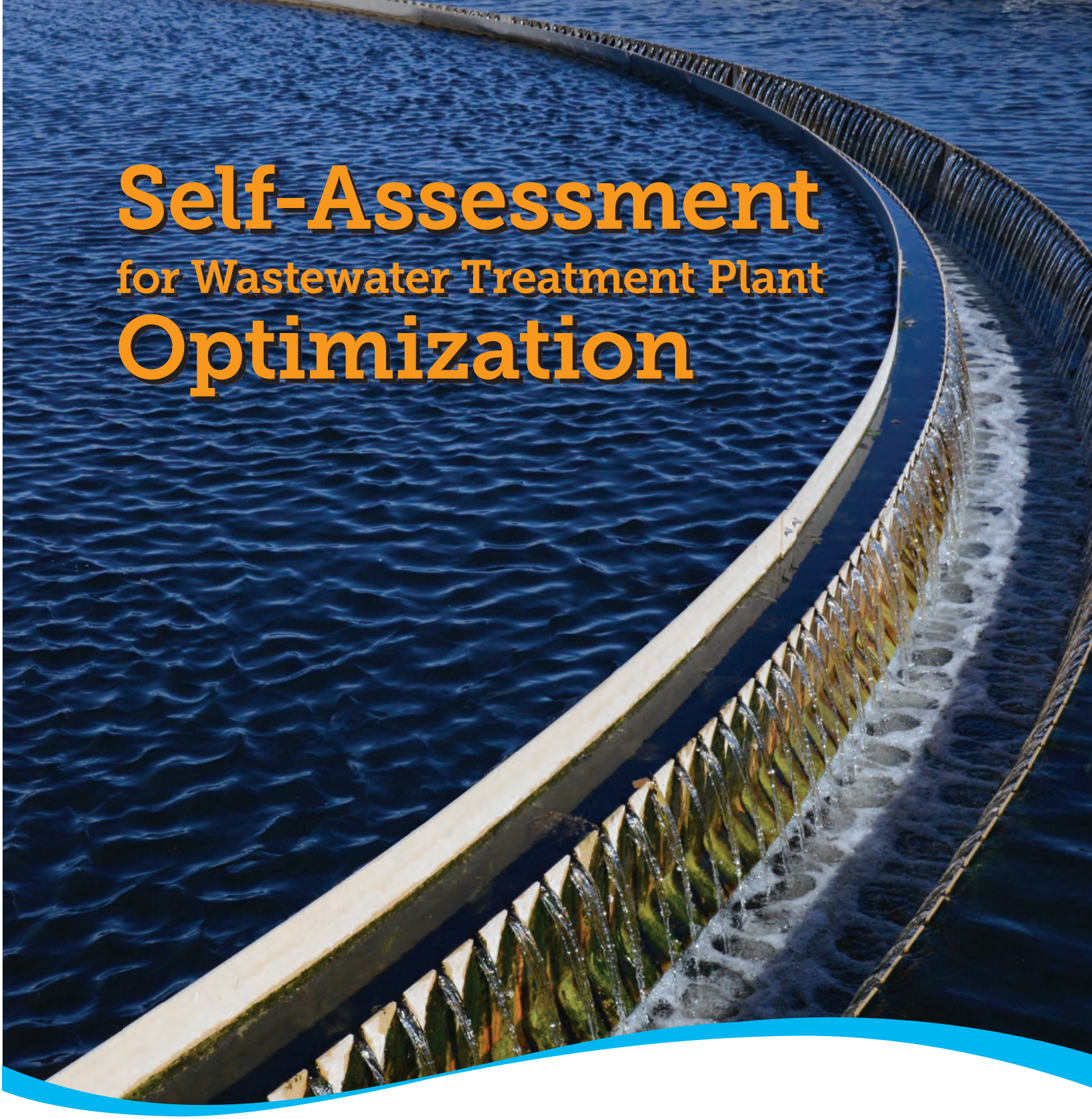

Self-Assessment
for Wastewater Treatment Plant
Optimization

American Water Works Association

PARTNERSHIP FOR CLEAN WATER

Partnership for Clean Water: Self-Assessment for Wastewater Treatment Plant Optimization

American Water Works Association

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These contents represent a sample chapter from the Partnership for Clean Water's wastewater treatment plant self-assessment guidance, Self-Assessment Guide for Wastewater Treatment Plant Optimization. This material is provided to Partnership for Clean Water subscribers, and prospective subscribers, to offer additional insight about this unique voluntary wastewater utility optimization program and the self-assessment process that comprises its core. The Partnership for Clean Water will be officially launched at ACE16.

Established as a parallel program to the successful Partnership for Safe Water, the Partnership for Clean Water's mission is to help utilities preserve environmental water quality and protect public health by optimizing wastewater system operation. Its wastewater treatment plant optimization program focuses on optimizing plant operations to improve effluent water quality, providing a margin of safety beyond current regulatory requirements, and to achieve this in as efficient a manner as possible, limiting consumption of natural resources.

This is achieved by completing a comprehensive self-assessment of wastewater treatment plant performance, operations, and energy efficiency, developing and implementing an action plan for improvement, and continuously monitoring progress towards optimization. The self-assessment process is designed to be flexible and applicable to wastewater treatment plants of a wide variety of sizes and process configurations–including water reuse facilities.

While any wastewater treatment plant may complete the self-assessment process by following the steps outlined in the full guide, utilities are encouraged to subscribe to the Partnership for Clean Water for access to additional resources, recognition, and other subscriber-only benefits. The Partnership for Clean Water welcomes utilities, worldwide, to participate in this voluntary wastewater utility optimization program and benefit from the program's optimization resources. Learn more about the Partnership for Clean Water–or subscribe to the program– at www.partnershipforcleanwater.org.

CHAPTER 1

Introduction

Why Optimize?

Wastewater utilities face the complex and often challenging task of collecting influent water, which can vary tremendously in its composition, and treating that water to a level suitable for discharge to the natural environment or another intended use. This water may contribute to a downstream community's drinking water source or be utilized for a specific reuse application. Because of this, wastewater treatment facilities strive to treat the influent water to maintain compliance with all applicable wastewater treatment regulations and proactively protect environmental water quality and its potential impact on public health. In addition, the facilities strive to meet these goals in as efficient a manner as possible. Wastewater treatment plant staff must be tenacious in order to achieve these goals, but how can they document that they are accomplishing this very important task?

The wastewater treatment process represents a significant consumption of power and natural resources for individual communities and collectively across North America. Wastewater treatment facilities that take steps to minimize power consumption and improve energy efficiency have the potential to reduce operating costs, reduce the consumption of natural resources, and reduce their environmental footprint. The most advanced wastewater treatment facilities truly operate as water resource recovery facilities, recovering resources such as energy and nutrients for beneficial use. How can these utilities establish a systematic process to continually improve process performance and efficiency?

The simple answer to address both of these questions is to participate in the Partnership for Clean Water program. Using the program's practical tools and guidance allows a wastewater utility to document its current performance and evaluate improvements in effluent water quality, while also quantifying improvements in process efficiencies. This is accomplished through a comprehensive self-assessment of wastewater treatment plant operations and performance—

a process that is provided in a stepwise and organized fashion throughout this guide. The objective of this process is to identify factors limiting optimized performance so that an action plan for improvement may be developed and implemented. The mission of the Partnership for Clean Water program is to guide wastewater utilities through this self-examination process while using the program's tools and resources. Although the Partnership for Clean Water program was launched in 2016, it was established as a parallel program to the Partnership for Safe Water, a drinking water utility optimization program with more than 20 years of history. The Partnership for Safe Water subscriber utilities collectively serve a population of more than 100 million across North America. Using similar tools and processes to those provided in this guide, the Partnership for Safe Water program has helped program subscribers to make significant improvements in drinking water quality.

Similar to the Partnership for Safe Water, the Partnership for Clean Water was established "For Utilities by Utilities" to provide a practical approach to improve operations, plant efficiency, and effluent water quality in a user-friendly, nonregulatory manner. For utility staff, the objective of this approach is for its application to quickly become second nature and inherent in day-to-day operations. The program's annual data submission and review process allow a utility to regularly monitor progress while striving to continually improve. Working through the process, the incremental changes and improvements made in process control actually become infectious—and therefore easily transferrable to transform the culture of the entire organization.

The foundation of this voluntary wastewater utility improvement program is the self-assessment process. Through this process, a utility evaluates its present strengths and weaknesses. Each utility can tailor the process to fit its own staff resources and experience based on a schedule set by the utility. No time requirements are associated with completion of the self-assessment process. The key is to take small, incremental steps to make operational improvements using the practical program tools. The Partnership for Clean Water data collection software allows a utility to collect data and analyze operations very easily, thus allowing fluctuations in daily, weekly, or monthly performance to be trended, reviewed, and improved. Over time, this approach allows the participating utilities to recognize trends and develop prioritized action plans that are managed and scheduled by the utility. This self-assessment process has been the key to the Partnership for Safe Water's success for the last 20 years, and it has been proven effective for utilities of any size. The self-assessment process is also the foundation of the Partnership for Clean Water Water program.

The Partnership for Clean Water program is supported by a very talented group of volunteers who provide utility peer review of the submitted Self-Assessment Completion Reports. With this approach, the people who are most familiar with day-to-day utility operations assist the participating utilities with

their optimization efforts. This makes the goal of continuous quality improvement much easier and attainable for utilities of any size.

The Partnership for Clean Water program's goal is to make small, incremental improvements in day-to-day operations that collectively lead toward continuous performance and operational improvements that can improve effluent quality and the efficiency of treatment plant operations. Why not join the best program available to accomplish this critical task?

Wastewater Treatment Terminology

Throughout the industry, a variety of terms may refer to the facilities that treat influent wastewater for discharge into the environment or for another intended use. Some common terms used to refer to these facilities include wastewater treatment plant (WWTP), wastewater treatment facility (WWTF), publicly owned treatment works (POTW), water reclamation plant (WRP), and water resource recovery facility (WRRF). The Partnership for Clean Water acknowledges the use of all these terms, which all are used to accurately reflect the nature of the treatment provided at a specific facility. The Partnership for Clean Water also acknowledges the applicability of the self-assessment process, and portions of this guidance, to water reuse facilities and applications.

For consistency, a single term was selected as the most accurate reflection of the objective of this guide: wastewater treatment plant (WWTP). The guidance provided relates to the optimization of wastewater treatment plants with regards to increasing the efficiency of the facility as well as improving effluent water quality. While resource recovery is encouraged at facilities for which it is a practical objective, comprehensive guidance for achieving recovery of energy and/or nutrient resources is beyond the scope of this work. Readers are directed toward the wastewater industry resources referenced at the end of this chapter for additional information regarding resource recovery.

An additional term used throughout this guide is 5-day biochemical oxygen demand (BOD_5), which is reflective of the total biochemical oxygen demand present in the water. Plants may analyze and be permitted on BOD_5 or carbonaceous biochemical oxygen demand ($CBOD_5$). The $CBOD_5$ is a measure of the carbonaceous biochemical oxygen demand of the water, accomplished by adding a nitrification inhibitor chemical to the sample prior to analysis, which prevents nitrification from occurring. Although it is difficult to define a relationship that is accurate for all waters, in some cases BOD_5 has been estimated to be approximately 15 percent higher than the $CBOD_5$ concentration. Throughout this book, the term BOD_5 is used to represent both BOD_5 and $CBOD_5$. Plant staff should select the appropriate parameter(s) to consider when completing the self-assessment process. In cases when BOD_5 and $CBOD_5$ must be differentiated, the distinction will be clearly noted in the text.

Partnership For Clean Water Background

The Partnership for Clean Water is a voluntary wastewater utility program that was originally created to parallel the Partnership for Safe Water's successful drinking water optimization program that has been active for more than 20 years. The Partnership for Clean Water program will ultimately consist of four phases, three of which have been launched at the time of this writing. All program subscribers are encouraged to participate through Phase III, the self-assessment phase. (The proposed Phase IV will represent fully optimized performance and will be optional.) Participating wastewater treatment plants that complete all four phases of the program are determined to have achieved fully optimized operations and performance as reviewed, analyzed, and approved by the Partnership for Clean Water peer reviewers and optimization experts. The Partnership for Clean Water program is designed to be flexible, with future program and resource development anticipated to meet additional industry needs, such as those associated with resource recovery.

Partnership programs are self-directed and self-paced. They are based on completing a comprehensive self-assessment of treatment plant operations and performance as described in this guide. Treatment plants participating in the program submit self-assessment completion reports. These reports are peer reviewed by utility professionals and optimization subject matter experts who complete the review based on an established process. The reports are evaluated according to specifically defined report evaluation criteria; the criteria are designed to evaluate a utility's efforts in completing the self-assessment process.

The following sections describe the three established phases of the Partnership for Clean Water program as well as key principles of the proposed Phase IV. These phases apply similarly to the Partnership for Clean Water program (discussed in this guide) and the Partnership for Safe Water drinking water optimization program (not covered in this guide). The Partnership for Safe Water program has a dedicated drinking water treatment plant self-assessment guide, available from AWWA, titled Self-Assessment for Water Treatment Plant Optimization. Additional information about the Partnership for Clean Water and Partnership for Safe Water programs may be obtained by contacting the American Water Works Association. To participate in either program, utilities must apply and meet specific program eligibility requirements.

Phase I: Phase I is based on utilities making the commitment to participate in the Partnership for Clean Water's wastewater treatment plant optimization program and complete the program through Phase III. To complete Phase I, the utility will return the membership application, pay its dues, and be provided with access to the program materials, such as the software, user information, and the published self-assessment guide. At this phase of the program, subscribers are encouraged to review the program resources provided and identify key individuals to be involved in the Partnership process.

Phase II: Phase II consists of submitting baseline data for selected wastewater treatment parameters, including biochemical oxygen demand (BOD_5), total suspended solids (TSS), total phosphorus, and ammonia nitrogen, relative to the plant flows and discharge permit levels. Wastewater utility staff use the program's data collection software to submit 12 months of performance data to the Partnership. After submitting baseline data, plants continue to submit data on an annual basis; the data are compiled into an annual report published by the Partnership for Clean Water program. By establishing a performance baseline, the utility will be able to quantify the impact of its ongoing optimization efforts on effluent water quality. In aggregate, this data also allows the overall impact of the program on wastewater effluent quality and, ultimately, its environmental impact to be quantified. All data submitted to the Partnership are confidential.

Phase III: Phase III represents the core of the Partnership program and consists of completing the wastewater treatment plant self-assessment process. Subscribing utilities are strongly encouraged to complete Phase III. Completing Phase III also serves as the basis for receipt of the Directors Award, industry-wide recognition provided by the Partnership for Clean Water for program subscribers that successfully complete the self-assessment process. The self-assessment process is designed to be utility-directed and self-paced, so that it may be completed according to a schedule that provides the greatest amount of information and benefit to utility staff. Utility staff follow the self-assessment process, as indicated in this self-assessment guide, in order to identify performance limiting factors (PLFs) and develop a targeted action plan to improve performance. The results of the self-assessment are compiled in the self-assessment completion report, which is submitted to the Partnership for Clean Water for peer review. The Phase III process continues to focus on effluent water quality and process efficiency; it also includes procedures for evaluating plant and process energy usage, which may be assessed on an annual basis to quantify the impact of optimization efforts.

The self-assessment completion report prepared by the utility in Phase III is reviewed by trained utility volunteers, consisting of wastewater treatment plant optimization experts, in accordance with an established process. This group of volunteers is referred to as the Program Effectiveness Assessment Committee (PEAC). The PEAC reviews self-assessment completion reports according to a set of defined evaluation criteria, which cover the broad categories of Performance, Administration, Operations, Design, and Overall. Reports are peer reviewed to ensure that utilities have made a good faith effort to assess wastewater treatment plant operations. After a successful review, the utility and treatment plant receive the program's Directors Award for completion of Phase III of the program. Award-winning utilities receive industry-wide recognition at AWWA's Annual Conference and other venues. Phase III utilities retain their award status by submitting annual progress updates, which consist of performance data and a short narrative report that describes optimization activities completed during the annual reporting period. The Partnership recognizes Phase

III utilities for maintaining their status and performance level for long-term periods, and utilities are recognized at five-year intervals.

Phase IV: Phase IV is an optional, but encouraged, phase of the program that is planned to recognize wastewater treatment plants that have achieved the highest possible levels of performance. Achieving Phase IV is based on meeting stringent effluent water quality performance goals and demonstrating full optimization. To apply for Phase IV program recognition, the plant must be a Phase III utility in good standing and is required to submit a Phase IV award application according to the Partnership for Clean Water guidelines. Phase IV award-winning facilities also receive industry-wide recognition for their achievements. At the time of this writing, Phase IV of the Partnership for Clean Water program is under development.

Partnership for Clean Water and Effective Utility Management (EUM)

The Partnership for Clean Water guidance and self-assessment process is designed to be complementary and compatible with existing resources and programs for wastewater utility operations and management. One of these resources is AWWA's Utility Management Standards, which includes ANSI/AWWA G510: Wastewater Treatment Plant Operation and Management. This standard includes detailed descriptions of the essential or critical requirements for the effective operation and management of a wastewater treatment plant. Many of these principles are echoed throughout the Partnership for Clean Water's wastewater treatment plant self-assessment process.

Effective Utility Management (EUM) resources are another tool that wastewater utilities may apply to assess and continuously improve utility management practices. EUM is built around *Ten Attributes of Effectively Managed Utilities and Five Keys of Management Success,* which cover all aspects of utility operations and is a well-accepted framework to help utilities improve their performance and move towards sustainable operations. EUM resources were developed by a collaborative partnership of several agencies, including the Association of Metropolitan Water Agencies (AMWA), the American Public Works Association (APWA), the American Water Works Association (AWWA), the National Association of Clean Water Agencies (NACWA), the National Association of Water Companies (NAWC), and the United States Environmental Protection Agency (USEPA). Many of these organizations also participate in Partnership programs, such as the Partnership for Clean Water and Partnership for Safe Water. The Ten Attributes include areas such as Operational Optimization, Product Quality, Operational Resiliency, Financial Viability, Employee Leadership and Development, and Stakeholder Understanding and Support. The Effective Utility Management Primer is a descriptive guide that provides a framework for assessing utility management practices according to the Ten Attributes. Areas of the

Partnership for Clean Water self-assessment process include consideration of topics that fall within several of The Ten Attributes areas. Completion of the Partnership for Clean Water self-assessment process can be a tool used to support and enhance a wastewater utility's EUM assessment, strategy, and progress. Additional information and EUM resources may be obtained online at www.watereum.org.

How To Use This Guide

Self-Assessment Overview

The self-assessment process was developed to assist a wastewater treatment plant in evaluating its current performance with respect to efficiently and consistently producing a compliant effluent water with concentrations of regulated contaminants (such as BOD_5, total suspended solids, and nutrients) meeting or exceeding regulatory permit requirements. The self-assessment process also helps utilities identify areas for improvement in energy efficiency and operations through which potential operational cost savings may be realized. Through completion of the self-assessment process, a wastewater treatment plant evaluates the current level of plant performance with respect to the Partnership's optimization goals and determines if performance improvements are needed. The objectives of the self-assessment are to identify the reasons for less-than-optimized performance by reviewing its operational practices, level of administrative support, and plant unit process capability, and to develop a plan to address the identified limitations in order to improve plant performance. In the process of completing the self-assessment, the utility may identify and prioritize performance limitations, develop an action plan, and, over a period of time, implement improvements to move the treatment plant toward optimized performance. It is important to note that, while some improvements may be implemented to result in near immediate changes, many wastewater treatment process improvements may take a significant amount of time (weeks, months, or even years, in some cases) to realize performance improvements. Both short- and long-term planning are encouraged in the development of action plans, which are described in greater detail in chapter 8.

This guide is a source document for utilities that would like to conduct a self-assessment to improve the performance of existing wastewater treatment plants employing a variety of unit processes. The guide primarily addresses the assessment and optimization of procedures to assist wastewater treatment plants in comfortably meeting typical regulatory permit requirements for parameters such as BOD_5, total suspended solids, and nutrients—and achieving these goals in as efficient a manner as possible. Optimization goals may be developed for any unit process in the treatment plant, however, and the consideration of these goals is encouraged. Optimization goals may address water quality parameters, operational parameters, or both. Achieving these levels of performance will help

to maximize the protection of environmental water quality from contamination by nutrients and other wastewater-related parameters and help to protect source water quality.

It is not anticipated that all utilities will meet the Partnership's suggested optimization goals, or their own internally established goals, when the self-assessment process is first undertaken. One objective of completing the assessment is to better understand and quantify current plant performance, so that areas limiting optimized performance can be identified and an action plan can be developed that allows the utility to work toward improved performance and, ultimately, optimization.

This guide is not intended to describe, in detail, cost-saving options or to present alternatives for designing new facilities for expansion purposes. The focus of the self-assessment is to maximize the performance of existing facilities by optimizing operations with limited capital expenditures. In some cases, however, the optimization approach described may result in cost savings and/or increased capacity from existing facilities, particularly with regards to improving the energy efficiency of facility operations. Utilities are encouraged to consider correlating their optimization efforts with any potential cost savings that may be achieved. Although beyond the scope of this work, utilities are also encouraged to consider opportunities for resource recovery in applications where it may be practical and beneficial.

This guide follows the framework of the Partnership for Clean Water program, a voluntary program designed to support and recognize utilities that make the commitment to improve environmental water quality by optimizing wastewater treatment plant and collection system operations. Although participation in the Partnership for Clean Water program is not required in order to assess treatment plant operations according to the steps presented in this guide, Partnership participation is encouraged in order to access the program's full offering of software tools, support, and resources.

The Structure of This Guide

This guide is designed for use in conjunction with additional Partnership tools that assist staff in conducting a comprehensive self-assessment of wastewater treatment plant performance and developing a self-assessment completion report. Partnership plants submit the completion report to the program's PEAC for utility peer review and feedback. After successful completion of this process, plants are eligible to receive the Phase III Directors Award. Although the guide focuses primarily on the assessment of wastewater plants for effluent quality and energy efficiency practices, the self-assessment principles and questions may be applied to any type of unit process and/or application, including proprietary processes.

The guide is organized to provide utility plant staff with steps for completing the self-assessment in a logical fashion. The self-assessment process includes

the following categories, each listed with the chapter number in which they are addressed:

- Performance Assessment (chapter 2)
- Capacity Assessment (chapter 3)
- Unit Process Performance Assessment (chapter 4)
- Facility Energy Optimization (chapter 5)
- Application of Operational Concepts (chapter 6)
- Administrative Assessment (chapter 7)
- Identification and Prioritization of Performance Limiting Factors and Action Plan Development (chapter 8)

Additionally, the guide's Appendix contains a variety of resource materials and links that are relevant to utilities completing the self-assessment process.

Each chapter is organized to include three primary sections titled Understanding, Status, and Action. The Understanding section provides background information about the topic, the key objectives for the section, selected case study examples, and discussion of the key issues critical to meeting the performance goals. The Status section contains the key self-assessment questions to be addressed by plant staff to gain insight into how current plant practices support the performance goals. The Action section contains information that may assist plant staff with developing an action plan to address performance limiting factors and work towards improved performance.

Throughout the guide, links are provided to relevant resources and tools, most of which are located in the Appendix section of this document. Look for references and links to these items to be highlighted throughout the document.

A wide range of unit processes are included in this guide but not all processes will be relevant to all treatment plants undertaking the self-assessment process. To complete the Partnership for Clean Water self-assessment process, utilities need only answer the self-assessment questions that pertain to the unit processes relevant to their treatment plant.

Composite Correction Program Background

To better understand the self-assessment process, it is helpful to have knowledge of the history and original basis for the process, which is described in more detail in this section. The authors encourage readers to refer to the original references if questions arise or if more historical context is desired. When older documents are referenced, the reader is reminded that significant changes have occurred in the industry—even though the principles and processes associated with completing the self-assessment have changed little in the past decades. Changes in treatment processes, water quality monitoring technologies, and the regulatory environment may impact specific components referenced in prior documentation.

The format for the self-assessment process was originally derived from the USEPA's work, "Improving POTW Performance Using the Composite Correction Program Approach," published in 1984. This work was written in response to the industry environment at that time, in which many wastewater treatment plants were in need of performance improvements, while provided with limited funding to implement such improvements. The work was developed in collaboration with consultant, Process Applications, Inc. (PAI), which has contributed to the wastewater and water treatment plant optimization effort for more than 30 years. The Composite Correction Program (CCP) approach was subsequently applied to water treatment plants in a work developed by the USEPA and PAI, in 1991, as a means to optimize drinking water plant performance for particulate removal to reduce the potential public health risks from pathogens, such as *Cryptosporidium* (Renner et al. 1991). Applied in both wastewater and drinking water, the CCP is a two-part process consisting of an evaluation phase, called a Comprehensive Performance Evaluation (CPE), and a correction phase, called Comprehensive Technical Assistance (CTA). The CCP is a comprehensive, systematic approach for assessing the root causes of performance problems at existing treatment plants. It is comprehensive in identifying the unique combination of factors in the areas of design, operation, maintenance, and administration that are limiting performance. Specific guidance on using the CCP for achieving optimized performance is provided in the USEPA CCP manual.

The Water Research Foundation (WRF, formerly AWWA Research Foundation) workshop titled Optimizing Surface Water Treatment Plant Performance (WRF 1995) also contributed to the Partnership's drinking water self-assessment content. During the workshop, approximately 20 water treatment experts from around the United States gathered to discuss water treatment optimization. The workshop participants focused on the factors affecting treatment optimization for particle removal at conventional water treatment plants. The information assembled during the workshop was intended for use by the Partnership for Safe Water's partner organizations (USEPA, American Water Works Association, Water Research Foundation, Association of Metropolitan Water Agencies, Association of State Drinking Water Administrators, and National Association of Water Companies) in their development of a utility staff-driven self-assessment process. Specific criteria for identifying optimized facilities were derived from this workshop (WRF 1997). Both the Partnership for Safe Water and Partnership for Clean Water self-assessment guidance documents stem from the outcome of this workshop, as well as the original USEPA manuals.

Performance limiting factors are broadly grouped in four areas: administration, maintenance, design, and operation. Each area is important because a single factor in any area can individually contribute to poor performance. However, when implementing a self-assessment program, the relationship of these categories to achieving the goal of consistently and efficiently producing a compliant

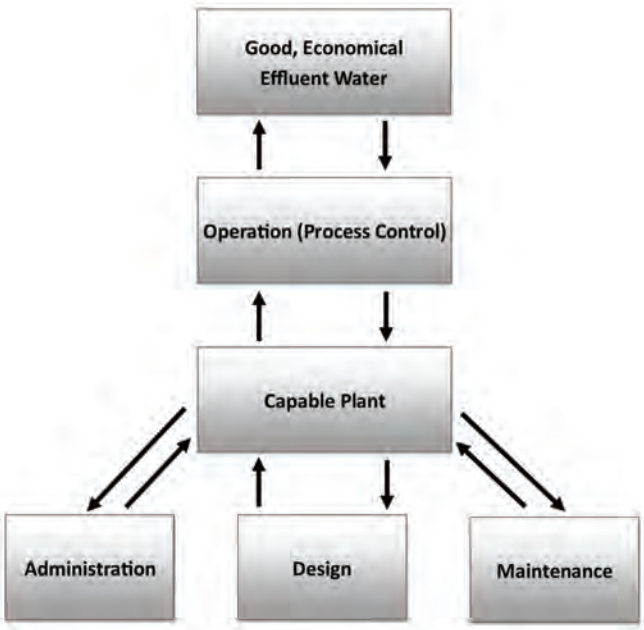

Figure 1-1 Capable plant model

effluent water must be understood. The relationship of utility administration, design, maintenance, and operation in the production of a compliant treated effluent water on a continuous basis is illustrated in Figure 1.1. As shown, good administration, design, and maintenance practices combine to make a plant that has the capability of producing a consistently compliant treated effluent. Applying good operational (process control) practices to a capable plant results in the efficient production of a good, economical effluent water on a continuous basis.

Figure 1.1 illustrates the most direct approach to improving performance. For example, if effluent nutrient concentrations cannot be consistently maintained at desired levels because operating staff are not at the plant to make process adjustments in response to changing influent water quality, then improved performance will require better staff coverage. In this case, identified limitations in meeting process control needs (i.e., limitations in making process adjustments) help establish the priority for improving staff coverage (i.e., an administrative issue). Additional staff would alleviate the identified deficiency and allow the processes to be adjusted so that progress toward the performance goal can be continued.

Self-Assessment Goals

The Partnership for Clean Water goal-setting philosophy, described in this section, encourages plants to set optimization goals representative of performance that provides a margin of safety for compliance with regulatory requirements without incurring extraneous treatment expenses.

Plants participating in the Partnership need to adopt a set of effluent quality, energy efficiency, and/or operational optimization goals to assess current plant performance and optimization status as well as complete the Performance Assessment component of the process. However, at this phase of Partnership involvement, plants working on completing the self-assessment are not required to meet these performance goals. Plants should consider adopting the Partnership optimization goals described in the following sections. Wastewater systems may also consider developing an internal or interim set of treatment plant optimization goals to be used for the assessment and long-term performance planning purposes.

The Partnership's effluent quality optimization goals for biochemical oxygen demand, total suspended solids, ammonia nitrogen, total phosphorus, and sludge accountability are displayed in Table 1.1. Again, note that the suggested goals are optimization targets—not discharge permit regulatory requirements or requirements for successfully completing the self-assessment. Plants also may want to develop their own unique set of optimization goals, for assessing performance, based on specific needs of the treatment plant, issues identified through the self-assessment process, or any other performance goals that the treatment plant wishes to attain, such as those associated with specific resource recovery or reuse applications. An important component of the self-assessment process is the assessment of plant performance relative to specific performance goals.

The effluent quality optimization goals are provided as a percentage of the plant's discharge permit limit. Therefore, the absolute numerical value of the optimization goal for each parameter may vary from plant to plant. If a plant does not have a permit limit for a specific parameter included on this table, they are still encouraged to monitor and report data for this parameter to the Partnership. All data submitted to the Partnership for Clean Water program remains confidential. The data collected and reported as part of the annual data reporting and self-assessment process may be evaluated by treatment plant staff for the purpose of establishing baseline performance, the result of which may be used to develop future plant-specific optimization goals. Similarly, plant-specific goals may be set for additional unit processes employed by the plant or for additional water quality parameters, as described in upcoming chapters. If plants do not have a means of monitoring water quality for each unit process described below, that should not be considered an obstacle to completing the self-assessment. Rather, plants with gaps in data collection may consider collecting as much data as possible using the means available to them and highlighting areas any data deficiencies that may exist as potential action items for future improvement.

It is important to note that, regardless of the unit process, a major goal for wastewater treatment plants completing the self-assessment is *consistent* treatment plant performance that is maintained regardless of changes in influent water quality or flow. Therefore, optimization goals should be considered relative to daily/monthly average permit limits, rather than solely the maximum values.

A more comprehensive discussion of optimization goals and their relation to the Performance Assessment is included in chapter 2 of this guide.

Table 1-1 Partnership for Clean Water optimization goals

Parameter	Goal description	Partnership optimization performance goal
Ammonia nitrogen (effluent)	Continuous stable performance regardless of variations in influent and upstream process quality	< 95% of plant permit limit
$CBOD_5/BOD_5$ (effluent)		
Total phosphorus (effluent)		
Total suspended solids (effluent)		
Sludge accountability	+/- 15% agreement between theoretical and actual sludge volumes based on use of the activated sludge mass control spreadsheet provided with this guide (refer to Chapter 2 for additional detail)	
Energy efficiency (kWh/MG)	Annual reduction in energy consumption per volume of water treated	

Getting Started With the Self-Assessment

While utilities may complete the self-assessment in any manner considered to be appropriate, the self-assessment should be a team effort among management, operations, maintenance, and lab staff. The greatest amount of learning and benefit can be obtained by involving staff at all levels in the self-assessment process and making continuous improvement and optimization a part of everyone's function at the utility, regardless of where a position may reside on the utility's organizational chart. Some suggestions for encouraging broad team involvement in the process include

- Seek management support for completing the self-assessment.
- Formally establish a self-assessment team that includes representatives from across the utility's treatment plant staff. The composition of this team may vary depending on the utility size and structure, but it is recommended that the team involve staff from as many levels and functions as possible.
- Establish regular self-assessment meetings during which staff are encouraged to discuss plant performance as well as specific self-assessment questions. The frequency of these meetings may vary, but many utilities

report scheduling team meetings at a frequency of once a week or once a month.

- Act on team findings. If an action item is identified that is able to be—or should be—addressed now, don't wait until the self-assessment is completed to take action. Allow staff to take ownership of actions they identify, including conducting special studies or developing operational tools, to start taking steps towards optimization. A report of the progress made can be included in the self-assessment completion report.
- Be mindful that the purpose of the self-assessment is not to find faults and assess blame, but rather to serve as a systematic process to identify and correct issues that are negatively impacting plant performance.

The many ways that utilities can encourage and promote team involvement in the self-assessment process are limited only by the ideas developed by utility staff. If a utility finds that it cannot complete the self-assessment as a team comprised of operations and management staff, it may consider how these attitudes may limit performance, particularly in the administrative section of the self-assessment. The utility may find that working through the self-assessment process as a team results in improved communication and understanding at all levels.

Finally, the self-assessment is a self-paced process. There is no time limit during which a utility is required to complete the self-assessment. The schedule for completion of the self-assessment is set by the utility in a manner that allows utility staff to derive the greatest benefit from the self-assessment process while working with the resources available.

Once the utility obtains support for the self-assessment process and forms a self-assessment team, it is ready to develop an approach and begin the process. As discussed previously, there is no deadline for completing the self-assessment, and utilities are free to complete the process according to a flexible timeline that provides the most benefit to utility staff and plant performance. There is no single correct way to complete the self-assessment, although many utilities have implemented regular, recurring meetings of utility staff to discuss the assessment questions and optimization principles.

The structure of this guide parallels the major steps of the self-assessment process and provides the complete framework required to complete a self-assessment of treatment plant performance according to Partnership for Clean Water guidelines.

Chapter 1

Chapter 1 provides background information about the self-assessment process and how to begin the process by establishing a team and procedures for completion.

Chapter 2

Chapter 2 describes how to conduct a performance assessment to determine the existing level of performance of the utility's wastewater treatment plant. Based on the findings of the performance assessment, the utility staff will know how the treatment plant performance compares relative to the Partnership's or the utility's internally established optimization goals. Even if the performance assessment reveals that plant performance is optimized, it is recommended that the utility complete the remaining parts of the self-assessment, which are required in order to attain the Phase III Directors Award level of program recognition. This will allow plants to more fully examine all aspects of treatment plant operations, including administration, process control, and energy usage, to identify and "polish" any potential factors limiting completely optimized performance, and to ensure that the plant's excellent performance is not simply due to a stable and predictable influent quality. Plants that receive a consistently stable and predictable influent stream may derive benefit from the self-assessment to ensure that this predictability does not mask a lack of treatment skills and lead to complacency in plant staff. After completion of the performance assessment, the self-assessment team should then proceed to the tasks outlined in chapters 3 through 7. These chapters examine design, operational, and administrative areas to help utilities identify any performance limiting factors that may inhibit optimized plant performance.

Chapter 3

Chapter 3 discusses the *capacity assessment*. An assessment is made of the physical size of the plant's major unit processes (i.e., the concrete basins) to determine if they are of adequate size to meet the desired performance goals to minimize the plant's impact on environmental water quality. These findings will help the assessment team determine if any of the plant's major unit processes are limiting the plant's performance and whether the current physical facilities are adequate to meet the optimization goals. If the basin sizes are adequate, it is likely that other factors in the areas of design, operation, or administration are limiting optimized performance. Although the objective of the self-assessment is to improve performance through operational improvements while minimizing major capital expenditures, plants that identify a severe design or capacity deficiency using the procedures provided in this chapter may find that more significant modifications to plant design may be required to ultimately improve plant performance.

Chapters 4–7

Chapters 4 through 7 outline procedures to identify *unit process-specific, operational, facility energy efficiency,* and *administrative* factors that may limit performance, respectively. In each chapter, one or more performance limiting factors

checklists allow the assessment team to review the material collected during the evaluation of a specific topic (e.g., unit process, operation, or administration).

- **Chapter 4: Unit Process-Specific.** Note that the unit process-specific components included in chapter 4 include aspects other than capacity that are not addressed in chapter 3. An example of a design aspect covered in this chapter may be the impact that flow distribution between multiple basins has on optimized performance.
- **Chapter 5: Facility Energy Efficiency.** Chapter 5 is specific to assessing and improving facility energy usage and site-specific energy efficiency (process-related energy efficiency aspects are addressed in chapter 4).
- **Chapter 6: Operational.** The operational topics addressed in chapter 6 include assessment of the plant's process control program and the operation staff's ability to interpret and respond to water quality and process changes with the appropriate controls.
- **Chapter 7: Administrative.** Chapter 7 addresses administrative issues such as staffing, funding, training, and policy that are required to provide a capable plant that allows operations staff to meet the performance goals. Many of the concepts included throughout these chapters are illustrated with utility case studies.

Each chapter contains a list of self-assessment questions for the team's consideration. At the end of each chapter is a table that summarizes responses to each question, including columns to indicate if each factor is considered Optimized, Partially Optimized, or Not Optimized. If the team considers an area to be optimized, the factor listed is not considered to be limiting plant performance and should not be considered further. The self-assessment completion report should contain documentation or an explanation that supports the selected optimization status, which may include information such as that generated by a special study in some cases. However, if the status of a particular item is determined to be Partially Optimized or Not Optimized, the factor is considered to be limiting plant performance and should be considered in the identification and prioritization activities of chapter 8. Likewise, the self-assessment completion report should include documentation to support the conclusion. Ultimately, factors that are determined to not be optimized should be associated with an action-improvement plan, as described in chapter 8.

Chapter 8

Chapter 8 presents a method for the self-assessment team to identify, in order of priority, the most important factors that may be limiting plant performance as determined from the assessment conducted in the previous chapters. This provides clarity to the team as to where follow-up activities should be conducted to implement improved plant performance. *The goal of the self-assessment is to optimize existing facilities without major capital improvements*. Utilities do not

need to wait until the self-assessment is complete to begin addressing action items. Utilities may find it beneficial to begin work on action items while the self-assessment is in process. Any progress made on action items should be documented in the self-assessment completion report (with the understanding that, with the implementation of some process improvements, it may take some time before performance improvements are realized).

A significant aspect of this program's assessment and optimization process is that it is valuable for utilities and plants of all sizes and process configuration. The Partnership for Safe Water program's parallel water treatment plant self-assessment process has been successfully applied at plants of a broad range of sizes and types, with some of the smallest plants to successfully complete the process serving a population as small as 2,000. Over the program's 20-year history, the plants serving the smallest populations were able to improve treated water quality to the same extent as plants serving populations higher than 700,000. While the numerical results of this drinking water program may not be directly transferrable to wastewater treatment plants, the ability of all treatment facilities to improve performance, regardless of size, as a result of staff focus on operations and performance is a concept relevant to both water and wastewater treatment plants alike.

For Partnership for Clean Water subscribers, the optimization process does not end after completion and submission of the self-assessment completion report. The optimization process is ongoing as plant operations, and the plant itself, continue to evolve and change with the passage of time. Once action items are identified and prioritized, utility staff should work on implementing and completing these items. Utility staff should continue to regularly review unit process performance data for the most critical operational parameters to ensure that performance continues to be maintained or improved. Plants that were performing at a very high level prior to completing the self-assessment may not see their improvements reflected as significantly in the data; in that case, the utilities should look to other areas to measure improvement, such as reliability, consistency, and operator knowledge. Utility staff should also plan to review progress on the action items and continue to identify any additional areas that may limit optimized performance. Plants may even want to repeat the completion of the self-assessment process on a regular basis, such as every three to five years, although this is not a Partnership for Clean Water program requirement. If needed, the utility can develop new action plans to address any newly identified performance limiting factors to ensure that the plant remains on track to continuously improve. By implementing such a process at a utility, the self-assessment and continuous improvement processes can eventually become an embedded component of the utility's culture.

Figure 1-2 presents a step-by-step representation of the recommended approach for completion of the self-assessment, as described in the previous section.

Step 1 Complete Performance Assessment (chapter 2) *Determine current level of plant performance versus optimization goals*
Step 2 Complete Capacity Assessment (chapter 3) *Determine if sizes of major unit processes are limiting performance*
Step 3 Complete Unit Process Performance and Energy Assessments (chapters 4–5) *Identify other aspects of unit process design limiting performance*
Step 4 Complete Operations Assessment (chapter 6) *Identify operational practices limiting performance*
Step 5 Complete Administration Assessment (chapter 7) *Identify administration practices limiting performance*
Step 6 Assemble and Prioritize Comprehensive List of Factors Limiting Performance (chapter 8) *Identify activities to address factors that will improve performance*
Step 7 Implement Activities that Will Improve Performance
Step 8 Assess Performance Improvements

Figure 1-2 Steps for completion of self-assessment

Self-Assessment and its Role in the Partnership for Clean Water

The self-assessment technique is a cornerstone of the Partnership for Clean Water program. The Partnership approach leaves all decision-making to the participating utility and provides guidance that allows utility staff to conduct their own specifically tailored approach to achieving optimization. This self-assessment guide provides questions that prompt utilities for answers that fit their own unique self-assessment process.

Utilities undertake their Phase III self-assessment in a manner that fits the organization and expertise within their specific utility. In most cases, a team is assembled comprising staff with a stake in optimizing treatment process control or an important role in achieving treatment optimization success. The team may consist of operations, maintenance, instrumentation, laboratory, and administrative/management personnel. In addition, one or two team members typically serve as "champions" of the self-assessment by guiding the team's efforts and tracking down answers to many of the team's questions. Once the team is assembled, the team members typically gather data and review the self-assessment guide through a series of meetings. The meetings can be spread over several months or longer. The self-assessment questions are intended to spark utility staff to further search for treatment optimization opportunities. The team may augment its meetings with visits to specific areas of the plant to view the aspects of treatment optimization under discussion.

Utilities have reported significant success in treatment optimization following the Partnership's self-assessment process. The strength of the process is a bottom-up approach where the utility undertakes and controls the optimization process using Partnership program guidance and data collection software. Utilities develop and implement action plans that are derived directly from the Partnership's self-assessment process. These action plans allow utilities to strive to identify and greatly reduce complacency, significantly increase reliability, and improve performance and efficiency.

Self-Assessment Completion Report

Partnership for Clean Water subscribers are required to submit a self-assessment completion report upon completion of the self-assessment process. After completing the self-assessment process with the team, using this guide as a tool, the team champion develops a report that summarizes the self-assessment results. In most cases, the utility will model its report after the Partnership's self-assessment completion report template and example reports that are available on the Partnership for Clean Water website. A team of volunteer utility peer optimization experts (known as the PEAC) reviews the report. It is important to understand that the report provides information to Partnership utility volunteer peer reviewers mainly on the

quality of the utility's self-assessment process and, secondarily, on the quality and improvement in plant effluent quality and energy efficiency goals. Successful peer review is required for plants to become eligible to receive the Partnership's Phase III Directors Award. Utilities that do not participate in the Partnership for Clean Water may also benefit from developing a self-assessment completion report as a means of organizing the major findings and outcomes of the self-assessment process and communicating the information to utility management and other stakeholders.

There is no single correct way to conduct the self-assessment, and there is no single right way to construct the self-assessment completion report. The program recommends, however, creating a report that follows the logical structure of this guide and the steps represented in Figure 1.2 in order to most clearly communicate the process undertaken and outcomes observed. A template for creating a Phase III Self-Assessment Completion Report and a sample self-assessment completion report are available on the Partnership for Clean Water website. Partnership subscribers are strongly encouraged to use the template for ease in assembling a structured self-assessment completion report. The Appendix provides examples of additional information that may be included in the report, such as a special study, standard operating procedures (SOPs), and operations logs. A Phase III Completion Report Checklist is also available on the Partnership for Clean Water website. The checklist defines the minimum acceptable contents for submission of a Phase III self-assessment completion report to the PEAC review team.

Staff preparing the completion report may want to review the appropriate Partnership for Clean Water resources and documentation to ensure that adequate information is provided for the peer review team. After the peer review is completed, the utility will receive feedback regarding the outcome of the evaluation and the team's team's award determination. Current Partnership for Clean Water subscribers are encouraged to visit the program website (www.partnershipforcleanwater.org) for the most up-to-date information regarding the program and report submission requirements.

Plants Undergoing Renovation

Because of the long-term nature of the self-assessment process, some plants may experience a major renovation or process change during this time. Progressive utilities are continuously evaluating current capabilities and improving their facilities to meet future demands and anticipated regulatory requirements, as well as working towards achieving resource recovery. In some situations, treatment plants require major renovations, such as the addition of basins, filters, or completely new treatment processes. These renovations present challenges to both the utility completing the self-assessment process and to the peer review team from the Partnership for Clean Water. Completion of the self-assessment

process can be accomplished while a plant is undergoing major renovations. The following guidance is offered to plants undergoing renovations during the self-assessment process:

- The self-assessment process is recommended as a tool to assist in determining whether the planned renovations adequately address performance limiting factors.
- The utility may consider the Partnership's optimization goals in selecting performance criteria for newly installed processes.
- Treatment plants should consider the timing of the self-assessment completion report submission in relation to the completion of the renovation. Construction should be far enough along that specific action plans addressing known performance limiting factors can be included in the submittal package.
- Plants undergoing major renovations are required to provide additional report content. Specific documentation should include operational activities used to optimize the existing plant and an explanation of how the renovation will improve operations, effluent quality, and energy efficiency.
- Include specific action plans describing how the renovation removes existing/previous plant limitations and improves plant operations and effluent quality. For example the self-assessment completion report would contain an explanation of:
  - The potential root cause of the issue the renovation is intended to address
  - The operational techniques currently implemented to help improve the situation
  - How the renovations will ultimately address the issue
- Include significant future operational changes that may potentially impact effluent water quality. Provide backup documentation used to support the proposed change (consider the use of a special study if the results help to provide support for the modification). Explain the operational and effluent water quality improvements expected after the renovation. If the anticipated improvements cannot be quantified, it may be necessary to postpone completion of the self-assessment until the results of the renovation are available.

The use of pilot study data may be indicated to support the anticipated impact of a plant renovation on operations and effluent water quality, particularly if the pilot study was conducted over an extended period of time and under varying conditions. Although plant renovations can pose an additional challenge when completing the self-assessment process, plants that conduct the self-assessment under these circumstances should be well prepared to meet the

challenges of operations when the renovated plant comes online and becomes fully operational.

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