, pumping, conveyance)

Reclaimed water systems are similar to public water systems, in that they need distribution systems, including storage, pump stations and transmission and distribution lines. They should include provisions for cross-connection control to prevent any interconnection to potable water systems, and to prevent the contamination of the reclaimed water.

Distribution systems may require multilevel designs if topographic concerns govern the design. The mains should be sized to provide peak hourly flows at adequate pressures, depending on the type of reuse application. Distribution system piping, valves, and hydrants should be color coded according to the international color code (purple) to ensure that they are not confused with potable water systems.

Storage and pumping facilities are typically located at the treatment facility; however, in large systems, additional storage or pumping may also be required near the reuse site. In-ground storage may be adequate at the treatment facility, but if storage facilities are required at the reuse site, consideration should be given to elevated tanks. Sufficient storage capacity should be required to accommodate the variations in production and usage rates.

E. Environmental Benefits

- Using treated wastewater reduces the amount of drinking water and irrigation water that must be withdrawn from the groundwater table or from surface water sources.
- Reuse utilizes a resource to replenish groundwater and surface water sources.
- Treated wastewater has nutrients such as nitrogen and phosphorus that can pollute surface waters, causing excessive algae concentrations and harming the health of streams, reservoirs and the Chesapeake Bay. Reusing the treated wastewater can eliminate these nutrients in surface waters, and help to improve the health of the resource.
- Reusing treated wastewater eliminates the use of potable water for non-potable uses. This will allow existing water treatment plants to postpone investment for the development of new water sources or expansion of existing treatment facilities.
- Using treated wastewater, instead of potable water, for aesthetic purposes, such as lakes, ponds, and fountains, can save money.
- Development in a Special Protection Watershed requires the evaluation of non-discharge alternatives for wastewater treatment. Reuse of treated wastewater can provide these nondischarge alternatives, while still allowing development to occur.

F. Knowledge, Skills and Abilities Necessary to Operate and Maintain the System

Many plants treat wastewater by providing aeration, clarification, and disinfection. While this treatment may be adequate for a limited number of reuse options, most reuse alternatives may require additional treatment. Additional treatment may include nitrification, denitrification, coagulation, filtration, or reverse osmosis. Systems wishing to implement water reuse practices must ensure that the plant operators receive adequate training for the use of any new equipment and processes necessary for the quality of water being reused.

G. Potential Uses of the Water

Public water treatment plants produce potable water; however, actual potable uses such as drinking, cooking, and dishwashing represent only a small portion of the total water produced. Other uses, such as residential irrigation, clothes washing, car washing, swimming, agricultural irrigation or construction uses may not require potable water. Non-potable water, such as reclaimed wastewater, treated to the appropriate quality which in some cases includes meeting all drinking water standards, may be substituted for potable water in these uses, without compromising quality.

While it is possible to produce reclaimed water that meets all safe drinking water standards, direct potable reuse of reclaimed water is prohibited. DEP will continue to evaluate additional research in this area as it is produced.

The Department does not permit urban reuse systems for internal non-potable residential uses such as toilet flushing. The possibility of an interconnection between the potable water system and the reuse system poses a significant health risk to the homeowner and other users of the public water supply.

DEP has identified many acceptable uses of reclaimed water in Pennsylvania. The list in the following section is not all-inclusive. DEP encourages the development of additional uses. Proposed new uses will be evaluated by DEP. The uses are listed with the minimum class guidelines for reuse water. Access is a significant factor in determining the class of water for the use. In many cases, the list includes a restricted access and unrestricted access for a particular use.

III. TREATMENT GUIDELINES FOR REUSED WATER

A. Classes of Reuse Water

1. Class A+ Reclaimed Water

Minimum treatment for Class A+ reclaimed water is secondary treatment, nitrification, denitrification, coagulation, filtration, reverse osmosis treatment, disinfection, and any other advanced treatment processes necessary to meet standards.

Class A+ reclaimed water should meet the following minimum standards:

Parameter	Treatment Standard		Monitoring Frequency
	Monthly Average	Maximum	
BOD	< 2 mg/L	5 mg/L	2 / Week
TOC	< 1 mg/L		2 / Week
Turbidity	≤ 0.3 NTU	1 NTU	Continuous
Fecal Coliform	< 2.2 / 100 mL	23 / 100 mL	2 / Week
TOX	< 0.2 mg/L		2 / Week
Total Nitrogen	< 10 mg/L		2 / Week
**Other Contaminants			Quarterly

** - All other primary and secondary drinking water contaminants.

Where chlorine is utilized for disinfection, a total chlorine residual of at least 1.0 mg/L should be maintained for a minimum contact time of 30 minutes at design average flow. The treatment facility should provide continuous on-line monitoring for chlorine residual. There should be a detectable chlorine residual (>0.02 mg/L) at the point of reuse application.

Where ultraviolet light is used for disinfection, a design dose of 50 mJ/cm² should be used. This dose should also be based on continuous monitoring of lamp intensity, UV transmittance and flow rate.

2. Class A Reclaimed Water

Minimum treatment for Class A reclaimed water is secondary treatment, nitrification, denitrification, filtration, and disinfection.

Class A reclaimed water should meet the following minimum standards:

Parameter	Treatment Standard		Monitoring Frequency
	Monthly Average	Maximum	
BOD	< 2 mg/L	5 mg/L	Weekly
TOC	< 10 mg/L		Weekly
Turbidity	≤ 2 NTU	5 NTU	Continuous
Fecal Coliform	< 2.2 / 100 mL	23 / 100 mL	2 / Week
TOX	< 0.2 mg/L		Weekly
Total Nitrogen	< 10 mg/L		Weekly
**Other Contaminants			Quarterly

** - All other primary and secondary drinking water contaminants.

For reuse applications where the reclaimed water will not reach the surface water or groundwater, nitrification and denitrification may not be required.

Where chlorine is utilized for disinfection, a total chlorine residual of at least 1.0 mg/L should be maintained for a minimum contact time of 30 minutes at design average flow. The treatment facility should provide continuous on-line monitoring for chlorine residual. There should be a detectable chlorine residual (>0.02 mg/L) at the point of reuse application.

Where ultraviolet light is used for disinfection, a design dose of 100 mJ/cm² under maximum daily flow should be used. The design dose may be reduced to 80 mJ/cm² for porous membrane filtration, and 50 mJ/cm² for semi-permeable membrane filtration. This dose should also be based on continuous monitoring of lamp intensity, UV transmittance and flow rate.

3. Class B Reclaimed Water

Minimum treatment for Class B reclaimed water is secondary treatment, filtration, and disinfection.

Class B reclaimed water should meet the following minimum standards:

Parameter	Treatment Standard		Monitoring Frequency
	Monthly Average	Maximum	
BOD	< 10 mg/L	20 mg/L	Weekly
Turbidity	< 10 NTU	15 NTU	Continuous
Fecal Coliform	< 2.2 /100 mL	23 / 100 mL	2 / Week

Where chlorine is utilized for disinfection, a total chlorine residual of at least 1.0 mg/L should be maintained for a minimum contact time of 30 minutes at design average flow. The treatment facility should provide continuous on-line monitoring for chlorine residual. There should be a detectable chlorine residual (>0.02 mg/L) at the point of reuse application.

Where ultraviolet light is used for disinfection, a design dose of 100 mJ/cm² under maximum daily flow should be used. The design dose may be reduced to 80 mJ/cm² for porous membrane filtration, and 50 mJ/cm² for semi-permeable membrane filtration. This dose should also be based on continuous monitoring of lamp intensity, UV transmittance and flow rate.

4. Class C Reclaimed Water

Minimum treatment for Class C reclaimed water is secondary treatment and disinfection.

Class C reclaimed water should meet the following minimum standards:

Parameter	Treatment Standard		Monitoring Frequency
	Monthly Average	Maximum	
BOD	< 30 mg/L	45 mg/L	Weekly
TSS	< 30 mg/L	45 mg/L	Weekly
Fecal Coliform	< 200 /100 mL	800 / 100 mL	Weekly

Where chlorine is utilized for disinfection, a total chlorine residual of at least 1.0 mg/L should be maintained for a minimum contact time of 30 minutes at design average flow. The treatment facility should provide continuous on-line monitoring for chlorine residual. There should be a detectable chlorine residual (>0.02 mg/L) at the point of reuse application.

Where ultraviolet light is used for disinfection, a design dose of 75 mJ/cm² under maximum daily flow should be used. The design dose may be reduced to 60 mJ/cm² for porous membrane filtration, and 40 mJ/cm² for semi-permeable membrane filtration. This dose should also be based on continuous monitoring of lamp intensity, UV transmittance and flow rate.

B. Monitoring

1. All reclaimed water should meet the standard established by the average monthly value, based on an analysis of an appropriate number of samples as required by the class of the water for reuse.
2. "Other contaminants" parameters shall meet the drinking water maximum contaminant levels on a running annual average basis, calculated quarterly.
3. No parameter shall exceed the limit established for the maximum concentration.
4. Samples for all parameters, other than fecal coliform and disinfection byproducts, shall be taken at the point of discharge from the treatment plant.
5. Samples for fecal coliform and disinfection byproducts shall be taken at the point of reuse.

C. Reuse Activity Guidelines

DEP has established treatment guidelines for the types of reuse applications that are allowable in Pennsylvania. The treatment guidelines have been established to protect human health, as well as the environment. The minimum treatment guidelines for each of the reuse applications is listed in TABLE I (page 12).

1. Unrestricted Public Access Systems

Unrestricted public access systems involve the use of reclaimed water where public exposure is likely.

Reuse water used for unrestricted public access systems must be highly treated and highly disinfected, and should meet the requirements for Class B or better.

2. Restricted Public Access Systems

Restricted access systems involve the use of reclaimed water where public exposure is controlled through signage, fencing or other barriers, or electronic surveillance.

Reuse water used for restricted public access systems must be treated and disinfected, and must meet the requirements for Class C or better.

3. Nonedible Crop Systems

Reuse water may be used for the irrigation of crops not intended for human consumption.

Reuse water used for irrigation of trees, fodder, fiber, and seed crops must be treated and disinfected, and should meet the requirements for Class C or better.

Reuse water used for irrigation of sod, commercial plants or pasture for dairy animals must be treated and disinfected, and should meet the requirements for Class C or better. Application areas should not be used for the grazing of dairy animals for a period of 15 days from the last application of reclaimed water.

4. Edible Crop Systems

Reuse water may be used for the irrigation of crops intended for human consumption. Examples include any edible crop that is peeled, skinned, cooked, or thermally processed before consumption or commercially processed foods.

a. Reuse water used for spray irrigation of edible crops must be highly treated and highly disinfected, and should meet the requirements for Class B or better. For a period of 15 days prior to harvest, reuse water should not be used for the irrigation of crops intended for human consumption.

b. Reuse water used for surface irrigation of edible crops, where there is no contact between the reuse water and the edible portion of the food crop must be treated and disinfected, and should meet the requirements for Class C or better.

- c. Reuse water used for irrigation of root crops must be highly treated and highly disinfected, and should meet the requirements for Class B or better. For a period of 15 days prior to harvest, reused water should not be used for the irrigation of crops intended for human consumption.
- d. Reuse water used for surface irrigation of orchards and vineyards must be treated and disinfected, and should meet the requirements for Class C or better. Any fruit that has come into contact with reuse water or the ground should not be harvested. For a period of 15 days prior to harvest, reuse water should not be used for the irrigation of crops intended for human consumption.
- e. Food crops that undergo commercial processing that is sufficient to destroy all pathogenic agents may be spray or surface irrigated with reuse water that meets the requirements for Class C or better.

5. Industrial Reuse

Reclaimed water for industrial reuse may be obtained from municipal water reclamation facilities.

The reuse of reclaimed water in industrial processes depends on the process. In planning for reuse water for industrial processes, the potential user must be contacted to determine the specific quality of water required for their specific process. In any case, in order to be used for industrial reuse, the reuse water should meet the requirements of Class C or better.

6. Construction Activities

Reclaimed water may be used for construction activities such as, cement making, dust control, vehicle washing, etc.

- a. Reuse water used for construction activities must be treated and disinfected, and should meet the requirements for Class C or better.
- b. Reuse water used for construction activities where frequent work contact with reclaimed water is likely must be treated and disinfected, and should meet the requirements for Class B or better.

7. Environmental Reuse

Reclaimed water may be used to enhance natural wetlands, to create man-made wetlands that can be used as wildlife habitat, and to sustain or augment stream flows.

These projects are typically implemented to create a habitat in which wildlife can thrive, or to develop/enhance an area of recreational or aesthetic value to the community.

All existing publicly owned treatment works in Pennsylvania with one or more point source discharges currently use their reclaimed water for stream augmentation.

Reuse water used for the creation of man-made wetlands, or for recreational and aesthetic impoundments must be treated and disinfected, and should meet the requirements for Class C or better. Reuse water used for the augmentation of natural wetlands, especially special protection wetlands may require greater treatment.

If the reclaimed water is being used for surface water augmentation, the project sponsor must obtain an NPDES permit, and must meet the limits specified in the permit.

8. Unrestricted Recreational Reuse

Reuse water may be used to create an impoundment of water in which no limitations are imposed on body-contact water recreation activities, such as swimming or wading.

Reuse water used for unrestricted recreational purposes must be highly treated and highly disinfected, and should meet the requirements for Class B or better.

9. Restricted Recreational Reuse

Reuse water may be used to create an impoundment of reclaimed water in which recreation is limited to fishing, boating, or other non-contact or incidental contact recreational activities.

Reuse water used in impoundments where recreation is limited to fishing, boating, and other non-contact recreational activities, and where there is no outlet to surface or groundwater, must be treated and disinfected, and should meet the requirements for Class C or better.

10. Groundwater Recharge Systems

Aquifers provide a mechanism for natural storage and subsurface transmission of groundwater. Highly treated reclaimed water may be reused with the intent to augment the groundwater supply. Aquifer storage and recovery systems can be used to overcome the differences in the rates of supply and demand for seasonal irrigation needs. The use of groundwater storage can also reduce the need for surface storage facilities, and the problems associated with such facilities, such as algae blooms, deteriorating water quality, odors, and evaporation losses.

All existing land application systems applying reclaimed water beyond the agronomic rate are recharging either a potable or non-potable aquifer.

Methods of application could include infiltration basins or direct injection. Certain requirements for the Environmental Protection Agency's (EPA) Underground Injection Control (UIC) Program may need to be met. Contact EPA Region III in Philadelphia for further information. The method of application should be discussed extensively in the Design Engineer's Report.

Direct injection should require the use of Class A+ reuse water. In addition, the project sponsor must provide sufficient documentation that the constituents of the reclaimed

water will not precipitate out of the water and clog the injection site. The project sponsor must also show that the reclaimed water will not leach contaminants from the aquifer, resulting in groundwater that does not meet drinking water standards. In aquifers used as drinking water sources, reclaimed water should be retained underground for a minimum of 12 months prior to withdrawal.

The use of infiltration basins for groundwater recharge should require Class A or better reuse water. In addition, the project sponsor should provide sufficient documentation that the reclaimed water will not leach contaminants from the aquifer, resulting in groundwater that does not meet drinking water standards. In aquifers used as drinking water sources, reclaimed water should be retained underground for a minimum of 9 months prior to withdrawal.

TABLE I

Minimum Reclaimed Water Class	Reclaimed Water Use
A+	Augmentation or recharge to potable water aquifers (direct injection) Augmentation or recharge to non-potable aquifers (direct injection) Salt water intrusion barriers (direct injection)
A	Augmentation or recharge to potable water aquifers (surface spreading) Augmentation or recharge to non-potable aquifers (surface spreading) Clothes washing* Outdoor residential washdown* Public swimming pools* Private swimming pools* Residential car washing* Salt water intrusion barriers (surface spreading)
B	Commercial toilet and urinal flushing Commercial chemical mixing (pesticides, herbicides, fertilizers) Commercial vehicle washing Commercial window washing and pressure cleaning Decorative water features such as fountains, reflecting pools and waterfalls Fire Protection Irrigation of golf courses Irrigation of public parks Irrigation of playfields Irrigation of residential landscaping Irrigation of root crops Hydroseeding Recreational lakes and ponds (unrestricted access) Snow making Spray irrigation of edible crops Street cleaning Wetland augmentation (unrestricted access) Wetland creation (unrestricted access)

C	<p>Animal fodder</p> <p>Animal pasture</p> <p>Boiler feed water</p> <p>Concrete production</p> <p>Dust control</p> <p>Evaporative cooling water</p> <p>Fiber crops</p> <p>Fish hatcheries</p> <p>Industrial process water</p> <p>Irrigation of commercially processed foods</p> <p>Man made recreational streams (restricted access)</p> <p>Recreational lakes and ponds (restricted access)</p> <p>Seed crops</p> <p>Silviculture</p> <p>Sod farms</p> <p>Stream augmentation</p> <p>Surface irrigation of edible crops (no contact between reuse water and edible portion of crops)</p> <p>Surface irrigation of orchards and vineyards (no contact between reuse water and edible portion of crops)</p> <p>Washing and processing aggregate</p> <p>Wetland augmentation (restricted access)</p> <p>Wetland creation (restricted access)</p>
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* May not require nitrification and denitrification.

IV. DESIGN AND PERMITTING

The most important design considerations for a reclaimed water system are the protection of public health, the reliability of service, proper operation of the system, and proper use of reclaimed water.

In all reuse projects, the person or persons proposing the reuse activity will need to obtain a Water Quality Management permit from DEP. For reuse projects involving stream augmentation, an NPDES permit will also be required.

Depending on the type of activity being proposed, the application may require the completion of Modules 14 (Spray Irrigation), 19 (Supplementary Geology and Groundwater Information) and/or 20 (Impoundments).

A. Design and Permitting Considerations for a New Reuse Project added to an Existing Treatment Facility

1. Design Considerations

a. Non-Potable Distribution System Design

(1) Bedding

A continuous and uniform bedding should be provided in the trench for all buried pipe. Backfill material should be tamped in layers around the pipe and to a sufficient height above the pipe to adequately support and protect the pipe. Stones found in the trench should be removed for a depth of at least 6 inches below the bottom of the pipe. If coarse bedding is used, it should be interrupted every 250 feet by an earth dike or barrier to prevent dewatering or drainage from the entire upland area of the bedding.

(2) Cover

All reclaimed water lines should be covered with sufficient earth or other insulation to prevent freezing. A metallic tracer strip should be buried 1 foot above all nonmetallic pipe.

(3) Blocking

All tees, bends, plugs and hydrants should be provided with reaction blocking, tie rods or joints designed to prevent movement.

(4) Velocity

At maximum monthly average flow, a velocity of at least two feet per second should be maintained.

(5) Air and Vacuum Relief Valves

An air relief valve should be placed at high points in the reclaimed water line to prevent air locking. Vacuum relief valves may be necessary to relieve negative pressure on reclaimed water lines. The reclaimed water line configuration and head conditions should be evaluated to determine the need for, and placement of, vacuum relief valves.

(6) Pipe and Design Pressure

All reclaimed water lines, including those not designed to provide fire protection, should be sized after a hydraulic analysis based on flow demands and pressure requirements. The pipe system and its appurtenances should be designed to maintain a minimum pressure of 20 psig at ground level at all points in the distribution system under all conditions of flow. The normal working pressure in the distribution system should be approximately 60 psig.

(7) Design Friction Losses

Friction losses through reclaimed water lines should be based on the Hazen-Williams formula or other acceptable method. When the Hazen-Williams formula is used, the following values for “C” shall be used for design.

Unlined iron or steel	100
PVC	130-150
All other	120

When initially installed, reclaimed water lines will have a significantly higher “C” factor. The higher “C” factor should be considered only in calculating maximum power requirements.

(8) Minimum Size

The minimum size of reclaimed water lines that provides for fire protection and serving fire hydrants should be 6-inches in diameter. Larger sized mains will be required if necessary to allow the withdrawal of the required fire flow while maintaining the minimum residual pressure of 20 psig.

The minimum size of reclaimed water lines in the distribution system where fire protection is not to be provided should be 3-inches in diameter. Any departure from minimum requirements should be justified by hydraulic analysis and future water use, and can be considered only in special circumstances.

(9) Fire Protection

When fire protection is to be provided, system design should be such that fire flows and facilities are in accordance with the requirements of the State Insurance Services Office.

(10) Dead Ends

Dead ends should be minimized by looping all mains whenever practical. Where dead end lines are necessary in the construction of a distribution system, the lines should be provided with an approved blow-off or flushing hydrant for flushing purposes.

(11) Flushing

Flushing devices should be sized to provide flows which will give a velocity of at least 2.5 feet per second in the reclaimed water lines when flushed. Fire hydrants may be used for this purpose provided they comply with all applicable requirements on fire hydrant installation.

(12) Separation from Water Mains

There should be at least a 10-foot horizontal separation between water mains and reclaimed water lines. Reclaimed water lines that cross water mains should be laid to provide a minimum vertical distance of 18 inches between the outside of the reclaimed water line and the outside of the water main. This should be the case where the water main is either above or below the reclaimed water line. At crossings, if possible, one full length of water pipe should be located so both joints will be as far from the reclaimed water line as possible. Special structural support for the water main and reclaimed water line may be required.

(13) Identification of Reclaimed Water Lines

To prevent the situation where reclaimed water lines are confused with potable water mains, the reclaimed water line and appurtenances should be color coded purple and appropriately identified as carrying non-potable water.

(14) Leakage Testing

Leakage tests, including testing methods and leakage limits, should be specified in contract documents.

b. Cross-Connection Control

In areas where both potable water and reclaimed water are being supplied, reduced pressure principle backflow prevention devices should be installed on the potable water supply connections.

c. Horizontal Isolation Distances

(1) Reclaimed Water for Unrestricted Public Access Systems

- (a) There should be a horizontal isolation distance of 400 feet from the edge of a wetted public access land application area to potable water supply wells that exist or have been approved for construction.
- (b) Horizontal isolation distances for Special Protection Streams should be determined on a case-by-case basis.
- (c) Low trajectory nozzles, or other means to minimize aerosol formation from spray irrigation, should be used within 100 feet of public eating, drinking and bathing facilities.
- (d) The edge of the wetted perimeter of the reuse application should not cross into adjoining sites, properties or public roadways that are not part of the DEP-approved location.
- (e) Direct spraying or aerosol transmission of reclaimed water onto any structure or across property lines should be prohibited. Additional setbacks from the wetted perimeter may be required for privately owned occupied dwellings adjacent to commonly owned or leased land utilizing reuse water.
- (f) Reclaimed water should not be allowed to be sprayed or run off onto any adjacent roads.

(2) Restricted Public Access and Crop Systems

- (a) There should be a horizontal isolation distance of 500 feet from the edge of a wetted public access land application area to potable water supply wells that exist or have been approved for construction. No horizontal isolation distance is required to any nonpotable water supply well.
- (b) Horizontal isolation distances of 500 feet should be provided from Special Protection Waters.
- (c) Horizontal isolation distances of 100 feet should be provided from any property line, public eating, drinking and bathing facilities.
- (d) A horizontal isolation distance of 100 feet should be maintained from spray irrigation and adjacent roads.

d. Access Control

- (1) For public access systems, no access control provisions are needed.
- (2) For restricted access reuse areas, access controls are needed and appropriate advisory signs designating the location as “Restricted Access” should be posted around the site boundaries to designate the nature of the project area. An access control plan should be submitted to DEP.

e. Advisory Signs

- (1) For public access systems, the public should be notified of the use of reused water. Examples of some of the notification methods include posting of advisory signs at entrances to residential neighborhoods where reuse water is used for landscape irrigation, and posting advisory signs at golf course entrances and at the first and tenth tees notes on scorecards, or by other methods. International signage is also encouraged. The use of the international standard color (purple) as a prominent color on advisory signs and written notices related to a reuse project is recommended.
- (2) For restricted access areas and agricultural crops, all employees with access to the areas should be notified in writing of the activity and must receive awareness instruction with respect to exposure to reuse water, which does not meet unrestricted public access criteria. This awareness instruction should be specified in the Operations Protocol.

f. Groundwater Monitoring

Groundwater monitoring may be required for groundwater recharge systems where large quantities of reclaimed water are entering the groundwater. This monitoring should consist, at a minimum, of one upgradient and two downgradient monitoring wells. Additional wells may be necessary based on the geology of the site. The wells should be sampled on a monthly basis for BOD, TOC, TOX, total nitrogen, and fecal coliform. The wells should be sampled annually for other primary and secondary drinking water contaminants. Baseline samples should be analyzed prior to system operation. Refer to DEP’s Groundwater Monitoring Guidance Manual, 383-3000-001.

2. Design Engineer’s Report

A Design Engineer’s Report should accompany a Water Quality Management permit application requesting authorization for new or expanded water reuse projects. The Design Engineer’s Report should include the following:

- a. Discussion of treatment processes and methods of operation to ensure compliance with required effluent limits. The discussion should include:
 - (1) The basis for the design of individual unit processes or systems that have been added to the existing permitted system. This summary should briefly

describe the function each unit process or system will provide, including all of the basic assumptions and rationale used in its design. The narrative should clearly identify all key process design parameters including the appropriate calculations.

This section should discuss the ability of the treatment system to meet the established minimum standards for the reuse water and should include the expected removal rates of each unit process and any factors that may affect its performance or operational efficiency. These expected levels of treatment may be based on literature reviews, bench scale tests or pilot plants, the performance of similar treatment facilities, or data from existing operations if the plant is currently in use.

- (2) Supplemental chemical addition or treatment. If supplemental chemical addition or specific chemical treatment is used in conjunction with any of the wastewater treatment processes, the types of chemicals used, the dosage rates, the points of application and the feeder equipment used should be described.
- (3) A map showing the location of all existing and proposed facilities and a description of pumping and distribution equipment. The report should describe any pumping equipment that may be used as part of the treatment, storage, and distribution equipment, including the capacity, location and function of each pump.
- (4) A description of monitoring and control equipment added to facilitate the reuse of the reclaimed water and how it is applied at each particular point in the facility's scheme.
- (5) A discussion of alarms added to facilitate the reuse of the reclaimed water. Attention should be given to the types and locations of all alarms that are used for conditions such as liquid levels, pressure, temperatures, etc. This discussion should also address the procedures for responding to these alarms.
- (6) A discussion of the procedures which will be used in the event that the treatment facility is inoperative, the water quality does not meet reuse standards, or the storage impoundment is not usable because of routine maintenance, power outages, equipment failure, etc. This discussion should also include a description of facility control measures that may be taken, such as the cessation or alteration of selected operations, or the complete discontinuation of the use of the facility during the inoperative period. The narrative should also include a discussion of any provisions for standby or backup systems, such as alternative electrical service and duplicate treatment units or storage facilities.
- (7) A description of site security.

- b. Site Location Information should include:
- (1) The exact boundaries of the reuse project, with horizontal isolation distances shown on the most recent U.S. Geological Survey (USGS) topographic map. These maps should show present land uses within 0.5 mile of the site boundaries.
 - (2) All potable and nonpotable water supply wells and monitoring wells should be located on USGS maps. The depth, yield and screen interval of each well within 500 feet of the reuse application sites along with the use and ownership should also be provided.
 - (3) If expansion of a water reuse project is anticipated, the area likely to be used in the expansion should be shown on the topographic map.
 - (4) Surface water locations, within 500 feet of the project site, should also be provided on the topographic map, along with water body classification, uses and approximate distance from the site.
- c. Project Evaluation should include:
- (1) An evaluation of the overall long-term effect of the proposed reuse project on environmental resources in the area, including changes in water table elevations, the rate and direction of movement of applied reuse water, and changes in water quality in the area associated with the project and similar information.
 - (2) Justification and documentation for using setback distances if other than the minimum outlined in this manual, selection of hydraulic loading rates, and loading and resting cycles.
 - (3) An evaluation of the benefits of the proposed project with respect to public health.
 - (4) Forecasts of flows and reuse water characteristics for the current and design year, including:
 - (a) Physical, chemical, and biological characteristics and concentrations.
 - (b) Reuse water flow patterns - total annual, monthly average, daily average, daily maximum and seasonal peak 1-hour flow during current and design years.
 - (5) Operation and control strategies.
 - (6) An analysis of the effect of removing some or all of the effluent to be reused on the flow of a receiving stream.

d. Soils Information

If the project sponsor requests an application rate greater than the rate specified in Section III. A. for other than Class C reuse water, the engineer's report should include a section on soils information, including:

- (1) A soils map of the site. The soils should be named and described in accordance with the standard criteria (e.g., soil surveys) of the U.S. Department of Agriculture (USDA), Unified or Burmeister Soil Classification System unless advised by the soil scientist of DEP or the National Resource Conservation Service (NRCS) that soils present are not appropriate for such characterization.
- (2) Physical characteristics of each significant soil, subsoil or substratum layer to a depth of 10 feet below the average water table, or to a 20-foot depth (as measured below the lowest point on the site) if no water table is encountered. Representative soil profiles of the site. Soil characteristics such as texture, hydraulic conductivity, available water capacity, organic matter content, pH, sodium adsorption ratio and cation exchange capacity. Appropriate chemical characteristics determined for soil profile horizons active in the chemical and biological renovation of reclaimed water or effluent.

Specific sites used for determining hydraulic conductivity shown on the soils map, and data submitted to substantiate that the proposed site is hydrologically capable of accommodating the design loading and whether or not the application rate will cause a groundwater recharge.

e. Hydrogeologic Survey

If the project sponsor is proposing a groundwater recharge project, the engineer's report should include a section on the hydrogeology of the site. The hydrogeologic information shall address:

- (1) Hydrogeologic data necessary to evaluate the capability of the proposed project to perform successfully at the site on a long-term basis. This information should include, but not be limited to, geophysical information concerning known "solution openings" and sinkhole features within 1 mile of the site; the identification (with applicable geologic sections), extent or continuity, and hydrologic characterization of aquifers and confining zones underlying the site (i.e., horizontal and vertical hydraulic conductivity, porosity, thickness); head relationships between aquifer systems; and information on the annual range of groundwater elevations at the proposed site.
- (2) The velocity and direction of existing groundwater movement and the points of discharge, shown on maps of the area. Similar information regarding environmental impact conditions anticipated as a result of the project.

- (3) Information on potable and nonpotable water supply wells (and monitoring wells, as appropriate, including the depth, length of casing, cone of depression and geophysical surveys of the wells (if available)).
- (4) Flood prone areas on the proposed site and within 0.5 mile of the site located on a map. Flooding frequencies and magnitude based on Pennsylvania State Flood Plans.

F. Land Management System shall include:

If the project sponsor proposes an irrigation project involving Class C reuse water, the engineer's report should include a section on the land management system. The land management system should address:

- (1) The present and intended soil-vegetation management program and the reuse location's vegetative covers. Reclaimed water characterized in terms of its physical, chemical and biological properties. Data and other documentation to verify the uptake of nutrients (such as nitrogen and phosphorus), moisture and salt tolerances, pollutant toxicity levels, yield of crops and similar information. For projects requesting authorization for reuse, detailed water and nutrient budgets (balances).
- (2) Harvesting frequencies and the ultimate use of crops. Length of operating seasons, application periods and rates, and resting or drying periods.
- (3) Plans for storage, reuse or disposal of reuse water during crop removal, wet weather, control of pests, equipment failures or other problems precluding land application.

B. Permitting a New Reuse Project and a New Treatment Facility

The design of a treatment facility requires a Water Quality Management Permit and is subject to the guidelines of the Domestic Wastewater Facilities Manual. The design of the reuse system is subject to the guidelines of Section A above.

C. Permitting an Expansion of an Existing Reuse Project

For projects involving only the expansion of existing reuse projects, DEP may accept an abbreviated engineering report with the following conditions:

1. An analysis of the existing system performance, including project management, shows that the existing project does not result in adverse environmental or health impacts.
2. A description of the proposed expansion adequately documents that the expanded project will be managed to prevent adverse environmental or public health impacts.
3. The expanded project does not require structural modifications of the treatment facility.

4. For Class C the expanded project does not involve the addition of new reuse sites.
5. For Class B and above, if a new reuse site does not discharge to a water body, or is an irrigation site applying water at less than or equal to the agronomic rate.

V. IMPLEMENTING A WATER REUSE PLAN

A. Operating Protocols

An operating protocol is a document describing how a wastewater treatment facility is operated to ensure that only reuse water meeting the applicable standards and quality is released to a reuse system. It is a detailed set of instructions for the operators of facilities. An operating protocol shall be submitted to DEP in support of all water reuse authorization requests. DEP may waive the requirement for an operating protocol for certain types of reuse, depending on the intended reuse application if wastewater quality is not an issue for any reason. An operating protocol shall be approved or waived by DEP before a reuse system is operated. Only operating protocols providing reasonable assurances that treatment and disinfection requirements will be met will be approved.

1. Operating Protocols should include, at a minimum:
 - a. The criteria used to make continuous determinations of the acceptability of the reuse water being produced. This should include the setpoints for parameters measured by continuous on-line monitoring equipment.
 - b. The steps and procedures followed by the operator when substandard water is produced.
 - c. The steps and procedures to be followed by the operator when the treatment facility returns to normal operation and acceptable quality reuse water is again being produced.
 - d. The steps to be taken when there is no reuse demand.
 - e. Procedures for start-up after a shut-down.

2. Operating Protocol Updates

The permittee should periodically review and revise the operating protocol, as appropriate, to ensure satisfactory system performance. The operating protocol should also be submitted for DEP review if the WQM permit is amended. Applications for amending the permit shall include the following:

- a. Current procedures and criteria addressing the requirement of reuse.
- b. Evaluation of the effectiveness of the procedures and criteria in ensuring that reuse requirements are met. This includes an evaluation of any violations of permit requirements during the existing permit.

B. Reclaimed Water Supplier and User Agreement

A Reclaimed Water Supplier and User Agreement is a binding agreement between the party who supplies reuse water and the user.

1. Where the wastewater treatment plant permittee reuses or provides reuse water on property owned by another party, a binding agreement between the involved parties is required. Such binding agreements are required for all reuse sites not owned by the permittee. The permittee shall retain primary responsibility for ensuring compliance with all requirements of DEP's Rules and Regulations.
2. The Reuse Supplier and User Agreement should detail how compliance with the reuse program requirements will be met.

C. Annual Reuse Report

After a facility has received DEP approval for water reuse, the operator should submit an annual report on the total reuse water flow to DEP. The report should include the following information:

1. The total flow reused with respect to the total flow treated by the wastewater treatment facility.
2. The total annual flow to each approved reuse location (name each reuse location).
3. The maximum monthly average flow over the past 12 months for each reuse site.

If the facility is required to submit a Chapter 94 report, the reuse report may be submitted as a section within the Chapter 94 report.