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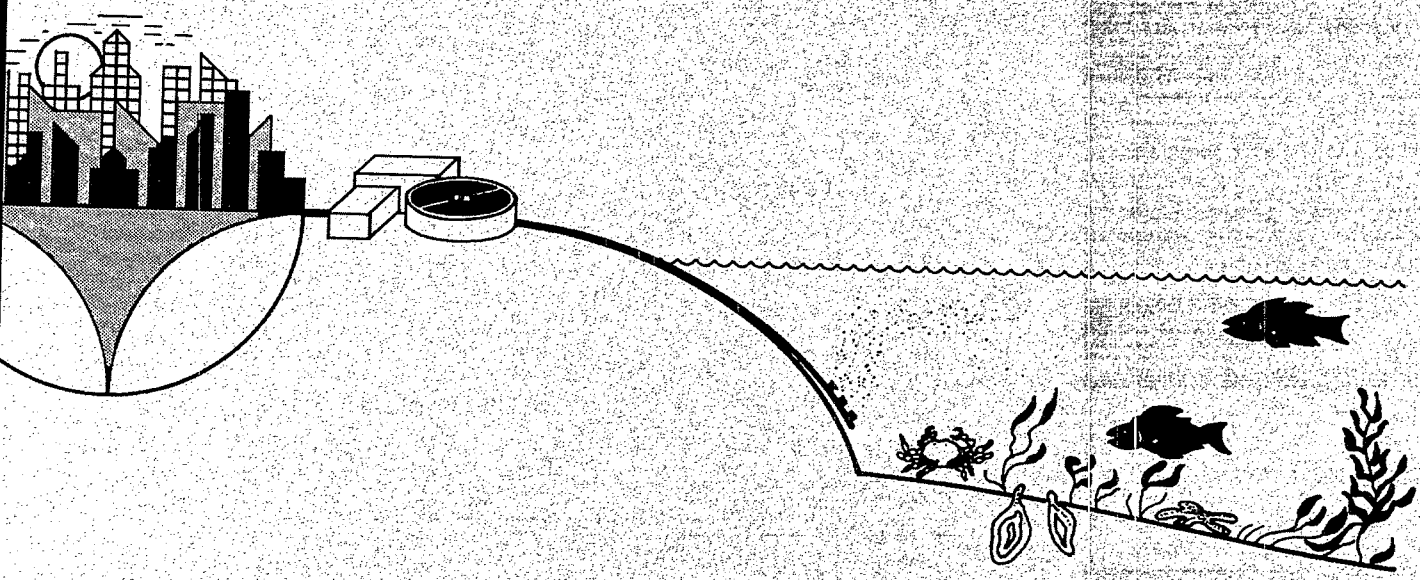

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Amended Section 301(h) Technical Support Document

Oceans and Coastal Protection Division (4504F)
Office of Wetlands, Oceans and Watersheds
United States Environmental Protection Agency
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PREFACE

The following is the amended technical support document for the Clean Water Act section 301(h) program. This document completely supersedes and replaces the earlier *Revised Section 301(h) Technical Support Document* and was made available in draft form for comment on January 24, 1991 (56 FR 2814).

This *Amended Section 301(h) Technical Support Document* (TSD) provides municipal dischargers with technical guidance on preparing applications for section 301(h) modified permits and evaluating the effects of 301(h) discharges on water quality. One of the primary purposes for amending the TSD is to add guidance concerning revisions to EPA's section 301(h) regulations (40 CFR Part 125, Subpart G) that the Agency promulgated on August 23, 1994 (59 FR 40642 August 9, 1994). EPA revised the section 301(h) regulations primarily to implement new section 301(h) requirements imposed by the Water Quality Act of 1987.

The guidance provided in this TSD is a general statement of policy. It does not establish or affect legal rights or obligations. It does not establish a binding norm and is not finally determinative of the issues addressed. Agency decisions in any particular case will be made by applying the law and regulations to the specific facts of the case.

ACKNOWLEDGMENTS

This guidance document was prepared by Tetra Tech, Inc. for the U.S. Environmental Protection Agency under the technical support contracts for marine discharge monitoring evaluations and technical support for the Office of Marine and Estuarine Protection data management and Clean Water Act implementation, U.S. EPA Contract Nos. 68-C8-0001 and 68-C1-0008. Ms. Virginia Fox-Norse was the Work Assignment Manager. Major technical contributors were Dr. Gordon Bilyard, Dr. Richard Harris, Dr. John Hochheimer, Dr. William Muellenhoff, Mr. James Pagenkopf, and Dr. A. Mills Soldate.

EXECUTIVE SUMMARY

Section 301(h) of the 1977 Clean Water Act (CWA) allows the U.S. Environmental Protection Agency (EPA), with concurrence of the state, to issue National Pollutant Discharge Elimination System (NPDES) permits to publicly owned treatment works (POTWs) for the discharge of less-than-secondary treated effluent. The statutory deadline for such applications was December 29, 1982.

Although this document addresses all of the 301(h) regulations, one of the primary purposes of this *Amended Section 301(h) Technical Support Document* is to identify changes to the section 301(h) regulations promulgated by EPA in 1994 to implement section 301(h) conditions resulting from the Water Quality Act (WQA) of 1987 and to provide technical guidance for implementing those changes. Guidance is also provided on assessments and data analyses that applicants should perform to satisfy all of the section 301(h) regulatory requirements and on methods to evaluate compliance with those regulatory requirements. This guidance is provided in three forms:

- Explanations of WQA sections 303(a) through 303(g) and resulting changes in the section 301(h) regulations;
- Technical guidance for implementing the new regulations, and updated technical guidance for implementing regulations that have not changed; and
- Guidance on the preparation of applications for reissuance of section 301(h) modified NPDES permits and on the evaluation of those applications to determine compliance with the regulations.

The WQA of 1987 amended CWA section 301(h) in eight respects, as summarized below. References to key affected sections of the amended CWA 301(h) regulations at 40 CFR Part 125, Subpart G, are shown in brackets.

(1) Section 301(h) modified discharges are prohibited from interfering, *alone or in combination with pollutants from other sources*, with the attainment or maintenance of water quality which assures the protection and uses listed in section 301(h)(2). (emphasis added) [§125.62(f)]

(2) The scope of monitoring investigations is limited to only those investigations necessary to study the effects of the modified discharge. [§125.63(a)]

(3) With respect to any toxic pollutant introduced by an industrial source and for which there is no applicable pretreatment requirement in effect, POTWs serving populations of 50,000 or more are required to demonstrate that industrial sources introducing waste into the POTW are in compliance with all applicable pretreatment requirements, that the POTW will enforce those requirements, and that the POTW has in effect a pretreatment program which, in combination with the POTW's own treatment processes, removes at least the same amount of toxic pollutant as would be removed if the POTW were to apply secondary treatment and had no pretreatment program for that pollutant. [§§125.58(g), 125.58(j), 125.58(q), 125.58(w), 125.58(aa), 125.65]

(4) At the time the section 301(h) modified permit becomes effective, the POTW must be discharging effluent that has received at least primary or equivalent treatment [as defined in §125.58(r)], and that meets applicable water quality criteria established under section 304(a)(1) of the CWA after initial mixing in the receiving waters. [§§125.58(r), 125.60, 125.62(a)]

(5) Section 301(h) modified permits may not be issued for discharges into marine waters that contain significant amounts of previously discharged effluent from the POTW. [§125.62]

(6) Section 301(h) modified permits may not be issued for discharges into saline estuarine waters that exhibit stressed conditions, regardless of the applicant's contribution to those stressed conditions. Section 301(h) modified permits may not be issued for discharges into the New York Bight Apex under any conditions. [§§125.59(b)(4), 125.59(b)(5)]

(7) Any POTW that had an agreement before 31 December 1982 to use an outfall operated by another POTW that had applied for or received a section 301(h) modified permit could have applied for its own section 301(h) modified permit within 30 days of enactment of the WQA. [No such application was filed]

(8) Some provisions of the WQA do not apply to applications that received tentative or final approval before enactment of the WQA, but apply to all applications for renewal of section 301(h) modified permits. [§125.59(j)]

Among the changes listed above, changes 1, 3, 4, 5, and 8 are most important to applicants and permittees that are not prohibited from applying for a section 301(h) modified permit under other provisions of the amended regulations. The first change requires POTWs to consider the impacts of their discharge on the receiving environment and biota in combination with pollutants from other sources. Previously, POTWs were required to consider only whether their discharge contributed to such impacts.

Change 3 requires applicants serving a population of 50,000 or more to implement additional toxics control efforts (urban area pretreatment program). This new statutory requirement complements the toxics control program requirements in §125.66 and applies in addition to any applicable pretreatment requirements contained in 40 CFR Part 403. Dischargers may demonstrate compliance with §125.65 by demonstrating that "an applicable pretreatment requirement is in effect" for the toxic pollutant or by demonstrating "secondary removal equivalency."

Applicable pretreatment requirements may be in the form of categorical pretreatment standards promulgated by EPA under CWA section 307, local limits developed in accordance with 40 CFR Part 403, or a combination of both. It is anticipated that most dischargers will be required to use a combination of categorical pretreatment standards and local limits to satisfy §125.65 with respect to toxic pollutants introduced into the treatment works by industrial sources. For any toxic pollutant introduced by an industrial source for which there is no categorical pretreatment standard and it is determined that no local limit is needed, for 301(h) purposes, an applicable pretreatment requirement can also be met by the following: annual monitoring and technical review of industrial discharges, and, where appropriate, implementation of industrial management practices plans, best management practices, and other pollution prevention activities, and determination on an annual basis of the need to revise local limits and/or to demonstrate that there is no need for a local limit for a specific toxic pollutant. When an industrial discharger is subject to both a categorical standard and a numerical local limit for a specific toxic pollutant, the more stringent of the two limits applies.

Alternatively, a discharger may demonstrate that its own treatment processes, in combination with pretreatment by industrial dischargers, achieves "secondary removal equivalency." Dischargers are required to make this demonstration whenever they cannot show that a toxic pollutant introduced by an industrial discharger is subject to an "applicable

pretreatment requirement." Although secondary treatment is intended to control conventional pollutants, a certain amount of toxic pollutants in the influent is removed during the process. This part of WQA section 303(c) requires that a section 301(h) discharger remove at least that same amount of a toxic pollutant through industrial pretreatment, plus the applicant's own treatment at less-than-secondary levels, as would be removed if the applicant were to apply secondary treatment and no pretreatment requirements existed for that pollutant. A secondary treatment pilot plant could be used to determine empirically the amount of a toxic pollutant that would be removed from the influent if the applicant were to apply secondary treatment. For each pollutant introduced by an industrial source, the applicant would then demonstrate that industrial pretreatment plus the POTW's own treatment processes removed at least the same amount of pollutant as was removed by the secondary treatment pilot plant. The permit will contain effluent limits based on data from the secondary equivalency demonstration when these values are more stringent than effluent limits required to assure all applicable environmental protection criteria are met. The POTW would then use local limits or perform additional treatment at the POTW, or combine the two to achieve the permit limit.

Change 4 requires all section 301(h) dischargers to achieve a minimum of primary or equivalent treatment, thereby establishing a primary treatment floor for all marine and estuarine POTWs, to demonstrate compliance with §125.60. This section (§125.60) requires at least 30 percent removal of both BOD and SS. Section 301(h) dischargers have always been required to meet state water quality standards that are appropriate for local conditions and that have been approved by EPA. In addition to the primary or equivalent treatment requirements (§125.60), §125.62 implements the new WQA requirement that 301(h) dischargers meet water quality criteria established under CWA section 304(a)(1) after initial mixing in the receiving waters. Under the new provision, dischargers must determine whether there is an EPA-approved state water quality standard that directly corresponds to the CWA section 304(a)(1) water quality criterion for each specific pollutant. If there is, this directly corresponding state standard would apply. In the absence of such a state standard, the section 304(a)(1) water quality criterion would apply. An EPA-approved state water quality standard would be deemed to "directly correspond" if (1) the state water quality standard addresses the same pollutant as EPA's water quality criterion and (2) the state water quality standard specifies a numeric criterion for that pollutant, or an objective methodology for deriving such a pollutant-specific criterion. For example, if a state water quality standard exists only for a group of toxic substances, such as metals, applicants would also be required to demonstrate compliance with the water quality criteria for individual metals (e.g., cadmium, lead, zinc) to demonstrate compliance with §125.62(a).

The section 301(h) regulations were not amended with respect to change 5, recirculation and reentrainment of previously discharged effluent from the POTW. However, POTWs,

especially those that discharge into receiving waters where reentrainment is likely, need to address the possible effects of such entrainment when demonstrating compliance with applicable state water quality standards, water quality criteria, and other section 301(h) criteria. Reentrainment is most often of concern where tidal currents predominate, and where previously discharged effluent is likely to be advected into the zone of initial dilution after the tidal currents reverse.

Change 8 in the regulations "grandfathers" applicants that had received tentative or final approval of their section 301(h) modified permits before passage of the WQA. Such applicants are "grandfathered" for changes 3, 4, and 5 above, but only for the term of that section 301(h) modified permit. Applicants for reissuance of section 301(h) modified permits must demonstrate compliance with all applicable section 301(h) criteria to qualify for renewal of the section 301(h) modified permit.

Under §125.59(e), those applicants that have already received tentative or final approvals (including grandfathered applicants) must submit to the EPA Regional Administrator a letter of intent to demonstrate compliance with the primary or equivalent treatment requirements (§125.60) by November 7, 1994. Also, applicants serving a population of 50,000 or more must, under §125.59(e), submit a letter of intent to demonstrate compliance with the urban area pretreatment requirements (§125.65). Those applicants without tentative approval must submit a letter of intent to demonstrate compliance with §§125.60 and 125.65 (if applicable) within 90 days of receiving tentative approval. Applicants that are not grandfathered must, by August 9, 1996, demonstrate compliance with §§125.60 and 125.65. Those applicants that are grandfathered must at the time of permit renewal or by August 9, 1996, whichever is later, meet all of the requirements of §§125.60 and 125.65.

In addition, definitions of *primary or equivalent treatment, pretreatment, categorical pretreatment standard, secondary removal equivalency, water quality criteria, permittee,* and *New York Bight Apex* have been added to the amended section 301(h) regulations, and definitions of industrial source, ocean waters, stressed waters, applications, and applicant questionnaire have been changed.

New technical guidance given in this document primarily addresses major changes 1, 3, 4, and 5 above. Hence, it includes the following:

- Guidance for assessing impacts of the applicant's modified discharge "alone or in combination with pollutants from other sources";

- Guidance on methods for demonstrating compliance with urban area pretreatment requirements;

- Guidance for demonstrating compliance with primary or equivalent treatment;

- Guidance for demonstrating compliance with applicable water quality standards and criteria; and

- Guidance for demonstrating that dilution water does not contain significant amounts of previously discharged effluent.

Updated guidance that reflects technical advances made since publication of the earlier version of this guidance document, the *Revised Section 301(h) Technical Support Document* (1982), is also provided for demonstrating compliance with the section 301(h) regulations. Technical areas that have been updated most extensively include the physical and water quality assessments and the discussion of navigational requirements.

General guidance, new guidance, and updated guidance are provided in the format of the Applicant Questionnaire, with supporting appendices as warranted. General guidance includes discussions of the types of demonstrations that should be included by applicants when responding to each question. Detailed technical explanations of analytical methods that may be used to demonstrate compliance with specific regulatory criteria are provided in six supporting appendices. Methods for calculating initial dilution of the wastefield are provided in Appendix A (Physical Assessment). Detailed descriptions of analytical methods to demonstrate compliance with water quality requirements are presented in Appendix B (Water Quality Assessment). These methods address suspended solids deposition, dissolved oxygen concentrations, sediment oxygen demand, suspended solids concentrations, effluent pH, light transmittance, and other water quality variables. Guidance for biological assessments, as represented by benthic community evaluations, is presented in Appendix C. Navigational considerations for sampling in estuarine and coastal areas are discussed in Appendix D. The new urban area pretreatment requirements and methods for demonstrating compliance with them are described in Appendix E. Finally, additional information on water quality-based toxics control is presented in Appendix F.

Because of the redundancy that existed between the Small and Large Applicant Questionnaires in the 1982 regulations, a single Applicant Questionnaire is included in the amended section 301(h) regulations. It combines relevant questions from the two earlier questionnaires and includes new questions that address the changes in the section 301(h)

regulations. In addition to providing technical guidance for responding to questions in the Applicant Questionnaire, this document identifies who must respond to each question (i.e., large dischargers, small dischargers, or both). It also discusses the levels of detail that are appropriate for responses by dischargers of different sizes and into different receiving environments.

Each application for a section 301(h) modified NPDES permit is submitted to, and reviewed by, the appropriate EPA Region. Having reached a decision regarding an application for issuance of a section 301(h) modified permit, the Region may issue or reissue the section 301(h) modified permit with the same or different permit conditions or may deny the section 301(h) modification. In the case of denial, the NPDES permit would then be reissued by EPA (or, in NPDES-delegated states, by the state) with secondary treatment requirements. This document provides guidance on procedures for reapplying for section 301(h) modified permits. However, it does not provide guidance on the preparation of NPDES permits, which has been published in the *Training Manual for NPDES Permit Writers* (U.S. EPA 1986b).

INTRODUCTION

Section 301(h) of the Clean Water Act (CWA) allows the U.S. Environmental Protection Agency (EPA) Administrator, upon application by publicly owned treatment works (POTWs) and with concurrence of the state, to issue National Pollutant Discharge Elimination System (NPDES) permits for the discharge of less-than-secondary treated effluent. POTWs were eligible to apply for such modified permits if they discharged to marine or estuarine waters, and EPA may issue a 301(h) modified permit if the POTW can demonstrate compliance with section 301(h) criteria and all other NPDES permit requirements. The statuatory deadline for 301(h) applications was December 29, 1982. EPA issued regulations and a technical support document (TSD) in 1979.

Section 301(h) was amended in 1981 by the Municipal Wastewater Treatment Construction Grants Amendments. In 1982, revised regulations and the *Revised Section 301(h) Technical Support Document* (U.S. EPA 1982c) were issued. The revised TSD identified the new regulatory requirements of section 301(h) and provided technical guidance on the preparation of section 301(h) applications. A companion document, *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a), was also issued in 1982. It provided guidance on the development and implementation of monitoring programs that would meet section 301(h) requirements.

Section 301(h) was amended again by the Water Quality Act (WQA) of 1987. That act did not extend the 1982 application deadline or reopen the application process to POTWs that had not applied by the 1982 deadline. However, it did amend section 301(h) for POTWs already in the program. One of the primary purposes of this technical support document is to identify changes to the regulations promulgated by EPA to implement new section 301(h) conditions resulting from the Water Quality Act of 1987 and to provide technical guidance for implementing those changes. This document also provides guidance on assessments and data analyses that applicants must perform to satisfy all applicable section 301(h) regulatory requirements and general considerations for applicants in preparing section 301(h) applications.

This document supersedes the *Revised Section 301(h) Technical Support Document.* It incorporates relevant guidance from that earlier document and from more recent guidance documents produced under the 301(h) program since 1982. *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* remains relevant to the 301(h) program, although much additional technical guidance is now available (see Question III.F.1 below). These more recent guidance documents provide updated guidance on the collection, analysis, and interpretation of monitoring data, including references for updated laboratory and

analytical techniques. This more recent guidance and the general guidance provided in the 1982 document provide a solid technical basis for the design and execution of section 301(h) monitoring programs.

This *Amended Section 301(h) Technical Support Document* is divided into two major sections: a main body of text and six appendices. The main body of text reviews the regulations implementing section 301(h) (i.e., Code of Federal Regulations, Title 40, Part 125, Subpart G, 59 FR 40642, August 9, 1994)* and highlights changes to those regulations made by EPA to reflect the amendments to section 301(h) made by the 1987 WQA. It also provides general technical guidance to dischargers on the preparation of section 301(h) applications for permit reissuance, including general discussions of the types of demonstrations that should be included by applicants when responding to each question in the Applicant Questionnaire. For example, it specifies whether large or small dischargers should respond to a given question and discusses the level of detail that is appropriate for each. Guidance on general considerations for dischargers in preparing section 301(h) applications is also discussed. The appendices contain detailed technical explanations of the analytical methods that may be used to demonstrate compliance with specific regulatory criteria (e.g., formulas to determine dissolved oxygen concentration following initial dilution and detailed discussions of methods to demonstrate compliance with urban area pretreatment requirements).

The section 301(h) regulations distinguish between large and small dischargers, and that distinction is maintained throughout this document. Dischargers are considered to be large or small based on their effluent flow and service population. Large dischargers are defined in §125.58(c) as POTWs that "have contributing populations equal to or more than 50,000 people or average dry weather flows of 5.0 MGD (million gallons per day) or more." Small dischargers "have contributing populations of less than 50,000 people and average dry weather flows of less than 5.0 MGD" [§125.58(c)]. The definition further stipulates that estimates of "the contributing population and flows shall be based on projections for the end of the five year permit term. Average dry weather flows shall be the average daily total discharge flows for the maximum month of the dry weather season."

* hereinafter referred to as 40 CFR Part 125, Subpart G.

BACKGROUND

Clean Water Act section 301(h) was amended by WQA section 303, entitled "Discharges into Marine Waters." Section 303 includes sections 303(a) through 303(g). The section 301(h) regulations have been changed in response to these statutory amendments, and guidance is now needed to implement the new regulations. As background to providing such guidance, each of the statutory amendments is summarized below, followed by a brief description of the corresponding changes in the section 301(h) regulations. Citations to the 40 CFR Part 125, Subpart G, regulations that appear in the discussion below refer to the section numbers of the regulations as renumbered. (The 1994 regulations added requirements and are therefore numbered differently from the 1982 regulations.)

Section 303(a) amends subsection 301(h)(2) to state that the modified discharge "will not interfere, *alone or in combination with pollutants from other sources*, with the attainment or maintenance of water quality which assures protection of public water supplies and the protection and propagation of a balanced indigenous population of shellfish, fish and wildlife, and allows recreational activities, in and on the water" (emphasis added). In response to WQA section 303(a), language was added to §125.62(f) to clarify that it is not sufficient to demonstrate that the applicant's discharge alone will not interfere with the attainment or maintenance of water quality as specified in the remainder of §125.62. Applicants must also demonstrate compliance with §125.62 based on the combined effects of the applicant's modified discharge and pollutants from other sources. This amendment [WQA section 303(a)] strengthens the existing regulatory requirements of §125.62(f) allowing discharges to stressed waters provided that the discharger can demonstrate (1) that the inability to achieve compliance with the requirements of §125.62(a) through (e) is due to perturbations other than its discharge, (2) that its modified discharge will not contribute to the stressed conditions or further degrade the biota or water quality, and (3) that its discharge will not retard the recovery of biota or water quality if the level of human perturbation from other sources decreases.

Under WQA section 303(b), the scope of a section 301(h) discharger's monitoring program is limited to "those scientific investigations that are necessary to study the effects of the proposed discharge." This limitation is applicable only to modifications and renewals of modifications that are tentatively or finally approved after the date of enactment of the WQA. Although the existing section 301(h) requirements for monitoring programs were already focused on the effects of the applicant's discharge, this limitation was added to §125.63 of the regulations. This limitation does not affect the precedent for developing monitoring programs on a case-by-case basis.

WQA section 303(c) is applicable only to large dischargers that receive toxic pollutants from industrial sources. It mandates that for any toxic pollutant introduced by an industrial source for which there are no applicable pretreatment requirements in effect, the applicant will demonstrate that sources introducing waste into the POTW are in compliance with all applicable pretreatment requirements, the applicant will enforce those requirements, and the applicant has in effect a pretreatment program that, in combination with the POTW's own treatment processes, removes at least the same amount of toxic pollutant as would be removed if the POTW were to apply secondary treatment and had no pretreatment program for the pollutant. Under this provision, each such applicant must demonstrate, for each toxic pollutant introduced by an industrial discharger, either that it has an "applicable pretreatment requirement in effect" or that it has implemented a program that achieves "secondary removal equivalency." In accordance with WQA section 303(c), POTWs are required to demonstrate that industrial sources of toxic pollutants are in compliance with all of their pretreatment requirements, including local limits, and that those standards will be enforced in accordance with Code of Federal Regulations, Title 40, Part 403, 46 FR 9439, 28 January 1981.*

To implement WQA section 303(c), §125.65 was added to the regulations, definitions were added to §125.58, and existing definitions in §125.58 were revised. Section 125.65 requires that an urban area pretreatment program be implemented by applicable POTWs to demonstrate that toxic pollutants are being controlled. It also provides alternative approaches for implementing urban area pretreatment. Definitions that are relevant to the urban area pretreatment program and that have been revised or added to the 301(h) regulations include *categorical pretreatment standard, industrial discharger* or *industrial source, pretreatment, secondary removal equivalency,* and *water quality criteria.*

WQA section 303(d) establishes a minimum of primary treatment (or its equivalent). *Primary or equivalent treatment* is defined in subsection 303(d)(2) as "treatment by screening, sedimentation, and skimming adequate to remove at least 30 percent of the biochemical oxygen demanding material and of the suspended solids in the treatment works influent, and disinfection, where appropriate." This section also mandates compliance with federal water quality criteria (U.S. EPA 1980, 1985f, 1986a) for section 301(h) dischargers.

To implement WQA section 303(d), §125.60, which requires a minimum of primary or equivalent treatment, was added to the regulations, and the definition of primary or equivalent treatment stated in the WQA was incorporated into the section 301(h) regulations at §125.58(r).

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* hereinafter referred to as 40 CFR Part 403.

Primary or equivalent treatment requires removal of both 30 percent of biochemical oxygen demand (BOD) and 30 percent of suspended solids (SS) [§125.58(r)].

Section 125.62(a) of the regulations was also amended to state that at and beyond the boundary of the zone of initial dilution (ZID), applicants must meet all applicable water quality standards, and all water quality criteria established under section 304(a)(1) of the CWA where no directly corresponding numerical water quality standards exist. Hence, in addition to demonstrating compliance with water quality standards [already required under the 1982 section 301(h) regulations], applicants will need to demonstrate compliance with those water quality criteria (if any) for which no directly corresponding water quality standards exist.

Under WQA section 303(e), section 301(h) modified permits may not be issued for discharges into marine waters where the dilution water contains "significant amounts of previously discharged effluent from such treatment works." Reentrainment of previously discharged effluent is often a potential problem in receiving waters that exhibit poor flushing characteristics, such as semi-enclosed bays or long, narrow estuaries. This section flatly prohibits issuance of section 301(h) modified permits for discharges into the New York Bight Apex, and further prohibits 301(h) modifications for discharges into saline estuarine waters unless those waters meet all of the following conditions:

- Support a balanced indigenous population (BIP) of shellfish, fish, and wildlife;
- Allow for recreational activities; and
- Exhibit ambient water quality characteristics that are adequate to protect public water supplies; protect shellfish, fish, and wildlife; allow for recreational activities; and comply with standards that assure the protection of such uses.

A section 301(h) modified permit for discharges into saline estuarine waters may not be issued if any one of the foregoing conditions is not met, regardless of whether the applicant's discharge contributes to departures from or retards recovery of such conditions.

Section 125.62(a)(1) of the 1982 regulations required the applicant's diffuser to be located and designed to provide initial dilution, dispersion, and transport sufficient to ensure compliance with water quality standards at and beyond the ZID boundary under critical environmental and treatment plant conditions. Because §125.62(a) was viewed to be a sufficient regulatory criterion

for ensuring that "significant amounts" of previously discharged effluent are not entrained, this subsection was not modified in response to WQA section 303(e). (However, additional technical guidance is provided herein on how to position monitoring stations to determine compliance with this provision of the WQA.) Section 125.59(b)(4) was modified to include the prohibition of section 301(h) modified discharges into stressed saline estuarine waters, and §125.62(f) was modified so that §125.62(f)(1)-(3) ("stressed water test") applies only to ocean waters, as defined.

WQA section 303(f) applies only to POTWs that had existing agreements (i.e., prior to 31 December 1982) to use outfalls of section 301(h) POTWs. This provision allows those POTWs to apply for their own section 301(h) modified permit within 30 days of enactment of the WQA. Because no POTW applied under this provision, the section 301(h) regulations were not amended to reflect section 303(f).

As stated in WQA section 303(g), sections 303(a), (c), (d), and (e) do not apply to section 301(h) modified permits that were tentatively or finally approved prior to enactment of the WQA. However, section 303(g) further states that those sections will apply to all renewals of section 301(h) modified permits that postdate enactment of the WQA. In response, §125.59(j) was added to the regulations, allowing certain applicants to defer compliance with the specified section of the WQA until permit renewal. Applicants that had been issued tentative denials, or that had withdrawn their section 301(h) applications prior to enactment of the WQA, may not take advantage of this "grandfathering" provision. A requirement was also added to §125.59(e) and (f) stating that "grandfathered" applicants and permittees must, within 90 days of the effective date of the regulatory revisions, submit additional information regarding their intent to demonstrate compliance with the new requirements under §125.60 (primary or equivalent treatment requirements) and §125.65 (urban area pretreatment requirements) within 2 years (non-grandfathered) or upon permit renewal, whichever is later (grandfathered).

The statutory deadline for section 301(h) applications was 29 December 1982. Neither the WQA nor the amended section 301(h) regulations extend that deadline. Hence, the aforementioned statute and changes to the regulations apply only to POTWs presently in the 301(h) program. POTWs currently in the program include those presently holding section 301(h) modified permits and those awaiting a final decision from EPA.

PURPOSE AND SCOPE

The primary purpose of this document is to provide technical support for implementing the section 301(h) regulations that were amended in response to WQA section 303. It does so in the following ways:

- Explains WQA sections 303(a) through 303(g), and resulting changes in the section 301(h) regulations (provided above, in the section entitled "Background," and below, in the section entitled "Statutory Criteria and Regulatory Requirements");

- Provides technical guidance for implementing the new regulations and updates that for existing regulations (provided below, in the chapter entitled "Demonstrations of Compliance by Permittees");

- Provides technical guidance on preparing applications for reissuance of section 301(h) modified permits (provided below, in the chapter entitled "Demonstrations of Compliance by Permittees"); and

- Provides additional technical guidance on preparing applications to demonstrate compliance with the regulations and on the issuance and reissuance of section 301(h) modified permits [provided below, in the chapter entitled "Determinations of Compliance with Section 301(h) Modified Permit Conditions and 301(h) Criteria"].

This document provides the following new technical guidance on how the results of studies and monitoring can be used to demonstrate compliance with the new regulations:

- Guidance for assessing impacts of the applicant's modified discharge "alone or in combination with pollutants from other sources";

- Guidance for demonstrating compliance with at least primary or equivalent treatment;

- Guidance on methods for demonstrating compliance with urban area pretreatment requirements;

- Guidance for demonstrating compliance with applicable water quality standards and criteria; and

- Guidance for demonstrating that dilution water does not contain significant amounts of previously discharged effluent.

This guidance appears in the chapter entitled "Demonstrations of Compliance by Permittees" below and, in some cases, the appendices. Updated guidance is also provided on the calculation of initial dilution, navigation and station positioning methods, analysis of water quality data, assessments of the long-term effects of 301(h) discharges, sedimentation and dispersion models, and the degree of recirculation in the presence of contaminated receiving waters.

Monitoring data collected during the term of the 301(h) modified permit are submitted to the regional jurisdiction of the U.S. EPA (hereinafter referred to as Regions) in accordance with permit procedures. The Regions use these data to determine continuing compliance with the terms and conditions of the permit and with section 301(h) regulations. Although this document was not written to help the Regions evaluate monitoring data during the terms of the modified permits, much of the guidance provided below is applicable to such evaluations.

NPDES permits are issued for 5-year periods. At least 180 days prior to expiration, POTWs holding section 301(h) modified permits must apply for reissuance of their NPDES permits. At the same time, they may apply for reissuance of their section 301(h) modification, as stipulated in §§125.59, 122.21(d),* and 124.3.† In the future, EPA will consider only section 301(h) applications submitted by the deadline (29 December 1982) on which there has not yet been a decision and those applications for reissuance.

According to §125.59(c), "applicants for permit renewal shall support continuation of the modification by supplying to EPA the results of studies and monitoring performed in accordance with §125.63 during the life of the permit." However, neither this section nor other parts of 40 CFR Part 125, Subpart G, provide specific guidance on how the results of studies and monitoring should be used to support the application for permit reissuance. This amended TSD with its appendices generally provides technical guidance to show how to use these results (see the chapter entitled "Determinations of Compliance with Section 301(h) Modified Permit Conditions and 301(h) Criteria").

In the 1982 section 301(h) regulations, EPA recognized the limited financial resources of most small applicants and the lower potential for environmental impacts typically associated with small discharges. Those regulations provided separate questionnaires for large and small

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* Found in Code of Federal Regulations, Title 40, Part 122, 48 FR 14153, 1 April 1983 (hereinafter referred to as 40 CFR Part 122).

† Found in Code of Federal Regulations, Title 40, Part 124, 48 FR 14264, 1 April 1983 (hereinafter referred to as 40 CFR Part 124).

applicants, with fewer requirements placed on small applicants. To avoid the excessive duplication that existed with the separate questionnaires, the amended section 301(h) regulations, and hence this document, present a single questionnaire. In this document, each question in the combined questionnaire is followed by a statement as to who must respond (i.e., large dischargers, small dischargers, or both) and guidance on how to respond.

As was true under the 1982 regulations, the level of detail expected of most small applicants in their responses is considerably less than that required of large applicants in their responses to the same questions. Because the amended section 301(h) regulations do not provide specific guidance on the required level of detail, the Regions have considerable discretion regarding the level of detail necessary for applicants to demonstrate continued compliance with the 301(h) regulations. This document addresses the levels of detail that may be required of small and large applicants during the permit reissuance process.

This document provides considerations for assessing compliance with section 301(h) regulations. Appropriate uses of monitoring data to assess compliance with regulatory criteria are discussed, including the use of monitoring data to evaluate predictions of conditions that were expected to occur during the term of the section 301(h) modified permit.

Having reached a decision regarding an application for reissuance of a section 301(h) modified permit, the Region may reissue the section 301(h) modified permit with the same or different permit conditions, or may deny the section 301(h) modification. In the case of denial, the NPDES permit would then be reissued by EPA (or, in NPDES-delegated states, by the state) with secondary treatment requirements. This document provides guidance on procedures for reapplying for section 301(h) modified permits. However, it does not provide guidance on the preparation of NPDES permits, which has been published elsewhere (see U.S. EPA, 1986b).

STATUTORY CRITERIA AND REGULATORY REQUIREMENTS

The WQA of 1987 amended CWA section 301(h) in eight respects. Each of these is summarized below, followed by references to key sections of the 301(h) regulations that respond to the statutory criteria of the CWA.

(1) Section 301(h) modified discharges are prohibited from interfering, *alone or in combination with pollutants from other sources*, with the attainment or maintenance of water quality which assures the protection and uses listed in section 301(h)(2) (i.e., assures protection of public water supplies and the

protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife, and allows recreational activities in and on the water). (emphasis added) [§125.62(f)]

(2) The scope of monitoring investigations is limited to only those investigations necessary to study the effects of the modified discharge. [§125.63(a)]

(3) With respect to any toxic pollutant introduced by an industrial source and for which there is no applicable pretreatment requirement in effect, POTWs serving populations of 50,000 or more are required to demonstrate that industrial sources introducing waste into the POTW are in compliance with all applicable pretreatment requirements, that the POTW will enforce those requirements, and that the POTW has in effect a pretreatment program which, in combination with the POTW's own treatment processes, removes at least the same amount of toxic pollutant as would be removed if the POTW were to apply secondary treatment and had no pretreatment program for that pollutant. [§§125.58(g), 125.58(j), 125.58(q), 125.58(w), 125.58(aa), 125.65]

(4) At the time the section 301(h) modified permit becomes effective, the POTW must be discharging effluent that has received at least primary or equivalent treatment [as defined in §125.58(r)], and that meets the water quality criteria established under section 304(a)(1) of the CWA after initial mixing in the receiving waters. [§§125.58(r), 125.60, 125.62(a)]

(5) Section 301(h) modified permits may not be issued for discharges into waters that contain significant amounts of previously discharged effluent from the POTW. [§125.62]

(6) Section 301(h) modified permits may not be issued for discharges into saline estuarine waters that exhibit stressed conditions, regardless of the applicant's contribution to those stressed conditions. Section 301(h) modified permits may not be issued for discharges into the New York Bight Apex under any conditions. [§§125.59(b)(4), 125.59(b)(5)]

(7) Any POTW that had an agreement before 31 December 1982 to use an outfall operated by another POTW that had applied for or received a section 301(h) modified permit could have applied for its own section 301(h)

modified permit within 30 days of enactment of the WQA. [No such application was filed.]

(8) Some provisions of the WQA do not apply to applications that received tentative or final approval before enactment of the WQA, but apply to all applications for renewal of section 301(h) modified permits. [§125.59(j)]

Among the changes listed above, changes 1, 3, 4, 5, and 8 are most important to applicants and permittees that are not prohibited from applying for a section 301(h) modified permit under other provisions of the amended regulations. The first change requires POTWs to consider the impacts of their discharge on the receiving water and biota in combination with pollutants from other sources. Previously, POTWs were required to consider only whether their discharge contributed to such impacts.

Change 3 requires applicants serving a population of 50,000 or more to implement additional toxics control efforts (urban area pretreatment program), discussed in detail below under "Demonstrations of Compliance by Permittees" and in Appendix E. This new statutory requirement complements the toxics control program requirements in §125.66 and applies in addition to any applicable pretreatment requirements contained in 40 CFR Part 403. Dischargers may demonstrate compliance with §125.65 by demonstrating that "an applicable pretreatment requirement is in effect" for the toxic pollutant or by demonstrating "secondary removal equivalency."

Applicable pretreatment requirements may be in the form of categorical pretreatment standards promulgated by EPA under CWA section 307, local limits developed in accordance with 40 CFR Part 403, or a combination of both. It is anticipated that most dischargers will be required to use a combination of categorical pretreatment standards and local limits to satisfy §125.65 with respect to toxic pollutants introduced into the treatment works by industrial sources. For any toxic pollutant introduced by an industrial source for which there is no categorical pretreatment standard and it is determined that no local limit is needed, for 301(h) purposes, an applicable pretreatment requirement can also be met by the following: annual monitoring and technical review of industrial discharges, and, where appropriate, implementation of industrial management practices plans (IMPs), best management practices (BMPs), and other pollution prevention activities, and determination on an annual basis of the need to revise local limits and/or to demonstrate that there is no need for a local limit for a specific toxic pollutant. When an industrial discharger is subject to both a categorical standard and a numeric local limit for a specific toxic pollutant, the more stringent of the two limits applies.

Alternatively, a discharger may demonstrate that its own treatment processes, in combination with pretreatment by industrial dischargers, achieves "secondary removal equivalency." Dischargers are required to make this demonstration whenever they cannot show that a toxic pollutant introduced by an industrial discharger is subject to an "applicable pretreatment requirement." Although secondary treatment is intended to control conventional pollutants, a certain amount of toxic pollutants in the influent is removed during the process. This part of WQA section 303(c) requires that a section 301(h) discharger remove at least that same amount of a toxic substance through industrial pretreatment, plus the applicant's own treatment at less-than-secondary levels, as would be removed if the applicant were to apply secondary treatment and no pretreatment requirements existed for that pollutant. A secondary treatment pilot plant could be used to determine empirically the amount of a toxic pollutant that would be removed from the influent if the applicant were to apply secondary treatment. For each pollutant introduced by an industrial source, that applicant would then demonstrate that industrial pretreatment plus the POTW's own treatment processes removed at least the same amount of pollutant as was removed by the secondary treatment pilot plant. The pemit will contain effluent limits based on data from the secondary equivalency demonstration when these values are more stringent than effluent limits required to ensure all applicable environmental protection criteria are met. The POTW would then use local limits or perform additional treatment at the POTW, or combine the two to achieve the permit limit.

Change 4 requires all section 301(h) dischargers to achieve a minimum of primary or equivalent treatment, thereby establishing a primary treatment floor for all marine and estuarine POTWs, to demonstrate compliance with §125.60. This section (§125.60) requires at least 30 percent removal of both BOD and SS. Section 301(h) dischargers have always been required to meet state water quality standards that are appropriate for local conditions and that have been approved by EPA. In addition to the primary or equivalent treatment requirements (§125.60), (§125.62) implements the new WQA requirement that 301(h) dischargers meet water quality criteria established under CWA section 304(a)(1) after initial mixing in the receiving waters. Under the new provision, dischargers must determine whether there is an EPA-approved state water quality standard that directly corresponds to the CWA section 304(a)(1) water quality criterion for each specific pollutant. If there is, this directly corresponding state standard would apply. In the absence of such a state standard, the section 304(a)(1) water quality criterion would apply. An EPA-approved state water quality standard would be deemed to "directly correspond" if (1) the state water quality standard addresses the same pollutant as EPA's water quality criterion and (2) the state water quality standard specifies a numeric criterion for that pollutant, or an objective methodology for deriving such a pollutant-specific criterion. For example, if a state water quality standard exists only for a group of toxic substances, such as metals, applicants

would also be required to demonstrate compliance with the water quality criteria for individual metals (e.g., cadmium, lead, zinc) to demonstrate compliance with §125.62(a).

The section 301(h) regulations were not amended with respect to change 5, recirculation and reentrainment of previously discharged effluent from the POTW. However, POTWs, especially those that discharge into receiving waters where reentrainment is likely, need to address the possible effects of such entrainment when demonstrating compliance with applicable state water quality standards, water quality criteria, and other section 301(h) criteria. Reentrainment is most often of concern where tidal currents predominate, and where previously discharged effluent is likely to be advected into the ZID after the tidal currents reverse. Technical guidance is provided herein to assist applicants in demonstrating compliance with this new requirement.

Finally, change 8 in the regulations "grandfathers" applicants that had received tentative or final approval of their section 301(h) modified permits before passage of the WQA. Such applicants are "grandfathered" for changes 3, 4, and 5 above, but only for the term of that section 301(h) modified permit. Applicants for reissuance of section 301(h) modified permits must demonstrate compliance with all applicable section 301(h) criteria to qualify for renewal of the section 301(h) modified permit.

Under §125.59(e), those applicants that have already received tentative or final approvals (including grandfathered applicants) must submit to the EPA Regional Administrator a letter of intent to demonstrate compliance with the primary or equivalent treatment requirements (§125.60) by November 7, 1994. Also, applicants serving a population of 50,000 or more must, under §125.59(e), submit a letter of intent to demonstrate compliance with the urban area pretreatment requirements (§125.65). Those applicants without tentative approval must submit a letter of intent to demonstrate compliance with §§125.60 and 125.65 (if applicable) within 90 days of receiving tentative approval. Applicants that are not grandfathered must, by August 9, 1996, demonstrate compliance with §§125.60 and 125.65. Those applicants that are grandfathered must at the time of permit renewal or by August 9, 1996, whichever is later, meet all of the requirements of §§125.60 and 125.65.

All but one (change 7) of these eight statutory changes have been integrated into the amended section 301(h) regulations and must be satisfied by all 301(h) applicants, including those for reissuance of section 301(h) modified permits. Regulations applicable to such applications include NPDES permit regulations (40 CFR Part 122) and the amended section 301(h) regulations (40 CFR Part 125, Subpart G). These regulations, including the changes that resulted from the WQA, are discussed below in detail. As previously noted, this document does not provide

guidance on the preparation of NPDES permits. Guidance on 40 CFR Part 122 can be found in U.S. EPA (1986b). For convenience, a portion is briefly discussed below.

40 CFR Part 122. U.S. EPA Administered Programs: The National Pollutant Discharge Elimination System

Section 122.21(d). Duty to Reapply--

Under this section, POTWs with an existing NPDES permit must submit an application for a new NPDES permit a minimum of 180 days before the existing permit expires. The applicant may ask to submit the new application after this due date, and the Region may grant such a request. The Region may extend the due date up to the expiration date of the existing permit. Upon review of an application, the Region may determine that additional information is needed to determine compliance with 301(h) regulations and permit conditions. Such information may be requested at any time (including after the application deadline has passed) in accordance with §122.41(h).

It is strongly recommended that POTWs submit their applications for reissuance of section 301(h) modified permits as early as possible, and no later than 180 days prior to expiration of the existing permit. This early submittal is particularly important because of the need to establish compliance with the recent statutory amendments to section 301(h). As discussed below, early submittal gives the Regions time to review applications for completeness and to request any information needed to complete applications before existing permits expire. Timely submittal of a completed application is required to qualify for the continuation described below.

Section 122.6. Continuation of Expiring Permits--

A permittee may have submitted a complete, timely application to the Region, but through no fault of the permittee, the Region may not have issued a new permit with an effective date on or before the expiration of the previous permit. This section provides that in those cases, the previous permit will remain fully effective and enforceable, pursuant to the Administrative Procedure Act.

40 CFR Part 125, Subpart G

Section 125.56. Scope and Purpose--

40 CFR Part 125, Subpart G, establishes the criteria by which EPA evaluates requests for section 301(h) modified permits. It also establishes special permit conditions that must be included in section 301(h) modified permits.

Section 125.57. Law Governing Issuance of Section 301(h) Modified Permit--

All applicants for section 301(h) modified permits must demonstrate satisfactorily to EPA that the modified discharge will meet all of the following nine requirements to qualify for a section 301(h) modified permit:

(1) An applicant must demonstrate that an applicable water quality standard exists for each pollutant for which the modification is requested. Details of this requirement are given in §125.61. Demonstrations that applicable water quality standards exist will be superfluous for reissuance of section 301(h) modified permits because the original section 301(h) modified permit was based, in part, on successful demonstrations that such standards exist. However, as specified in §125.61, an applicant must demonstrate that the modified discharge will comply with applicable water quality standards. An applicant must also provide a determination signed by an authorized state or interstate agency, stating that the modified discharge will comply with state law. Both the demonstration of compliance with applicable water quality standards and the state's determination are required of applicants for reissuance of section 301(h) modified permits.

(2) An applicant must demonstrate that the modified discharge, alone or in combination with pollutants from other sources, will not interfere with the attainment or maintenance of water quality that assures the protection of public water supplies; assures the protection and propagation of a balanced indigenous population of fish, shellfish, and wildlife; and allows for recreational activities. Specific demonstrations that must be performed by an applicant are stated in §125.62. All are required of applicants for reissuance of section 301(h) modified permits.

(3) An applicant must demonstrate that a monitoring program has been established to monitor the impact of the modified discharge on a representative sample of aquatic biota. The scope of that monitoring program should include only those investigations necessary to study the effects of the modified discharge. General requirements of monitoring program design and specific requirements of the biological, water quality, and effluent monitoring components are specified in §125.63. Demonstrating that an effective monitoring program has been established will be simple for most POTWs that apply for reissuance of section 301(h) modified permits because monitoring data will have been collected over the life of the existing permit. However, EPA may require an applicant to demonstrate the effectiveness of an established monitoring program if the quality of the data is suspect, if incomplete data have been submitted to EPA, or if when the data are analyzed it is evident that additional data collection is needed to adequately characterize and detect the effects of the discharge.

(4) An applicant must demonstrate that the modified discharge will not result in additional requirements on other point or nonpoint sources of pollutants. Section 125.64 requires an applicant to provide a determination signed by an authorized state or interstate agency indicating whether the modified discharge will result in any such additional requirements. The foregoing demonstration and determination of compliance are required of applicants for reissuance of section 301(h) modified permits.

(5) An applicant with a treatment works that serves a population of 50,000 or more and that receives toxic pollutants introduced into the treatment works by one or more industrial dischargers must demonstrate that it has an urban area pretreatment program in effect at the time of final permit approval (§125.65). This requirement can be met in one of two ways. An applicant may demonstrate that applicable pretreatment requirements, as defined in §125.65(c), will be in effect for each toxic pollutant introduced by an industrial source into the treatment works. Alternatively, an applicant may demonstrate that it has a program in effect that achieves "secondary removal equivalency," as defined in §125.58(w) and explained in §125.65(d).

(6) An applicant must demonstrate that pretreatment requirements for sources that introduce wastes into the treatment works will be enforced. This demonstration includes chemical analyses of the discharge for all toxic

pollutants and pesticides; identification of sources of toxic pollutants and pesticides; and development of, implementation of, and compliance with an approved industrial pretreatment program, as specified in §§125.65 and 125.66. However, these requirements are waived for small applicants that certify that there are no known or suspected sources of toxic pollutants and pesticides, and that document the certification with an industrial waste survey as described by 40 CFR 403.8(f). Most small applicants for reissuance of section 301(h) modified permits will be required to provide only an updated certification that there are no known or suspected sources of toxic pollutants or pesticides. Because industrial sources of pollutants may have changed over the term of the original section 301(h) modified permit, both large and small applicants should review updated information on industrial sources of pollutants before performing the required demonstration or certifying that there are no known industrial sources of toxic pollutants or pesticides.

(7) An applicant must demonstrate that a schedule of activities has been established to eliminate the introduction of toxic substances from nonindustrial sources into the treatment works. Just as was required in the original section 301(h) application, applicants must comply with the specific requirements of §125.66(d). These requirements are that a public education program be developed, submitted with the application, and implemented; that nonindustrial source control programs be developed and implemented in accordance with schedules submitted with the application; and that the foregoing program may be revised by EPA before issuance or reissuance of a section 301(h) modified permit, or during the term of that permit. However, for small applicants certifying that there are no known or suspected problems related to toxic pollutants or pesticides in the discharge, only a public education program is required. As was true for the original section 301(h) applications, most small applicants should be able to provide the foregoing certification. However, the small applicant should review updated information on water quality, sediment quality, and biological conditions before certifying that there are no known or suspected water quality, sediment accumulation, or biological problems that are related to the discharge of toxic pollutants or pesticides.

(8) An applicant must demonstrate that the modified discharge will not result in new or substantially increased discharges of the pollutant for which a section 301(h) modification is being requested above the discharge specified in the

section 301(h) modified permit. Details of this requirement are given in §125.67, which states that where pollutant discharges are attributable, in part, to combined sewer overflows, an applicant must minimize such overflows and prevent increased discharges of pollutants. An applicant must also project effluent volumes and mass emission rates for pollutants to which the modification applies. These projections must be provided in 5-year increments for the design life of the facility. This demonstration applies to applicants for reissuance of section 301(h) modified permits.

(9) An applicant must demonstrate that the modified discharge will have received at least primary or equivalent treatment, as required under §125.60 and defined in §125.58(r). An applicant must also meet the criteria established under CWA section 304(a)(1) in accordance with §125.62(a). Section 301(h) modified discharges are prohibited into waters that contain "significant amounts of previously discharged effluent from such treatment works" and into saline estuarine waters that at the time of application do not support a balanced indigenous population of shellfish, fish, and wildlife, do not allow recreation in or on the waters, or exhibit ambient water quality that does not meet specified standards. "A significant amount of previously discharged effluent" is that amount which would cause the discharge plume to violate water quality standards or water quality criteria beyond the zone of initial dilution.

Section 125.58. Definitions--

This section defines terms applicable to the 40 CFR Part 125, Subpart G, regulations. Definitions of *primary or equivalent treatment, pretreatment, categorical pretreatment standard, secondary removal equivalency, water quality criteria, permittee,* and *New York Bight Apex* have been added to the amended section 301(h) regulations, and definitions of *industrial source, ocean waters, stressed waters, applications,* and *applicant questionnaire* have been changed.

Section 125.59. General--

This section establishes general criteria and requirements that must be met by applicants for section 301(h) modified permits. Also specified are several regulatory options that may be exercised by EPA during the application process. As indicated below, some of the general regulations are not relevant to applications for reissuance of section 301(h) modified permits.

According to §125.59(a), an application may be based on a current, improved, or altered discharge into ocean waters or saline estuarine waters. This requirement remains relevant to applications for reissuance of section 301(h) modified permits.

No section 301(h) modified permits may be issued for the following discharges:

- Discharges that would not assure compliance with 40 CFR Part 122 and 40 CFR Part 125, Subpart G;
- Discharges of sewage sludge;
- Discharges that would not be in compliance with applicable provisions of state, local, or other federal laws and Executive orders;
- Applicants that have not met at least primary or equivalent treatment requirements;
- Discharges entering saline estuarine waters that are stressed in the manner set forth in §125.59(b)(4); and
- Discharges that enter the New York Bight Apex.

These prohibitions are relevant to applications for reissuance of section 301(h) modified permits.

Section 125.59(c) specifies that all applications for section 301(h) modified permits must contain a signed, completed NPDES application; a completed Applicant Questionnaire; and a certification of completeness and accuracy. This provision remains valid for applications for reissuance of section 301(h) modified permits. Applicants for permit renewal should support continuation of their modification with results of studies and monitoring performed during the life of the permit. As was the case for original section 301(h) applications, the level of detail required of applicants responding to questions in the Applicant Questionnaire will vary according to the volume, composition, and characteristics of the discharge, as well as the characteristics of the receiving water and biota. Applicants should consult with the EPA Region about permit reissuance well in advance of the application deadline. Timely consultation will help ensure that each applicant is informed of the appropriate level of detail required to complete the Applicant Questionnaire and that all data necessary for completing the questionnaire have been collected and are adequate to demonstrate compliance with 301(h) criteria and regulations.

Revisions to original section 301(h) applications that were submitted under the 1979 and 1982 application deadlines are discussed in §125.59(d). Such revisions are not relevant to applications for reissuance of section 301(h) modified permits. Also as noted above, a discharger holding an existing section 301(h) modified permit must submit an application for a new section 301(h) modified permit at least 180 days before the existing permit expires if the section 301(h) modification is to be renewed. [See §125.59(f)(1).]

Deadlines for submittal of applications for reissuance of section 301(h) modified permits are specified in §122.21(d) and are discussed above. The distribution of such applications is not specified in 40 CFR Part 124 or 40 CFR Part 125, Subpart G. However, applicants should adhere to the distribution schedule required for original section 301(h) applications, as indicated in §125.59(f)(1): one original and one copy to the appropriate U.S. EPA Regional Administrator, and one copy to state and interstate agencies authorized to provide certification or concurrence in accordance with §§124.53-124.55. Deadlines for applicants desiring to submit revised applications following the issuance of a tentative decision are stated in §125.59(f)(2).

Under §125.59(e), applicants or permittees are required to submit additional information regarding their intent to demonstrate compliance with §125.60 (primary or equivalent treatment requirements) and §125.65 (urban area pretreatment requirements) by November 7, 1994. Section 125.59(e) specifies the additional information required and the conditions under which the submittal of this information may be delayed until the time of permit renewal. Deadlines for providing additional information to demonstrate compliance with §§125.60 and 125.65 are specified in §125.59(f)(3).

A favorable state determination is required before the Region reviews an application. Under §125.59(f)(4), state determinations are due to the Regions no more than 90 days after an application is submitted to EPA. The Regions may extend this 90-day deadline upon request by the state. However, extensions may decrease the amount of time remaining until expiration of the existing modified permit and the amount of time available for an applicant to respond to concerns of the state.

Under §125.59(g), the Regions may authorize or request an applicant to submit additional data after the application deadline. Such information must be submitted within 1 year of the date of the authorization or request.

Options that the Regions and states may exercise in granting or denying a section 301(h) modified permit are specified in §125.59(i). All remain relevant to applications for reissuance of section 301(h) modified permits. For the Administrator to grant a section 301(h) modified

permit, an applicant must have demonstrated compliance with §§125.59 through 125.68. State certification (concurrence) is also required, with the state director cosigning the section 301(h) modified permit if an intent to do so was indicated in the written concurrence. Section 301(h) modified permits must be issued in accordance with procedures in 40 CFR Part 124 and must contain all applicable terms and conditions specified in 40 CFR Part 122 and §125.68. Appeals of section 301(h) determinations may be made in accordance with procedures in 40 CFR Part 124. Under §125.59(h), the Administrator may grant a tentative decision on a section 301(h) modified permit if the applicant can demonstrate that the modified discharge will comply with the provisions of 40 CFR Part 125, Subpart G, based on a schedule submitted by the applicant.

Section 125.68. Special Conditions for Section 301(h) Modified Permits--

Section 125.68 sets forth special conditions that must be included in section 301(h) modified permits, in addition to those specified in 40 CFR Part 122. All remain valid for reissued section 301(h) modified permits. The special conditions are as follows:

- That effluent limitations and mass loadings assure compliance with 301(h) regulations;

- That schedules of compliance, if needed (e.g., if a permittee had been a small applicant but became a large applicant and would need to develop a pretreatment program) be included for the required industrial pretreatment program [§125.66(c)], the nonindustrial source control program [§125.66(d)], and control of combined sewer overflows [§125.67].

- That the proposed monitoring program include provisions for monitoring biota [§125.63(b)], water quality [§125.63(c)], and effluent [§§125.60(b) and 125.63(d)]; and

- That the monitoring data be reported at the frequency prescribed in the approved monitoring program.

DEMONSTRATIONS OF COMPLIANCE BY PERMITTEES

The 1994 amendments to 40 CFR Part 125, Subpart G, have been integrated into the section 301(h) Applicant Questionnaire, which must be completed and included with all applications for renewal of section 301(h) modified permits. Explanations of the demonstrations that are required of applicants are given below following each question, and in the appendices to this document, as appropriate.

All applicants for new or reissued section 301(h) modified permits are required to demonstrate compliance with the new regulatory criteria. However, §125.59 establishes special procedures and deadlines for demonstrating compliance with §125.60 (i.e., primary or equivalent treatment requirements) and §125.65 (i.e., urban area pretreatment requirements). Compliance with §125.62(a)(1) (i.e., water quality standards and criteria, as applicable) is not included in the special procedures and deadlines established under §125.59.

Under §125.59(e), applicants for new or reissued section 301(h) modified permits must submit a letter of intent to demonstrate compliance with §§125.60 and 125.65. For compliance with §125.60, the letter of intent must include a description of the proposed treatment system and a project plan for achieving compliance (including a schedule for data collection; dates for design and construction of necessary facilities; submittal of influent, effluent, and receiving water quality data; and any other information necessary for determining compliance with §125.60). For compliance with §125.65, the letter of intent must include a description of the approach that will be used to achieve compliance and a project plan for achieving compliance (including necessary data collection activities, submittal of additional information, and the development of any appropriate pretreatment limits). Applicants that submit additional information must modify their NPDES form and Applicant Questionnaire as needed to ensure that the information in their application is complete and correct, must obtain new state determinations as specified in §§125.61(b)(2) and 125.64(b), and must provide the certification required under §122.22(d).

Section 125.59(f) requires permittees and applicants with tentative or final approval of section 301(h) modifications to submit a letter of intent that contains the information required under §125.59(e)(1). This letter must be submitted by November 7, 1994. Applicants that have not yet received tentative approval of a section 301(h) modification must submit a letter of intent within 90 days of receipt of that tentative approval. Applicants that are not "grandfathered" under §125.59(j) must demonstrate compliance with §§125.60 and 125.65 by August 9, 1996. Applicants grandfathered under the aforementioned subsection must demonstrate compliance with these subsections at the time of permit renewal or by August 9, 1996, whichever is later.

APPLICATION FORMAT

As specified in §125.59(c), a full, completed application for a section 301(h) modified permit contains a certification of completeness and accuracy; a signed, completed NPDES application [Short Form A or Standard Form A in accordance with §§122.21(d) and 124.3]; and a completed Applicant Questionnaire. The order in which these parts are to be assembled is not specified in the 301(h) regulations.

To facilitate review by the Region and appropriate state agencies, it is recommended that the application be assembled in the following sequence:

- A cover letter signed by the responsible official for the POTW;
- The statement of completeness and accuracy mandated in §122.22(d), signed by the responsible official for the POTW [§125.59(c)(3)];
- A table of contents for the application, including any appendices;
- A list of figures for the application;
- A list of tables for the application;
- A signed, completed NPDES application Short Form A or Standard Form A;
- A completed Applicant Questionnaire; and
- Any accessory documents (e.g., technical reports) considered necessary for an independent review of the application.

The Applicant Questionnaire given as Appendix A of 40 CFR Part 125, Subpart G, is designed to provide EPA with all information necessary to determine whether an applicant meets the statutory criteria and regulations of 40 CFR Part 125, Subpart G. Guidance provided in this document and in *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a) complements the questionnaire. Although applicants are required to respond to applicable questions, the Regions may determine the appropriate level of response to each question for each applicant. The Region may also allow an applicant to incorporate data by reference to previous submittals.

Applicants/permittees should consult with the appropriate EPA Region in a timely manner so the Region can assist in determining the level of response needed. This will help the permittee to submit the appropriate information on time. EPA encourages applicants to work closely with the Region, particularly during the end of the existing permit term. This will help to ensure that all data necessary for completion of the Applicant Questionnaire are available well in advance of the application deadline, and that the applicant understands the level of detail appropriate for each response. Such discussions should result in more concise responses to the questions and should help avoid unnecessary effort and expense by the applicant during the application process.

REQUIRED DATA

Applicants "shall support continuation of the modification by supplying to EPA the results of studies and monitoring performed in accordance with §125.63 during the life of the permit" [§125.59(c)]. For many dischargers, data collected during these studies and monitoring programs will be relevant to many, or all, of the questions in the Applicant Questionnaire. Additional relevant data may be found in publications and technical reports produced by other agencies, institutions, and companies working in nearby areas of the receiving waters. Data from such surveys could be used to better define environmental factors, such as the critical density profile for initial dilution calculations or biological conditions in a reference area. However, for some applicants, no new data [i.e., data collected after issuance of the original section 301(h) modified permit] will be available to respond to some of the questions in the Applicant Questionnaire.

Although the Regions may be of assistance in clarifying the appropriate application requirements, it is the permittee's responsibility to contact the Region well in advance of the application deadline. Once informed of information deficiencies, permittees must collect, analyze, and interpret the necessary information for incorporation into the application for permit reissuance. Failure to supply necessary information could result in permit denial, based on the grounds that a complete application was not submitted. After an application has been received, however, the Region may determine that additional information is needed to determine compliance with 301(h) regulations and permit conditions. Such information may be requested at any time (including after the application deadline has passed) in accordance with §§122.41(h) and 125.59(f).

INTEGRATION OF DATA WITH EPA DATABASES

Many EPA databases are available for the storage, retrieval, and analysis of water quality, sediment, and biological sampling data. Although the use of these systems is not mandated by

current legislation, they are useful tools for both the regulated community and the various federal, state, and regional regulatory authorities. EPA is modernizing its water information systems, which include ODES (Ocean Data Evaluation System), STORET (Water Quality Information System), and BIOS (Biological Information System). The systems are used extensively because of their unique functionality: to manage and analyze water quality and biological monitoring data. The major objective of the modernization program is to move ODES, STORET, and BIOS into a relational database environment, facilitating data integration and sharing while accommodating emerging informational needs. Applicants for 301(h) permit waivers are encouraged to use these systems for storing and analyzing data required for the application, as well as for ongoing monitoring programs.

PREPARATION OF THE APPLICANT QUESTIONNAIRE FOR MODIFICATION OF SECONDARY TREATMENT REQUIREMENTS

I. INTRODUCTION

The Applicant Questionnaire is to be submitted by both small and large applicants for modification of secondary treatment requirements under CWA section 301(h). A small applicant is defined as a POTW that has a population contributing to its wastewater treatment facility of less than 50,000 and a projected average dry-weather flow of less than 5.0 MGD (0.22 cubic meters/sec) [§125.58(c)]. A large applicant is defined as a POTW that has a population contributing to its wastewater treatment facility of at least 50,000 or a projected average dry-weather flow of its discharge of at least 5.0 MGD [§125.58(c)]. The questionnaire is in two sections, a general information and basic requirements section (Part II) and a technical evaluation section (Part III). Satisfactory completion by small and large dischargers of the appropriate questions is necessary to enable EPA to determine whether the applicant's modified discharge meets the criteria of section 301(h) and EPA regulations (40 CFR Part 125, Subpart G).

Most small applicants should be able to complete the questionnaire using available information. However, small POTWs having low initial dilution, discharging into shallow waters or waters with poor dispersion and transport characteristics, discharging near distinctive and susceptible biological habitats, or discharging substantial quantities of toxics should anticipate the need to collect additional information and/or conduct additional analyses to demonstrate compliance with section 301(h) criteria. If there are questions in this regard, applicants should contact the appropriate EPA Regional Office for guidance.

Guidance for preparing a complete application for reissuance of a section 301(h) modified permit is provided below. Special instructions and exceptions for small applicants are also provided. The sequence in which the application parts are discussed corresponds to that recommended in the "Application Format" section of this document. Accessory doucments (e.g., data reports) should be appended to the application.

Just as original section 301(h) applications were based on the most recent, appropriate, and technically correct data available at the time the application was prepared, applications for reissuance of section 301(h) modified permits should consider monitoring data collected over the term of the existing modified permit, as required under §125.59(c)(4). When monitoring data and other information, collected over the term of the existing permit, confirm that all the values used in analyses provided in the original application have not changed and are not expected to change over the term of the new modified permit, the applicant may summarize the available data and provide evidence demonstrating the basis for determining that no change in information has been realized or expected. In cases where the values of one or more parameters have changed, however, or where new monitoring data are useful for supporting a given demonstration, those data should be included in the required response.

Under section 301(h)(2) and §§125.57(a)(2) and 125.62(f), all demonstrations of compliance with applicable statutes and regulations must consider the effects of the discharge singly and in combination with pollutants from other sources, if any other sources exist. When demonstrating such compliance, the level of detail required of small applicants is considerably less than that required of large applicants for the same demonstration. Applicants should consult with the appropriate EPA Region before submitting an application to determine the level of detail that is appropriate for their discharge. POTWs that have been classified as small dischargers, but that no longer meet the conditions of the definition of small discharger [§125.58(c)] or that are not expected to meet those small discharger conditions during the next permit term, must apply for reissuance of this section 301(h) modified permit as large dischargers.

II. GENERAL INFORMATION AND BASIC DATA REQUIREMENTS

II.A. Treatment System Description

II.A.1. On which of the following are you basing your application: a current discharge, improved discharge, or altered discharge, as defined in 40 CFR 125.58? [40 CFR 125.59(a)]

*** ***Large and small dischargers must respond.***

Applicants should consider "current discharge" to mean the actual volume, composition, and location of a 301(h) permittee's discharge at the time of permit reapplication. Use of the latest 12 months of data would be most appropriate in the application.

An "improved discharge" may result from any of the following changes:

- Improvements to the collection system, treatment plant, or outfall (including outfall relocations);
- Improvements to treatment levels or discharge characteristics;
- Improvements in the operation or maintenance of the treatment system; or
- Measures to control the introduction of pollutants into the treatment works.

For improved discharges, applicants should briefly describe the changes to the treatment system or its operation on which the application is based.

Discharge alterations include all changes that result in a treatment level less than that currently achieved, including changes in effluent volume or composition. All changes that result in the downgrading of effluent characteristics, regardless of whether the outfall was previously improved or relocated to compensate for lower effluent quality, are considered altered discharges. An applicant that proposes downgrading treatment levels and/or changes outfall and diffuser location and design must justify the proposal on the basis of substantial changes in circumstances beyond the applicant's control since the time of application submission and must comply with applicable state antidegradation policy. Applicants that propose altered discharges based on changed circumstances and that propose improvements in treatment levels must comply with the applicable state's antidegradation policy and should briefly describe the changes to the treatment system or its operation on which the application is based.

II.A.2. Description of the Treatment/Outfall System [40 CFR 125.62(a) and 125.62(e)]

a. Provide detailed descriptions and diagrams of the treatment system and outfall configuration which you propose to satisfy the requirements of section 301(h) and 40 CFR Part 125, Subpart G. What is the total discharge design flow upon which this application is based?

b. Provide a map showing the geographic location of the proposed outfall(s) (i.e., discharge). What is the latitude and longitude of the proposed outfall(s)?

c. For a modification based on an improved or altered discharge, provide a description and diagram of your current treatment system and outfall configuration. Include the current outfall's latitude and longitude, if different from the proposed outfall.

**** Large and small dischargers must respond.*

Most of the above information can be found in sections 1-13 of the NPDES Standard Form A. Past experience in the 301(h) program has shown that applicants often neglect to describe the treatment and outfall system in sufficient detail to allow evaluation of the technical merit of the application. Applicants should provide a detailed description of this system such that the reader will have a complete picture of the physical aspects of the treatment and outfall system and will be able to understand the treatment processes that occur therein. Information on diffuser dimensions used to determine the port flow distribution achieved by the outfall is especially important (see Question II.A.8 below) and should be specified as accurately as possible. Figures and drawings with dimensions should be included if possible. In those descriptions, applicants should emphasize any changes in the service area, treatment system, or outfall system that were implemented during the term of the existing permit. Water depths and navigational coordinates of the outfalls as they exist should be correctly specified. Water depth of the outfall should be specified as the water depth at the midpoint of the diffuser, referenced to mean sea level or mean lower low water. Water depths and navigational coordinates found in engineering design documents are often incorrect because of changes in the lengths and routes of the outfalls made during construction. Hence, drawings of as-built conditions should be used.

II.A.3. Primary or equivalent treatment requirements [40 CFR 125.60]

a. Provide data to demonstrate that your effluent meets at least primary or equivalent treatment requirements as defined in 40 CFR 125.58 (r). [40 CFR 125.60]

b. If your effluent does not meet primary or equivalent treatment requirements, when do you plan to meet them? Provide a detailed schedule, including design, construction, start-up and full operation, with

your application. This requirement must be met by the effective data of the new section 301(h) modified permit.

*** ***Large and small dischargers must respond.***

Applicants must demonstrate that the treatment works will discharge, at a minimum, primary treated effluent (or its equivalent) at the time their modification becomes effective, as mandated by §§125.57 and 125.60. Applicants are advised that "primary or equivalent treatment" is defined in §125.58(r) as "treatment by screening, sedimentation, and skimming adequate to remove at least 30 percent of the biochemical oxygen demanding material and of the suspended solids in the treatment works influent, and disinfection, where appropriate." To support this demonstration, the applicant should supply monthly averaged data for influent and effluent BOD, suspended solids, and flow for the last 1-year period. The averaging period (e.g., weekly) for such data should be specified precisely for each parameter.

EPA believes that the monthly period for averaging monitoring results to determine compliance with the 30 percent BOD removal requirement will be appropriate for most applicants. However, as noted in the preamble discussion of primary treatment in the 1994 regulations, EPA also recognizes that the 30 percent removal rate for BOD may be difficult to achieve on a monthly average basis in certain cases, e.g., where there is dilute wastewater or proportionately low concentrations of insoluble BOD. Because of this, §125.60(c) provides flexibility in achieving 30 percent removal of BOD, in certain instances, by allowing compliance monitoring data to be averaged for a period longer than monthly, up to annually.

EPA anticipates that compliance requirements established for longer-than-monthly averaging periods for BOD removal will be the exception, not the general practice. An applicant that has demonstrated a consistent ability to achieve 30 percent removal of BOD on a monthly average basis over the year preceding the promulgation of these regulations (or another time period established by the Regional Administrator when this time period is not applicable) will not be eligible for the longer-than-monthly averaging period. Eligibility for the longer period is limited to those POTWs that, based on circumstances listed below, and subject to the qualifications listed below, truly cannot achieve 30 percent removal on a monthly average.

Eligibility for longer-than-monthly averaging periods will be determined by the Regional Administrator on a case-by case basis. The Regional Administrator will judge each eligible case, taking into account climatic, seasonal, or other factors causing significant fluctuations in influent characteristics that could affect BOD removal efficiencies. Appropriate circumstances may include:

- Seasonally dilute influent BOD concentrations due to relatively high (although nonexcessive) inflow and infiltration;

- Relatively high soluble-to-insoluble BOD ratios on a fluctuating basis; or

- Cold climates resulting in cold influent.

The longer period must be requested by the applicant, and the burden of justifying a longer averaging period will be on the applicant. In addition to justifying the application on the basis of the conditions listed above, to qualify for the longer averaging period the applicant must demonstrate to the satisfaction of the Regional Administrator that the treatment facility is properly designed and operated; that the applicant will be able to meet all section 301(h) requirements with the longer averaging basis; and, because of circumstances beyond the applicant's control (listed above), the applicant cannot achieve the 30 percent removal requirement for BOD on a monthly averaging basis. Section 125.60(c)(2) of the new regulations also requires that inflow and infiltration (I&I) be nonexcessive to ensure that applicants have corrected, as feasible, deficiencies in their collection system that result in extremely dilute wastewater. The determination of whether the I&I is excessive will be based on the definition of excessive I&I in 40 CFR 35.2005(b)(16),* plus the additional criterion that inflow is nonexcessive if the total flow to the primary treatment plant is less than 275 gallons per capita per day, consistent with 40 CFR 133.103(d)† of the secondary treatment regulations.

If the applicant has received the Regional Administrator's approval to demonstrate compliance with the 30 percent BOD removal requirement on other than a monthly average basis [§125.60(c)(1)], monitoring data for determining compliance based on the approved compliance period should be submitted. The Regional Administrator has discretion to establish averaging periods up to yearly (e.g., quarterly or semi-annually).

The applicant must maintain the sampling and reporting frequencies for all parameters, as specified in its permit (e.g., weekly averages, monthly averages). The modified time period used to calculate compliance with the 30 percent removal requirements applies only to BOD, not to other measured parameters. For BOD, the goal for whichever averaging period is approved,

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* As found in Code of Federal Regulations, Title 40, Part 35, 47 FR 44954, 12 October 1982 (hereinafter referred to as 40 CFR Part 35).

† As found in Code of Federal Regulations Title 40, Part 133, 49 FR 37006, 20 September 1984 (hereinafter referred to as 40 CFR Part 133).

up to annually, is to achieve at least 30 percent removal. If the problem is seasonal, a separate averaging period can be established for that season. However, the POTW will still need to achieve a 30 percent removal rate for that period. This type of averaging period may require bracketing the season with monthly average removals greater than 30 percent to achieve the seasonal 30 percent removal rate. The Regional Administrator may require 30 percent removal on a monthly average basis for other times of the year.

In the event the averaging period is lengthened to a year, the permit may be written to provide for timely and effective enforcement of the specified 30 percent removal of BOD and suspended solids and, at the discretion of the permit writer, set interim monthly minimums. These monthly minimums would be set on a case-by-case basis so that compliance with the 30 percent removal on the basis of an alternative averaging period would be maintained. Historical performance levels pertaining to the percent removal of BOD and suspended solids and seasonal fluctuations from month to month, accounting for changes in I&I, could be a factor in determining the minimum levels. This information could also help to ensure that POTWs maintain or surpass their historical operating performance. These minimum values, *based on past removal performance*, could be set as high as practicable for the applicant to maintain operating efficiency, which depends on the particular situation and conditions. In addition, permits would still incorporate daily, 7-day average, and monthly average concentrations, as well as mass emission rate (MER)-based limits according to the limits on BOD and suspended solids proposed in waiver applications.

Additional provisions address the primary treatment compliance time frame [§125.59(f)(3)]. Under §125.59(f)(3), by August 9, 1996 applicants that are not grandfathered have to comply and applicants that are grandfathered have until permit renewal or by August 9, 1996, whichever is later, to comply with the primary treatment requirements. This 2-year time period is designed to allow 1 year for plant construction and another year to demonstrate compliance with the primary treatment requirements. If approved by the Regional Administrator, compliance demonstration may be based on less than 1 year's worth of data. The period to determine compliance may be less than 1 year if there are sufficient data to determine compliance, the plant is well designed and there are no operational or maintenance problems, and the applicant has been complying with the 30 percent removal rate for at least 3 months.

II.A.4. Effluent Limitations and Characteristics [40 CFR 125.61(b) and 125.62(e)(2)]

a. *Identify the final effluent limitations for five-day biochemical oxygen demand (BOD_5), suspended solids, and pH upon which your application for a modification is based:*

- *BOD_5 _____ mg/L*
- *Suspended solids _____ mg/L*
- *pH _____ (range)*

b. *Provide data on the following effluent characteristics for your current discharge as well as for the modified discharge if different from the current discharge:*

Flow (m^3/sec):
- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

BOD_5 (mg/L) for the following plant flows:
- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Suspended solids (mg/L) for the following plant flows:
- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Toxic pollutants and pesticides (ug/L):
- *list each toxic pollutant and pesticide*

- *list each 304(a)(1) criteria and toxic pollutant and pesticides*

pH:

- *minimum*
- *maximum*

Dissolved oxygen (mg/L, prior to chlorination) for the following plant flows:

- *minimum*
- *average dry weather*
- *average wet weather*
- *maximum*
- *annual average*

Immediate dissolved oxygen demand (mg/L)

**** Large and small dischargers must respond.*

Applicants should specify the effluent limitations requested for their section 301(h) modified permits and the basis (e.g., monthly average values) for those limits. Applicants must request specific limitations. Except for pH, ranges of values or a list of alternatives is not acceptable. The remaining information on effluent characteristics can usually be found by analyzing plant operating records.

II.A.5. Effluent Volume and Mass Emissions [40 CFR 125.62(e)(2) and 125.67]

a. Provide detailed analyses showing projections of effluent volume (annual average, m^3/sec) and mass loadings (mt/yr) of BOD_5 and suspended solids for the design life of your treatment facility in five-year increments. If the application is based upon an improved or altered discharge, the projections must be provided with and without the proposed improvements or alterations.

b. Provide projections for the end of your five-year permit term for 1) the treatment facility contributing population and 2) the average daily total discharge flow for the maximum month of the dry weather season.

**** Large and small dischargers must respond.*

Applicants should project effluent flows and mass emissions for the term of the modified permit being requested, and for subsequent years at 5-year intervals. Projections should be based on the annual average flows and annual average effluent characteristics. Projections should reflect expected changes in the service area and population over the term of the modified permit being requested, and over the subsequent periods of time being considered. Projections for the new end-of-permit year must be given, including the average daily flow for the maximum month of the dry-weather season and the average effluent characteristics for that month.

II.A.6. Average Daily Industrial Flow (m^3/sec). Provide or estimate the average daily industrial inflow to your treatment facility for the same time increments as in question II.A.5 above. [40 CFR 125.66]

*** ***Large and small dischargers must respond.***

Annual average flow data will generally be sufficient for nonseasonal (i.e., continuous operation) industries. For seasonal industries, average daily flows for the periods of operation should be provided. Supporting information (e.g., lists of industries and products manufactured) may be required.

II.A.7. Combined Sewer Overflows [40 CFR 125.67(b)]

a. Does (will) your treatment and collection system include combined sewer overflows?

b. If yes, provide a description of your plan for minimizing combined sewer overflows to the receiving water.

*** ***Large and small dischargers must respond.***

Locations, flow quantities, and frequency of overflows should be specified. Data on total effluent flow and on effluent suspended solids and BOD_5 concentrations should be provided for times when overflows occur. The effect of increased infiltration during the rainy season should be discussed. Applicants should also provide a plan, including a narrative description and implementation schedule for minimizing the discharge of combined sewer overflows to the receiving water.

II.A.8. Outfall/Diffuser Design. Provide the following data for your current discharge as well as for the modified discharge, if different from the current discharge: [40 CFR 125.62(a)(1)]

- *Diameter and length of the outfall(s) (meters)*
- *Diameter and length of the diffuser(s) (meters)*
- *Angle(s) of port orientation(s) from horizontal (degrees)*
- *Port diameter(s) (meters)*
- *Orifice contraction coefficient(s), if known*
- *Vertical distance from mean lower low water (or mean low water) surface and outfall port(s) centerline (meters)*
- *Number of ports*
- *Port spacing (meters)*
- *Design flow rate for each port, if multiple ports are used (m^3/sec)*

**** Large and small dischargers must respond.*

The information requested above should be available from the engineering drawings for the treatment plant outfall and diffuser system. If risers are used, information sufficient to compute the riser discharge coefficient by using the method of Koh (1973) should also be provided. For example, if the riser consists of a vertical pipe, the following details should be specified: length and inside diameter of the pipe, material from which it is made, and diameter of the port orifice. Missing information should be so indicated in the responses to the foregoing questions. Because outfalls and diffusers are often built somewhat differently than specified in the engineering design drawings, applicants are advised to provide as-built information.

In addition to the foregoing information, applicants should provide information on the slope of the diffuser and the slope of the port centerlines if they differ from that of the diffuser. If the diffuser ports discharge to opposite sides of the diffuser, that information should be noted. The depths of the ports below mean lower low water (or mean low water) should be provided, as should any variations in port depths along the length of the diffuser.

The information provided in this section is routinely used in the review process to determine whether the diffuser is well-designed hydraulically for the range of flow (daily minimum to daily maximum) expected during the requested permit term. Among the characteristics of a well-designed diffuser are uniform port flows and individual port densimetric Froude numbers that are always greater than 1. Methods for computing the port flow distribution from a multiport diffuser are described by Grace (1978). Discharge coefficients for risers can

be computed using methods provided by Koh (1973). The effect of the bottom slope must be included in the diffuser hydraulics computations because some diffusers behave properly on a horizontal seafloor but poorly on a sloping bottom, especially at low flow rates.

II.B. Receiving Water Description

II.B.1. Are you applying for a modification based on a discharge to the ocean [40 CFR 125.58(n)] or to a saline estuary [40 CFR 125.58(v)]? [40 CFR 125.59(a)]

*** ***Large and small dischargers must respond.***

Ocean waters are defined in §125.58(n) as coastal waters, other than saline estuarine waters (defined below), landward of the baseline of the territorial seas, the deep waters of the territorial seas, or the waters of the contiguous zone. Territorial seas extend 3 miles outward from the baseline, and the contiguous zone extends an additional 9 miles.

Saline estuarine waters are defined in §125.58(v) as coastal waters inside the baseline from which the territorial seas are measured which have a free connection to the territorial sea in which the salinity is diluted by freshwater inflows, undergo net seaward exchange with ocean waters, and have salinities comparable to those of the ocean. Generally, these waters are near the mouth of estuaries and have cross-sectional, annual mean salinities greater than 25 parts per thousand (ppt). It should be noted, however, that 25 ppt is used as a general test in §125.58(v). The failure of the receiving water to meet this salinity concentration does not absolutely preclude eligibility for consideration under section 301(h). However, where salinities fall substantially below this concentration, applicants should be careful to document that the waters into which they discharge meet the other requirements of §125.58(v) (i.e., inside the baseline from which the territorial seas are measured, free connection to the territorial sea in which the salinity is diluted by freshwater inflows, and net seaward exchange with ocean waters).

Estuarine dischargers are advised that according to §§125.57(a)(9) and 125.59(b)(4), section 301(h) modified permits may not be issued for discharges into saline estuarine waters unless those waters meet all of the following conditions:

- Support a balanced indigenous population of shellfish, fish, and wildlife;
- Allow for recreational activities in and on the waters; and

- Exhibit ambient water quality that meets applicable water quality standards adopted for the protection of public water supplies, shellfish, fish, and wildlife, or recreational activities, or such other standards necessary to assure support and protection of such uses.

These conditions must be met, regardless of whether the applicant's discharge contributes to departures from such conditions. According to section 301(h) and §125.57(e), the foregoing prohibition does not apply to discharges with section 301(h) modified permits that were tentatively or finally approved prior to the enactment of the Water Quality Act of 1987. However, the foregoing prohibitions are in force for all renewals of section 301(h) modified permits that postdate enactment of the Water Quality Act of 1987. Thus, all estuarine dischargers must demonstrate that the receiving waters exhibit the above characteristics (i.e., that they are not stressed) at the time of permit reissuance, regardless of whether such conditions existed at the time the existing section 301(h) modified permit was issued.

II.B.2. Is your current discharge or modified discharge to stressed waters as defined in 40 CFR 125.58(z)? If yes, what are the pollution sources contributing to the stress? [40 CFR 125.59(b)(4) and 125.62(f)]

**** Large and small dischargers must respond.*

Stressed waters are defined in §125.58(z) as those ocean waters in which the absence of a balanced indigenous population of shellfish, fish, and wildlife is caused solely by human perturbations other than the applicant's modified discharge. Section 125.57(a) prohibits reissuance of section 301(h) modified permits if the discharge alone or in combination with pollutants from other sources adversely impacts the balanced indigenous population, water quality, or recreational activities. In addition, dischargers to estuaries are advised that under section 301(h)(9) and §§125.57(a)(9) and 125.59(b)(4), permits may not be reissued for discharges to stressed saline estuarine waters.

Guidance for establishing monitoring programs to determine whether receiving waters should be characterized as stressed waters is found in section III.F of this document. Detailed guidance on the design of section 301(h) monitoring programs is provided in *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Water* (U.S. EPA 1982a) and *Framework for 301(h) Monitoring Program* (U.S. EPA 1987e).

Sections (a) through (e) of §125.62 address the attainment and maintenance of water quality, assuring the protection of public water supplies and the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife and allowing recreational activities. In accordance with §125.62(f), stressed waters, if an applicant that discharges into ocean waters believes that its failure to meet the requirements of §125.62(a) through (e) is entirely attributable to conditions resulting from human perturbations other than its modified discharge (including, without limitation, other municipal or industrial dischargers, nonpoint source runoff, and the applicant's previous discharges), the applicant need not demonstrate compliance if it demonstrates to the satisfaction of the Administrator that its modified discharge does not or will not (1) contribute to, increase, or perpetuate stressed conditions; (2) contribute to further degradation of the biota or water quality if the level of human perturbation from other sources increases; and/or (3) retard the recovery of the biota or water quality if the level of human perturbation from other sources decreases.

Applicants that respond "no" to this question should explain the basis for their conclusion.

II.B.3. Provide a description and data on the seasonal circulation patterns in the vicinity of your current and modified discharge(s). [40 CFR 125.62(a)]

*** ***Large and small dischargers must respond.***

The applicant should provide sufficient information on current speed and direction in the vicinity of the discharge to predict the dispersion and transport of diluted effluent. This information should include a description of current patterns and general density structure on a seasonal basis, as well as the variation over a tidal cycle. Estimates of near-surface and near-bottom lowest 10 percentile current speeds, as well as the locations of the current meters and the time span over which data were collected, should also be provided. Hydraulic residence times and flushing characteristics should be described for discharges into estuaries and semi-enclosed bodies of water. Any periods of net drift stagnation and natural upwelling should be described, including changes in the current patterns and stratification.

The applicant should also discuss the occurrence of onshore surface currents. Because onshore winds induce onshore currents, wind speed and direction statistics that are appropriate for the diffuser location should also be provided. Useful sources of information include data collected during execution of the monitoring program for the existing modified permit, data collected in the vicinity of the discharge by other researchers, and U.S. Department of Commerce tidal current tables (e.g., National Ocean Survey 1988a, 1988b).

Section 125.57(a)(9) prohibits section 301(h) modified permits for discharges where the dilution water contains "significant amounts of previously discharged effluent from such treatment works." In responding to Question II.B.3, applicants should discuss the potential for reentrainment of previously discharged effluent or the presence of nuisance materials (e.g., floatables, scum, oil sheen) in and around the discharge area. Reentrainment is a potential problem primarily in receiving waters that exhibit poor flushing characteristics. Such conditions can also occur, however, in open coastal areas during periods of tidal or wind-driven current reversals, or temporary stagnation of longshore coastal currents.

II.B.4. Oceanographic conditions in the vicinity of the current and proposed modified discharge(s). Provide data on the following: [40 CFR 125.62(a)]

- ***Lowest ten percentile current speed (m/sec)***
- ***Predominant current speed (m/sec) and direction (true)* during the four seasons***
- ***Period(s) of maximum stratification (months)***
- ***Period(s) of natural upwelling events (duration and frequency, months)***
- ***Density profiles during period(s) of maximum stratification***

**** Only large dischargers must respond.*

The vertical and areal distribution of currents and water density in both the nearfield and farfield are needed to evaluate plume dilution, wastefield transport, and potential reentrainment of previously discharged effluent. Data collected from previous studies or nearby similar areas will often be appropriate.

The number and location of sampling stations needed to provide sufficient data will depend on the bathymetric and hydrographic environment. For open coastal sites with uniform bathymetry and minimal freshwater inflows, as few as five stations may be adequate. For an estuary with significant freshwater inflow and highly variable bathymetry, however, as many as 50 stations may be necessary.

For existing discharges, the measurements should be made in the vicinity of the outfall but outside the region directly influenced by the discharge. For relocated outfalls, measurements should be made in the vicinity of the proposed discharge location. Current data should be

* The direction is specified in terms of true north (T).

obtained near the surface, at the approximate depth of the wastefield, and in the bottom 2 meters (6.6 feet) of the water column. Water depths at the stations should be similar to the water depth at the site of the existing and relocated outfalls (if present).

The duration of time within which these measurements should be obtained is dependent on the current regime and the variability of the density structure. If the currents are predominantly tidal (which could be the case for both open coastal and estuary sites), the current measurements should be at approximately 30-minute intervals for not less than 29 days. If seasonal changes in oceanographic conditions (e.g., low or variable longshore current speeds or directions, upwelling, shoreward transport, high and low runoff) are significant, then information should be obtained for each season. The question is based on the presumption that periods of maximum stratification will be important for calculating critical initial dilutions. Field data on other potentially critical periods (e.g., periods of longshore current stagnation) may be necessary for determining whether this presumption is true.

Reduction and presentation of data should be of sufficient detail to support the interpretation and analyses performed in the application. The following forms of data reduction and presentation are recommended:

- Current persistence tables—Summary of the frequency and duration of specific current speed and direction events. For example, currents with speeds between 10 and 15 cm/sec (0.33 and 0.49 ft/sec), directions between 260 and 280 degrees (T), and durations of at least 1 hour occurred for 18 percent of the data record.

- Current speed and direction frequency tables—Frequency of specific current speed and direction intervals. For example, currents with speeds between 5 and 10 cm/sec (0.16 to 0.33 ft/sec) occurred for 20 percent of the data record, and currents with directions between 80 and 90 degrees (T) occurred for 23 percent of the data record.

- Net coastal orthogonal component analysis—By determining the predominant directions of current flow, a primary axis for orthogonal component decomposition of each current vector can be selected. The net component relative to each axis can then be determined. If the currents do not exhibit predominant flow directions, an axis parallel to the local bathymetry or in the direction of an area of significance can be selected.

- Current mean and variance—For the predominant directions of current flow or the selected primary axis, the mean and variance of the current speed can be determined.

Guidance on instrumentation and methods for oceanographic data collection is provided in *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a).

II.B.5. Do the receiving waters for your discharge contain significant amounts of effluent previously discharged from the treatment works for which you are applying for a section 301(h) modified permit? [40 CFR 125.57(a)(9)]

*** ***Large and small dischargers must respond.***

Applicants should explain the basis for their response to this question. Explanations should consider the hydrographic characteristics of the receiving water and the behavior of the effluent plume through time. Applicants that respond negatively to this question should demonstrate that little or no previously discharged effluent will be carried into the ZID (after having been transported out of the ZID) to become entrained in the effluent plume. This demonstration will be relatively simple for applicants that discharge to open coastal areas where currents are unidirectional most of the time. Those applicants should be able to plot effluent transport through time and thereby demonstrate that little or no effluent reenters the ZID. The demonstration will be much more complicated for dischargers into estuarine environments where tidal currents oscillate. In estuaries, effluent transported away from the ZID during the first half of a tidal cycle may be transported back into the ZID on the second half of that cycle. If effluent is likely to be transported back into the ZID, the applicant should estimate the quantities of effluent that would be entrained.

In responding to this question, applicants should demonstrate that all applicable water quality standards and water quality criteria are met at and beyond the ZID boundary. If the dilution water contained significant quantities of previously discharged effluent, it is unlikely that an applicant would be able to meet all applicable water quality standards and water quality criteria. Responses given for Questions II.D.1, II.D.2, and II.D.3 of the Applicant Questionnaire may be cited to support this demonstration.

II.B.6. Ambient water quality conditions during the period(s) of maximum stratification: at the zone of initial dilution (ZID) boundary, at other areas of potential impact, and at control stations. [40 CFR 125.62(a)]

a. Provide profiles (with depth) on the following for the current discharge location and for the modified discharge location, if different from the current discharge:

- *BOD_5 (mg/L)*
- *Dissolved oxygen (mg/L)*
- *Suspended solids (mg/L)*
- *pH*
- *Temperature (°C)*
- *Salinity (ppt)*
- *Transparency (turbidity, percent light transmittance)*
- *Other significant variables (e.g., nutrients, 304(a)(1) criteria and toxic pollutants and pesticides, fecal coliform bacteria)*

b. Provide available data on the following in the vicinity of the current discharge location and for the modified discharge location, if different from the current discharge: [40 CFR 125.61(b)(1)]

- *Dissolved oxygen (mg/L)*
- *Suspended solids (mg/L)*
- *pH*
- *Temperature (°C)*
- *Salinity (ppt)*
- *Transparency (turbidity, percent light transmittance)*
- *Other significant variables (e.g., nutrients, 304(a)(1) criteria and toxic pollutants and pesticides, fecal coliform bacteria)*

c. Are there other periods when receiving water quality conditions may be more critical than the period(s) of maximum stratification? If so, describe these and other critical periods and data requested in 6.a. for the other critical period(s). [40 CFR 125.62(a)(1)]

**** Small dischargers must respond to parts b and c.*

**** Large dischargers must respond to parts a and c.*

To document the periods of maximum stratification, temperature and salinity profiles that are sufficient to determine the most stratified and the typical conditions should be provided for each oceanographic season. The "most stratified" temperature and salinity profile with depth is the profile that will produce the lowest initial dilution (see Question III.A.1 for definition). In some locations, such a profile has the steepest gradients of temperature or salinity near mid-depth. Both temperature (expressed in degrees Celsius) and salinity (expressed in parts per thousand, ppt) should be measured accurately to two decimal places so that density (expressed in grams per cubic centimeter, gm/cm^3) can be computed accurately to five decimal places. Also, only measured profiles should be provided. Averages of measured profiles or "representative" profiles should never be substituted. Density profiles should exhibit a stable water column over the plume height-of-rise (i.e., no higher-density water should overlie lower-density water). The minimum period of time over which oceanographic data must be collected to establish typical and most stratified conditions is 1 year. Because oceanographic conditions vary among years, it is recommended that data collected over 5 years be provided.

Sampling for nutrients, coliform or other indicator bacteria, and other major parameters may be conducted at selected depths and should be measured in terms that can be compared with water quality standards. The evaluation of light transmittance may require the measurement of one or more water clarity parameters and a comparison of values recorded in the vicinity of the outfall with those recorded in control areas. Parameters that are widely measured to assess light transmittance include turbidity, Secchi disc depth, beam transmittance, and downward irradiance. The applicant should review Chapter B-VII in Appendix B for more information on the selection of sampling methods appropriate for various waterbody conditions (e.g., the presence of submerged plumes). The applicant should state the reason(s) for the light transmittance method(s) selected. In addition, because sunlight greatly increases die-off rates of enteric bacteria (Crane and Moore 1986, Elliot and Colwell 1985), bacteriological sampling should be conducted during early morning or at night. Ambient water quality data collection procedures and requirements are different for existing and for proposed or relocated discharge locations, as discussed in *Design of 301(h) Monitoring Program for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a) and summarized below.

For existing discharges, station locations should include sampling at the ZID boundaries (both upcurrent and downcurrent), at control (i.e., background ambient) stations, along the primary axis of the longshore component of the current (both upcurrent and downcurrent), at intermediate upcurrent stations located between the ZID boundary and the upcurrent control station, and in potential impact areas (e.g., in the nearshore zone and close to areas with distinctive habitats). The applicant should use information on local currents and wastefield

dispersion patterns to select sampling station locations in potentially impacted areas. Sampling stations located at the ZID boundary, at control stations along the primary axis of current, and at intermediate upcurrent stations should be in waters of approximately the same depth. Control (i.e., background ambient) stations should be located in areas not influenced by the applicant's discharge. The intermediate upcurrent stations are intended to represent the approximate residual wastefield concentrations (i.e., affected ambient) upcurrent of the discharge location to account for potential recirculation of previously discharged effluent (by reversing tidal currents, upwelling, or stagnant net circulation). Data should be collected at the intermediate and ZID stations at least twice during the day (e.g., high and low slack tides) to allow evaluation of short-term conditions. The duration of the longshore current in relation to the time of sampling is an important factor in determining whether the intermediate upcurrent stations are representative of persistent conditions or of only a temporary plume reversal. For discharges involving outfall relocation, monitoring stations must be located at the current discharge site until cessation of that discharge, and at the relocation site.

For each survey, the following information should be submitted along with the data: a chart showing exact locations of the stations, the depth at which the measurements were taken, and the sampling dates and times. For existing discharges, the applicant should state whether effluent was discharging from the outfall at the time of the survey and should provide the flow rate, BOD_5 concentration, pH, and suspended solids concentration of the effluent, if available. Any unusual meteorological or oceanographic conditions (e.g., storms, onshore transport, low or stagnant longshore currents) should be discussed. Current data or other oceanographic information should be collected (e.g., deploy drogues) at the time of the survey in order to determine the direction of movement of the wastefield.

Other periods when water quality conditions may be more critical include periods of maximum hydraulic loading from the POTW, exceptional biological activity, poor background water quality, minimum stratification, low net circulation, and low effective net flushing or low intertidal mixing. The frequency and duration of each of these observed conditions should be provided. Any unusual meteorological, oceanographic, or POTW operating conditions should also be described. The last three cases represent the potential for recirculation or reentrainment of previously discharged effluent or the presence of nuisance materials (e.g., floatables, scum, oil sheen) in and around the discharge area. The degree of recirculation would become significant if the discharge caused a violation in water quality standards or water quality criteria, as appropriate, at the ZID boundary, when under normal circulation conditions it would meet the standards or criteria at the ZID boundary.

II.B.7. Provide data on steady state sediment dissolved oxygen demand and dissolved oxygen demand due to resuspension of sediments in the vicinity of your current and modified discharge(s) (mg/L/day).

*** ***Only large dischargers must respond.***

Dissolved oxygen depletion due to steady sediment demand and sediment resuspension depends on sediment composition (e.g., grain size distribution and organic content), sediment accumulation rates, current speeds, and circulation patterns. Field or laboratory measurements can be used to determine oxygen consumption rates. The results of these measurements and the procedures used should be described.

II.C. Biological Conditions

In the section 301(h) process, the determination of adverse biological effects involves assessing whether a balanced indigenous population (BIP) of shellfish, fish, and wildlife exists in the vicinity of the discharge and in other areas potentially affected by the discharge. Since the BIP concept forms an integral part of the applicant's biological assessment, it is important to establish the meaning and interpretation of the term in the context of a section 301(h) biological demonstration.

The term *population* does not mean a reproductive unit of a single species but rather all biological communities existing in the receiving water body. Similarly, the terms *shellfish, fish,* and *wildlife* should be interpreted to include any and all biological communities that might be affected adversely by a marine POTW discharge [§125.58(y)].

A BIP is defined in the section 301(h) regulations [§125.58(f)] as "an ecological community which: (1) exhibits characteristics similar to those of nearby, healthy communities existing under comparable but unpolluted environmental conditions; or (2) may reasonably be expected to become re-established in the polluted water body segment from adjacent waters if sources of pollution were removed." Balanced indigenous populations generally occur in unpolluted waters. The second part of the definition concerning the re-establishment of communities is included because of its relevance to proposed, improved discharges and to discharges into waters that are stressed by sources of pollution other than the applicant's modified discharge.

The biological community characteristics that might be examined in an evaluation of a BIP include (but are not limited to) species composition, abundance, biomass, dominance, and diversity; spatial and temporal distributions; growth and reproduction of populations; disease frequency; trophic structure and productivity patterns; presence or absence of certain indicator species; bioaccumulation of toxic materials; and the occurrence of mass mortalities of fish and invertebrates.

The first step in an applicant's BIP demonstration is to define the "indigenous population" and establish the natural variability of the "balanced population." Because EPA has determined that these are observable characteristics of natural communities that exist in the absence of human disturbance, a comparative strategy is found throughout the section 301(h) regulations. Biological parameters of concern within and beyond the ZID should be compared to the range of natural variability found in comparable but unpolluted habitats.

The extent of documentation provided by the applicant in the marine biological assessment should reflect the quality and quantity of the effluent and the sensitivity of the receiving water. Data requirements will probably be least for applicants without substantial industrial waste sources whose discharges into ocean waters do not potentially affect distinctive habitats of limited distribution or important fishery resources.

> ***II.C.1. Provide a detailed description of representative biological communities (e.g., plankton, macrobenthos, demersal fish, etc.) in the vicinity of your current and modified discharge(s): within the ZID, at the ZID boundary, at other areas of potential discharge-related impact, and at reference (control) sites. Community characteristics to be described shall include (but not be limited to) species composition; abundance; dominance and diversity; spatial/temporal distribution; growth and reproduction; disease frequency; trophic structure and productivity patterns; presence of opportunistic species; bioaccumulation of toxic materials; and the occurrence of mass mortalities.***

*** ***Only large dischargers must respond.***

Of the marine communities that may be affected by POTW discharges, benthic communities or other communities that depend on the benthos as a food source (i.e., bottom-dwelling or bottom-feeding organisms) are usually the most sensitive to pollutants. The rate of accumulation of discharged solids and associated toxic substances near a POTW outfall affects the magnitude and extent of impacts to benthic communities. Based on the review of biological conditions near both large and small discharges in a variety of marine and estuarine

environments, it is apparent that the effects of POTW discharges on the benthos are determined primarily by the influence of the local hydrographic regimes on solids deposition and accumulation. Observed biological effects in areas of solids accumulation are generally associated with decreased abundances of suspension-feeding animals and increased abundances of deposit-feeding animals. Such effects would be expected to occur in sediments enriched with organic matter (e.g., from POTWs).

The biological information must be used to describe existing conditions near the discharge and to determine whether a BIP exists (or will exist) near the existing and modified discharges. This descriptive information must be used as the basis for the applicant's response to Question III.D.1. The applicant should design the monitoring program to collect data on biological conditions and habitat characteristics within and at the ZID-boundary, nearfield, farfield, and reference sites, ensuring that conditions near the discharge and shoreward are not excluded.

Applicants must submit descriptions of representative biological communities (typically benthic infauna and demersal fishes) in the receiving water body. These descriptions will form the basis for the comparative BIP demonstrations. It is important that the applicant assess biological community characteristics at a minimum of four sites: within the ZID, at or immediately beyond the ZID boundary, within the expected discharge impact area outside the ZID, and at appropriate reference sites.

Benthic data should be adequate to perform valid statistical and community analyses for the purposes of determining whether the following conditions exist:

- Benthic community structure in the discharge area differs from that in the control area.
- Benthic biomass in the discharge area differs from that in the control area.
- Opportunistic or pollution-tolerant species dominate benthic communities in the discharge area.
- Anoxic sediment conditions occur in the discharge area.
- Distinctive habitats of limited distribution (when present) are adversely affected by the applicant's discharge.

- The discharge contributes to or perpetuates ambient stresses in the receiving water (stressed water discharges only).

When the applicant's discharge is located in an area of soft substrates, sediment data should also be collected simultaneously with the benthic community at each sampling station. These data should include grain size composition and a measure of organic content. Data on Kjeldahl nitrogen, sediment BOD_5, and other sediment parameters may also be collected. Sediment data will be used to identify correlations between benthic community structure and attributes of the sedimentary environment in the receiving waters. Detailed guidance for evaluating benthic community conditions in the vicinity of an outfall is given in Appendix C.

II.C.2. a. Are distinctive habitats of limited distribution (such as kelp beds or coral reefs) located in areas potentially affected by the modified discharge? [40 CFR 125.62(c)]

b. If yes, provide information on type, extent, and location of habitats.

*** ***Large and small dischargers must respond.***

"Distinctive habitats of limited distribution" include marine environments whose protection is of special concern because of their ecological significance or value to humans. These habitats include, but are not limited to, coral reefs, kelp beds, seagrass meadows, salt marshes, spawning or nursery areas for commercial species, sites of aesthetic appeal, and rocky intertidal habitats (where they are uncommon). Distinctive habitats of limited distribution may be highly susceptible to the potential effects of discharged suspended solids and nutrients on the unique floral (e.g., kelp, seagrass) or faunal (e.g., coral) components of the communities. The potential for adverse effects of bioaccumulation of toxic substances is also relatively high because sessile floral and faunal organisms may constitute important trophic pathways within these communities. These attached communities are also susceptible because of the potential for continuous exposure to the effluent plume.

The applicant should describe distinctive habitats of limited distribution within the receiving water environment, as follows:

- Kinds of distinctive habitats that occur in the general vicinity of the discharge;

- Areal extent and location of the habitats in the region (shown on a map);

- Approximate distance from the discharge to sensitive habitats;
- Physical characteristics of each distinctive habitat (water column and substrate);
- Species composition of the flora and fauna;
- Abundance or percent cover (as applicable) of resident species; and
- Spatial and temporal variations in the biotic and abiotic components of each distinctive habitat present.

The basic information supplied by the applicant is expected to be descriptive in nature and should not require field surveys. Possible sources for information on distinctive habitats include contacts with local offices of state conservation agencies, and literature and resource maps, which are available for many areas.

II.C.3. a. Are commercial or recreational fisheries located in areas potentially affected by the discharge? [40 CFR 125.62(c) and (d)]

b. If yes, provide information on types, location, and value of fisheries.

*** ***Large and small dischargers must respond.***

Assessment of impacts on fisheries is important because of their economic significance, their recreational potential, and the potential for human consumption of contaminated organisms. The applicant should provide information on all fishery resources, both harvested and unharvested, near the outfall and in other areas potentially influenced by the discharge. Emphasis should be placed on regulatory or health-related factors that prevent utilization of the resource, especially if such factors are related to contamination. Information pertaining to water quality criteria and the associated human health risk levels is discussed under Question III.F.1. Additionally, Question III.F.1 discusses the possibilities of adverse effects due to the current discharge and references the guidance needed to effectively assess the levels of toxic accumulation in any contaminated organisms. Sources of information include natural resource agencies, public health agencies, local anglers, and academic institutions. For this assessment, the applicant should specify where species of recreational or commercial importance occur (i.e., in the immediate vicinity of the discharge, in the general region of the discharge, as migrants through the region).

The immediate vicinity of a discharge includes the outfall structure and the area associated with the discharge plume or clearly impacted by the deposition of discharged sediment. The spatial extent of the fisheries data will depend on the size and potential effects of the discharge and on the characteristics of the data. Many state fish and game agencies have established statistical areas for recording fisheries data. In these cases, an applicant can consider regional fisheries as those occurring in the statistical block that includes the outfall. If the outfall is located within an embayment or estuary where fisheries occur, the applicant should address commercial and recreational fisheries throughout the embayment or estuary.

Distances of the various fishery resources from the discharge should be provided. The following information should be provided:

- Magnitude of the fisheries:
  - Effort levels (e.g., number of vessels or number of fishermen) and
  - Economic value of commercial landings or sport fishery;
- Temporal pattern of the fisheries.

II.D. <u>State and Federal Laws [40 CFR 125.61 and 125.62(a)(1)]</u>

II.D.1. Are there water quality standards applicable to the following pollutants for which a modification is requested:

- ***Biochemical oxygen demand or dissolved oxygen?***
- ***Suspended solids, turbidity, light transmission, light scattering, or maintenance of the euphotic zone?***
- ***pH of the receiving water?***

*** ***Large and small dischargers must respond.***

Applicants should contact the state water quality agency for an answer to this question.

II.D.2. If yes, what is the water use classification for your discharge area? What are the applicable standards for your discharge area for each of the parameters for which a modification is requested? Provide a copy of all applicable water quality standards or a citation to where they can be found.

*** ***Large and small dischargers must respond.***

In response to Question II.D, applicants should demonstrate compliance with state water quality standards [§125.61(b)]. Individual states often have water quality standards that must be met independently from federal water quality criteria. State standards that are applicable to the discharge must be provided in this response, and determinations of compliance with those standards must be provided in the response to Questions III.B.6 and III.B.7. Occasionally, state water quality standards are dependent on the location of the outfall diffuser. If the effluent wastefield is transported to a location having standards different from those of the diffuser location, then both sets of standards apply [§125.62(a)(1)].

II.D.3. Will the modified discharge: [40 CFR 125.59(b)(3)]

- ***Be consistent with applicable State coastal zone management program(s) approved under the Coastal Zone Management Act as amended, 16 U.S.C. 1451 et seq.? [See 16 U.S.C. 1456(c)(3)(A)]***

- ***Be located in a marine sanctuary designated under Title III of the Marine Protection, Research, and Sanctuaries Act (MPRSA) as amended, 16 U.S.C. 1431 et seq., or in an estuarine sanctuary designated under the Coastal Zone Management Act as amended, 16 U.S.C. 1461? If located in a marine sanctuary designated under Title III of the MPRSA, attach a copy of any certification or permit required under regulations governing such marine sanctuary. [See 16 U.S.C. 1432(f)(2)]***

- ***Be consistent with the Endangered Species Act as amended, 16 U.S.C. 1531 et seq.? Provide the names of any threatened or endangered species that inhabit or obtain nutrients from waters that may be affected by the modified discharge. Identify any critical habitat that may be affected by the modified discharge and evaluate whether the modified discharge will affect threatened or endangered species or modify a critical habitat. [See 16 U.S.C. 1536(a)(2)]***

**** Large and small dischargers must respond.*

Applicants should contact the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and applicable state coastal zone management agency for answers to this question.

II.D.4. Are you aware of any State or Federal laws or regulations (other than the Clean Water Act or the three statutes identified in item 3 above) or an Executive order which is applicable to your discharge? If yes, provide sufficient information to demonstrate that your modified discharge will comply with such law(s), regulation(s), or order(s). [40 CFR 125.59 (b)(3)]

*** ***Large and small dischargers must respond.***

Because each application for permit reissuance is considered to be an application for a new NPDES permit, applicants are required to provide new determinations of compliance with all applicable local, state, and federal laws and regulations, as indicated above.

III. TECHNICAL EVALUATION

III.A. Physical Characteristics of Discharge [40 CFR 125.62(a)]

III.A.1. What is the critical initial dilution for your current and modified discharge(s) during 1) the period(s) of maximum stratification? and 2) any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?

*** ***Large and small dischargers must respond.***

POTW effluents are normally discharged into marine waters through outfalls that range from open-ended pipes to extensive diffusers. The characteristics of the effluent and the receiving water, the diffuser design, and the depth of discharge will determine the amount of effluent dilution achieved. As shown in Figure 1, the lower-density (nonsaline) discharged effluent creates a buoyant plume that rises rapidly toward the water surface, entraining significant amounts of ambient saline water. The momentum and buoyancy of the discharged effluent are primarily responsible for the entrainment of dilution water (i.e., mixing of ambient saline water with effluent). As the plume rises and entrains ambient saline water, its density increases and its momentum and buoyancy decrease accordingly. If a sufficient ambient vertical density gradient or zone of stratification (like a pycnocline or thermocline) is present, the plume will spread horizontally at the level of neutral buoyancy (i.e., where the plume density equals ambient water density). If a sufficient density gradient is not present, the diluted effluent will reach the water surface and flow horizontally. The vertical distance from the discharge points to the centerline of the plume when it reaches the level of neutral buoyancy or the water surface is

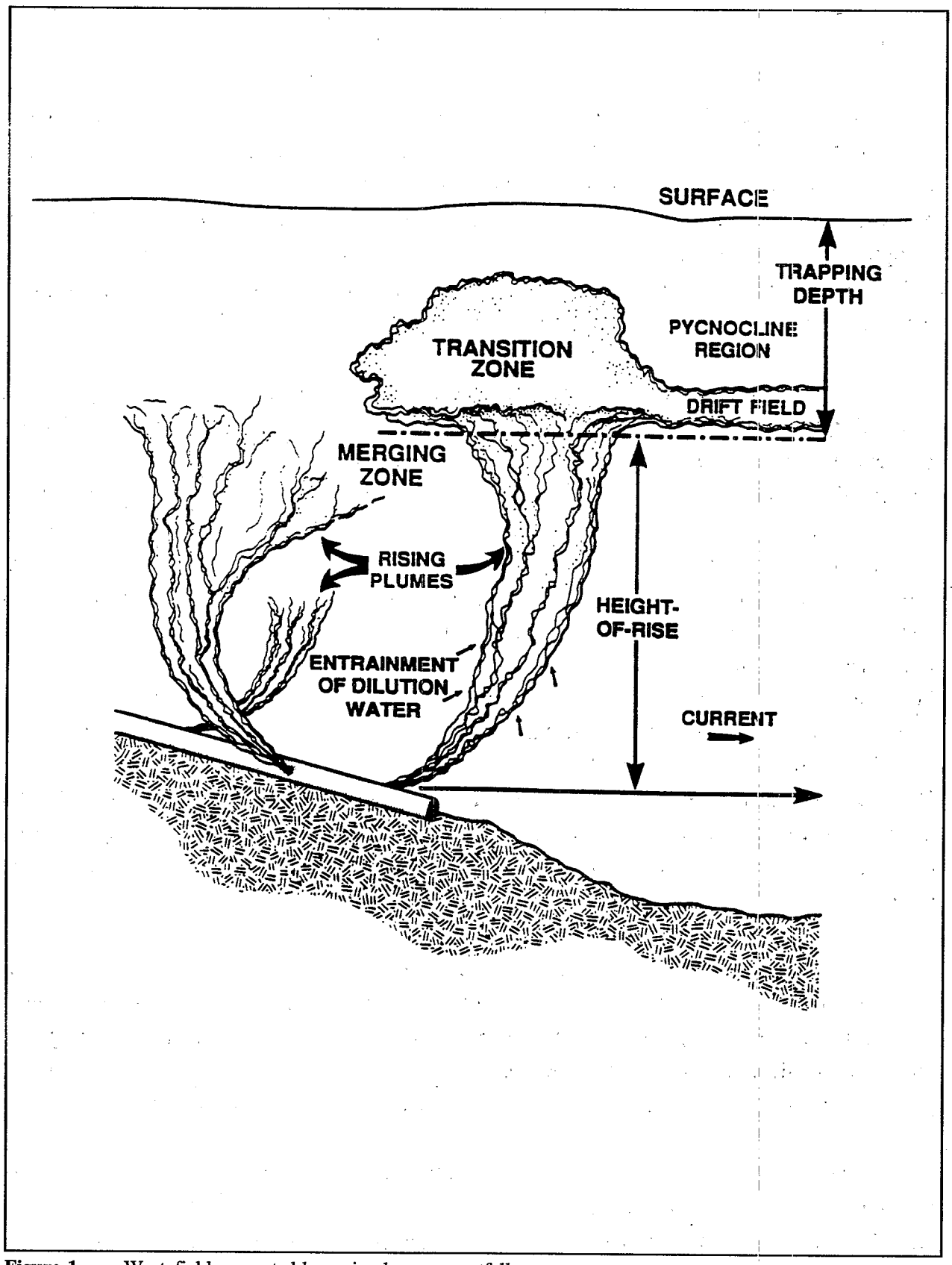

Figure 1. Wastefield generated by a simple ocean outfall.

called the "height-of-rise" (sometimes referred to as the height to "trapping" or "equilibrium" level).

The dilution achieved at the completion of this process is called the "initial dilution." Dilution is the ratio of the total volume of a sample (ambient water plus effluent) to the volume of effluent in the sample. A dilution of 100 is, therefore, a mixture composed of 99 parts of ambient water to 1 part of effluent. The initial dilution is a critical parameter relative to compliance with water quality standards and is thus discussed in some detail in the evaluation of both large and small applications. The magnitude of initial dilution achieved is dependent on ambient density gradients and diffuser design.

The lowest (i.e., critical) initial dilution must be computed for each of the critical environmental seasons. The predicted peak 2- to 3-hour effluent flow for the new end-of-permit year and a current speed no higher than the lowest 10 percentile current speed must be used. A simplified procedure for computing initial dilution is described in Appendix A. Five EPA-supported computer models (i.e., UPLUME, UOUTPLM, UMERGE, UDKHDEN, ULINE) and several analytical formulas for computing initial dilution are described by Muellenhoff et al. (1985a, 1985b). These five models were designed for submerged discharges in oceans. All but one can be used on rivers, lakes, and estuaries with appropriate input modifications; UPLUME is restricted to stagnant water environments where ambient water current velocity is zero (e.g., lakes, reservoirs). Also available through EPA is CORMIX, an expert system that guides the user in selecting an appropriate modeling strategy for rivers or estuaries (U.S. EPA 1991b). ASCII files containing FORTRAN code for these models are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161, (703) 487-4650. These files are on either nine-track tape or floppy diskettes that can be read by an IBM-compatible personal computer. Muellenhoff et al. (1985a) discuss guidelines for use of the models.

The method described in Appendix A to calculate initial dilution is most applicable to situations where ample dilution waters are available. Three assumptions are made when using the simplified method: (1) the discharge is submerged; (2) the submergence depth of the port is more than 10 times the diameter of the port; and (3) the hydraulic pressure within the port is greater than ambient water pressure (i.e., there is a constant flow out of the outfall).

Care should be taken when using this method of calculation in situations where ample dilution waters are not available. Using these calculations for discharges into shallow waters or estuarine areas may result in overconservative or invalid results. Additional information for

modeling of estuarine areas can be found in *Technical Guidance Manual for Performing Waste Load Allocations, Book III: Estuaries, Part 3 Use of Mixing Zone Models in Estuarine Waste Load Allocations* (Ambrose et al. 1992).

The method presented Appendix A is for use in the absence of site-specific information. Where site-specific information is available, or where site-specific circumstances make the calculation of the initial dilution ratio suspect, the numerical model UPLUME or UMERGE can be used to provide a better estimate of initial dilution. Case-by-case assessments of the accuracy of calculations made using the Appendix A method may be necessary in such instances. Site-specific information on topography, density profile, type of outfall, current measurements, physical circulation patterns, and temperature is needed to obtain an accurate calculation of initial dilution. Recalculation with site-specific information using the methods in *Mixing in Inland and Estuarine Waters* (Fischer et al. 1979) could be conducted.

During computation of initial dilution by one of these methods, the flow from each of the ports modeled should be approximately constant within a section of the diffuser. The initial dilution and trapping depth for each section should be a flow rate averaged to obtain the initial dilution and trapping depth, respectively, for the entire diffuser. The depth of the discharge is determined as the depth of section below mean lower low water (or mean low water) or as the average for the diffuser. If the adjacent ports discharge on opposite sides of the diffuser, the port spacing should be equal to the distance between ports discharging on the same side of the diffuser. (This stipulation is applicable to UMERGE and UDKHDEN, but not ULINE.) Sufficient documentation of the methods and parameters used by the applicant to calculate initial dilution must be provided so that the results obtained can be duplicated independently.

When monitoring data and other information, collected over the term of the existing permit, confirm that all the values used in analyses provided in the original application have not changed and are not expected to change over the term of the new modified permit, the applicant may summarize the available data and provide evidence demonstrating the basis for determining that no change in information has been realized or expected. In cases where the values of one or more parameters have changed, however, or where new monitoring data are useful for supporting a given demonstration, those data should be included in the required response.

Under section 301(h)(2) and §§125.57(a)(2) and 125.62(f), all demonstrations of compliance with applicable statutes and regulations must consider the effects of the discharge singly and in combination with pollutants from other sources, if any other sources exist. Some applicants will find, however, that monitoring data or other information collected during the term

of the original modified permit requires that new calculations be performed. For example, new calculations will be required where the water column density profile is better defined, effluent flows have changed or are expected to change, or the number of open ports has changed.

III.A.2. What are the dimensions of the zone of initial dilution for your modified discharge(s)?

*** ***Large and small dischargers must respond.***

The zone of initial dilution (ZID) is the region of initial mixing surrounding or adjacent to the end of the outfall pipe or diffuser ports and includes the underlying seabed. The ZID describes an area in which inhabitants, including the benthos, may be chronically exposed to concentrations of pollutants in violation of water quality standards and criteria or at least to concentrations more severe than those predicted for critical conditions. The ZID is not intended to describe the area bounding the entire mixing process for all conditions or the total area impacted by the sedimentation of settleable material.

In general, the ZID can be considered to include that bottom area and the water column above that area circumscribed by distance d from any point of the diffuser, where d is equal to the water depth. Several different diffuser configurations and corresponding ZID dimensions are shown in Figure 2. The water depth used should be the maximum water depth along the diffuser axes with respect to mean lower low water (or mean low water) and may not be larger than allowed by mixing zone restrictions in applicable water quality standards [§125.58(dd)].

Unless changes to the outfall system have been made or are anticipated, or unless incorrect water depths or outfall characteristics were used in the original section 301(h) application, the calculation presented here should be identical to that presented in the original application. Repetition of the calculation in the application for reissuance of the section 301(h) modified permit is necessary to confirm that all values used in the original application were correct and that the outfall system has not changed and will not change over the term of the new permit.

III.A.3. What are the effects of ambient currents and stratification on dispersion and transport of the discharge plume/wastefield?

*** ***Only large dischargers must respond.***

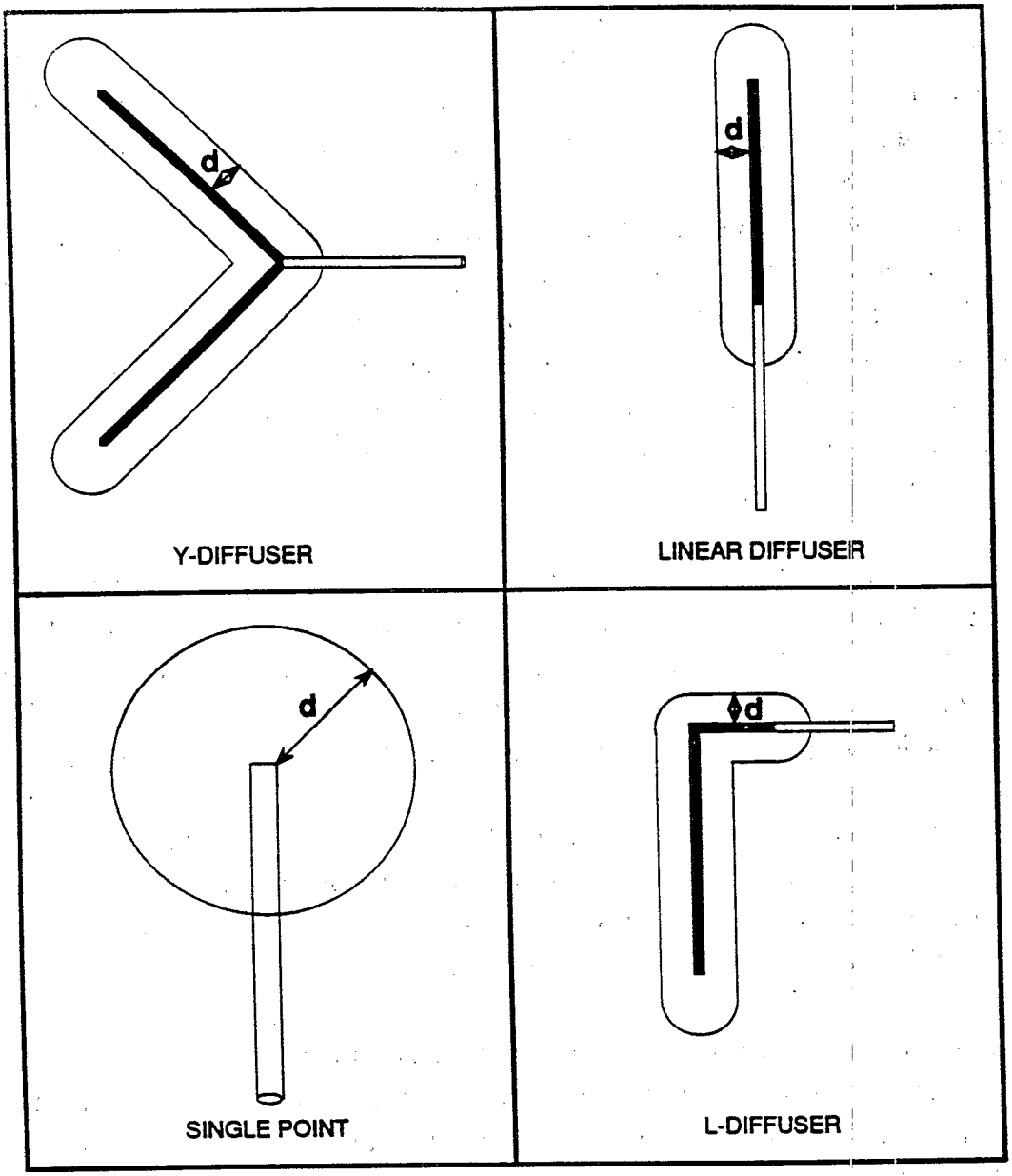

Figure 2. Diffuser types and corresponding ZID configurations.

A general description of the ambient currents expected within the influence of the diffuser site is required by EPA. Since this description is primarily of use in determining where the effluent wastefield is likely to be transported during several days' time, the response to this subsection should be of sufficient detail for this purpose. Knowledge of the subsequent movement of the wastefield is also needed to address the potential for reentrainment of previously discharged effluent, which could effectively increase wastefield concentrations at the boundary of the ZID. The applicant should take into account that dilution water is entrained into the effluent plume throughout the depth over which the plume rises. The diluted wastefield may be transported by either surface currents or subpycnocline currents at different times during a tidal cycle. In a region where currents are predominantly tidal, current persistence and the mean current speed and its variance with respect to the primary directions of water flow should be given. If the currents have large components unrelated to tidal influences (e.g., wind-induced currents), then a more detailed analysis should be performed. The mean, variance, and direction of the tidal component should be determined, and a synopsis of the nontidal current speed, direction, and persistence should be provided. Vertical variations in currents are important at depths where the effluent wastefield is trapped.

The basis for the current estimates should be provided. Acceptable sources of information are site-specific measurements and published measurements or predictions. The Tidal Current Tables published annually by the U.S. Department of Commerce (see National Ocean Survey 1988a, 1988b) provide tidal current information for a large number of locations. Information from other published documents is usable if the documents are made available to EPA on request.

Expected or measured effluent dilutions at important shoreline stations should be included. Chapters B-II, Dissolved Oxygen Concentration Following Initial Dilution, and B-III, Farfield Dissolved Oxygen Depression, in Appendix B of this document provide further guidance on computing farfield dilutions for water quality parameters.

Under certain circumstances, such as low nontidal currents or reversing tidal currents, the affected "ambient" water quality concentrations of the dilution water for the plume may be temporarily higher than the normal background concentration. Thus, higher concentrations of pollutants may occur within the ZID. This issue is of primary concern for discharges located in estuaries or semi-enclosed water bodies but may also be of concern for open coastal sites. To ensure that the discharge meets all applicable water quality criteria during these other critical conditions, the applicant should evaluate the recirculation potential of the existing or proposed discharge through an analysis of currents, dye or field mixing studies (for existing discharges only), numerical modeling analyses (for relocated or proposed new discharges), or evaluation of water quality data collected during the existing discharge monitoring program. A monitoring

strategy is described below in guidance for questions in III.F (Establishment of a Monitoring Program).

Dye studies are particularly useful to evaluate the recirculation potential under short-term tidal cycle influences for existing discharges. Current-meter data should be made available to evaluate both the high-frequency (tidal) and low-frequency (nontidal) current regimes that exist at the time of the dye study.

For relocated or proposed new discharges, numerical circulation and transport models are the most useful methods for assessing the effects of ambient currents and stratification on dispersion and transport of the wastefield and for estimating the potential for recirculation of previously discharged effluent. There are two general approaches. The first is to simulate a conservative substance (i.e., no decay) as a tracer for the wastefield to estimate numerical dilution factors surrounding the discharge. These dilution factors can be used to estimate the affected ambient concentration of any water quality parameter as input to the initial and subsequent dilution techniques presented elsewhere in this document. The second approach, which is more complex, is to simulate directly the water quality parameters and the kinetic processes that govern their fate (e.g., BOD decay, suspected solids settling).

Several specific guidelines can be offered to applicants in the use of numerical models. Typically, the most critical conditions for recirculation and build-up of previously discharged effluent would occur when the water column is density-stratified in the presence of tidally reversing currents and low nontidal currents and the wastefield remains submerged below the pycnocline following initial dilution. If such conditions occur at the applicant's outfall site, the numerical model should be layered vertically, with a minimum of two layers. The plume should be discharged into the bottom layer to simulate the submerged discharge. The applicant should set up the grid system for the numerical model such that the smallest segments are located in the vicinity of the diffuser and the segments gradually increase in size with distance from the diffuser. The applicant might choose to experiment with grid configuration by starting with a coarse grid and then decreasing the grid size until the model results do not change greatly.

A variety of numerical circulation and transport models exist with various levels of detail, user documentation, and applicability. Examples of potentially applicable models include CAFE/DISPER (Wang and Connor 1975; Christodoulou, Connor, et al. 1976; Christodoulou, Pagenkopf, et al. 1976; Pagenkopf et al. 1976); TEA/ELA (Baptista et al. 1984, Westerink et al. 1985); Spaulding and Pavish (1984); and Sheng and Butler (1982). The applicant must use a model that is supported by a fully documented computer program so that EPA and other

interested parties can conduct analyses (i.e., run simulations) on generally available computer systems.

III.A.4. Will there be significant sedimentation of suspended solids in the vicinity of the modified discharge?

*** ***Only small dischargers must respond.***

The accumulation of suspended solids from municipal wastewater discharges may lower dissolved oxygen concentrations in near-bottom waters and cause changes in benthic communities. Accumulation of suspended solids in the vicinity of a discharge is influenced by the amount of solids discharged, the settling velocity distribution of the particles in the discharge, the plume height-of-rise, and current velocities. Hence, sedimentation of suspended solids is generally of little concern for small discharges into well-flushed receiving waters.

In response to this question, the applicant must predict the seabed accumulation that results from the discharge of suspended solids into the receiving water. The applicant may use any applicable well-documented sedimentation model. A simplified approach for small dischargers is provided in Chapter B-I of Appendix B. A simplified sedimentation model for large dischargers, or small dischargers for whom the simplified approach is not appropriate, is also described in Chapter B-I of Appendix B. The sedimentation model DECAL (a simplified Deposition Calculation) is available as an Ocean Data Evaluation System (ODES) tool.

III.A.5. Sedimentation of suspended solids.

a. What fraction of the modified discharge's suspended solids will accumulate within the vicinity of the modified discharge?

b. What are the calculated area(s) and rate(s) of sediment accumulation within the vicinity of the modified discharge(s) ($g/m^2/yr$)?

c. What is the fate of settleable solids transported beyond the calculated sediment accumulation area?

*** ***Only large dischargers must respond.***

Information on the fate of suspended solids is needed to calculate oxygen consumption rates and interpret biological data. Settling velocity distributions of the effluent should be provided, if available. Graphs showing the settling velocity (cm/sec) and percent of solids that

settle at that velocity or less are preferred. The suspended solids concentration (mg/L), test conditions, and laboratory procedures that are used should be described.

The applicant should calculate whether substantial sedimentation of suspended solids occurs. These calculations should be made for the annual period and for the critical 90-day period (i.e., the 90-day period during which the highest sedimentation rate occurs). The average plume height-of-rise with respect to the seafloor should be used in these calculations. A simplified procedure for calculating the effect of sedimentation is described in Chapter B-I of Appendix B.

III.B. Compliance with Applicable Water Quality Standards and CWA §304(a)(1) water quality criteria [40 CFR 125.61(b) and 125.62(a)]

III.B.1. What is the concentration of dissolved oxygen immediately following initial dilution for the period(s) of maximum stratification and any other critical period(s) of discharge volume/composition, water quality, biological seasons, or oceanographic conditions?

*** ***Large and small dischargers must respond.***

Dissolved oxygen in the receiving water is diminished by the low oxygen content and immediate dissolved oxygen demand (IDOD) of the effluent within the ZID and by oxidation of organic material in the diluted effluent beyond the ZID. A simplified procedure for calculating the dissolved oxygen concentration immediately following initial dilution is explained in Chapter B-II of Appendix B. Note that some states limit the maximum allowable depression in dissolved oxygen concentration and that the maximum dissolved oxygen depression may not occur during the season that has the lowest initial dilution.

III.B.2. What is the farfield dissolved oxygen depression and resulting concentration due to BOD exertion of the wastefield during the period(s) of maximum stratification and any other critical period(s)?

*** ***Large and small dischargers must respond.***

A simplified procedure for calculating the farfield dissolved oxygen depression is given in Chapter B-III of Appendix B.

III.B.3. What are the dissolved oxygen depressions and resulting concentrations near the bottom due to steady sediment demand and resuspension of sediments?

*** ***Only large dischargers must respond.***

Suspended solids that accumulate on the seabed can exert a dissolved oxygen demand due to continuous oxidation of organic material at the sediment surface and occasional rapid oxidation of resuspended sediments. Estimates of dissolved oxygen depressions that result from steady state sediment demand and resuspension of solids should be made using the methods described in Chapter B-IV of Appendix B. If field or laboratory measurements are available, the results can be used in these analyses.

III.B.4. What is the increase in receiving water suspended solids concentration immediately following initial dilution of the modified discharge(s)?

*** ***Large and small dischargers must respond.***

Suspended solids in the water column can reduce light transmittance and thus water clarity. Reduction of the depth to which sunlight penetrates can also affect biological communities within the water column. The suspended solids concentration following initial dilution can be estimated by a simple mass balance calculation.

The formula provided in Chapter B-V of Appendix B should be used to calculate the receiving water suspended solids concentration following critical initial dilution. In cases where the initial dilution or the concentration of suspended solids in the effluent has not changed since the original application was submitted, and is not expected to change over the term of the new permit, it will be necessary only to reproduce the calculation provided in the original application. However, changes in either parameter will necessitate recalculating the receiving water suspended solids concentration.

III.B.5. What is the change in receiving water pH immediately following initial dilution of the modified discharge(s)?

*** ***Only large dischargers must respond.***

The pH of the receiving water can be affected by the discharge of highly acidic or highly alkaline wastes. Final pH values after initial dilution can be estimated from field measurements or calculated from carbonate system alkalinity relationships.

In most settings, the influence of a municipal waste discharge on the receiving water pH is small. This section provides a method to calculate the pH change of receiving waters due to a waste discharge and to determine whether standards are violated.

The pH at completion of initial dilution can be estimated from Table 1. The values shown in this table were generated by a pH-alkalinity model (based on the carbonate system) that simulates the mixing of effluent and seawater. The methods used to calculate the values in this table are explained in Chapter B-VI of Appendix B. Because waste plumes are usually submerged during initial dilution, no exchange with the atmosphere is included. The results are

TABLE 1. ESTIMATED pH VALUES AFTER INITIAL DILUTION

Seawater Temp.	5 °C					15 °C					25 °C				
	Initial Dilution														
Seawater pH	10	25	50	75	100	10	25	50	75	100	10	25	50	75	100
						Effluent pH = 6.0 Alk = 0.1									
7.00	6.97	6.98	6.99	6.99	6.99	6.97	6.99	6.99	6.99	6.99	6.97	6.99	6.99	6.99	6.99
7.50	7.40	7.46	7.48	7.48	7.49	7.42	7.47	7.48	7.49	7.49	7.43	7.47	7.48	7.49	7.49
7.70	7.58	7.65	7.67	7.68	7.68	7.61	7.66	7.68	7.69	7.69	7.63	7.67	7.68	7.69	7.69
8.00	7.89	7.96	7.98	7.98	7.99	7.93	7.97	7.99	7.99	7.99	7.96	7.98	7.99	7.99	7.99
8.30	8.23	8.27	8.28	8.29	8.29	8.27	8.29	8.29	8.29	8.29	8.28	8.29	8.29	8.29	8.29
8.50	8.46	8.48	8.49	8.49	8.49	8.48	8.49	8.49	8.49	8.49	8.49	8.49	8.49	8.49	8.49
						Effluent pH = 6.0 Alk = 0.6									
7.00	6.80	6.91	6.95	6.96	6.97	6.80	6.91	6.95	6.96	6.97	6.80	6.91	6.95	6.97	6.97
7.50	7.05	7.28	7.38	7.42	7.43	7.07	7.30	7.39	7.42	7.44	7.09	7.32	7.40	7.43	7.45
7.70	7.13	7.42	7.55	7.60	7.62	7.18	7.46	7.58	7.62	7.64	7.22	7.50	7.60	7.63	7.65
8.00	7.29	7.69	7.85	7.90	7.92	7.40	7.78	7.90	7.93	7.95	7.53	7.84	7.92	7.95	7.96
8.30	7.57	8.06	8.19	8.23	8.24	7.82	8.15	8.23	8.25	8.26	7.98	8.19	8.25	8.26	8.27
8.50	7.90	8.32	8.41	8.44	8.46	8.15	8.38	8.44	8.46	8.47	8.25	8.41	8.46	8.47	8.48
						Effluent pH = 6.0 Alk = 1.0									
7.00	6.70	6.85	6.92	6.94	6.96	6.70	6.86	6.92	6.94	6.96	6.71	6.86	6.92	6.95	6.96
7.50	6.89	7.17	7.31	7.37	7.40	6.90	7.19	7.33	7.38	7.41	6.92	7.21	7.34	7.39	7.42
7.70	6.94	7.28	7.46	7.54	7.57	6.97	7.33	7.50	7.56	7.60	7.01	7.38	7.53	7.59	7.62
8.00	7.04	7.50	7.74	7.83	7.87	7.12	7.62	7.82	7.88	7.91	7.22	7.71	7.87	7.91	7.93
8.30	7.20	7.86	8.11	8.18	8.21	7.40	8.02	8.17	8.22	8.24	7.65	8.10	8.21	8.24	8.25
8.50	7.39	8.17	8.35	8.40	8.43	7.77	8.29	8.40	8.43	8.45	8.01	8.34	8.42	8.45	8.46
						Effluent pH = 6.0 Alk = 2.0									
7.00	6.53	6.75	6.85	6.90	6.92	6.53	6.75	6.86	6.90	6.92	6.54	6.75	6.86	6.90	6.92
7.50	6.64	6.97	7.17	7.26	7.31	6.65	6.99	7.19	7.28	7.33	6.67	7.01	7.21	7.30	7.34
7.70	6.67	7.04	7.28	7.40	7.46	6.69	7.08	7.33	7.44	7.50	6.71	7.12	7.38	7.48	7.53
8.00	6.72	7.17	7.50	7.66	7.74	6.76	7.27	7.62	7.75	7.82	6.81	7.39	7.71	7.82	7.86
8.30	6.79	7.39	7.87	8.03	8.11	6.88	7.64	8.02	8.12	8.17	6.99	7.84	8.10	8.17	8.20
8.50	6.86	7.67	8.17	8.29	8.35	7.01	8.00	8.28	8.36	8.40	7.23	8.15	8.34	8.39	8.42
						Effluent pH = 6.5 Alk = 0.5									
7.00	6.95	6.98	6.99	6.99	6.99	6.95	6.98	6.99	6.99	6.99	6.95	6.98	6.99	6.99	6.99
7.50	7.35	7.44	7.47	7.48	7.48	7.37	7.45	7.47	7.48	7.48	7.39	7.45	7.47	7.48	7.48
7.70	7.52	7.62	7.66	7.67	7.68	7.55	7.64	7.67	7.68	7.68	7.58	7.65	7.67	7.68	7.69
8.00	7.81	7.93	7.96	7.97	7.98	7.87	7.95	7.97	7.98	7.98	7.91	7.97	7.98	7.99	7.99
8.30	8.16	8.25	8.27	8.28	8.28	8.22	8.27	8.28	8.29	8.29	8.24	8.28	8.29	8.29	8.29
8.50	8.40	8.46	8.48	8.48	8.49	8.44	8.47	8.49	8.49	8.49	8.46	8.48	8.49	8.49	8.49
						Effluent pH = 6.5 Alk = 1.0									
7.00	6.90	6.95	6.97	6.98	6.98	6.90	6.96	6.98	6.98	6.98	6.90	6.96	6.98	6.98	6.99
7.50	7.23	7.38	7.43	7.45	7.46	7.25	7.39	7.44	7.46	7.47	7.27	7.40	7.45	7.46	7.47
7.70	7.35	7.55	7.62	7.65	7.66	7.40	7.58	7.64	7.66	7.67	7.44	7.60	7.65	7.66	7.67
8.00	7.59	7.84	7.92	7.95	7.96	7.70	7.89	7.95	7.96	7.97	7.78	7.92	7.96	7.97	7.98
8.30	7.96	8.18	8.24	8.26	8.27	8.09	8.22	8.26	8.27	8.28	8.15	8.24	8.27	8.28	8.28
8.50	8.24	8.41	8.45	8.47	8.48	8.33	8.44	8.47	8.48	8.48	8.38	8.45	8.47	8.48	8.48

TABLE 1. (Continued)

Seawater Temp.	5 °C					15 °C					25 °C				
	Initial Dilution														
Seawater pH	10	25	50	75	100	10	25	50	75	100	10	25	50	75	100
	Effluent pH = 6.5 Alk = 2.0														
7.00	6.82	6.91	6.95	6.97	6.97	6.82	6.91	6.95	6.97	6.97	6.82	6.92	6.95	6.97	6.97
7.50	7.06	7.28	7.38	7.41	7.43	7.08	7.29	7.39	7.42	7.44	7.10	7.31	7.40	7.43	7.45
7.70	7.14	7.42	7.55	7.59	7.62	7.18	7.46	7.57	7.61	7.63	7.22	7.49	7.60	7.63	7.65
8.00	7.28	7.68	7.84	7.89	7.92	7.39	7.76	7.89	7.92	7.94	7.50	7.82	7.91	7.94	7.96
8.30	7.54	8.04	8.18	8.22	8.24	7.78	8.13	8.22	8.24	8.26	7.93	8.17	8.24	8.26	8.27
8.50	7.85	8.30	8.40	8.44	8.45	8.10	8.36	8.43	8.45	8.46	8.21	8.39	8.45	8.46	8.47
	Effluent pH = 9.0 Alk = 2.0														
7.00	7.06	7.02	7.01	7.00	7.00	7.06	7.02	7.01	7.00	7.00	7.07	7.02	7.01	7.00	7.00
7.50	7.56	7.52	7.51	7.50	7.50	7.56	7.52	7.51	7.50	7.50	7.56	7.52	7.51	7.50	7.50
7.70	7.75	7.72	7.70	7.70	7.70	7.75	7.72	7.71	7.70	7.70	7.75	7.72	7.71	7.70	7.70
8.00	8.03	8.01	8.00	8.00	8.00	8.03	8.01	8.00	8.00	8.00	8.03	8.01	8.00	8.00	8.00
8.30	8.31	8.30	8.30	8.30	8.30	8.31	8.30	8.30	8.30	8.30	8.31	8.30	8.30	8.30	8.30
8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.49	8.49
	Effluent pH = 9.0 Alk = 4.0														
7.00	7.10	7.04	7.02	7.01	7.00	7.10	7.04	7.02	7.01	7.01	7.11	7.04	7.02	7.01	7.01
7.50	7.59	7.53	7.51	7.51	7.50	7.59	7.53	7.51	7.51	7.50	7.59	7.53	7.51	7.51	7.50
7.70	7.76	7.72	7.71	7.70	7.70	7.76	7.72	7.71	7.70	7.70	7.76	7.72	7.71	7.70	7.70
8.00	8.02	8.01	8.00	8.00	8.00	8.02	8.00	8.00	8.00	8.00	8.02	8.00	8.00	8.00	8.00
8.30	8.29	8.29	8.29	8.29	8.29	8.28	8.29	8.29	8.29	8.29	8.28	8.29	8.29	8.29	8.29
8.50	8.47	8.48	8.49	8.49	8.49	8.46	8.48	8.49	8.49	8.49	8.46	8.48	8.49	8.49	8.49
	Effluent pH = 9.0 Alk = 6.0														
7.00	7.14	7.05	7.02	7.01	7.01	7.14	7.05	7.02	7.01	7.01	7.15	7.06	7.03	7.02	7.01
7.50	7.61	7.54	7.52	7.51	7.51	7.61	7.54	7.52	7.51	7.51	7.61	7.54	7.52	7.51	7.51
7.70	7.78	7.73	7.71	7.71	7.70	7.77	7.73	7.71	7.71	7.70	7.77	7.73	7.71	7.71	7.70
8.00	8.02	8.00	8.00	8.00	8.00	8.01	8.00	8.00	8.00	8.00	8.01	8.00	8.00	8.00	8.00
8.30	8.27	8.28	8.29	8.29	8.29	8.26	8.28	8.29	8.29	8.29	8.26	8.28	8.29	8.29	8.29
8.50	8.44	8.47	8.48	8.49	8.49	8.43	8.47	8.48	8.49	8.49	8.43	8.47	8.48	8.48	8.49

based on a seawater alkalinity of 2.3 meq/L (Stumm and Morgan 1981) and dissociation constants from Stumm and Morgan (1981) and Dickson and Riley (1979).

Effluent alkalinity depends on the alkalinity of the source water and any infiltrating water, the type of treatment process, and the volume and type of industrial waste that enters the treatment plant. Effluent alkalinity can range from 0 to 6.0 meq/L. A typical value for effluent alkalinity is 2 meq/L or higher (Metcalf and Eddy 1979). Because alkalinity data are scarce, final pH values calculated for a range of alkalinities are provided in Table 1. If significant industrial waste is present in an effluent, or if pure oxygen or nitrification-denitrification treatment processes are used, effluent pH and alkalinity should be measured. For cases of weak

primary effluents with no industrial waste components, an alkalinity value of 0.1 meq/L with an effluent pH of 6.0 can be used to estimate the final pH. If the lowest effluent pH is 6.5 or higher, an alkalinity value of 0.5 meq/L with an effluent pH of 6.5 can be used to estimate the final pH.

The applicant should first estimate the pH at completion of initial dilution for the case when the effluent pH is 6.0 and the ambient pH is equal to the minimum ambient pH in the vicinity of the discharge. The estimated value should be compared with the appropriate state standard to determine whether the standard is met.

The applicant may also perform laboratory tests when the predicted pH values in Table 1 indicate that contraventions of pH standards are possible. Some of the buffering constituents in municipal effluents are not readily quantified (e.g., organic acid ligands) and have not been included in the calculations used to produce the table. The laboratory test would include measuring the pH of effluent-receiving water mixtures as discussed below.

If the effluent pH drops below 6.0, the applicant should indicate the number of times per year effluent pH values fell below 6.0 and the suspected causes of those low values. If effluent pH values below 6.0 occur frequently, a laboratory test of pH after mixing the effluent and receiving water should be performed for the critical conditions. The sample mixture should not be allowed to equilibrate with the atmosphere. The pH should be measured at close intervals until no further change in pH is observed. The applicant should describe conditions of the test, including temperature, pH, and alkalinity of the effluent and receiving water; initial dilution; and the measured values after mixing. The measured values should then be compared with the applicable standard to determine whether a violation is likely. The frequency of violations should be estimated.

III.B.6. Does (will) the modified discharge comply with applicable water quality standards for:

- ***Dissolved oxygen?***
- ***Suspended solids or surrogate standards?***
- ***pH?***

*** ***Large and small dischargers must respond.***

The applicant must demonstrate compliance with applicable receiving water quality standards. Typically, standards exist for dissolved oxygen, suspended solids, and pH, in which

case the results of previous sections may be used. If a quantitative state standard exists for turbidity expressed in a given turbidity unit, then turbidity of the effluent and the receiving water (expressed in turbidity units as a function of concentration) should be measured to demonstrate that the standard will be met. Methods to determine compliance with water quality standards for DO, TSS, pH, and turbidity are discussed in Appendix B, Chapters B-I to B-VII.

According to §125.57(a)(9), permits may not be issued if the dilution water for the discharge contains significant amounts of previously discharged effluent. In general, this criterion will be met if all water quality standards and/or water quality criteria established under section 304(a)(1) of the Clean Water Act, as noted in Question III.B.7 below, are met.

> ***III.B.7. Provide data to demonstrate that all applicable State water quality standards, and all applicable water quality criteria established under Section 304(a)(1) of the Clean Water Act for which there are no directly corresponding numerical applicable water quality standards approved by EPA, are met at and beyond the boundary of the ZID under critical environmental and treatment plant conditions in the waters surrounding or adjacent to the point at which your effluent is discharged. [40 CFR 125.62(a)(1)]***

*** ***Large and small dischargers must respond.***

At the time the 301(h) modification becomes effective, the applicant's outfall and diffuser must be located and designed to provide adequate dilution, dispersion, and transport of wastewater to meet, at and beyond the ZID, all applicable water quality standards and all applicable water quality criteria for which there are no directly corresponding approved water quality standards. A state water quality standard is considered to "directly correspond" to an EPA water quality criterion only if (1) the state water quality standard addresses the same pollutant as that addressed by the EPA water quality criterion and (2) the state water quality standard specifies a numeric criterion for that pollutant or a state objective methodology for deriving such a numeric criterion [§125.62(a)]. Compliance with criteria and standards other than those discussed in Question III.B.6, such as standards for nutrients, toxic pollutants, and coliform bacteria concentrations at the edge of the ZID, is necessary.

To support this demonstration, applicants should submit pollutant concentration data in a form that satisfies state water quality regulations and all applicable EPA water quality criteria. Where average values are given (e.g., average dry-weather flow), applicants should specify how they were calculated. Applicants should also submit data on the predicted maximum 2- to 3-hour flow for the end-of-permit year (U.S. EPA 1985e). Monitoring data collected during the term

of the original section 301(h) permit may be useful for demonstrating compliance with applicable receiving water standards and criteria, and for verifying predictions made in the original application [§125.59(c)(4)]. Detailed guidance for assessing compliance with some specific water quality standards is provided in Appendix B, Chapter B-VIII. Also note that according to §125.57(a)(9), permits may not be issued if the dilution water for the discharge contains significant amounts of previously discharged effluent. In general, demonstrated compliance with this criterion can be shown if all water quality standards and 304(a)(1) water quality criteria are met.

Under the CWA, states may develop water quality standards based on the 304(a)(1) criteria, as modified to reflect site-specific conditions, or they may use other scientifically defensible methods for developing water quality standards. State water quality standards are developed, by states, to protect the types of biota in and beneficial uses of their local waters and thus represent scientifically appropriate standards for each state's specific situation. State standards are subject to EPA review and approval. In the absence of an EPA-approved state water quality standard that directly corresponds to the section 304(a)(1) water quality criteria for a given pollutant, EPA requires compliance with the section 304(a)(1) water quality criteria.

To demonstrate compliance with state water quality standards and water quality criteria, applicants must show that the applicable numerical criteria are not exceeded after critical initial dilution. For most cases, either analytical or computer models can be used to evaluate the water quality impacts. The dilution achieved during the initial mixing process is dependent on ambient and discharge conditions and is, therefore, highly variable. In evaluating a discharge's effect on water quality, the appropriate conditions to consider are those which result in the "lowest" dilution and those which occur at times when the environment is most sensitive. For example, minimum dilution can be predicted using a combination of maximum vertical density stratification, minimum initial density difference between the effluent and the ambient seawater, maximum waste flow rate, and minimum currents for a particular site. Other situations may be more critical depending on the ambient water quality and applicable criteria.

To determine initial dilutions, it is necessary to know specific characteristics of the discharge, the outfall, and the receiving waters. The discharge volumetric flow rate and density are required. Alternately, the effluent temperature and salinity (major inorganic ions contributing to density) can be used to estimate density based on known relationships to seawater. Municipal effluent densities typically range from 0.9970 to 1.0003 g/cm^3, and salinities range to 5 ppt. The highest 2- to 3-hour flow rate during a period of concern should be used to calculate the minimum initial dilution for that period. The principal environmental quantities to consider in dilution prediction are the ambient density stratification and local currents. These parameters

should be considered for periods of maximum wastewater flow; any other periods of maximum loadings; and times of seasonal maximum and minimum stratification, low ambient water quality, low net circulation or flushing, or exceptional biological activity. The quantities selected to represent these periods should reflect lowest 10 percentile conditions (U.S. EPA 1985e).

The critical initial dilution factor can be calculated with any or all of the following data: (1) effluent monitoring, (2) ambient water quality monitoring, or (3) modeling. A list of toxic pollutants [as defined in §125.58(p) and (aa)] is found in Table 2, and corresponding marine water quality criteria are summarized in Table 3. Guidance on sampling and analytical methods for 301(h) monitoring programs is found in EPA guidance (U.S. EPA 1982a, 1987c, 1987e) and 40 CFR Part 136. Remember, in addition to factoring in reentrainment of previously discharged effluent, section 301(h) of the Clean Water Act requires an applicant to demonstrate that the 301(h) modified discharge will not interfere, alone or in combination with pollutants from other sources, with the attainment or maintenance of water quality. Hence, data on pollutant loadings in the ambient receiving waters may be required to calculate values of water quality parameters after initial dilution. Furthermore, the modified discharge must not result in any additional requirements on any other point or nonpoint sources of pollution [§125.64].

Compliance with water quality standards and the 304(a)(1) water quality criteria in marine waters can be determined by the applicant's documenting water quality in the vicinity of the ZID boundary, at control or reference stations, and at areas beyond the ZID where discharge impacts might reasonably be expected. Monitoring should reflect conditions during all critical environmental periods as identified in the 301(h) application (e.g., dry-weather flow or maximum 2- to 3-hour flow conditions). Selection of specific sampling station locations depends on the monitoring requirements. For example, when determining compliance with water quality standards at the edge of the ZID, sampling stations should be located at various points around the ZID boundary. Sampling in estuaries should be conducted at slack water. Where tidal effects are to be discriminated, sampling should be done at several times over a tidal cycle for both spring and neap tides. To verify continuing compliance with 301(h) requirements, the ZID boundary stations should be sampled during those times of the year when the discharge is least diluted (U.S. EPA 1982a).

Applicants should be aware that EPA promulgated the National Toxics Rule (Code of Federal Regulations, Title 40, Part 131, 57 FR 60848, 22 December 1992),* which establishes chemical-specific, numeric criteria for the priority toxic pollutants necessary to bring all states

*hereinafter referred to as 40 CFR Part 131.

TABLE 2. LIST OF PESTICIDES AND TOXIC POLLUTANTS
(as defined in §125.58(p) and (aa))

Pesticides

Demeton
Guthion
Malathion
Methoxychlor
Mirex
Parathion

Toxic Pollutants[a]

Chlorinated Benzenes
- Chlorobenzene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2,4-Trichlorobenzene
- Hexachlorobenzene

Chlorinated Ethanes
- Chloroethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- Hexachloroethane

Chlorinated Phenols
- 2-Chlorophenol
- 2,4-Dichlorophenol
- 2,4,6-Trichlorophenol
- 4-Chloro-3-methyl phenol

Other Chlorinated Organics
- Chloroform (trichloromethane)
- Carbon tetrachloride (tetrachloromethane)
- bis(2-Chloroethoxy)methane
- bis(2-Chloroethyl)ether
- 2-Chloroethyl vinyl ether (mixed)
- 2-Chloronaphthalene
- 3,3-Dichlorobenzidine
- 1,1-Dichloroethylene
- trans-1,2-Dichloroethylene
- 1,2-Dichloropropane
- 1,2-Dichloropropylene (1,3-dichloropropene)
- Tetrachloroethylene
- Trichloroethylene
- Vinyl chloride (chloroethylene)
- Hexachlorobutadiene
- 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)

Haloethers
- 4-Chlorophenyl phenyl ether
- 2-Bromophenyl phenyl ether
- bis(2-Chloroisopropyl) ether

Halomethanes
- Methylene chloride (dichloromethane)
- Methyl chloride (chloromethane)
- Methyl bromide (bromomethane)
- Bromoform (tribromomethane)
- Dichlorobromomethane
- Chlorodibromomethane

Nitrosamines
- N-Nitrosodimethylamine
- N-Nitrosodiphenylamine
- N-Nitrosodi-n-propylamine

Phenols (other than chlorinated)
- 2-Nitrophenol
- 4-Nitrophenol
- 2,4-Dinitrophenol
- 4,6-Dinitro-o-cresol (4,6-dinitro-2-methylphenol)
- Pentachlorophenol
- Phenol
- 2,4-dimethylphenol

Phthalate Esters
- bis(2-Ethylhexyl)phthalate
- Butyl benzyl phthalate
- Di-n-butyl phthalate
- Di-n-octyl phthalate
- Diethyl phthalate
- Dimethyl phthalate

Polynuclear Aromatic Hydrocarbons (PAHs)
- Acenaphthene
- 1,2-Benzanthracene (benzo(a)anthracene)
- 3,4-Benzo(a)pyrene (benzo(a)pyrene)

TABLE 2. (Continued)

PAHs (continued)
- 3,4-Benzofluoranthene (benzo(b)fluoranthene)
- 11,12-Benzofluoranthene (benzo(k) fluoranthene)
- Chrysene
- Acenaphthalene
- Anthracene
- 1,12-Benzoperylene (benzo(g,h,i)perylene)
- Fluorene
- Fluoranthene
- Phenanthrene
- 1,2,5,6-Dibenzanthracene (dibenzo(a,h) anthracene)
- Indeno(1,2,3-cd)pyrene (2,3-o-phenylene pyrene)
- Pyrene

Pesticides and Metabolites
- Aldrin
- Dieldrin
- Chlordane (technical mixture and metabolites)
- alpha-Endosulfan
- beta-Endosulfan
- Endosulfan sulfate
- Endrin
- Endrin aldehyde
- Heptachlor
- Heptachlor epoxide (BHC-hexachlorocyclohexane)
- alpha-BHC
- beta-BHC
- gamma-BHC (Lindane)
- delta-BHC
- Toxaphene

DDT and Metabolites
- 4,4-DDT
- 4,4-DDE (p,p-DDX)
- 4,4-DDD (p,p-TDE)

Polychlorinated Biphenyls (PCBs)
- PCB-1242 (Arochlor 1242)
- PCB-1254 (Arochlor 1254)
- PCB-1221 (Arochlor 1221)
- PCB-1232 (Arochlor 1232)
- PCB-1248 (Arochlor 1248)
- PCB-1260 (Arochlor 1260)
- PCB-1016 (Arochlor 1016)

Other Organics
- Acrolein
- Acrylonitrile
- Benzene
- Benzidine
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- 1,2-Diphenylhydrazine
- Ethylbenzene
- Isophorone
- Naphthalene
- Nitrobenzene
- Toluene

Inorganics
- Antimony
- Arsenic
- Asbestos
- Beryllium
- Cadmium
- Chromium
- Copper
- Cyanide, total
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

[a]Source: U.S. EPA 1993b.

TABLE 3. SUMMARY OF U.S. EPA MARINE WATER QUALITY CRITERIA

(NOTE: This summary should be used only as estimates for the criteria. These values are subject to change. Refer to the appropriate criteria source (e.g., the current *Quality Criteria for Water*) for up-to-date criteria values.)

Pollutant	Saltwater Acute Criteria (µg/L)	Saltwater Chronic Criteria (µg/L)	Human Health[g] (µg/L)
Pollutants with numeric criteria:			
Acenaphthene	970[a]	710[a]	2,700[k]
Acrolein	55[a]	-[b]	780[i]
Acrylonitrile	-[b]	-[b]	0.66[h]
Aldrin	1.3[c]	-[b]	0.00014[h]
Anthracene	-[b]	-[b]	10,000[h]
Antimony	-[b]	-[b]	4,300[h]
Arsenic	69[l]	36[l]	0.14[m]
Benzene	5,100[a]	700[a]	71[h]
Benzidine	-[b]	-[b]	0.00054[h]
Benzofluoranthene 3,4	-[b]	-[b]	0.031[h]
Benzofluoranthene 11,12	-[b]	-[b]	0.031[h]
Benzoanthrancene 1,2	-[b]	-[b]	0.031[h]
Benzopyrene 3,4	-[b]	-[b]	0.031[h]
BHC	0.34[a]	-[b]	-[j]
BHC - alpha	-[b]	-[b]	0.013[h]
BHC - beta	-[b]	-[b]	0.046[h]
BHC - gamma	0.16[c]	-[b]	0.063[h]
Bromoform	-[b]	-[b]	360[h]
Cadmium	43[l]	9.3[l]	-[n]
Carbon tetrachloride	50,000[a]	-[b]	4.4[h]
Chlordane	0.09[c]	0.004[f]	0.00059[h]
Chlorinated benzenes	160[a]	129[a]	-[j]
Chlorobenzene	-[b]	-[b]	21,000[h]
Dichlorobenzenes	1,970[a]	-[b]	2,600[i]
Dichlorobenzene 1,2	-[b]	-[b]	17,000[h]
Dichlorobenzene 1,3	-[b]	-[b]	2,600[h]
Dichlorobenzene 1,4	-[b]	-[b]	2,600[h]
Hexachlorobenzene	-[b]	-[b]	0.00077[h]
Pentachlorobenzene	-[b]	-[b]	85[i]
Tetrachlorobenzene 1,2,4,5	-[b]	-[b]	48[i]
Chlorinated ethanes			
Dichloroethane 1,2	113,000[a]	-[b]	99[h]
Hexachloroethane	940[a]	-[b]	8.9[h]
Pentachloroethane	390[a]	281[a]	-[j]
Tetrachloroethane 1,1,2,2	9,020a	-[b]	11.0[h]
Trichloroethane 1,1,1	31,200[a]	-[b]	-[n]
Trichloroethane 1,1,2	-[b]	-[b]	42[h]
Chlorinated ethylenes			
Dichloroethylenes	224,000[a]	-[b]	-[j]

TABLE 3. (Continued)

Pollutant	Saltwater Acute Criteria (µg/L)	Saltwater Chronic Criteria (µg/L)	Human Health[g] (µg/L)
Dichloroethylene 1,1	-[b]	-[b]	3.2[h]
Tetrachloroethylene	10,200[d]	450[a]	8.85[i]
Trichloroethylene	2,000[a]	-[b]	81[h]
Chlorodibromomethane	-[b]	-[b]	34[h]
Chloronaphthalene 2	7.5[a]	-[b]	4,300[k]
Chlorinated phenols			
Chlorophenol 2	-[b]	-[b]	400[k]
Chlorophenol 4	29,700[a]	-[b]	-[j]
Dichlorophenol 2,4	-[b]	-[b]	790[h]
Pentachlorophenol (penta)	13[d]	7.9[e]	8.2[h]
Tetrachlorophenol 2,3,5,6	440[a]	-[b]	-[j]
Trichlorophenol 2,4,6	-[b]	-[b]	6.5[h]
Chlorine	13[d]	7.5[e]	-[j]
Chloroethyl ether 2	-[b]	-[b]	1.4[h]
Chloroisopropyl ether 2	-[b]	-[b]	170,000[h]
Chloromethyl ether	-[b]	-[b]	0.00184[i]
Chloroform	-[b]	-[b]	470[h]
Chlorpyrifos	0.011[o]	0.0056[p]	-[j]
Chromium			
Hexavalent	1,100[l]	50[l]	-[n]
Trivalent	10,300[a]	-[b]	-[n]
Chrysene	-[b]	-[b]	0.0311[h]
Copper[k]	2.9[l]	2.9[l]	-[j]
Cyanide	1.0[d]	1.0[e]	220,000[h]
DDT	0.13[c]	0.001[f]	0.00059[h]
DDT Metabolites			
DDD (TDE)	3.6[a]	-[b]	0.00084[h]
DDE	14[a]	-[b]	0.00059[h]
Demeton	-[b]	0.1[e]	-[j]
Dibenzo(a,h)anthrancene	-[b]	-[b]	0.0311[h]
Dichlorobenzidine 3,3	-[b]	-[b]	0.077[h]
Dichlorobromomethane	-[b]	-[b]	22[h]
Dichloropropane	10,300[a]	3,040[a]	-[j]
Dichloropropane 1,2	10,300[a]	3,040[a]	39[k]
Dichloropropene	790[a]	-[b]	14,100[i]
Dichloropropylene 1,3	-[b]	-[b]	1,700[h]
Dieldrin	0.71[c]	0.0019[f]	0.00014[h]
Dimethylphenol 2,4	-[b]	-[b]	2,300[k]
Dimethyl dinitrophenol 4,6	-[b]	-[b]	765[h]
Dinitrophenol	-[b]	-[b]	14,300[i]
Dinitrophenol 2,4	-[b]	-[b]	14,000[h]

TABLE 3. (Continued)

Pollutant	Saltwater Acute Criteria (µg/L)	Saltwater Chronic Criteria (µg/L)	Human Health[g] (µg/L)
Dinitro-o-cresol 2,4	_[b]	_[b]	765[h]
Dinitrotoluene 2,4	590[a]	370[a]	9.1[i]
Dioxin (2,3,7,8-TCDD)	_[b]	_[b]	0.000000014[i]
Diphenylhydrazine 1,2	_[b]	_[b]	0.54[h]
Endosulfan	0.034[c]	0.0087[f]	159[i]
Endosulfan sulfate	_[b]	_[b]	2.0[h]
Endosulfan-alpha	0.034[c]	0.0087[f]	2.0[h]
Endosulfan-beta	0.034[c]	0.0087[f]	2.0[h]
Endrin	0.037[c]	0.0023[f]	0.81[h]
Endrin aldehyde	_[b]	_[b]	0.81[h]
Ethylbenzene	430[a]	_[b]	29,000[h]
Fluoranthene	40[a]	16[a]	370[h]
Fluorene	_[b]	_[b]	14,000[h]
Guthion	_[b]	0.01	_[j]
Halomethanes	12,000[a]	6,400[a]	15.7[i]
Heptachlor	0.053[c]	0.0036[f]	0.00021[h]
Heptachlor epoxide	0.053[c]	0.0036[f]	0.00011[h]
Hexachlorobutadiene	32[a]	_[b]	50[h]
Hexachlorocyclohexane (HCH)			
Lindane (gamma-HCH)	0.16[c]	__[b]	0.063[h]
HCH (mixture of isomers)	0.34[a]	_[b]	_[j]
HCH - alpha	_[b]	_[b]	0.013[h]
HCH - beta	_[b]	_[b]	0.046[h]
HCH - technical	_[b]	_[b]	0.0414[i]
Hexachlorocyclopentadiene	7.0[a]	_[b]	17,400[h]
Indenopyrene 1,2,3-cd	_[b]	_[b]	0.0311[h]
Isophorone	12,900[a]	_[b]	490,000[h]
Lead	140[d]	5.6[e]	_[j]
Malathion	_[b]	0.1	_[j]
Manganese	_[b]	_[b]	100[i]
Mercury	2.1[d]	0.025[e]	0.15[h]
Methoxychlor	_[b]	0.03	_[j]
Methyl bromide	_[b]	_[b]	4,000[h]
Methylene chloride	_[b]	_[b]	1,600[h]
Mirex	[b]	0.001	_[j]
Naphthalene	2,350[a]	_[b]	_[j]
Nickel	75[c]	8.3[f]	3,800[h]
Nitrobenzene	6,680[a]	_[b]	1,900[h]
Nitrophenols	4,850[a]	_[b]	_[j]
Nitrosamines	3,300,000[a]	_[b]	_[j]
Nitrosodibutylamine N	_[b]	_[b]	0.587[i]

TABLE 3. (Continued)

Pollutant	Saltwater Acute Criteria (µg/L)	Saltwater Chronic Criteria (µg/L)	Human Health[g] (µg/L)
Nitrosodiethylamine N	_[b]	_[b]	0.0012[i]
Nitrosodimethylamine N	_[b]	_[b]	8.1[h]
Nitrosodiphenylamine N	_[b]	_[b]	16[h]
Nitrosopyrolidine N	_[b]	_[b]	91.9[i]
N-Nitrosodi-n-propylamine	_[b]	_[b]	1.4[k]
pH	5,800[a]	6.5-8.5	_[j]
Phenol	_[b]	_[b]	4,600,000[h]
Phosphorous (elemental)	2,944[a]	0.1	_[j]
Phthalate esters	_[b]	3.4[a]	_[j]
Butylbenzyl phthalate	_[b]	_[b]	5,200[k]
Di-n-butyl phthalate	_[b]	_[b]	12,000[h]
Diethyl phthalate	_[b]	_[b]	120,000[h]
Dimethyl phthalate	_[b]	_[b]	2,900,000[i]
Ethylhexyl phthalate	10[a]	0.03[f]	5.9[h]
Polychlorinated biphenyls	_[b]	_[b]	0.000079[i]
PCB - 1016	_[b]	_[b]	0.000045[h]
PCB - 1221	_[b]	_[b]	0.000045[h]
PCB - 1232	_[b]	_[b]	0.000045[h]
PCB - 1242	_[b]	_[b]	0.000045[h]
PCB - 1248	_[b]	_[b]	0.000045[h]
PCB - 1254	_[b]	_[b]	0.000045[h]
PCB - 1260	300[a]	_[b]	0.0311[i]
Polynuclear aromatic hydrocarbons	_[b]	_[b]	11,000[h]
Pyrene	300[c]	71[f]	_[j]
Selenium (inorganic selenite)	2.3[l]	_[b]	_[j]
Silver	_[b]	2[f]	_[j]
Sulfide (hydrogen sulfide, H_2S)	2,130[a]	_[b]	6.3[h]
Thallium	6,300[a]	5,000[a]	200,000[h]
Toluene	0.21[d]	0.0002[e]	0.00075[h]
Toxaphene	_[b]	_[b]	525[h]
Vinyl chloride	95[l]	86[l]	_[j]
Zinc			

Pollutants with no established criteria or with criteria dependent on other water quality parameters:

Acenaphthylene	Alachlor	Alkalinity
Aluminum (pH dependent)	Ammonia (pH and temperature dependent)	Asbestos
Atrizine	Bacteria (use dependent)	Barium
Benzoperylene 1,12	Beryllium[n]	Beta particle and photon activity
BHC - delta	Bromophenyl phenyl ether 4	Carbofuran
Chloride	Chloroalkyl ethers	Chloroethane
Chloroethoxy methane 2	Chloroethyl vinyl ether 2	Chlorophenoxy Herbicide 2,4,5-TP

TABLE 3. (Continued)

Chlorophenoxy Herbicide 2,4-D	Chlorophenyl phenyl ether 4	Color
Dibromochloropropane	Dichloroethane 1,1	Dichloroethylene cis 1,2
Dichloroethylene trans 1,2[k]	Dinitrotoluene 2,6	Di-n-octyl phthalate
Ethylene Dibromide	Gasses, total dissolved	Gross alpha particle activity
Haloethers	Iron	Methyl Chloride
Methylchlorophenol 3,4	Nitrate	Nitrite
Nitrophenol 2	Nitrophenol 4	Oil and grease
Oxygen, dissolved	Parathion	Phenanthrene
Radium 226/228	Solids, dissolved and salinity	Solids, suspended and turbidity
Styrene	Temperature	Tetrachloroethanes
Trichlorinated ethanes	Trichlorobenzene 1,2,4	Trichlorophenol 2,4,5
Xylenes		

[a]Data insufficient to derive criteria. Value presented is the lowest observed effect level (LOEL). These concentrations represent apparent threshold levels for acute and/or chronic toxic effects, and are intended to convey information about the degree of toxicity of a pollutant in the absence of established criteria. (U.S. EPA 1986a)
[b]Criterion has not been established for marine water quality.
[c]Final acute value, which by 1980 guidelines is instantaneous (U.S. EPA 1986a).
[d]Maximum 1-hour average. Not to be exceeded more than once every 3 years on the average (U.S. EPA 1986a).
[e]Maximum 96-hour (4-day) average. Not to be exceeded more than once every 3 years (U.S. EPA 1986a).
[f]Maximum 24-hour average. Not to be exceeded more than once every 3 years U.S. EPA 1986a).
[g]Human health (10^{-6} risk level for carcinogens) for consumption of marine organisms only. The 10^{-6} risk level is calculated assuming the following constant values are used in the equation: body weight equals 70 kg; exposure duration equals 70 years; exposure frequency equals 48 days/year; ingestion rate equals 6.5 grams per day; and averaging time equals 70 years. Criteria in the matrix are based on carcinogenicity (10^{-6} risk). For a risk level of 10^{-5}, move the decimal point in the table value one place to the right.
[h]Recalculated values using IRIS, as of December 22, 1992 Toxics Rule 57 FR 60911-60916.
[i]Published human health criteria values (U.S. EPA 1986a).
[j]No value available.
[k]Values presented in the proposed Toxics Rule that are not being presented as regulatory criteria, but were presented as notice for inclusion in future state triennial reviews (Toxics Rule, 57 FR 60890).
[l]Criteria for these metals are expressed as a function of the water effect ratio, as defined in 40 CFR 131.36(c).
[m]Criteria revised to reflect current EPA q_1^* or RFD, as contained in the Integrated Risk Information System (IRIS). The fish tissue bioconcentration factor (BCF) from the 1980 criteria documents was retained in all cases. The criteria refer to the inorganic form only. (57 FR 60916)
[n]Human health criteria for these pollutants were issued in 1980 (45 FR 79331) and were withdrawn in 1992 (57 FR 60848).
[o]Maximum 1-hour average. Not to be exceeded more than once every 3 years on the average (U.S. EPA 1987g).
[p]Maximum 96-hour (4-day) average. Not to be exceeded more than once every 3 years (U.S. EPA 1987g).

into compliance with section 303(c)(2)(B) of the CWA. With the National Toxics Rule, all states have legally enforceable state water quality standards for all toxic pollutants where 304(a)(1) water quality criteria had been established.

For carcinogens, EPA's section 304(a)(1) human health criteria for carcinogenic pollutants recommend a concentration of zero for maximum protection of human health. However, the CWA section 304(a)(1) criteria provide a range of risk levels and a corresponding criterion for each specific risk level. EPA has not established a specific risk level for use in the 301(h) program. However, there are EPA-approved numeric state water quality standards for carcinogens under CWA section 303 that correspond to risk levels above zero. The approach

adopted for section 301(h) provides consideration of the state's views on an appropriate risk level or, in the absence of such state input, provides for EPA to consider all relevant information in setting a risk level. This information will include evidence that the state has consistently used a particular risk level when establishing its water quality standards for other carcinogens (see 56 FR 2814, 24 January 1991, for a more detailed description).

In the absence of an EPA-approved state water quality standard for a carcinogenic pollutant, the Administrator will consider a consistently used, or state-adopted or formally proposed, risk level recommendation with a satisfactory demonstration that the level is adequately protective of human health in light of exposure and uncertainty factors and population exposed (refer to *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual*, U.S. EPA 1989a). Exposure factors would include, for example, local patterns of fish consumption, cumulative effects of multiple contaminants, and local population sensitivities. Factors related to uncertainty would include, for example, the weight of scientific evidence concerning exposures and health effects and the reliability of exposure data. The state demonstration will need to account for the relevant exposure and uncertainty factors, show adequate public participation in the selection of the risk level, and show that use of the selected risk level is adequately protective of human health. EPA considers these and other pertinent factors to complete an overall judgment of human health risk factors. In cases where there is no consistent state policy or satisfactory state demonstration on which to base a risk level, EPA will set a specific risk level (for example, 10^{-6}) based on the circumstances of each case.

Additional guidance for demonstrating compliance with applicable state water quality standards and section 304(a)(1) criteria is provided in Appendix B; under Questions III.B.1 through III.B.6 for conventional water quality parameters; under Questions III.E.2 and III.F.1 for conventional parameters, toxic substances, and pathogens; and under Questions III.H.1 and III.H.2 for toxic substances. Guidance for performing the monitoring necessary to demonstrate compliance with these requirements can be found in the EPA documents *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a) and *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables* (U.S. EPA 1985e). Applicants should also refer to Appendix E of this document for further guidance regarding toxic pollutant criteria. The "Determinations of Compliance with Section 301(h) Modified Permit Conditions and 301(h) Criteria" chapter of this document should also be reviewed.

Another approach that EPA has used to assess the potential impacts of wastewater discharges on water quality and the biota in the receiving waters is the water quality-based toxics

control approach. Information derived from this approach may be used to further support the applicant's response. Guidance for implementing the water quality-based toxics control approach can be found in the *Technical Support Document for Water Quality-Based Toxics Control* (U.S. EPA 1985g). Information regarding the water quality-based toxics control approach is briefly summarized in Appendix F.

III.B.8. Provide the determination required by 40 CFR 125.61(b)(2) for compliance with all applicable provisions of State law, including water quality standards or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.

*** ***Large and small dischargers must respond.***

Because all applications for reissuance of section 301(h) modified permits are considered applications for new NPDES permits, all applicants are required to provide new determinations of compliance, as required by §125.61(b)(2). A copy of the letter that requests the required determination may be provided if the determination by the appropriate state agency has not yet been received.

III.C. Impact on Public Water Supplies [40 CFR 125.62(b)]

III.C.1. Is there a planned or existing public water supply (desalinization facility) intake in the vicinity of the current or modified discharge?

*** ***Large and small dischargers must respond.***

It is possible that a public water supply (desalinization plant) intake could be contaminated by marine POTW discharges. Although such a possibility may be remote, the applicant should verify that no public water supply intakes are located within 16 km (10 mi) of the discharge. If none exist within 16 km (10 mi) of the discharge, no analyses are required. The names of the agencies contacted and the person(s) involved should be listed in the application.

III.C.2. If yes,

a. What is the location of the intake(s) (latitude and longitude)?

b. Will the modified discharge(s) prevent the use of intake(s) for public water supply?

c. Will the modified discharge(s) cause increased treatment requirements for public water supply(s) to meet local, state, and EPA drinking water standards?

**** Large and small dischargers must respond.*

If the answer to Question III.C.1 is affirmative, the location of the desalinization plant should be shown on a map with the discharge site marked. The travel time to the intake should be estimated using the average current speed. The applicant should show that all applicable water quality standards for use as a public water supply are met at the intake and that water quality at the intake will not result in any significant increase in treatment requirements to comply with local, state, and EPA standards for treated water.

III.D. Biological Impact of Discharge [40 CFR 125.62(c)]

POTW discharges can affect biological communities in the following ways:

- Modifications to the structure of benthic communities (bottom-dwelling/feeding fishes and invertebrates) caused by accumulation of discharged solids on the seabed;
- Increases in phytoplankton or macroalgal growth due to nutrient inputs;
- Reductions in phytoplankton or macroalgal growth due to turbidity increases;
- Reductions in dissolved oxygen due to phytoplankton blooms and subsequent die-offs, leading to mass mortalities of fish or invertebrates;
- Bioaccumulation of toxic substances in marine organisms due to direct contact with sediment, ingestion of sediment, direct uptake from effluent, or ingestion of contaminated organisms; and

- Induction of diseases in marine organisms caused by contact with contaminated sediments, ingestion of contaminated organisms, or exposure to effluent.

Most of these potential impacts are associated with discharged particulate matter. The potential effects of discharged solids may be compounded by the toxic substances adsorbed to these solids. Hence, the primary potential effects of sediment enrichment by organic particles and sediment contamination by toxic substances are closely linked and are generally manifested in the same biotic groups. Discharged effluent solids tend to accumulate near the sewage outfalls, and bottom-dwelling marine organisms (e.g., benthic macroinvertebrates and bottom-feeding fishes) are potentially affected by these accumulations because they live in or on the sediments.

Additional environmental effects are associated with the discharge of plant nutrients (e.g., nitrogen, phosphorus), which may result in eutrophication, especially in estuaries or coastal embayments. Related impacts can include stimulation of toxic or nuisance algal blooms. Such phytoplankton blooms may adversely affect commercial and recreational fisheries because the decomposition of phytoplankton after massive blooms can cause dissolved oxygen deficiencies and associated fish or invertebrate kills.

Biological assessments for improved discharges, altered discharges, or discharges into stressed waters involve predictive demonstrations of future biological conditions near the outfall and elsewhere in the receiving water body. These analyses may involve establishing relationships between water quality conditions and biological conditions and predicting future conditions based on these relationships. Thus, biological assessments for improved or altered discharges involve not only describing existing biological communities but also determining whether a BIP will exist beyond the ZID after improvements or alterations to the discharge.

To support a section 301(h) modification, the applicant does not have to show that conditions of each biological community at all points beyond the ZID fall within the natural range of variation observed at the reference sites. Rather, the applicant's assessment should concentrate on determining the conditions of the following types of biological assemblages at control sites and at the areas of potential impact:

- Communities that are most susceptible to impacts from POTW discharges;

- Communities of threatened and endangered species;

- Communities with aesthetic, recreational, or commercial importance; and

- Communities with distributional patterns that enable quantitative assessment with reasonable sampling effort and resources.

Using this approach, applicants should be able to study the important communities that are expected to demonstrate discharge-related effects while not wasting effort on studies with a limited potential for providing meaningful results. Based on the review of existing section 301(h) applications, the major potential effects of POTW discharges are associated with benthic macroinvertebrates and demersal fishes. Because of their distribution characteristics, both of these communities can be assessed quantitatively with a reasonable level of sampling effort. Benthic macroinvertebrates are also the primary food items for demersal fishes and early life stages of certain other fishes. Consequently, these two communities are linked by a food web relationship, and severe impacts on benthic macroinvertebrates may result in secondary impacts on demersal or other fishes.

Benthic macroinvertebrates and demersal fishes are two important groups that typically warrant BIP demonstrations. It should not be assumed, however, that these are the only biological communities that should be studied in all cases. Particular attention should be given to threatened and endangered species. The concept of a BIP includes any and all biological communities potentially affected by the discharge.

III.D.1. Does (will) a balanced indigenous population of shellfish, fish, and wildlife exist:

- ***Immediately beyond the ZID of the current and modified discharge(s)?***

- ***In all other areas beyond the ZID where marine life is actually or potentially affected by the current and modified discharge(s)?***

*** ***Large and small dischargers must respond.***

The purpose of the question is to demonstrate whether unacceptable biological impacts are occurring or will occur beyond the ZID as a result of the modified discharge, either alone or in combination with other discharges. Effective demonstrations include comparisons of biological conditions and habitat characteristics among stations or groups of stations at ZID-boundary, nearfield, farfield, and reference areas.

The applicant should compare the ranges of biological characteristics among the four specified areas where communities are to be assessed. If differences that are attributable to the discharge are detected between study areas (e.g., ZID boundary vs. reference), the applicant should assess the spatial extent of those differences. In addition, the magnitude of the effect should be characterized with regard to the relative deviation from reference conditions (e.g., percent reduction in species richness), the potential for intertrophic effects (e.g., reductions in fish food organisms), and the potential for involvement of threatened and endangered species and recreationally or commercially important species.

Numerous parameters can be used to describe and compare biological communities (e.g., numbers of species; total abundances of organisms; abundances of selected pollution-sensitive, pollution-tolerant, and opportunistic species). [See U.S. EPA (1987f) for further guidance on the selection of biological indices.] Physical characteristics of the receiving water that are often measured include water column characteristics, (e.g., depth, water temperature, salinity, nutrient concentrations, chlorophyll *a* concentrations) and substrate characteristics (e.g., bottom type and composition). Information on the physical characteristics of the environment may be used to interpret the biological data and to determine whether the discharge is altering the physical or chemical characteristics of the receiving water.

Species vary in their sensitivities to pollutants, including organic enrichment. Changes in species composition and abundance begin to occur when the mass emission rates of materials in a sewage discharge are sufficiently high to affect the most sensitive species. As the abundances of pollution-sensitive species decrease or are driven to zero, abundances of opportunistic and pollution-tolerant species are typically enhanced. For this reason, changes in the values of community parameters (e.g., numbers of species, total abundances, dominance) are often accompanied by changes in the abundances of opportunistic and pollution-tolerant species. Additional guidance on the evaluation of biological communities is provided in Appendix C.

Special Considerations for Small Dischargers

During the preparation of applications for original section 301(h) modified permits, many small applicants were able to respond to this question without conducting field studies of biological communities in the vicinity of the discharge. Those small applicants used existing information to demonstrate that the characteristics of the discharge and receiving water indicated a very low potential for adverse impacts. If an applicant was not required to collect biological information during the term of the existing permit, that applicant may continue to use other available information to demonstrate that the characteristics of the discharge and receiving water

indicate a very low potential for adverse impacts. Applicants are reminded, however, that such demonstrations must consider the potential for adverse impacts of the discharge alone and in combination with other discharges (if any exist) [§125.57(a)(2)]. The following characteristics indicate a low potential for impact:

- Location of the discharge in water depths greater than 10 m (33 ft);
- Hydrographic conditions that result in low predicted solids accumulation rates;
- The absence of distinctive habitats of limited distribution and the absence of fisheries in the vicinity of the outfall, when such absences are not due to anthropogenic stresses; and
- The absence of known or suspected sources of toxic pollutants and pesticides or low concentrations of these substances in the effluent.

Most small dischargers that previously demonstrated a low potential for impact should be able to do so again. They need demonstrate only that characteristics of the discharge and receiving waters did not change greatly during the term of the existing permit. Monitoring data collected during the term of the original section 301(h) modified permit should also be useful for such demonstrations.

Some small dischargers may not be able to demonstrate a low potential for impacts because characteristics of the discharge or receiving water differ from those listed above. In some cases, the discharge or receiving water may not have exhibited the aforementioned characteristics at the time the original application for a section 301(h) modified permit was prepared. In others, characteristics of the discharge or receiving water may have changed, or additional information may now be available that documents a greater potential for impact than was previously supposed. For example, the composition of the discharge may have changed to include toxic pollutants or pesticides from a new industrial source. Alternatively, a fishery for a previously underutilized species may have developed in the vicinity of the discharge, or research by local scientists may have discovered that the habitat in the vicinity of the outfall is an important nursery ground for a commercially harvested species of fish or shellfish.

When it is apparent for one or more reasons that the discharge or receiving water does not exhibit characteristics that would indicate a low potential for impacts, the Regions have the discretion to require that an applicant perform a detailed assessment of biological conditions in

the vicinity of the outfall. The level of detail that would be expected in such a demonstration would be comparable to that required of large dischargers.

In some cases, the applicant may have been required to monitor one or more biological communities under the conditions of the existing section 301(h) modified permit. The Region may require the applicant to analyze and discuss those biological monitoring data in response to this question. When biological monitoring data were not collected, but concern exists that the modified discharge might cause adverse impacts to the biota, the Region may require the applicant to collect biological data in support of the application for permit reissuance. The applicant should consult with the Region well in advance of the application deadline, especially if the Region required the collection of additional data. This will give the applicant adequate time to prepare and execute appropriate studies. Applicants required to perform these field surveys should consult U.S. EPA (1982a, 1987a, 1987c, 1987f) for guidance on the design and execution of such surveys. It is the applicant's responsibility to ensure the collection of adequate, high-quality data during all phases of the necessary studies.

III.D.2. Have distinctive habitats of limited distribution been impacted adversely by the current discharge and will such habitats be impacted adversely by the modified discharge?

*** ***Large and small dischargers must respond.***

If distinctive habitats are present in areas potentially influenced by the discharge, the applicant should provide information documenting the extent and condition of those habitats. The applicant should also provide a detailed evaluation of available historical information on the spatial distribution of any distinctive habitats near the outfall and in nearby reference areas. Trends in spatial occurrence should be evaluated relative to historical discharges by the applicant and relative to other water quality or biological factors that may influence the habitat.

If available, the applicant should include documentation of any long-term changes in spatial extent or general health of the distinctive habitat. Examples of such information include areal extent of kelp beds or condition of algal cover on coral reefs. If historical changes in the habitat have occurred, the applicant should attempt to relate those changes to natural or pollution-related events. For example, severe storms can damage coral reefs and heavy pedestrian traffic can degrade rocky intertidal communities.

The applicant should evaluate any effects of the discharge with emphasis on the physical, chemical, and biological conditions that occurred within the distinctive habitats in the vicinity

of the outfall during the term of the existing 301(h) permit. The applicant's discussion should be oriented toward an assessment of the potential for contact of the effluent plume with any nearby distinctive habitats. In cases where a distinctive habitat occurs near an outfall, the applicant can evaluate impacts by considering the following:

- Degree of initial dilution;
- Degree of farfield dispersion;
- Frequency and direction of waste transport; and
- Lack of prior appreciable harm.

The most effective demonstrations of impacts (or the lack of impacts) include comparisons of potentially impacted areas with reference areas beyond the influence of the discharge. Experience with applications for section 301(h) modified permits has shown, however, that suitable reference areas for distinctive habitats of limited distribution are often difficult to find. The biota that characterize distinctive habitats often require specific environmental conditions that occur discontinuously within the biogeographic zone, and often only in small areas. When a suitable reference area for a distinctive habitat of limited distribution does not occur in the vicinity of the applicant's outfall, the applicant should present (to the extent possible) detailed information on the typical physical, chemical, and biological characteristics of that distinctive habitat within the biogeographic zone. When suitable data are available, the applicant should assess potential impacts to distinctive habitats of limited distribution by using the graphical and mathematical tools discussed in Appendix C.

Special Considerations for Small Dischargers

When it appears that a small discharger is causing (or has the potential to cause) impacts to distinctive habitats of limited distribution, the Region may require the applicant to perform a detailed assessment of distinctive habitats in the vicinity of the discharge. Such a detailed assessment would be comparable to that required of large dischargers, as described above. Therefore, guidance provided above and under Questions II.C.2 and III.D.1 of the questionnaire is relevant to the performance of such detailed demonstrations. It is the applicant's responsibility to identify the need for additional data on distinctive habitats and provide adequate time to design and execute appropriate studies. Moreover, the applicant should work closely with the Region during all phases of the studies to ensure that adequate, high-quality data are collected.

III.D.3. Have commercial or recreational fisheries been impacted adversely by the current discharge (e.g., warnings, restrictions, closures, or mass mortalities) or will they be impacted adversely by the modified discharge?

*** ***Large and small dischargers must respond.***

If fishery resources are present in areas potentially influenced by the discharge, the applicant should assess the effects of the discharge on these resources by analyzing catch records, market acceptability, contamination of tissues by toxic substances, prevalence of disease, and harvest warnings/closures.

The applicant should also determine whether any potential fishery resources remain unharvested in the area because of warnings or closures. If unharvested resources are identified, the applicant should indicate the reasons why these resources are not utilized, such as the following:

- Health-related factors [including paralytic shellfish poisoning (PSP), bacteriological contamination, and bioaccumulation of toxic substances];
- Economic or marketing considerations;
- Resource protection closures; and
- Other regulatory closures.

If closures are the result of tissue contamination, the applicant should specify the contributing pollutant sources.

Many sources of information are available to address the fish and fishery concerns outlined above:

- Local anglers;
- Public, institutional, and agency libraries;
- Academic institutions (e.g., marine science, biology, zoology departments; Sea Grant offices; cooperative fishery research units);

- Local (e.g., conservation boards), state (e.g., fish and game departments), and federal natural resource agencies and affiliated laboratories (e.g., National Marine Fisheries Service, U.S. Fish and Wildlife Service);

- Regional fishery management councils (contact information available from National Marine Fisheries Service); and

- County, state, and federal environmental protection and public health agencies.

Environmental protection and public health agencies should be contacted to obtain information on the health of fishes in the vicinity of an outfall. These agencies monitor water quality and coliform bacteria concentrations in shellfish as part of a national public health program. They will also provide information on PSP if it is known to occur in the geographic area. Depending on the distribution of fishery resources and pollutant levels in receiving waters, the agencies may also conduct laboratory studies on toxic bioaccumulation in fish species harvested for human consumption. An applicant should request all available information concerning the region and immediate vicinity of the discharge and, with the assistance of agency personnel, attempt to determine the discharge's contribution to any observed fish health problems. A conclusion by agency personnel that the discharge is not contributing to public health problems should be documented by the applicant.

State departments of environmental protection or ecology are generally responsible for recording occurrences of fish kills within state waters. Typically, a report is filed by a departmental agent who investigated the kill, recording such information as the severity of the incident and its probable causes. An applicant should request and review reports of relevant fish kills and document whether the discharge has been implicated in any of these incidents.

Some environmental protection and public health agencies do not routinely assess the health status of fish unless a serious problem with toxics bioaccumulation is suspected in species sought by commercial or recreational fishermen. However, many state environmental agencies conduct biological surveys as a part of intensive surveys and use attainability analyses. Also, numerous agencies are adding fish tissue monitoring to statewide monitoring efforts. Sources of information on fish diseases or abnormalities include academic institutions or fisheries agencies, many of which have conducted fish surveys in the vicinity of an outfall. In addition, the applicant should not overlook the possibility of state environmental agencies as sources of information.

A careful review of available information should enable a small applicant to characterize the local fish communities and fisheries without an actual field survey unless there is sufficient evidence to indicate that the discharge has adversely impacted, or is likely to adversely impact, important fish resources. Where a survey of fish and/or shellfish is necessary to determine levels of toxics accumulation in tissues, applicants should consult the EPA guidance documents *Bioaccumulation Monitoring Guidance: 4. Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Tissue from Estuarine and Marine Organisms* (U.S. EPA 1985d) and *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual* (U.S. EPA 1989a). The first document describes analytical methods that allow for sensitive analyses of the target compounds with a reasonable amount of laboratory effort. The second document contains information on how to perform a health risk assessment based on standard toxicological parameters and criteria. Information on sampling design, target species selection, sampling location, quality assurance/quality control (QA/QC) protocols, and other topics is also presented.

III.D.4. Does the current or modified discharge cause the following within or beyond the ZID: [40 CFR 125.62(c)(3)]

- ***Mass mortality of fishes or invertebrates due to oxygen depletion, high concentrations of toxics, or other conditions?***
- ***An increased incidence of disease in marine organisms?***
- ***An abnormal body burden of any toxic material in marine organisms?***
- ***Any other extreme, adverse biological impacts?***

*** ***Small dischargers must respond to the extent practicable***
*** ***Large dischargers must respond.***

This question requires the assessment of several specific potential impacts of POTW discharges. The applicant should review and summarize available information on occurrences of mass mortalities of marine organisms in the receiving water environment. The suspected causes of mass mortalities should be evaluated to determine whether any of these events could have resulted from the discharge. Evaluation of actual or potential mass mortalities is especially important for applicants with discharges into estuaries or enclosed embayments. Dissolved oxygen deficiencies in waters with limited flushing characteristics may result from BOD inputs

or algal decomposition following bloom conditions. Evaluation of disease incidence or tissue contamination in marine organisms should be conducted by spatial comparisons of communities near the discharge (ZID and ZID boundary) with those in control areas (see U.S. EPA 1985a, 1985b, 1985c, 1985d, 1987a).

Many studies have suggested that a relationship exists between the incidence of disease in marine organisms and contact with POTW effluents. These diseases include exophthalmia in spotfin croakers (*Roncador stearnsil*) and white seabass (*Cynoscion nobilis*), lip papilloma in white croakers (*Genyonemus lineatus*), and discoloration in halibut (*Macrostomus pacificus*) (McDermott-Ehrlich et al. 1977, Mearns and Sherwood 1974). Bioaccumulation of chlorinated hydrocarbons and heavy metals has been reported in marine organisms collected near sewage outfalls off southern California. Affected species included the Dover sole (*Microstomus pacificus*), rock crab (*Cancer anthonyi*), mussel (*Mytilus californianus*), and rock scallop (*Hinnites multirugosus*) (McCain et al. 1992; McDermott et al. 1976; McDermott-Ehrlich et al. 1978; Waterman and Kranz 1992; Young, McDermott, et al. 1976a; Young et al. 1978). A methodology for portraying the seriousness of probable pollutant-induced diseases to facilitate defensible decisions is presented in *Index of Pollutant-Induced Fish and Shellfish Disease* (National Ocean Survey 1987). Disease prevalence is indexed on a simple numeric scale, with corresponding categories of seriousness labeled "normal," "warning," and "alarm."

The discharge of sewage effluents containing toxic substances can result in bioaccumulation, especially in areas of organic sediment accumulation. Toxic heavy metals and persistent synthetic organic compounds generally have the highest potential for bioaccumulation in marine organisms (Office of Technology Assessment 1987). The identification of substantial concentrations of such substances in the plant effluent in combination with either of the following receiving water characteristics indicates the need for evaluation of bioaccumulation:

- Evidence of effluent transport toward areas used for shellfish harvesting or
- Significant occurrence of important recreational or commercial species and evidence of potential sediment accumulation near the outfall.

One approach the applicant may use to evaluate the potential for bioaccumulation is to compare the concentrations of toxic pollutants after initial dilution with EPA aquatic life water quality criteria. Two types of information are required for this comparison:

(1) Concentration of the pollutant in the discharged effluent and

(2) Critical initial dilution.

The value of (1) divided by (2) should then be compared with the available criterion.

Most of the toxic pollutants with a high bioaccumulation potential, however, will be associated with organic particulates in the discharged effluent. Thus, in determining bioaccumulation potential, it is important not only to evaluate concentrations of these substances in the effluent and in the receiving water following initial dilution, but also to examine sediment accumulation patterns. Substantial bioaccumulation is possible even when water quality criteria are met because of localized accumulation of contaminated sediments. Alternatively, the applicant may be able to demonstrate that bioaccumulation is not a serious problem even though toxic substances are present in the effluent, by providing information that demonstrates the following:

- Adequate initial dilution and
- Sufficient circulation to prevent localized accumulation of solids or trapping of effluent plumes in the nearfield and farfield.

The degree to which the applicant may be required to assess bioaccumulation using field surveys is also dependent upon the kinds of organisms present. Several investigators have demonstrated the ability of bivalve molluscs and crustaceans to accumulate metals and organic substances near sewage discharges (Brown et al. 1984; McLean et al. 1992; Young, McDermott, et al. 1976b; Young et al. 1978). Studies at some of the same sites and at other contaminated areas have indicated that demersal marine fishes do not generally accumulate metals in muscle tissue (with the exception of organic mercury) but accumulate organic substances such as high-molecular-weight chlorinated hydrocarbons (McDermott-Ehrlich et al. 1978, McDermott et al. 1976). The degree to which pollutants bioaccumulate in aquatic organisms depends on the type of food chain, on the availability and persistence of the pollutant, and especially on the physical-chemical properties of the pollutant (Rand and Petrocelli 1985). The degree of bioaccumulation is generally correlated with the partition coefficient measured in an octanol-water mixture. Chemicals with large partition coefficients (e.g., halogenated hydrocarbons) are more likely to bioaccumulate. The physical fate of trace metals in seawater is directly related to their particle or biological reactivity (NOAA 1988). Additional guidance on bioaccumulation can be found in *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual* (U.S. EPA 1989). Thus, in cases where an effluent contains substantial amounts of heavy metals, the potential data requirements would be greater if shellfish resources also occurred in

potentially impacted areas than if fishes constituted the only locally important resources. Furthermore, the potential for bioaccumulation would be less if fishes with only transitory plume exposure were present (e.g., pelagic or migratory species) than if demersal species dominated in areas of sediment deposition.

Sessile filter-feeding molluscs that are highly susceptible to bioaccumulation, and that may also be important commercial or recreational resources, are generally found in nearshore habitats, especially in embayments or estuaries. If an applicant can demonstrate that shellfish resources do not occur in the outfall vicinity or in other areas potentially impacted by the discharge, or that effluent dispersion is adequate, tissue analyses of indigenous biota may not be required to demonstrate the absence of adverse bioaccumulation. Information can be obtained from *The 1990 National Shellfish Register of Classified Estuarine Water*, which contains data on 3,172 shellfishing areas encompassing 18.7 million acres of classified estuarine and offshore waters in 23 states (National Ocean Survey 1991). Discharges located in areas with limited dispersion, such as estuaries or embayments, may cause contamination of local shellfish resources. In such cases, the applicant should conduct analyses of tissue concentrations of toxic substances identified in the plant effluent. Examples of species that may be appropriate for tissue analyses include oysters, clams, mussels, crabs, and lobsters (U.S. EPA 1985b).

An additional situation that will influence the requirement for direct assessment of bioaccumulation is where other pollutant sources cause observed contamination of fish or shellfish resources. This would especially pertain to cases of nearby fishery closures or harvesting restrictions due to pollutant inputs. In such cases, it is important for the applicant to demonstrate that its discharge is not contributing to the existing contamination. This demonstration can be accomplished by the previously described analyses of effluent pollutant concentrations and initial dilutions, and/or by evaluation of existing information on the spatial patterns of pollutant concentrations in organisms or sediments. It may be necessary for the applicant to conduct tissue or sediment analyses if effluent and dilution analyses indicate the potential for bioaccumulation and sufficient data are not available to determine pollutant sources in areas of existing contamination of fishery resources. Where a survey of fish and/or shellfish is necessary to determine levels of toxics accumulation in tissues, applicants should consult the EPA guidance documents *Bioaccumulation Monitoring Guidance: 4. Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Tissue from Estuarine and Marine Organisms* (U.S. EPA 1985d) and *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual* (U.S. EPA 1989a). These documents contain information on how to perform a health risk assessment based on standard toxicological parameters and criteria. Information on

sampling design, target species selection, sampling location, QA/QC protocols, etc. is also presented.

Special Considerations for Small Dischargers

As indicated in the regulations [125.63(b)(2)], small applicants are not subject to the biological monitoring requirements of paragraphs 125.63(b)(1)(ii) through (iv) under special circumstances, which relate to assessments required for this question. These special circumstances include discharging at depths greater than 10 meters and demonstrating through a suspended solids deposition analysis that there will be negligible seabed accumulation in the vicinity of the modified discharge. Many of the small applicants used existing information to demonstrate that the characteristics of the discharge and receiving water indicated a very low potential for adverse impacts. If an applicant was not required to collect biological information during the term of the existing permit, that applicant may continue to use other available information to demonstrate that the characteristics of the discharge and receiving water indicate a very low potential for adverse impacts. Applicants are reminded, however, that such demonstrations must consider the potential for adverse impacts of the discharge alone and in combination with other discharges (if any exist) [§125.57(a)(2)]. The following characteristics indicate a low potential for impact:

- Location of the discharge in water depths greater than 10 m (33 ft);
- Hydrographic conditions that result in low predicted solids accumulation rates;
- The absence of distinctive habitats of limited distribution and the absence of fisheries in the vicinity of the outfall, when such absences are not due to anthropogenic stresses; and
- The absence of known or suspected sources of toxic pollutants and pesticides in the effluent.

Most small dischargers that previously demonstrated a low potential for impact should be able to do so again. They need demonstrate only that characteristics of the discharge and receiving water did not change greatly during the term of the existing permit. Monitoring data collected during the term of the original section 301(h) modified permit should also be useful for such demonstrations.

Some small dischargers may not be able to demonstrate a low potential for impacts because the characteristics of the discharge or receiving water differ from those listed above. In some cases, the discharge or receiving water may not have exhibited the aforementioned characteristics at the time the original application for a section 301(h) modified permit was prepared. In others, characteristics of the discharge or receiving water may have changed, or additional information may now be available that documents a greater potential for impact than was previously supposed. For example, the composition of the discharge may have changed to include toxic pollutants or pesticides from a new industrial source. Alternatively, a fishery for a previously underutilized species may have developed in the vicinity of the discharge, or research by local scientists may have discovered that the habitat in the vicinity of the outfall is an important nursery ground for a commercially harvested species of fish or shellfish.

When it is apparent for one or more reasons that the discharge or receiving water does not exhibit characteristics that would indicate a low potential for impacts, the Regions have the discretion to require that an applicant perform a detailed assessment of biological conditions in the vicinity of the outfall. The level of detail that would be expected in such a demonstration would be comparable to that required of large dischargers.

In some cases, the applicant may have been required to monitor one or more biological communities under the conditions of the existing section 301(h) modified permit. The Region may require the applicant to analyze and discuss those biological monitoring data in response to this question. When biological monitoring data were not collected, but concern exists that the modified discharge might cause adverse impacts to the biota, the Region may require the applicant to collect biological data in support of the application for permit reissuance. It is the applicant's responsibility to identify the need for additional biological data and provide adequate time to design and execute appropriate studies. Moreover, the applicant should work closely with the Region during all phases of the studies to ensure that adequate, high-quality data are collected. Applicants required to perform these field surveys should consult U.S. EPA (1982a, 1987a, 1987c, 1987f) for guidance on the design and execution of those surveys.

III.D.5. For discharges into saline estuarine waters: [40 CFR 125.62(c)(4)]

- ***Does or will the current or modified discharge cause substantial differences in the benthic population within the ZID and beyond the ZID?***

- ***Does or will the current or modified discharge interfere with migratory pathways within the ZID?***

- ***Does or will the current or modified discharge result in bioaccumulation of toxic pollutants or pesticides at levels which exert adverse effects on the biota within the ZID?***

No section 301(h) modified permit shall be issued where the discharge enters into stressed saline estuarine waters as stated in 40 CFR 125.59(b)(4).

*** ***Large and small dischargers must respond.***

The Water Quality Act of 1987 prohibits the issuance of section 301(h) modified permits for discharges into saline estuaries with any of the following characteristics regardless of the causes of any of those conditions:

- The estuary does not support a balanced indigenous population of shellfish, fish, and wildlife.
- The estuary does not allow for recreational activities.
- The estuary exhibits ambient water quality characteristics that are not adequate to protect public water supplies; protect shellfish, fish, and wildlife; allow for recreational activities; and comply with standards that assure and protect such uses.

Estuaries are generally more productive than nonestuarine coastal areas and are often more sensitive to pollutants. They also serve as spawning and nursery grounds for many invertebrates and fishes. Moreover, the flushing characteristics of estuaries may be considerably less than those of open coastal areas, especially during periods of reduced freshwater input. Thus, for a given discharge size, there is generally a higher potential impact in estuaries than in open coastal environments.

Additional information is required for saline estuarine discharges. U.S. EPA regulations [§125.62(c)(4)] require applicants to demonstrate that no substantial differences exist between the benthic communities within the ZID and those beyond the ZID. Hence, applicants discharging into saline estuaries must compare benthic communities within the ZID and beyond the ZID boundary with benthic communities at reference sites.

The applicant should also assess the degree to which the discharge could interfere with migratory pathways within the ZID. Where a survey of fish and/or shellfish is necessary to

determine levels of toxics accumulation in tissues, applicants should consult the EPA guidance documents *Bioaccumulation Monitoring Guidance: 4. Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Tissue from Estuarine and Marine Organisms* (U.S. EPA 1985d) and *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish: A Guidance Manual* (U.S. EPA 1989a). These documents contain information on how to perform a health risk assessment based on standard toxicological parameters and criteria. Information on sampling design, target species selection, sampling location, QA/QC protocols, and other topics is also presented. In conducting this assessment, the applicant can calculate the proportion of the cross sectional area of the estuary that is influenced by the ZID. The potential for migratory interference can then be evaluated by considering the relative size and characteristics of the discharge-affected area and its location in the estuary with respect to known migratory pathways.

Applicants with saline estuarine discharges must also assess the bioaccumulation of toxic substances within the ZID (see U.S. EPA 1985a, 1985b, 1985c, 1985d, 1987d). There are several advantages of using caged indicator species versus indigenous species to monitor bioaccumulation (U.S. EPA 1992a). However, results using caged organisms may not provide an accurate estimate of the bioavailability of certain contaminants occurring at the site. If elevated or increasing concentrations of toxic substances are found in fish or shellfish, the applicant should assess the potential for adverse impacts such as restrictions on human use (e.g., FDA Action Levels), induction of disease, or interference with fish and shellfish growth or reproduction (U.S. EPA 1986a).

Special Considerations for Small Dischargers

When there is reasonable concern that one or more of the three foregoing conditions prohibiting the issuance of section 301(h) modified permits for discharges into saline estuaries has come into existence during the term of an existing section 301(h) modified permit, the Regions may require small applicants to demonstrate successfully that none of the conditions exist. To do so, small applicants may be required to perform a detailed biological survey similar to that required of large dischargers. Small applicants are advised to consult the information provided under Questions II.C.1 and III.D.1 (above) and in section III.F for guidance on the design and execution of detailed biological surveys. It is the applicant's responsibility to identify the need for a detailed biological survey to document the absence of stressed conditions in the receiving water and to allow adequate time to design and execute appropriate studies. Moreover, the applicant should work closely with the Region during all phases of the studies to ensure that adequate, high-quality data are collected.

III.D.6. For improved discharges, will the proposed improved discharge(s) comply with the requirements of 40 CFR 125.62(a) through 125.62(d)? [40 CFR 125.62(e)]

*** ***Large and small dischargers must respond.***

EPA regulations require applicants that propose discharge improvements to demonstrate that the improvements will result in compliance with §125.62(a) through (d). This demonstration might be accomplished by comparing conditions at the outfall location with conditions near discharges that are similar to the proposed improved discharge. Assuming that there is a basic similarity in indigenous biota of the receiving water, such a comparison may be sufficient to predict protection of a BIP. Applicants may also conduct predictive analyses of effluent dispersion and seabed accumulation of solids following discharge improvements.

Applicants whose discharge improvement plans include outfall relocation should describe existing biological conditions at both the existing and proposed outfall sites. Those applicants are also to predict future biological conditions at the proposed site following relocation of the outfall. Such predictions might be made on the basis of comparisons with other discharges that are similar to the relocated discharge. Discharges used for such comparisons should be located in receiving waters similar to the applicant's.

III.D.7. For altered discharge(s), will the altered discharge(s) comply with the requirements of 40 CFR 125.62(a) through 125.62(d)? [40 CFR 125.62(e)]

*** ***Large and small dischargers must respond.***

Applicants requesting modifications for altered discharges may use predictive methods similar to those described for improved discharges. However, such applicants must demonstrate that the increased pollutant loading resulting from population growth or industrial growth within the service area will still enable compliance with §125.62(a) through (d) as well as the appropriate state's antidegradation requirements. These predictions of compliance with 301(h) criteria during the 5-year permit term may be technically difficult and may require extensive analyses.

III.D.8. If your current discharge is to stressed ocean waters, does or will your current or modified discharge: [40 CFR 125.62(f)]

- ***Contribute to, increase, or perpetuate such stressed condition?***

- ***Contribute to further degradation of the biota or water quality if the level of human perturbation from other sources increases?***

- ***Retard the recovery of the biota or water quality if human perturbation from other sources decreases?***

*** ***Large and small dischargers must respond.***

When it appears that an applicant's receiving waters are or may be stressed, the Region may require the applicant to demonstrate the presence or absence of stressed conditions. If stressed conditions exist, the areal extent and magnitude of those stresses should be documented. Because stressed water determinations are largely based on biological conditions in the receiving water, the Region may require applicants to perform detailed biological surveys. Applicants required to perform detailed biological surveys for the purpose of determining whether stressed conditions exist in the receiving water should consult section III.F of this document and guidance documents cited therein for information on the design and execution of those surveys. It is the applicant's responsibility to identify the need for a detailed biological survey to determine whether stressed conditions exist in the receiving water and to allow adequate time to design and execute appropriate studies. The applicant should work closely with the Region during all phases of the studies to ensure that adequate, high-quality data are collected.

III.E. Impacts of Discharge on Recreational Activities [40 CFR 125.62(d)]

It is necessary to ensure that a 301(h) modified discharge (1) will meet water quality standards relevant to recreational activities beyond the ZID and (2) will not cause legal restrictions on activities that would be lifted or modified if the applicant's POTW were updated to secondary treatment.

III.E.1. Describe the existing or potential recreational activities likely to be affected by the modified discharge(s) beyond the zone of initial dilution.

*** ***Large and small dischargers must respond.***

The impact of POTW discharges on recreational activities must be assessed. Recreational fisheries are considered in the biological evaluation section. Other activities involving contact with water may be affected by microbial contamination. For recreational impact assessment, dispersion and transport of the effluent need to be considered in conjunction with the applicant's disinfection procedures.

All recreational activities currently occurring within the bay, estuary, or an 8-km (5-mi) radius of the outfall should be identified (e.g., swimming, boating, fishing, shellfishing, underwater diving, picnicking, other beach activities). Any additional potential future recreational activities should also be identified (e.g., new ports, boat harbors). A map that indicates the location of current activities, along with the location of the existing or proposed outfall, should be provided. Qualitative or, whenever possible, quantitative information that indicates the extent of the existing activities should be provided. This information could include the number of boats or boat slips in the area, species of fish and shellfish recreationally harvested, size of catch, and number of beach user days.

III.E.2. What are the existing and potential impacts of the modified discharge(s) on recreational activities? Your answer should include, but not be limited to, a discussion of fecal coliform bacteria.

*** ***Large and small dischargers must respond.***

Water quality standards for protecting recreational uses, particularly coliform bacteria or enterococci standards, should be provided. Water classifications within 8 km (5 mi) of the discharge should be indicated. The schedule and frequency of chlorination should be established. To confirm compliance with standards relevant to recreational activities, any required coliform or enterococci bacteria monitoring data for the effluent obtained at the ZID boundary and on the adjacent shoreline should be submitted. Bacteriological sampling should be limited to the night or early morning hours. If shoreline areas are not normally monitored, sampling should occur on the shore near popular water activity areas. If noncompliance with coliform bacteria standards is noted, an explanation and corrective measures should be provided. Other sources of coliform bacteria present in the area that could be contributing to the problem should be identified.

III.E.3. Are there any Federal, State, or local restrictions on recreational activities in the vicinity of the modified discharge(s)? If yes, describe the restrictions and provide citations to available references.

*** ***Large and small dischargers must respond.***

Any federal, state, or local restrictions or closures relating to the discharge and recreational activities should be identified. The nature of the restrictions, the date implemented, and the agency responsible (e.g., state department of health) should be indicated.

III.E.4. If recreational restrictions exist, would such restrictions be lifted or modified if you were discharging a secondary treatment effluent?

**** Large and small dischargers must respond.*

If restrictions are in place, the relation of the restriction to the current or modified discharge quantity and quality should be established. If an improvement in the discharge quality would modify or eliminate the restriction on recreational activities, this should be indicated. In all such events, it should be determined whether secondary treatment would improve the discharge sufficiently to allow the restriction to be modified.

III.F. Establishment of a Monitoring Program [40 CFR 125.63]

A monitoring program for applicants granted section 301(h) modified discharge permits is important to evaluate the impact of the modified discharge on selected marine biological communities, to demonstrate continued compliance with applicable water quality standards or criteria, and to monitor the effectiveness of the urban pretreatment and toxics control programs. Only those scientific investigations which are necessary to study the effects of the proposed discharge should be included in the scope of the monitoring program [§125.63(a)(1)(i)(B)]. Unless special circumstances exist (e.g., the presence of distinctive habitats, high mass emission rates of toxic substances), monitoring programs for small dischargers are typically much less comprehensive than those for large dischargers.

The monitoring program consists of four parts: biological, water quality, influent, and effluent. Although each of these parts involves sampling at different locations and for different parameters, they should not be considered as independent activities, but as an integrated study. In this manner, the applicant will be able to meet the specific objectives of each part of the study while also conducting a meaningful assessment of impacts of the discharge. Moreover, as predictable relationships are established among the biological, water quality, influent, and effluent monitoring parameters, it should be possible to delete certain elements of the field monitoring studies.

The continued assessment of marine biota as part of the monitoring program involves the same type of comparative strategy as is required for a BIP demonstration in the application. The characteristics of selected marine communities in the discharge vicinity are compared with biological characteristics at reference areas. Hence, a primary objective of the biological monitoring program is to evaluate continued compliance with the BIP requirements. This

demonstration can be accomplished by conducting periodic (e.g., quarterly) seasonal surveys of biological communities.

Biological communities selected for study in the monitoring program should include those communities which are most likely affected by the discharge. As is the case for BIP demonstrations in the original application, the monitoring program should address any biological effects in terms of spatial extent, magnitude, potential for secondary impacts, and potential for involvement of commercial or recreational species. All of these factors will be important in determining whether detectable differences in biological characteristics are adverse.

Bioaccumulation determinations and sediment sampling are used to evaluate biological effects of toxic substances in the effluent. The results of these studies can indicate the potential for adverse effects on human health, especially if recreationally or commercially important fishery resources occurred in the outfall vicinity. These results may also be used to determine the need for additional (or fewer) analyses of toxic substances in sediments or in organisms exposed to the diluted effluent. The National Research Council (1989) and, more recently, U.S. EPA (1992b) have completed studies on the assessment and classification of contaminated sediments. Also, considerable work is currently under way on how contaminated sediments and the potential for bioaccumulation are related.

The water quality monitoring program is intended to evaluate compliance with applicable water quality standards and criteria and to measure the presence of toxic substances. An additional objective of the water quality monitoring program is to provide information that will supplement the biological monitoring program, in particular to assist in the interpretation of observed biological differences.

Monitoring POTW influent and effluent is important for providing supplementary information for both the water quality and biological programs. Influent and effluent data are also used as a means of demonstrating continued compliance with the modified permit effluent limitations and removal efficiency requirements, and as a data source for permit renewal applications.

III.F.1. Describe the biological, water quality, and effluent monitoring programs which you propose to meet the criteria of 40 CFR 125.63. Only those scientific investigations that are necessary to study the effects of the proposed discharge should be included in the scope of the 301(h) monitoring program [40 CFR 125.63(a)(1)(i)(B)].

**** Large and small dischargers must respond.*

The extent of the monitoring program required as part of a section 301(h) variance will depend on the characteristics of the discharge and the receiving water. Monitoring of the influent, effluent, and receiving water may also be required as part of the applicant's existing NPDES permit or to meet state regulations. The applicant's proposed monitoring program must be submitted with the section 301(h) application.

Detailed guidance on the design of section 301(h) monitoring programs is provided in *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Water* (U.S. EPA 1982a) and *Framework for 301(h) Monitoring Program* (U.S. EPA 1987e). Although some technical information (primarily literature citations, analytical protocols, and legal citations and requirements) provided in U.S. EPA (1982a) has been superseded, most of the information is still valid and applicable to the design of 301(h) monitoring programs. More recent documents (e.g., U.S. EPA 1985e, 1986c, 1987c, 1987e) include the addition of recent literature citations, updated analytical protocols, and updated legal citations and requirements. The updated information in these more recent documents, together with the earlier guidance provided by U.S. EPA (1982a, 1987e), is sufficient to design and implement an effective monitoring program. Applicants are referred to the following documents for additional or updated guidance on specific topics relevant to the design and execution of 301(h) monitoring programs:

- U.S. EPA (1987a) for information on positioning methods in nearshore marine and estuarine waters;
- U.S. EPA (1985c, 1985d, 1985e, 1986c) for information on analytical methods;
- U.S. EPA (1987c) for information on quality assurance/quality control procedures for field and laboratory methods;

- U.S. EPA (1985a, 1985b, 1985c, 1985d, 1987d) for information on bio-accumulation monitoring studies;

- U.S. EPA (1987b) for information on fish liver pathology monitoring studies; and

- U.S. EPA (1989a) for information on human health risk assessments associated with contaminated fish and shellfish.

The full titles and facts of publication for these documents can be found in the reference section of this manual.

Biological Monitoring

The applicant's biological monitoring program must include the following elements to the extent practicable:

(1) Periodic surveys of control sites and biological communities most likely to be affected by the discharge;

(2) Periodic bioaccumulation studies and examination of possible adverse effects of effluent-related toxic substances;

(3) Periodic sampling of sediments; and

(4) Periodic assessment of commercial or recreational fisheries (if present).

Small applicants are not subject to items (2) through (4) above if they discharge at depths greater than 10 meters and if they demonstrate through a suspended solids deposition analysis that there will be negligible seabed accumulation in the vicinity of the modified discharge.

The objectives of the biological monitoring program are to evaluate the impact of the modified discharge and to demonstrate compliance with section 301(h) biological requirements. Thus, the biological monitoring program must enable the same spatial comparisons (i.e., ZID, ZID boundary, discharge impact area, and control) as are required for demonstration of a BIP.

The applicant's monitoring program should include only those study elements which are practicable and appropriate in the receiving water. When the applicant believes that one or more

of the aforementioned study types is not practicable, a justification for the proposed deletion from the monitoring program should be provided. Examples of situations in which reductions in the frequency or extent of biological surveys would be reasonable might include conditions of high current speeds or adverse climatic periods (sampling not practical) and periods of low biological variability or extremely low productivity (sampling not appropriate).

Monitoring program specifications supplied by the applicant must include the following information:

- Biological groups to be sampled;
- Sampling methods;
- Station locations;
- Sampling schedules;
- Preservation techniques;
- Analytical techniques;
- Quality assurance/quality control procedures;
- Statistical analyses; and
- Taxonomic sources.

The three types of sampling stations that should generally be included in the periodic biological surveys to the extent practicable are located as follows:

- In the vicinity of the ZID;
- In other areas of potential discharge impact; and
- In control (i.e., reference) areas.

Monitoring at intermediate sites between control and outfall locations may be necessary, especially for large discharges where definition of the spatial extent of biological effects is an important consideration. Additional station requirements would also be associated with discharges into estuaries (within-ZID station), into stressed waters, or in situations where other pollutant sources potentially affect biological communities near the discharge. For modified

discharges involving outfall relocation, monitoring must be conducted at the existing discharge site until cessation of discharge, and at the relocation site.

Selection of control stations is one of the more important aspects of monitoring program design because BIP comparisons will rely on data from these sites. Control stations should be located in areas not influenced by the applicant's previous or existing discharge or other pollutant sources. Sediment characteristics at control station(s) should be similar to those expected to occur naturally in the vicinity of the discharge. Discharge and control stations should be located at similar water depths.

Bioaccumulation studies are to be included in the monitoring program to evaluate the potential adverse effects of toxic substances. Section III.D.4 provides additional discussion on bioaccumulation studies. *In situ* bioassays may be needed on a case-by-case basis. Caged specimens of bivalve molluscs (e.g., *Mytilus edulis* or *M. californianus*) are recommended as test organisms for *in situ* bioassays. Exposures should be conducted in the discharge vicinity and at an appropriate reference site. Additional exposure sites may be necessary for large dischargers, especially in situations where other pollutant sources contribute toxic substances to the receiving water body. Those toxic pollutants and pesticides known or suspected in the applicant's discharge need to be measured in the exposed organisms. Specific guidance on bioaccumulation studies can be found in the following documents:

- *Bioaccumulation Monitoring Guidance: 1. Estimating the Potential for Bioaccumulation of Priority Pollutants and 301(h) Pesticides Discharged into Marine and Estuarine Waters* (U.S. EPA 1985a).

- *Bioaccumulation Monitoring Guidance: 2. Selection of Target Species and Review of Available Bioaccumulation Data* (U.S. EPA 1985b).

- *Bioaccumulation Monitoring Guidance: 3. Recommended Analytical Detection Limits* (U.S. EPA 1985c).

- *Bioaccumulation Monitoring Guidance: 4. Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Tissues from Estuarine and Marine Organisms* (U.S. EPA 1985d).

- *Summary of U.S. EPA-Approved Methods, Standard Methods, and Other Guidance for 301(h) Monitoring Variables* (U.S. EPA 1985e).

- *Analytical Methods for U.S. EPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments* (U.S. EPA 1986c).

- *Guidance for Conducting Fish Liver Pathology Studies During 301(h) Monitoring* (U.S. EPA 1987b).

The monitoring program must also include sediment sampling for toxic substances in the vicinity of the discharge, in other areas of expected solids accumulation, and at appropriate reference sites. Within-ZID sampling should be undertaken where practicable. The sediment sampling is intended to provide an indication of the toxics accumulation within sediments near the discharge and the associated contamination potential. If elevated or increasing concentrations of toxic substances are detected, the applicant must also analyze tissue concentrations of toxic substances in indigenous organisms to determine whether adverse bioaccumulation is occurring. Recommended organisms for such analyses include demersal fishes (e.g., flounder or sole), epibenthic megainvertebrates (e.g., crabs or lobster), or sessile filter-feeding organisms (e.g., clams, mussels, or oysters). Detailed guidance on sediment sampling can be found in *Analytical Methods for EPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments* (U.S. EPA 1986c).

Sediment samples should also be analyzed for characteristics that would support the water quality and biological surveys. These parameters should include particle size distribution and total volatile solids. Other parameters, such as BOD_5, sulfides, and total organic carbon, are also useful and may be required by some states.

If recreational or commercial fisheries are present in areas potentially affected by the discharge, the applicant should also periodically assess those fisheries. The kinds of evaluations conducted will depend on the nature of the local fisheries and on the level of detail of available fisheries data. These evaluations should reflect an understanding of the potential impacts of the discharge on the fisheries. Sources of information used to determine the productivity and status of fisheries include state resource agencies, voluntary logbooks, interviews, and field observations. The period and level of effort of fishery surveys will depend on the size and location of the discharge, concentrations of toxic substances in the effluent, species harvested, and importance of the commercial or recreational fishery.

Water Quality Monitoring

The objectives of the water quality monitoring program are to provide data for determining compliance with applicable water quality standards and criteria and to measure the presence of toxics identified or expected in the effluent. However, some pollutants are not readily detected in the water column alone. As a result, the collection of biological data and sediment sampling are necessary for a comprehensive monitoring program.

The water quality measurements usually required include dissolved oxygen, BOD_5, suspended solids, pH, temperature, salinity, and light transmittance. Light transmittance standards may be specified in terms of turbidity, Secchi disc depth, extinction coefficient, or percent light transmittance. With the exception of Secchi disc depth, water column profiles should be determined for these parameters. However, because the Secchi disc provides cumulative data on water transparency measured from the surface down to the depth at which the Secchi disk disappears from sight, the Secchi disc should not be used to detect the effect of a submerged plume on light transmittance.

Other parameters that may be required include nitrogen (nitrate, nitrite, total Kjeldahl nitrogen, and ammonia), total and reactive phosphorus, toxic substances identified in the effluent, chlorophyll *a*, floating particulates, color, settleable solids, surface oil and grease, total and fecal coliform bacteria, and enterococci bacteria. Samples for these parameters should be collected 1.0 m (3.3 ft) below the water surface, at mid-depth, and 1.0 m (3.3 ft) above the bottom. In deep water, sampling at additional water column depths may be required. The applicant's monitoring program should specify the parameters for which profiles are to be taken along with the sampling interval. Table 2 provides a list of the priority pollutants and 301(h) pesticides.

For existing discharges, stations should be located in the following areas:

- ZID boundaries (both upcurrent and downcurrent);
- Control (i.e., background) stations along the primary axis of the longshore component of the current (both upcurrent and downcurrent);
- Intermediate upcurrent stations between the ZID boundary and the upcurrent control station; and

- Potential impact areas (e.g., in the nearshore zone and close to areas with distinctive habitats).

The applicant should use information on local currents and wastefield dispersion patterns in selecting sampling station locations in potentially impacted areas. Sampling stations located at the ZID boundary, control stations, and intermediate upcurrent stations should be in approximately the same depth of water. Control stations should be located in areas not influenced by the discharge. Intermediate upcurrent stations should be selected to represent the approximate residual wastefield concentrations upcurrent of the location, thereby accounting for potential recirculation of previously discharged effluent (by reversing tidal currents, upwelling, or stagnant net circulation). Data should be collected at the intermediate and ZID stations at least twice daily (e.g., high and low slack tides) to evaluate short-term conditions. The duration of the longshore current in relation to the time of sampling is an important factor in determining whether the intermediate upcurrent stations are representative of persistent conditions or of only a temporary plume reversal. For discharges involving outfall relocation, monitoring stations must be located at the current discharge site until cessation of discharge, and at the relocation site.

For all cases, the applicant should include a chart showing the location of the outfall, the shoreline, any distinctive habitats, and all sampling stations. The latitudes, longitudes, and depths of the stations should be specified.

Sampling frequencies should be selected to comply with state requirements and to provide data for critical periods. In most cases, quarterly surveys that include the critical periods (e.g., time of maximum stratification) should meet state requirements. More frequent sampling (e.g., for coliform bacteria) in swimming or shellfish-harvesting areas may be required by some states. The analytical methods and quality control/quality assurance procedures should be described. [For detailed guidance on quality assurance/quality control procedures for field and laboratory methods, refer to *Quality Assurance/Quality Control Procedures for 301(h) Monitoring Programs* (U.S. EPA 1987c).]

Influent and Effluent Monitoring

The major objectives of treatment plant monitoring are to provide data for determining compliance with permit effluent limitations, section 304(a)(1) water quality criteria, and state requirements; to measure the effectiveness of the toxic substance control program; and to relate discharge characteristics to the receiving water biological and water quality conditions. In

addition, influent and effluent monitoring provides data for assessment of treatment plant performance that may be required to meet modified discharge permit conditions.

Parameters that should be measured in the influent are BOD_5 and suspended solids; however, other parameters may also require measurement. Parameters that should be measured in the effluent are BOD_5, suspended solids, pH, dissolved oxygen, section 304(a)(1) water quality criteria pollutants, toxic pollutants, and pesticides present or likely to be present in the discharge. The toxic pollutants and pesticides that should be measured are specified in §125.58(aa) and (p). Monitoring of other parameters, such as grease and oil, settleable solids, nutrients, fecal coliform bacteria, pathogens, and temperature, may also be required by other permit conditions or monitoring requirements.

Required influent samples should be collected just downstream of any coarse screens or grit chambers. Effluent samples should be collected downstream of any chlorination or disinfection units. Effluent samples to be analyzed for toxic substances should be collected just upstream of the outfall. Sample collection and analysis should be performed as required in 40 CFR Part 136, or as specified by EPA.

III.F.2. Describe the sampling techniques, schedules, and locations, analytical techniques, quality control and verification procedures to be used.

*** ***Large and small dischargers must respond.***

The following information must be provided for all portions of the proposed monitoring program:

- Parameters to be measured;
- Sampling methods;
- Sampling schedule;
- Sampling locations;
- Analytical techniques; and
- Quality control and verification procedures.

Guidance on the above subjects is provided in the documents listed under Question III.F.1. Current EPA-approved methods should be used for all parameters. Additional guidance on navigational requirements is provided in Appendix D.

III.F.3. Describe the personnel and financial resources available to implement the monitoring programs upon issuance of a modified permit and to carry it out for the life of the modified permit.

*** ***Large and small dischargers must respond.***

The applicant must provide information on available personnel, facilities, and financial resources to show that the proposed monitoring program can be implemented and continued for the term of the modified discharge permit if a section 301(h) modification is granted. The applicant should review state monitoring requirements to ensure that the proposed program meets those requirements.

III.G. Effect of Discharge on Other Point and Nonpoint Sources [40 CFR 125.64]

III.G.1. Does (will) your modified discharge(s) cause additional treatment or control requirements for any other point or nonpoint pollution source(s)?

*** ***Large and small dischargers must respond.***

The section 301(h) regulations require an analysis of whether a decreased treatment level at the applicant's discharge would require other pollution sources in the vicinity to increase their treatment levels or apply additional controls. For open coastal waters, a list of discharges within the anticipated impact area of the applicant's modified discharge should be provided. The subsequent dilution at each outfall can be estimated using Table B-5 in Chapter B-IV of Appendix B of this document. The total dilution is the product of the initial dilution and the subsequent dilution. If the effect of the applicant's discharge on other sources is small, further analysis may not be needed. Otherwise, an analysis of compliance with water quality standards at the other discharger sites is appropriate for determining the effects of the applicant's discharge at those sites. For most small POTW discharges, the effects on other sources should be negligible.

In estuaries where outfalls are close together, effects on other sources are possible. The approach outlined above can be used to estimate total dilution at the other outfalls.

III.G.2. Provide the determination required by 40 CFR 125.64(b) or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.

*** ***Large and small dischargers must respond.***

The applicant must provide a copy of a determination from the state or interstate agencies that are authorized to establish wasteload allocations indicating whether the proposed discharge will result in the imposition of additional pollution control requirements on any other point or nonpoint sources. This determination must also explain the basis of the conclusions.

If the required determination has not been received when the application is submitted to EPA, the applicant should include copies of the request letters to the appropriate agencies. When the determination is made, a copy of the determination letter should be forwarded to EPA.

III.H. Toxics Control Program and Urban Area Pretreatment Program [40 CFR 125.65 and 125.66]

The toxics control program is designed to identify and ensure control of toxic pollutants and pesticides discharged to the POTW. The section 301(h) toxics control provisions (§125.66) require both industrial and nonindustrial source control programs. In addition, applicants serving a population of 50,000 or more must now comply with the urban area pretreatment requirements under §125.65. Applicants must also comply with the pretreatment program requirements and compliance schedules in 40 CFR Part 403. The pretreatment program regulations [40 CFR 403.8(d)] require all industrial pretreatment programs to have been approved by 1 July 1983.

U.S. EPA's section 301(h) toxics control program regulations (§125.66) apply to all 301(h) applicants. However, small applicants that certify that there are no known or suspected sources of toxic pollutants and pesticides to the POTW are relieved of most of the cost burden for industrial pretreatment toxics control program development.

III.H.1. a. Do you have any known or suspected industrial sources of toxic pollutants or pesticides?

b. If no, provide the certification required by 40 CFR 125.66(a)(2) for small dischargers, and required by 40 CFR 125.66(c)(2) for large dischargers.

c. ***Provide the results of wet and dry weather effluent analyses for toxic pollutants and pesticides as required by 40 CFR 125.66(a)(1).***

d. ***Provide an analysis of known or suspected industrial sources of toxic pollutants and pesticides identified in (1)(c) above in accordance with 40 CFR 125.66 (b).***

*** ***Small dischargers must respond to parts a and b through d to the extent practicable.***
*** ***Large dischargers must respond to parts a through d.***

Applicants must conduct an industrial waste survey, as described in 40 CFR 403.8(f)(2), as the basis for determining whether there are any known or suspected industrial sources of toxic pollutants or pesticides. Guidance for conducting an industrial waste survey is provided by EPA (U.S. EPA 1983).

Toxic pollutants and pesticides are defined in §125.58(aa) and (p), respectively, and include those substances listed in Table 2. Marine water quality criteria are summarized in Table 3. Guidance on sampling and analytical methods is found in U.S. EPA (1982a, 1987c, 1987e) and 40 CFR Part 136.

If there are no known or suspected industrial sources of toxic pollutants or pesticides, the applicant must certify this fact, based on the results of an industrial waste survey.

Large and small applicants must submit results of wet- and dry-weather analyses of the treatment plant effluent if known or suspected industrial sources of toxic pollutants or pesticides exist. The analysis must be performed on a minimum of two 24-hour composite effluent samples (one dry-weather and one wet-weather). Applicants subject to the urban area pretreatment requirements under §125.65 must also conduct representative sampling and analysis of the POTW influent, effluent, and sludge for toxic pollutants. The Pretreatment Regulations (40 CFR Part 403) require that an applicant comply with Code of Federal Regulations, Title 40, Part 503, 58 FR 9387, 19 February 1993* (Standards for the Use or Disposal of Sewage Sludge). Sludge sampling is required in order to determine compliance with 40 CFR Part 503. Other applicants not subject to the pretreatment regulations may also be required to conduct sludge sampling and analysis. The *POTW Sludge Sampling and Analysis Guidance Document* (U.S. EPA 1989b) provides guidance on sludge sampling and analysis. If historic data are available, they should

*hereinafter referred to as 40 CFR Part 503.

be presented as well. Results of the analyses should be tabulated in a summary form that allows the toxic quality of the discharge to be evaluated. The applicant should describe the sampling effort by describing the procedures for collecting, compositing, and preserving the samples. The number of grab samples taken for volatile organics analysis should be included in the discussion.

Rainfall data submitted for at least 5 days preceding the sampling will confirm wet or dry conditions at the time of sampling. In past analyses (Feiler 1980), toxics concentrations have been substantially higher on Monday through Friday than on Saturday and Sunday. It is therefore recommended that composite effluent samples not be collected on weekends unless it can be shown that this sampling period is more representative.

Analytical methods should be discussed, with appropriate references to published analytical procedures. The analytical laboratory should be identified. Quality assurance procedures for the analysis should be summarized, and results presented for review. Differences between the wet- and dry-weather analyses should be explained, if possible. Also, a comparison with past results can be made.

Sources of detected toxic pollutants must be identified and, to the extent practicable, categorized according to industrial and nonindustrial origins. The purpose of this identification and categorization is to provide a useful reference for toxics monitoring and source controls. If the applicant recognizes that the source list requires improvement, procedures to accomplish this improvement should be described. In-system sampling and analysis, industrial discharge analysis, permit data, and site inspections could yield quantitative information as to sources of identified priority pollutants. A list entitled "Industrial Categories Subject to National Categorical Pretreatment Standards" can be found at 40 CFR Part 403, Appendix C. Additional information on categorical pretreatment standards can be found at 40 CFR 403.6 and under appropriate sections of 40 CFR chapter I, subchapter N (Effluent Guidelines).

Special Considerations for Small Dischargers

In the original section 301(h) application, unless required by the state, many small applicants were exempted from providing an analysis of toxic substances and pesticides in their effluent because they were able to certify that there were no known or suspected sources of those substances in their service area. However, those exemptions were not permanent (U.S. EPA 1982b). Section 125.63(d) requires all section 301(h) modified permit holders to analyze their effluent for toxic substances and pesticides, to the extent practicable, as part of their monitoring programs and to measure the effectiveness of the toxic control program. Hence, to the extent practicable, all section 301(h) permittees will have performed at least one effluent analysis for

toxic substances at a representative time during the 5-year term of the original section 301(h) permit. To the extent practicable, they will also perform another effluent analysis for toxic substances at a representative time during the 5-year term of the reissued permit. Results of those analyses should be used to demonstrate compliance with federal water quality criteria.

III.H.2. a. Are there any known or suspected water quality, sediment accumulation, or biological problems related to toxic pollutants or pesticides from your modified discharge(s)?

b. If no, provide the certification required by 40 CFR 125.66(d)(2) together with available supporting data.

c. If yes, provide a schedule for development and implementation of nonindustrial toxics control programs to meet the requirements of 40 CFR 125.66(d)(3).

d. Provide a schedule for development and implementation of a nonindustrial toxics control program to meet the requirements of 40 CFR 125.66(d)(3).

*** ***Small dischargers must respond to parts a through c.***
*** ***Large dischargers must respond to part d.***

The purpose of nonindustrial source control programs is to identify the specific nonindustrial sources of priority pollutants and pesticides and then to develop specific means for their control. To properly address these requirements, the applicant should describe existing programs or present a schedule and description of proposed programs to identify and control non-industrial sources of toxic pollutants and pesticides. At a minimum, all applicants must develop a public education program to limit nonindustrial sources (see Question III.H.3 below).

Nonindustrial source control programs must be developed and implemented within 18 months of the issuance of a section 301(h) modified permit; applicants for reissued 301(h) modified permits must have nonindustrial source control programs in place. The schedule must include the following two elements:

- A schedule of activities for identification of nonindustrial sources of toxic pollutants and pesticides and

- A schedule for the development and implementation of practicable control programs for nonindustrial sources of toxic pollutants and pesticides.

Activities to identify nonindustrial sources could include literature searches, in-system sampling and analysis, research on nonindustrial products commonly released to the sewer, and pooling of information with other POTW operators having a similar mix of users. The applicant should also consult the data and guidance on nonindustrial sources provided by EPA (U.S. EPA 1991a).

There are no clearly defined rules to determine the level of effort that an applicant should apply to identify nonindustrial sources. This level of effort, however, is expected to be directly related to the size of the discharger. For example, dischargers with diverse land uses within the service area may find it necessary to perform in-system sampling and analysis to explain the occurrence of toxic pollutants and pesticides.

Concentrations of pollutants within the system not accounted for by industrial sources are generally attributable to nonindustrial sources. Applicants should therefore be careful not to duplicate any in-system sampling efforts performed for compliance with industrial pretreatment regulations.

Extensive control measures may be necessary where nonindustrial sources produce concentrations of toxic pollutants and pesticides within 50 percent or more of the receiving water criteria after initial dilution. These measures could include control of the sale, use, handling, and disposal stages of substances containing priority pollutants and pesticides.

EPA recognizes the potential for serious adverse effects on marine organisms and humans that can result from the accumulation and bioaccumulation of discharged toxic pollutants and pesticides. EPA also recognizes the potential complexity of nonindustrial source control programs. Therefore, applicants are encouraged to consult with EPA during development of nonindustrial source control programs. Proposed nonindustrial source control programs are subject to review and revision by EPA prior to the issuance of a section 301(h) modified permit and during the term of any such modified permit.

III.H.3. Describe the public education program you propose to minimize the entrance of nonindustrial toxic pollutants and pesticides into your treatment system [40 CFR 125.66(d)(1)]

*** ***Large and small dischargers must respond.***

The applicant must propose a public education program to minimize the amounts of nonindustrial toxic pollutants and pesticides that enter the waste stream. The plan must be developed and implemented within 18 months of the issuance of a 301(h) modified permit; applicants for reissued 301(h) modified permits must have a public education program in place. The public education program may include preparation of newspaper articles, posters, or radio and television announcements to increase public awareness of the need for proper disposal of waste oils, solvents, herbicides, pesticides, and other substances that contain toxic pollutants.

III.H.4. ***Do you have an approved industrial pretreatment program (40 CFR 125.66(c)(1)?***

a. ***If yes, provide the date of EPA approval.***

b. ***If no, and if required by 40 CFR Part 403 to have an industrial pretreatment program, provide a proposed schedule for development and implementation of your industrial pretreatment program to meet the requirements of 40 CFR Part 403.***

*** ***Large and small dischargers must respond.***

An applicant with known or suspected industrial sources of toxic pollutants or pesticides must have an approved pretreatment program and demonstrate compliance with its requirements before a waiver may be granted. Applicants that certify to the Administrator that they have no known or suspected industrial sources of toxic pollutants or pesticides are not required to have an industrial pretreatment program.

In this section, applicants required to have an industrial pretreatment program should indicate the date of approval and clearly present a history of compliance with the 40 CFR Part 403 industrial pretreatment program requirements. The history of compliance should summarize all compliance inspections and the results of those inspections; any enforcement actions including notices of violation, the reason for the enforcement action, and any actions taken to correct the causes of violations; and the current compliance status at the time of application.

III.H.5. Urban area pretreatment requirement [40 CFR 125.65]
Dischargers serving a population of 50,000 or greater must respond.

a. Provide data on all toxic pollutants introduced into the treatment works from industrial sources (categorical and noncategorical).

b. Note whether applicable pretreatment requirements are in effect for each toxic pollutant. Are the industrial sources introducing such toxic pollutants in compliance with all of their pretreatment requirements? Are these pretreatment requirements being enforced? [40 CFR 125.65(b)(2)]

c. If applicable pretreatment requirements do not exist for each toxic pollutant in the POTW effluent introduced by industrial sources,

- *provide a description and a schedule for your development and implementation of applicable pretreatment requirements [40 CFR 125.65(c)], or*

- *describe how you propose to demonstrate secondary removal equivalency for each of those toxic pollutants, including a schedule for compliance, by using a secondary treatment pilot plant. [40 CFR 125.65(d)]*

**** Dischargers serving a population of 50,000 or more must respond.*

Applicants must conduct an industrial waste survey, as described in 40 CFR 403.8(f)(2), as the basis for characterizing industrial sources by industry type (SIC code), types and concentrations of toxic pollutants in discharge(s), wastewater flow to the POTW, and other factors as outlined in guidance provided by EPA (U.S. EPA 1983). All industrial sources should be identified separately as categorical or noncategorical industries. It is likely that this information has already been developed as part of the applicant's approved industrial pretreatment program under 40 CFR Part 403.

Once the toxic pollutants being introduced by industrial sources and those sources have been identified, the applicant can choose between two methods to comply with the urban area pretreatment requirements. The applicant must address each toxic pollutant introduced by industrial sources. In the first method, called the Applicable Pretreatment Requirement Approach, the applicant would demonstrate that it has in effect applicable pretreatment requirements for each toxic pollutant discharged to the POTW by industry [§125.65(c)]. In the second method,

called the Secondary Removal Equivalency Approach, the applicant would demonstrate that the existing POTW treatment process (including any existing pretreatment) removes at least the same amount of that toxic pollutant as would have been removed by secondary treatment if there were no pretreatment for that toxic pollutant [§125.65(d)]. Appendix E provides guidance for conducting the above demonstrations for compliance with urban area pretreatment requirements. A summary of these methods is provided below.

Applicable Pretreatment Requirement Approach

General Approach. Under §125.65(b)(1)(i), an applicant must have in effect applicable pretreatment requirements for each toxic pollutant discharged to the POTW from one or more industrial users. Applicable pretreatment requirements may take the form of (1) categorical standards; (2) local limits (numeric and/or narrative), or a combination of (1) and (2); and (3) where it is determined that local limits are not necessary for a toxic pollutant, annual monitoring and technical review of industrial discharges, and, where appropriate, implementation of industrial management practices plans (IMPs), best management practices (BMPs), and other pollution prevention activities, and determination on an annual basis of the need to revise local limits and/or to demonstrate that there is no need for a local limit for a specific toxic pollutant. When an industrial discharger is subject to both a categorical standard (1) and a numeric local limit (2) for a specific toxic pollutant, the more stringent of the two limits applies.

Categorical standards (see 40 CFR 403.6) are nationally uniform, technology-based limits developed for specific industries and for specific toxic pollutants. All categorical industries must comply with categorical standards, even if they discharge to a POTW without a federally approved local pretreatment program. By contrast, local limits are developed by the POTW, among other purposes, to prevent interference with the treatment works or pass-through of toxic pollutants, as required by 40 CFR 403.5(b).

A specific categorical industry may be subject to categorical standards for some pollutants and local limits for other pollutants. When both local limits and categorical standards address a particular pollutant for a specific industry, the more stringent requirement applies. Furthermore, local limits for specific toxic pollutants found in the POTW waste stream can apply to both categorical and noncategorical industries when the toxic pollutants cannot be entirely attributed to categorical industries and/or when categorical standards alone are not sufficient to satisfy the requirements of 40 CFR Part 403.

Local limits (see 40 CFR 403.5) are requirements developed by a POTW based on local conditions and unique requirements at the POTW. These limits are primarily intended to protect

the treatment plant from industrial discharges that could interfere with POTW treatment processes or pass through the treatment plant to receiving waters and adversely impact water quality or the environment. Local limits are also designed to prevent sludge contamination and protect workers at the treatment plant.

Under the applicable pretreatment requirement approach, the applicant must address each toxic pollutant introduced by industry. However, the POTW need not develop a specific numeric local limit that applies to each industrial source of each toxic pollutant. After conducting a local limit analysis, the POTW may apportion the allocation of the numeric local limit (if any) to any number of industrial sources of the toxic pollutant (categorical and/or noncategorical) that the POTW deems appropriate, subject to approval of the applicable Regional office. Moreover, when it is not appropriate or practical to develop and implement numeric local limits to prevent pollutant pass-through or interference for a specific toxic pollutant, the EPA pretreatment program has provided for narrative local limits (i.e., industrial management and best management practices) as useful supplements to numeric limits. Narrative local limits are most appropriate where management plans are needed to help control or eliminate chemical spills or leaks, slug discharges, or the handling of hazardous or toxic materials from both categorical and noncategorical industries.

For toxic pollutants for which the POTW determines that neither numeric nor narrative local limits are necessary, a program of periodic POTW monitoring and annual technical review of data on industrial discharges would be conducted by the POTW and, where appropriate, would require industrial users to institute IMPs and other pollution prevention activities to control and reduce the levels of those toxic pollutants for selected industries. For those toxic pollutants, the POTW would report annually to EPA on the status of the need for development of local limits. If such monitoring and technical review of data indicate that a local limit is needed, the POTW would establish and implement a local limit.

IMPs are intended to minimize the discharge of toxic pollutants to the sewer, or reduce the impact of toxic pollutant discharges by avoiding short-term, high-concentration discharges. IMPs can be applied to all classes of industrial users, e.g., major and minor industrial users. Examples of appropriate uses of IMPs include control of chemical spills and slug discharges to the POTW through formal chemical or waste management plans (including BMPs), solvent management plans, batch discharge policies, waste recycling, and waste minimization. It would also be appropriate to consider IMPs in cases where the POTW does not include biological treatment processes, or provides less treatment, e.g., primary treatment. In these cases, IMPs can be tailored for industrial sources of toxic pollutants that might otherwise interfere with biological treatment or would be degraded or removed through additional treatment.

EPA's *Guidance on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program* (U.S. EPA 1987h) provides various methods for calculating numeric local limits. Applicants should consult the appropriate EPA Regional office for more specific information regarding pretreatment programs and local limits development. The following discussion is intended as a guidance framework for a process to demonstrate and comply with the §125.65 urban area pretreatment requirements through the applicable pretreatment requirement approach.

Maximum Allowable Headworks Loading (MAHL) Method. The predominant approach used is a chemical-specific approach known as the maximum allowable headworks loading (MAHL) method. This is accomplished pollutant by pollutant for each environmental criterion or plant requirement, and the lowest or most limiting value for each pollutant serves as the basis for allocation to industry and ultimate numeric local limits. As an example, steps of the maximum allowable headworks loading method are summarized below, as the method might be applied for purposes of meeting the urban area pretreatment requirements (i.e., applicable pretreatment requirement in effect). Other approaches for establishing numeric local limits may also be appropriate. Applicants should establish local limits programs in coordination with Regional Administrators on a case-by-case basis. Appendix E provides additional information on the MAHL approach and on alternative approaches.

Determine Pollutants of Concern--The applicant must address all toxic pollutants [40 CFR 401.15 and §125.65(b)(1)] that are identified as known or suspected to be discharged by industry to the POTW. An initial screening of the known or suspected toxic pollutants may be performed to select those likely to require numeric local limits as determined under the MAHL method. For the remaining toxic pollutants, the POTW must evaluate the need to set narrative local limits (i.e., industrial management and best management practices) to control and reduce levels of these toxic pollutants from appropriate industrial sources. For toxic pollutants for which the POTW determines that neither numeric nor narrative local limits are necessary, the POTW must conduct periodic monitoring and annual review of industrial discharges to check the status of the need for development of local limits.

Characterize Existing Loadings--An industrial waste survey must be conducted, as previously discussed, using guidance provided by EPA (U.S. EPA 1983). The POTW must characterize existing loadings to the treatment plant by conducting monitoring of all industrial users. Either POTW monitoring data or self-monitoring data are acceptable, and information from the industrial waste survey may also be of use. The applicant should also characterize

nonindustrial sources of toxic pollutants such as hauled wastes and domestic/background sources. The applicant must conduct sufficient monitoring at the treatment plant to adequately characterize influent, effluent, and sludge loadings of toxic pollutants. Monitoring of the treatment plant influent, effluent, and sludge should represent a minimum of 5 consecutive days to capture the typical short-term range and variability in the wastewater composition. Preferably, in addition, monitoring should include data for at least 1 day per month over at least 1 year for metals and other inorganic pollutants and 1 day of sampling per year for all other toxic pollutants. The method for analysis of a toxic pollutant should be selected according to the type of pollutant to be analyzed (i.e., grab samples over 24 hours for volatile organic compounds, total recoverable phenolic compounds, and cyanide and flow-proportioned 24-hour composite samples for all other toxic pollutants). Appendix E provides additional guidance on development of a toxic pollutant monitoring program.

Determine Applicable Environmental Criteria--Environmental criteria generally include NPDES permit limits, water quality standards or criteria, sludge disposal requirements, and unit process inhibition values. Other appropriate requirements may include worker health and safety criteria, collection system effects, incinerator emission requirements, or other applicable federal, state, or local environmental protection requirements.

Calculate Maximum Headworks Loadings--If using the MAHL approach, the applicant calculates the maximum amount (lb/day) of each toxic pollutant contributed by an industrial user or received at the headworks of the treatment plant that will allow the POTW to achieve all of the above applicable environmental criteria. All calculations should be consistent with the approach outlined in the EPA guidance manual (U.S. EPA 1987h).

Calculate Allowable Industrial Loadings--If using the MAHL approach, the applicant incorporates a safety factor (range of 10 to 30 percent) and discounts the value for domestic/background loadings in order to determine the maximum allowable allocation available for industrial users.

Allocate Allowable Industrial Loadings--The method chosen to allocate the allowable industrial loading depends on the number and types of industrial users and the method of application (permits, contract, or sewer use ordinance) employed by the POTW. Where the current loading of a toxic pollutant exceeds the maximum allowable headworks loading, the applicant must establish a numeric local limit to reduce loadings to within the range of the maximum allowable headworks loading. Under the applicable pretreatment requirement approach, the POTW must address each toxic pollutant introduced by industry. The POTW may allocate the allowable industrial loading among any number of industrial sources of the toxic

pollutant (categorical and/or noncategorical) that the POTW deems appropriate, subject to the approval of EPA. Where the current loading is below the maximum allowable headworks loading, the applicant is encouraged, but not required, to set industrial discharge limits at current loadings to provide a safety factor. Numeric local limits could be allocated, for example, according to the following classification scheme developed under the industrial waste survey. For major or significant industries, the POTW could set specific effluent limitations (categorical standards, numeric local limits, or both). For minor industries, the POTW may choose to set numeric local limits when these industries as a group represent a significant source of toxic pollutants to the POTW; otherwise, the POTW could evaluate the need to set narrative local limits for appropriate industries (i.e., industrial management and best management practices) to control and reduce levels of toxic pollutants. Examples of industrial management practices include waste recycling, solvent management plans, batch discharge policies, and other "good housekeeping" practices. Narrative local limits may also be implemented in conjunction with numeric local limits for the same industry, if deemed appropriate. Once local limits have been developed, they must be effectively implemented. Local limits should be incorporated into the sewer use ordinance or some form of individual control mechanism.

Ongoing Review/Revision of Local Limits and Screening Pollutants of Concern. Local limits should be reviewed and revised on a periodic basis to reflect changes in conditions or assumptions. Conditions that might require that local limits be revised include, but are not limited to, changes in environmental criteria, changes in the industrial users, availability of additional monitoring data, changes in plant processes, and changes in POTW capacity or configuration.

Annual monitoring should be conducted by the POTW as described above and in Appendix E. The results of the monitoring and data review must be made available in the annual report required under 40 CFR 403.12. If the applicant determines, based on results of annual monitoring of the POTW influent/effluent/sludge and/or technical review of data on discharges from industrial sources (also updated annually), that the level of a toxic pollutant is expected to exceed the maximum allowable level determined through the local limits analysis, the applicant should establish a new numeric local limit and modify the individual control mechanism or sewer use ordinance, as appropriate, to implement the new local limit. Furthermore, the applicant should update the initial screening of toxic pollutants based on results of the same technical review to determine the need for inclusion of any new toxic pollutants/industries in the local limits analysis (either numeric or narrative).

Ongoing Analysis of Other Toxic Pollutants Not Addressed by Local Limits. For toxic pollutants for which the POTW determines that neither numeric nor narrative local limits are necessary

(e.g., not pollutants of concern, insignificant industrial contribution), a program of periodic POTW monitoring (as described above and in Appendix E) and annual technical review of data on industrial sources should be conducted. Where appropriate, the POTW should require industrial users to institute IMPs and other pollution prevention activities to control and reduce the levels of these toxic pollutants for selected industries. For these toxic pollutants, the POTW should report annually to EPA on the status of the need for development of local limits (e.g., whether these toxics are now pollutants of concern, whether IMPs are needed for additional industries, etc.). If such monitoring and technical review of data indicate that a local limit is needed, the POTW would establish and implement a local limit.

Secondary Removal Equivalency Approach

Alternatively, an applicant may demonstrate that its own treatment processes, in combination with existing pretreatment by industrial dischargers, achieves "secondary removal equivalency." Applicants are required to make this demonstration when they cannot show that a known or suspected toxic pollutant introduced by an industrial discharger has an "applicable pretreatment requirement" in effect as defined in §125.65(c) and discussed above. Although secondary treatment removes conventional pollutants, a certain amount of toxic pollutants in the influent is incidentally removed during the process. In the absence of an applicable pretreatment requirement in effect for a toxic pollutant, WQA section 303(c) requires that a section 301(h) discharger remove at least that same amount of a toxic pollutant, through a combination of industrial pretreatment and the applicant's own treatment at less-than-secondary levels, as would be removed if the applicant were to apply secondary treatment and no pretreatment program existed for that pollutant.

To demonstrate secondary removal equivalency, an applicant would need to use a secondary treatment pilot plant. By diverting part of its primary effluent (secondary influent) to the pilot plant, the applicant would empirically determine the incremental amount of each toxic pollutant that would be removed from the primary effluent (secondary influent) if secondary treatment were applied. Having determined the amount of each toxic pollutant removed, the applicant would then demonstrate that its existing less-than-secondary treatment plus industrial pretreatment removes at least the same amount of each toxic pollutant as did the secondary treatment pilot plant (including removals in the primary effluent) without any industrial pretreatment.

In cases where an applicant already has an ongoing industrial pretreatment program that addresses categorical industries but not all toxic pollutants discharged to the POTW from categorical and noncategorical industries, the applicant may choose to perform the empirical

secondary removal equivalency demonstration using influent that has been subject to that existing industrial pretreatment. (The applicant is not expected, in most cases, to be able to provide "unpretreated" industrial wastewaters to perform the empirical demonstration.) Such a demonstration may then be conservative because it may overstate the amount of toxic pollutant that would be removed by applying only primary and secondary treatment. Because it would be conservative, applicants are permitted (but not required) to make the secondary equivalency demonstration using effluent that has undergone partial industrial pretreatment.

Effluent limits (concentration values and/or flow-corrected mass loading values) will be developed based on data from the secondary removal equivalency demonstration when these values are more stringent than effluent limits based on state water quality standards or water quality criteria, or required to ensure that all applicable environmental protection criteria are met. Once the effluent limits are established, the applicant may either develop local limits (as described above) or perform additional treatment at the POTW, or combine the two to achieve the permit limit.

DETERMINATIONS OF COMPLIANCE WITH SECTION 301(h) MODIFIED PERMIT CONDITIONS AND 301(h) CRITERIA

PERMIT CONDITIONS

POTWs that hold section 301(h) modified permits must comply with section 301(h) criteria and regulations, as well as all applicable state water quality standards, state and federal laws, regulations, and Executive orders. General guidance is presented below for assessing the effects of POTW discharges into the marine environment, including water quality, physical, and biological evaluations. Question III.B.7 of the Applicant Questionnaire places additional requirements to meet federal water quality criteria, as well as applicable state standards [§125.62(a)(1)] on all section 301(h) dischargers. These requirements have the potential to expand the scope of the water quality demonstrations that must be made by each section 301(h) discharger to include more parameters, but do not create a fundamentally different, or new, class of standards, criteria, or requirements that must be met. Therefore, the general guidance provided below includes information relevant to determinations of compliance with the federal water quality criteria and applicable state standards. Guidance is also presented on the evaluation of biological monitoring data collected to identify biological impacts that may occur as a result of a discharge. Such biological monitoring efforts should be designed to identify potential problems early, as well as to demonstrate compliance with 301(h) requirements.

The first step in evaluating effects of 301(h) discharges on water quality, especially when applicants are seeking renewal of a 301(h) modified permit, is to compare the data to be submitted for the renewal with the data collection requirements specified in the existing section 301(h) modified permit. The following two key questions should be addressed:

- Are all physical, chemical, and biological parameters required by the section 301(h) modified permit measured?

- Is each required parameter measured at the specified locations and at the specified frequency?

If either question cannot be answered affirmatively, the applicant could be considered in noncompliance with the terms of the existing section 301(h) modified permit. In cases of apparent noncompliance, the applications for reissuance of the modified permit may be denied without further examination of the monitoring data.

Assuming that all the appropriate data are available, the second step is to evaluate the technical merit and interpretation of the data. Three major areas should be considered when preparing assessments of the data:

- Data quality;
- Execution of the analyses; and
- Interpretation of the analytical results.

Applicants should provide sufficient information to document that data quality is high, analyses are properly executed, and data interpretation is reasonable. Procedures for proper data collection are found in guidance presented in U:S. EPA (1982a, 1982c) and guidance given under the appropriate questions in the Applicant Questionnaire (especially Questions III.F.1 and III.F.2). Of critical importance to the collection of data for any parameter is whether appropriate field and laboratory methods are used to collect the data and whether appropriate QA/QC procedures are followed. Data are of little value if they are collected using inappropriate methods or if the collection process is so poorly executed that their accuracy is in doubt. Refer to U.S. EPA (1987c) for additional QA/QC guidance.

As is true for data collection methods, data analysis methods vary greatly in terms of the various types of physical, chemical, and biological parameters. Applicants are referred to the aforementioned documents for guidance on evaluating data analysis methods. The following questions should be kept in mind during the presentation of the data analyses:

- Are values for each parameter reported in appropriate units?
- Are the analytical methods appropriate for the type of data being analyzed?
- Do the mathematical or graphical analyses illustrate what is being discussed in the text of the application?
- Are calculations correct, and have data points been plotted correctly?

Provided that the foregoing questions (and other questions related to data analysis that may be relevant in specific instances) are answered in the affirmative, applicants should indicate how the data and the results of analyses of those data support the applicant's conclusions concerning

whether the existing or proposed discharge contributes to adverse impacts on the receiving water or biota.

DETERMINATIONS OF COMPLIANCE WITH SECTION 301(h) CRITERIA

When monitoring data indicate that impacts to water quality, sediment quality, or biota are occurring, it will be necessary to determine whether such impacts are adverse. Many physical and chemical criteria (e.g., dissolved oxygen concentrations, concentrations of toxic pollutants in the water column after initial dilution) are quantitative. Determinations of water quality values are reasonably straightforward and rely primarily on the results of well-documented mathematical calculations. Provided that the physical and chemical data were properly collected and analyzed, the resulting values for each physical and chemical parameter can be compared with applicable section 301(h) criteria, state standards, and federal water quality criteria. Results of such comparisons can be used to determine the presence of an adverse impact.

The initial dilution is a critical parameter relative to compliance with water quality standards and 304(a)(1) water quality criteria. The magnitude of initial dilution achieved depends on ambient water density gradients and diffuser design. The ZID size is important to determine compliance with water quality and biological criteria. Methods for determining the size of the ZID can be found in discussions of Questions III.A.1 and III.A.2 and Appendix A.

The transport of diluted effluent beyond the ZID is also important to determine whether a discharge will comply with water quality standards. In addition, dischargers—particularly those to estuaries or partially enclosed (e.g., restricted flow) areas—may need to demonstrate that reentrainment or accumulation of effluent will not result in violations of applicable water quality standards.

When the values of one or more physical or chemical parameters consistently fall outside the ranges specified by the foregoing criteria, the discharge can be inferred (by definition) to be causing adverse impacts to the physical or chemical characteristics of the receiving water. Applicants that propose improvements to outfall or treatment systems will need to predict the values of parameters relevant to 301(h) criteria that can be expected following implementation of the proposed improvements.

The assessment of adverse biological effects in the section 301(h) process involves assessment of whether a balanced indigenous population of shellfish, fish, and wildlife exists in the vicinity of the discharge and in other areas potentially affected by the discharge. Since the BIP concept forms an integral part of the applicant's biological assessment, it is important to

establish the meaning and interpretation of the term in the context of a section 301(h) biological demonstration.

The term "population" does not mean a reproducing unit of a single species, but rather all biological communities existing in the receiving water body. Similarly, the terms "shellfish," "fish," and "wildlife" should be interpreted to include any and all biological communities that may be affected adversely by a marine POTW discharge [§125.58(y)].

A BIP is defined in the section 301(h) regulations [§125.58(f)] as "an ecological community that: (1) exhibits characteristics similar to those of nearby, healthy communities existing under comparable but unpolluted environmental conditions; or (2) may reasonably be expected to become re-established in the polluted water body segment from adjacent waters if sources of pollution were removed." Balanced, indigenous populations occur in unpolluted waters. The second part of the definition concerning the reestablishment of communities is included because of its relevance to proposed, improved discharges and to discharges into waters that are stressed by sources of pollution other than the applicant's modified discharge.

The biological community characteristics that might be examined in an evaluation of a BIP include, but are not limited to, species composition, abundance, biomass, dominance, and diversity; spatial/temporal distributions; growth and reproduction of populations; disease frequency; trophic structure and productivity patterns; presence or absence of certain indicator species; bioaccumulation of toxic materials; and the occurrence of mass mortalities of fish and invertebrates.

The first step in an applicant's BIP demonstration is to define the "indigenous population" and establish the natural variability of the "balanced population." Because EPA has determined that these are observable characteristics of natural communities existing in the absence of human disturbance, a comparative strategy is found throughout the section 301(h) regulations. Biological parameters of concern near the discharge should be compared to the range of natural variability found in comparable, but unpolluted, habitats. The section 301(h) applicant should compare biological conditions at reference (control) sites with conditions in areas of potential discharge impact within and beyond the ZID.

While biological criteria are not defined in the same straightforward, quantitative way as physical and chemical criteria, some extreme adverse impacts are defined specifically in the

301(h) regulations and are known endpoints in a spectrum of possible biological conditions that might result from the discharge of sewage effluent. For example, the 301(h) regulations state that conditions within the ZID must not contribute to extremely adverse biological impacts, including the following conditions:

- Destruction of distinctive habitats of limited distribution;
- Presence of disease epicenters;
- Stimulation of phytoplankton blooms that have adverse impacts beyond the ZID; and
- Conditions that result in mass mortalities of fish and invertebrates.

In addition, other biological effects on a particular marine community that result in substantial secondary effects on another community, or result in a potential for adverse effects on humans, would normally be considered adverse. For example, within and beyond the ZID, adverse impacts include, but are not limited to, the following:

- Damage to distinctive habitats of limited distribution;
- Creation of disease epicenters in commercially or recreationally important species;
- Contamination of fishery resources by pathogenic microorganisms or their indicators;
- Mass mortalities of fish or shellfish;
- Bioaccumulation of toxic substances in fish and shellfish at levels injurious to the marine organisms or humans; or
- Substantially decreased abundance of commercially or recreationally important species.

Applications that propose improvements to eliminate any of these adverse impacts may be considered. Because all of these impacts are considered extremely adverse, however, it would

be difficult to demonstrate that a balanced indigenous population will become reestablished following improvements to the treatment plant or outfall.

Many biological impact assessments that are necessary under 301(h) regulations require determinations of degrees of impact relative to unstressed conditions. These assessments rely largely on comparisons of biological conditions between reference areas and potentially impacted areas to determine the locations of changes along theoretically or empirically derived impact gradients. Quantitative comparisons between reference sites and potentially impacted areas may be made using various types of biological data [e.g., numbers of individuals per unit area, values of the Infaunal Trophic Index (Word 1978, 1980)] and various analytical tools (e.g., normal classification analysis), as discussed under Question III.D.1 above. However, no quantitative biological criteria have been established. Therefore, changes in, or differences between, biological communities require careful consideration of the types of responses that are manifested by the pollutant stress, as well as their spatial extent and magnitude.

Three approaches have been used in the 301(h) program to assess the degree of change in the biota (and associated receiving water). The first is to determine whether the observed change represents a reduction in the areal extent or health of a community or ecosystem. This approach has most often been used in cases where a change in major taxa that characterize the community greatly modifies the environment, thereby creating habitat for other, less desirable species. Primary examples include distinctive habitats of limited distribution, such as kelp communities, coral reefs, and seagrass beds. Because most of the taxa in these communities are highly dependent on the major taxa that characterize the community (and create habitat niches), the loss of those major taxa due to pollutant impacts results in destruction of the community. One assemblage of organisms is not replaced by another in which the species belong to the same, or similar, major taxonomic groups, and in which the new taxa are able to tolerate, and in many cases thrive in, the modified environment. In cases where a community or ecosystem is highly dependent on a limited number of major taxa to provide habitat for a wide variety of dependent species, any loss or decline in the health of those major taxa is an adverse impact.

In communities where pollutant impacts result in changes in species composition and abundance, but not in the destruction of the habitat, it is more difficult to assess changes. However, two approaches to the problem have been used in the past. The first is based on the assumption that a major change in the function (i.e., trophic relationships) of a community (e.g., benthic infauna, demersal fishes) affects, or has the potential to affect, all of the major elements of the ecosystem. The second approach is a corollary of the first. It assumes that a major change in the structure (i.e., species composition and abundance) of a community indicates that change in the function of that community has occurred, even if a change in function cannot be

demonstrated. A change in the structure of a community is usually much easier to document than is a change in the function of a community.

Benthic infauna are used in the following example to demonstrate how the functional and structural approaches may be implemented to demonstrate compliance with section 301(h) regulatory requirements. The generalized model developed by Pearson and Rosenberg (1978) for changes in benthic communities along a gradient of organic enrichment (Figure 3) has been used extensively in the 301(h) program and has been successfully applied to a variety of soft-bottom benthic communities in temperate and tropical latitudes. At low to moderate levels of organic enrichment (i.e., the "transition zone" in Figure 3), biomass increases moderately and numbers of species increase slightly. Total abundance does not increase significantly until the "ecotone point" is approached. In the "transition zone," there is simply an enhancement of the community that is typical of the biogeographic region, with the addition of a few new species. There are no major functional or structural changes. If there are no major impacts associated with other aspects of the benthic infauna (e.g., bioaccumulation of toxic substances), the impact to benthic infauna may or may not be evidence of the presence of a BIP.

At and beyond the "peak of opportunists" as shown in Figure 3, Pearson and Rosenberg (1978) document that the number of species and abundance of the benthic infauna change substantially. The fauna becomes dominated by a few opportunistic or pollution-tolerant species whose abundance increases dramatically in response to increased organic loading. Most of these species are surface or subsurface deposit feeders. Suspension feeders and surface detrital feeders typically decrease in abundance or are eliminated. Hence, the structure (i.e., species composition and abundance) and function (i.e., trophic relationships) of the benthic infauna are altered substantially.

In most cases, information is not available to demonstrate that major changes in the structure and function of a particular benthic community affect other biological communities (e.g., demersal fishes). However, many cases of prey specificity by demersal fishes and large epibenthic invertebrates that prey on benthic infauna have been recorded in the scientific literature. Hence, there is a sound scientific basis for assuming that major changes in the structure and function of benthic communities as a result of organic enrichment can induce changes in the species composition and abundance of predators on infauna, most of which are demersal fishes and large epibenthic invertebrates.

The concepts of spatial extent of the discharge-related biological and intercommunity effects are important in a BIP demonstration. Therefore, if differences between the ZID boundary communities and control communities are observed, the assessment of a BIP should include a characterization of the extent and possible interrelationship of effects beyond the ZID.

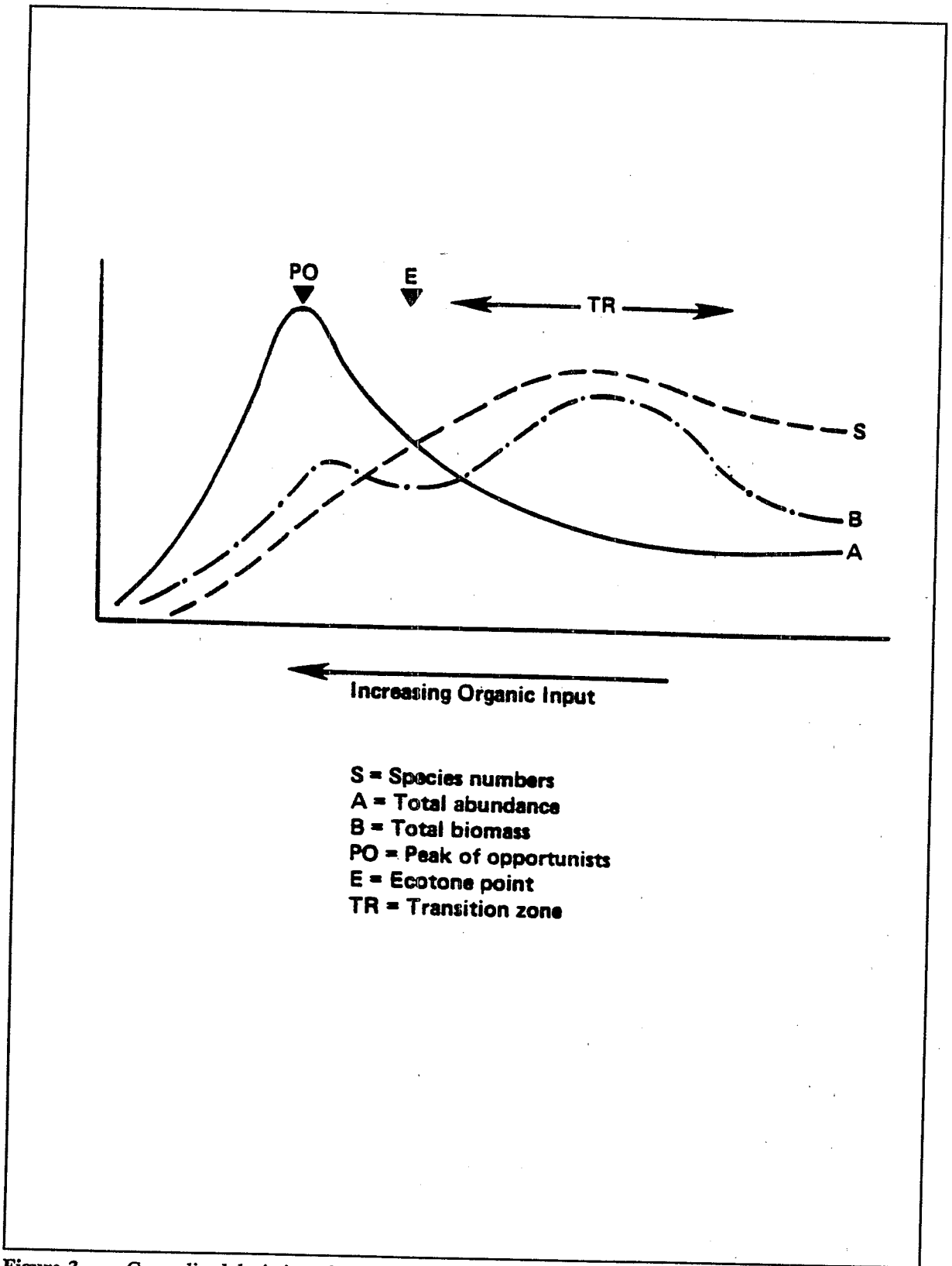

Figure 3. Generalized depiction of changes in species numbers, total abundances, and total biomass along a gradient of organic enrichment (Pearson and Rosenberg 1978).

Special emphasis should be placed on any predicted changes in the areal extent of discharge-related effects following discharge improvements or alterations. Further, in addition to assessing benthic communities and demersal fishes, the applicant should consider the need to assess other discharge-related effects on other biological communities. In assessing this need, the applicant should consider the nature of the discharge (e.g., flow, location, solids emission rates, and concentrations of discharged pollutants, including toxic substances) and characteristics of the receiving water body (e.g., circulation patterns, productivity, and trophic relationships). For example, if a discharge is located close to shore or there is significant onshore transport, the assessment of effects on intertidal or subtidal macroalgae may be another important component of the BIP demonstration. Similarly, if a discharge is located in an estuary or enclosed embayment where phytoplankton blooms may be stimulated by nutrient inputs, the assessment of plankton communities may be appropriate as part of the applicant's demonstration.

If an existing discharge may be causing an adverse impact to the biota or if the proposed discharge has the potential to cause an adverse impact to the biota or would result in non-compliance with section 301(h) criteria, then the applicant should perform a detailed biological demonstration to support approval of the application. The Region could require detailed biological demonstrations to be performed to validate the acceptability of proposed improvements. It is the applicant's responsibility to allow sufficient time to design and execute appropriate studies.

EVALUATIONS OF PREDICTED CONDITIONS AND PREDICTED CONTINUED COMPLIANCE

Under the original 301(h) regulations, POTWs were allowed to apply for first-time section 301(h) modified permits based on current, improved, or altered discharges. A "current discharge" is defined in §125.58(h) as the volume, composition, and location of an applicant's discharge at the time of permit application. An "improved discharge" may include planned improvements in the outfall, the level of treatment, discharge characteristics, operation and maintenance procedures, or controls on the introduction of pollutants into the treatment system [§125.58(i)]. An "altered discharge" is defined as any discharge other than a current discharge or an improved discharge as defined in §125.58(b).

For improved and altered discharges, applicants were required to predict conditions that would occur in the receiving water following implementation of the proposed improvements or alterations. Section 301(h) modified permits were issued upon a satisfactory demonstration that the predicted conditions were reasonable and would satisfy section 301(h) criteria and regulations. For dischargers whose original section 301(h) modified permit was issued based in part on

predictions of conditions that would occur after proposed improvements or alterations were implemented, prior to reissuance of a permit it is necessary to evaluate whether the predicted conditions have been realized. Because monitoring data collected during the term of the existing permit should be used in support of the application for permit reissuance, evaluations of the applicant's original predictions of compliance are not unlike other determinations of compliance.

As was the case for original section 301(h) applications, applications for reissuance of section 301(h) modified permits may propose improved levels of sewage treatment, either in response to comments by EPA or at the permittee's initiative. Applications for permit reissuance that are based on altered discharges are also allowed when downgrading of effluent quality is attributable entirely to population growth and/or industrial growth within the service area. Applicants that propose improved or altered discharges must also comply with the appropriate state's antidegradation requirements. Proposals for improved and altered discharges require that the permittee predict the physical, chemical, and biological conditions that will occur in the receiving water as a result of the proposed discharge. In such cases [as in the original section 301(h) applications], it will be necessary to evaluate whether the permittee's predictions are reasonable and whether the predicted conditions would satisfy section 301(h) criteria and regulations.

Applicants should consider the following when preparing applications with predictions based on improved or altered discharges:

- Appropriateness of the models used to generate the predictions (see discussion in Appendix A);
- Data quality;
- Execution of the analyses; and
- Interpretation of the analytical results.

It is essential that the applicant conduct each of these steps in the predictive process properly. Otherwise, the validity of the results and compliance with applicable regulations and criteria may be questionable.

To predict conditions that might occur as a result of a proposed discharge, applicants may compare attributes of the proposed discharge (e.g., volume and composition) and receiving water with conditions near other outfalls that discharge effluent of similar volume and composition and in similar receiving waters. The validity of such comparisons rests on the similarity of the

discharges and the similarity of the receiving waters. Substantial differences in the diffuser design, the volumes of the two discharges, or the mass emission rates of pollutants from the two discharges would render such comparisons questionable, especially for biological parameters. For physical and chemical parameters, it might be possible to compensate mathematically for such differences. However, biological responses to pollutants cannot be assumed to be linear. Therefore, the validity of predictions involving comparisons between substantially different discharges is very tenuous unless the response patterns of the biota within the biogeographic region are well known.

Similarity of the receiving waters is also critical to such comparisons. It is important that both discharges be located within the same biogeographic zone because responses to pollutants vary among species. Species in one biogeographic zone may respond somewhat differently to a given pollutant than do species in another biogeographic zone. For that reason, it may be possible to predict the general types of changes that might occur as a result of the proposed discharge, but it will not generally be possible to predict the areal extent or magnitude of such changes unless both discharges are in the same biogeographic zone. It is also important that the physical and chemical characteristics of both receiving waters be similar. For example, discharges into open coastal areas should not be compared with discharges into embayments. The more similar the two receiving waters are, the more reliable the applicant's predictions may be assumed to be.

Applicants may also use water quality models to predict impacts of the proposed discharge. Such models would be especially helpful for physical and chemical parameters (e.g., deposition of suspended solids in the receiving water, concentrations of toxic substances at the ZID boundary). The appropriateness of such models should be judged on their prior use in the 301(h) program, their acceptance or recommendation by EPA, and their acceptance by the scientific community. Models that have not been evaluated previously or that have not been received favorably should be avoided.

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APPENDIX A
PHYSICAL ASSESSMENT

PHYSICAL ASSESSMENT

The primary purpose of this appendix is to provide guidance on the calculation of initial dilution and trapping depth. For the purpose of section 301(h) evaluations, "dilution" is defined as the ratio of the total volume of a sample (ambient water plus wastewater) to the volume of wastewater in that sample. A dilution of 100 to 1, therefore, is a mixture composed of 99 parts of ambient water and 1 part of wastewater. The calculation of initial dilution and trapping depth consists of two sets of procedures:

- Calculate the port flow distribution along the outfall diffuser(s) for the total effluent flow rates of importance.

- Compute initial dilution and trapping depth based on a characterization of the computed port flow distribution, the physical characteristics of the outfall diffuser, and the receiving water density and current velocity profiles.

An important variable in both sets of procedures is the total effluent flow rate. Historical data should be used to determine the minimum, average, highest 2- to 3-hour average, and maximum flow rates for dry-weather, wet-weather, and annual average conditions. The adequacy of the diffuser's hydraulic design is dependent on the port flow distribution of the diffuser during minimum and maximum flow. Characteristics of a hydraulically well-designed diffuser are described by Grace (1978). According to Mullenhoff et al. (1985a) the critical (i.e., minimum) initial dilutions must be calculated on the basis of the highest 2- to 3-hour average flow rates. Average flow rates, together with average receiving water current speeds, are commonly used to compute the trapping depth used in effluent suspended solids accumulation predictions.

Port flow distribution along an outfall diffuser is commonly calculated using computer programs based on well-known hydraulic methods (Grace 1978, Fischer et al. 1979). This distribution depends on the total effluent flow rate, the effluent density, the density of seawater at the average diffuser port depth, and the physical specifications of the diffuser. The physical specifications include diffuser pipe diameter, depth, and port diameter and type (i.e., bell-mouth or sharp-edged) for each port in the diffuser. In the event that the risers are used instead of the ports, specifications sufficient to compute the discharge coefficient of the risers must be known. These specifications include the diameter, length, shape, type of transition between the riser pipe and the diffuser pipe, number of ports, and shape and diameter of the ports for each riser. Koh (1973) provides a useful method for computing riser discharge coefficients. (Note, however, that the summary of this method in Fischer et al. (1979) contains errors.) Head loss determinations

for contractions, expansions, and bends can be found in standard engineering and hydraulics texts (e.g., Brater and King 1976, Daugherty and Franzini 1977).

The port flow distribution should be computed for the minimum and maximum flows to ensure that the diffuser is hydraulically well-designed (Grace 1978). For any diffuser, there is a minimum flow below which the diffuser is inoperable. For flows lower than the minimum, not all of the ports flow fully and the port flows from the diffuser can behave erratically (Grace 1978). On a sloping bottom, the minimum operational flow usually increases with increasing bottom slope. Port flows along the diffuser may be very uneven on a sloping bottom, even for flows above the minimum operational flow. The hydraulic behavior of the diffuser should also be checked to investigate whether the port flows vary greatly at maximum flows.

Initial dilution computations are usually not performed for each port individually, but rather on groups of ports within which the port flows are relatively uniform. The initial dilution and trapping depth for each group of ports are then computed based on the average port flow and port depth within the group. The group initial dilutions and trapping depths can then be flow-rate-averaged as a group to obtain estimates of the average initial dilution and trapping depth for the diffuser for a specific total effluent flow rate and set of receiving water conditions. A common choice for a group is a diffuser pipe section, within which the diffuser pipe diameter and the diffuser port (riser) specifications are constant.

Initial dilution is the flux-averaged dilution achieved during the period when dilution is primarily a result of plume entrainment. It is averaged over the cross-sectional area of the plume and characterized by a time scale on the order of minutes. With proper location and design, marine outfalls can achieve initial dilution values of about 100 to 1 or better before the plume begins a transition from an essentially vertical flow to an essentially horizontal flow dominated by ambient oceanographic conditions.

Adequate initial dilution is necessary to ensure compliance with water quality standards. The following factors influence the degree of initial dilution that will be achieved:

- Discharge depth;
- Flow rates;
- Density of effluent;
- Density gradients in the receiving water;

- Ambient current speed and direction;
- Diffuser characteristics:
  - Port sizes,
  - Port spacing,
  - Port orientation, and
  - Port depth.

Because initial dilution calculations can be strongly dependent on the vertical gradient of ambient density, larger applicants should evaluate a substantial amount of data from both the discharge site and nearby areas that have similar environmental conditions before selecting a worst-case density profile (i.e., the profile producing the lowest initial dilution). Often the worst-case profiles are not the most stratified, but rather are those having sufficiently steep density gradients some distance [on the order of 5 m (16 ft)] above a diffuser port. These profiles can usually be identified only by computing initial dilutions for several or all of the available density profiles. Because ambient currents may affect the initial dilution achieved, a modest amount of current (the lowest 10 percentile) can be used when predicting initial dilution for use in determining compliance with applicable water quality standards and criteria.

Five numerical mathematical models to calculate initial dilution are available from EPA (Muellenhoff et al. 1985a, 1985b). Characteristics of these models are summarized below and in Table A-1:

- UPLUME - Analyzes a single, positively buoyant plume in an arbitrarily stratified stagnant environment.
- UOUTPLM - Analyzes a single, positively buoyant plume in an arbitrarily stratified flowing environment.
- UDKHDEN - Analyzes a multiport, positively buoyant plume in a linearly stratified flowing receiving water.

TABLE A-1. SUMMARY OF PLUME MODEL CHARACTERISTICS

Model Name	Current Speed	Current Direction Θ[a]	Port Type	Density Profile Type
UPLUME	No		Single	Arbitrary
UOUTPLM	Yes	90°	Single	Arbitrary
UDKHPLM	Yes	$45° < \Theta < 135°$	Multiple	Arbitrary
UMERGE	Yes	90°	Multiple	Arbitrary
ULINE	Yes	$0 \leq \Theta \leq 180°$	Line	Arbitrary

Source: From Table 1 of Muellenhoff et al. (1985a).
[a]A current flowing perpendicular to the diffuser axis has current direction $\Theta = 90°$. The widest range of possible angles is 0 to 180°.

- UMERGE - Analyzes either positively or negatively buoyant discharges. Analyzes a plume element through the history of its trajectory and dilution, accounting for the effects of adjacent plume interference in a receiving water with arbitrary vertical density and current variation.

- ULINE - Treats discharges as a line source accounting for adjacent plume interference. Can analyze positively buoyant discharges in an arbitrarily stratified receiving water with a current flowing parallel or perpendicular to the diffuser.

In situ observations may also be used to determine initial dilution. However, if *in situ* observations are used, the applicant should demonstrate that they represent the lowest dilutions in center sections of the effluent wastefield, not merely a typical dilution.

Other mathematical methods available in the published literature can be adapted for estimating initial dilution. The following references describe several of these methods: Abraham (1963, 1971); Baumgartner and Trent (1970); Baumgartner et al. (1971); Briggs (1969); Brocard (1985); Brooks (1973); Cederwall (1971); Davis (1975); Davis and Shirazi (1978); Fan (1967); Hinwood and Wallis (1985); Hirst (1971a, 1971b); Isaacson et al. (1983); Kannberg and Davis (1976); Koh and Fan (1970); Lee and Cheung (1986); Morton (1959); Morton et al. (1956); Priestley and Ball (1955); Roberts (1979); Roberts et al. (1989a, 1989b, 1989c); Rouse et al. (1952); Sotil (1971); Teeter and Baumgartner (1979); Wallace and Sheff (1987); Winiarski and Frick (1976); and Wright (1982). Only flux-averaged initial dilutions should be used in water

quality computations. Other types of initial dilutions, such as centerline and minimum surface, must be converted to flux-averaged. Many of the above investigations provide ways to estimate flux-averaged initial dilutions (see Fischer et al. 1979 for additional guidance).

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APPENDIX B
WATER QUALITY ASSESSMENT

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INTRODUCTION

This appendix provides detailed guidance for responding to water quality-related questions in the Applicant Questionnaire. Methods for predicting values of the following water quality variables are presented:

- Suspended solids deposition;
- Dissolved oxygen concentration following initial dilution;
- Farfield dissolved oxygen depression;
- Sediment oxygen demand;
- Suspended solids concentration following initial dilution;
- Effluent pH after initial dilution;
- Light transmittance; and
- Other water quality variables.

B-I. SUSPENDED SOLIDS DEPOSITION

The applicant must predict the seabed accumulation due to the discharge of suspended solids into the receiving water. Two prediction methods are described in this appendix. The first is a simplified approach for small dischargers only. If this method is applicable, then a small discharger need not perform dissolved oxygen calculations dependent on settled effluent suspended solids accumulations. The second prediction method is applicable for both small and large dischargers.

SMALL DISCHARGER APPROACH

Two types of problems (dissolved oxygen depletion and biological effects) and two types of receiving water environments (open coastal and semi-enclosed bays or estuaries) are considered in the following approach.

Figure B-1 is to be used for open coastal areas that are generally considered well-flushed. The dashed line represents combinations of solids mass emission rates and plume heights-of-rise that would result in a steady-state sediment accumulation of 50 g/m^2. Review of data from several open coast discharges has indicated that biological effects are minimal when accumulation rates are estimated to be below this level. Consequently, if the applicant's mass emission rate and height-of-rise fall below this dashed line, no further sediment accumulation analyses are needed. Applicants whose charge characteristics fall above the line should conduct a more detailed analysis of sediment accumulation, as discussed in the following section.

The solid line in Figure B-1 represents a combination of mass emission rates and plume heights-of-rise that were projected to result in sufficient sediment accumulation to cause a 0.2-mg/L oxygen depression. Applicants whose discharge falls below this solid line need not provide any further analysis of sediment accumulation as it relates to dissolved oxygen.

Figure B-2 should be used in a similar manner for discharges to semi-enclosed embayments or estuaries. Because estuaries and semi-enclosed embayments are potentially more sensitive than open coastal areas, the critical sediment accumulation was set at 25 g/m^2.

Methods described in U.S. EPA (1982a) were used to determine the mass emission rates and heights-of-rise resulting in the sediment accumulation rates specified above. To use these methods, several assumptions were made. A current velocity of 5 cm/sec was assumed for the open coastal sites, and a velocity of 2.5 cm/sec was assumed for the semi-enclosed embayments. These velocities are conservative estimates of average current velocities over a 1-year period.

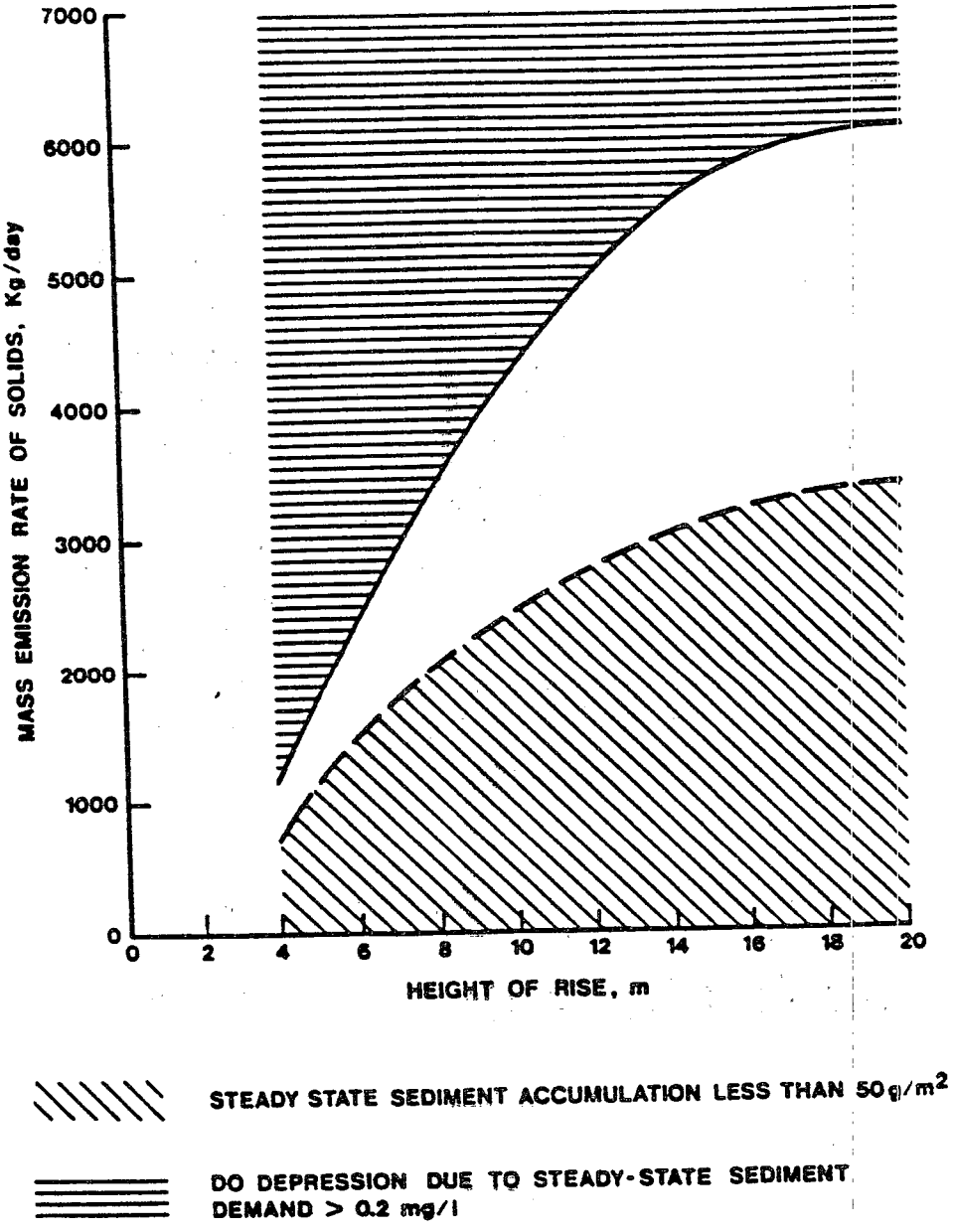
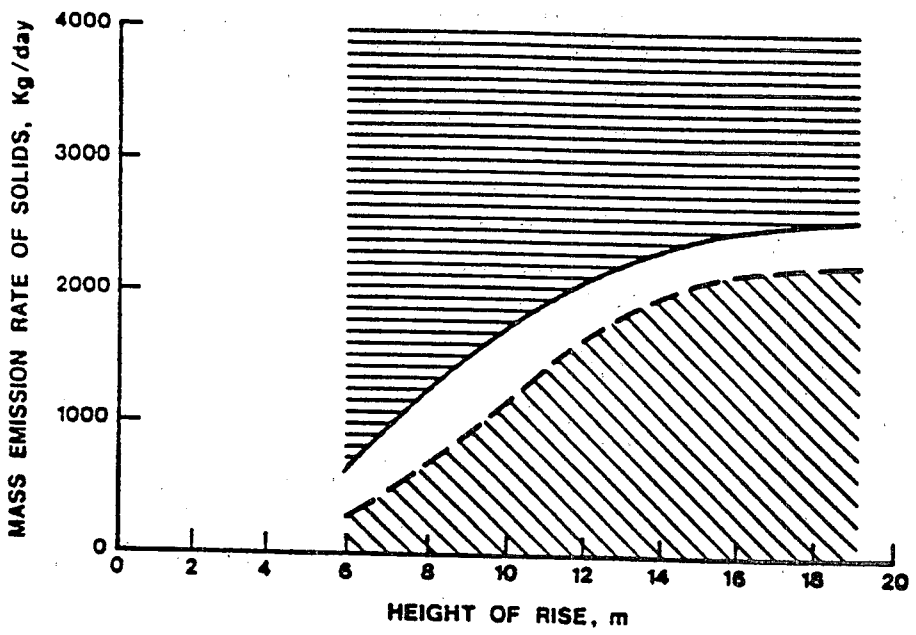


Figure B-1. Projected relationships between suspended solid mass emission, plume height-of-rise, sediment accumulation, and dissolved oxygen depression for open coastal areas (U.S. EPA 1982b).



STEADY STATE SEDIMENT ACCUMULATION LESS THAN 25g/m^2

DO DEPRESSION DUE TO STEADY-STATE SEDIMENT DEMAND > 0.2 mg/l

Figure B-2. Projected relationships between suspended solid mass emission, plume height-of-rise, sediment accumulation, and dissolved oxygen depression for semi-enclosed embayments and estuaries (U.S. EPA 1982b).

The settling velocity (V_s) distribution used is considered typical of primary or advanced primary effluents and is shown below:

5 percent have $V_s \geq 0.1$ cm/sec
20 percent have $V_s \leq 0.01$ cm/sec
30 percent have $V_s \geq 0.006$ cm/sec
50 percent have $V_s \geq 0.001$ cm/sec

The remaining solids settle so slowly that they are assumed to remain suspended in the water column indefinitely. The effluent is considered to be 80 percent organic and 20 percent inorganic. The above distribution is based on the review of data in section 301(h) applications and other published data (Myers 1974, Herring and Abati 1978).

The annual suspended solids mass emission rate should be calculated using the average flow rate and an average suspended solids concentration. The plume height-of-rise, determined previously in the initial dilution calculation, or 0.6 times the water depth, whichever is larger, should be used in the appropriate figure (Figure B-1 or B-2).

LARGE DISCHARGER APPROACH

The approach described here considers the processes of sediment deposition, decay of organic materials, and resuspension. However, the strictly quantitative prediction of seabed accumulation is based only on the processes of deposition and decay. Because resuspension is not evaluated easily using simplified approaches, the analyses described in this chapter consider resuspension separately and in a more qualitative manner that is based on measured near-bottom current speeds in the vicinity of the diffuser.

Data Requirements

To predict seabed deposition rates of suspended solids, the following information is required:

- Suspended solids mass emission rate;
- Current speed and direction;
- Height-of-rise of the plume; and

- Suspended solids settling velocity distribution.

The mass emission rate, M (kg/day), is:

$$M = 86.4(S) \qquad \text{B-1}$$

where:

S = Suspended solids concentration, mg/L
Q = Volumetric flow rate, m^3/sec.

It is suggested that the applicant develop estimates of the suspended solids mass emission rate for the season (90-day period) critical for seabed deposition and for a yearly period. If the applicant anticipates that the mass emission rate will increase during the permit term, the mass emission rate at the end of the permit term should be used.

Current-speed data are needed to determine the distance from the outfall that the sediments will travel before accumulating on the bottom. Consequently, depth-averaged values are best, if available. Otherwise, current speeds near mid-depth may be sufficient. The following current data are needed for the assessment:

- Average value upcoast, when the current is upcoast;
- Average value downcoast, when the current is downcoast;
- Average value onshore, when the current is onshore; and
- Average value offshore, when the current is offshore.

If no current data are available, values of 5 cm/sec for longshore transport and 3 cm/sec for onshore-offshore transport have been found to be reasonable.

Plume-trapping levels representative of both the critical 90-day period and the annual cycle are needed. The applicant should use density profiles, effluent volumetric flow rates, and ambient currents characteristic of these time periods. Extreme values should not be used. Usually the annual average and critical 90-day average flow rates and current speeds (in the predominant current direction) should be used. The expected average plume heights-of-rise above

the seafloor should be determined using available receiving water density profiles. If large numbers of profiles exist for each month (or oceanographic season), then the applicant can compute the plume height-of-rise above the seafloor for each of the available profiles and then average the heights. If relatively few profiles are available for each month, then the applicant can compute the plume height of rise for each profile and substitute the lowest height-of-rise as the average. The monthly average heights-of-rise can then be used to compute the average height-of-rise for annual and critical 90-day periods. If so few profiles exist that it is not possible to determine whether differences exist between months (or oceanographic seasons), then the applicant should substitute the lowest plume height-of-rise (based on calculations using the average effluent flow and current speed) as the average height-of-rise for both the annual and critical 90-day periods.

If the applicant has not determined a suspended solids settling velocity distribution, the following can be used based on [data from other section 301(h) applications]:

Primary or Advanced Primary Effluent	Raw Sewage
5 percent have $V_s \geq 0.1$ cm/sec	5 percent have $V_s \geq 1.0$ cm/sec
20 percent have $V_s \geq 0.01$ cm/sec	20 percent have $V_s \geq 0.5$ cm/sec
30 percent have $V_s \geq 0.006$ cm/sec	40 percent have $V_s \geq 0.1$ cm/sec
50 percent have $V_s \geq 0.001$ cm/sec	60 percent have $V_s \geq 0.01$ cm/sec
	85 percent have $V_s \geq 0.001$ cm/sec.

The remaining solids settle so slowly that they are assumed to remain suspended in the water column indefinitely (i.e., they act as colloids). Consequently, 50 percent of the suspended solids in a treated effluent and 85 percent of those in a raw sewage discharge are assumed to be settleable in the ambient environment.

Prediction of Deposition

Although a portion of the settled solids is inert, the organic fraction of the settled solids is a primary concern. For purposes of this evaluation, composition of the waste discharge can be assumed to be as follows:

- 80 percent organic and 20 percent inorganic for primary or advanced primary effluent or
- 50 percent organic and 50 percent inorganic for raw sewage.

Accumulation of solids should be predicted for the critical 90-day period when seabed deposition is likely to be highest and for steady-state conditions where average annual values are used. The results should be presented in graphical form, as shown in Figure B-3. Supporting tables should be submitted with the application. The applicant must exercise judgment when developing the contours, especially when accounting for rapid depth changes offshore. Sediment contours should be expressed in units of g/m^2, not as an accumulation depth.

An applicant may use a proprietary or publicly available sedimentation model. Two widely known models are that of Hendricks (1987), which has been used extensively offshore of Palos Verdes Peninsula in the Southern California Bight, and that of Farley (U.S. EPA 1987), which describes the Ocean Data Evaluation System (ODES) model DECAL. The model DECAL is publicly available through EPA. A simple model is described herein. It can be used to obtain estimates of sediment accumulation in a variety of environments. If its use predicts sediment accumulations that lead to violations of state standards or federal criteria for receiving water quality, an applicant may opt to try a more sophisticated effluent sediment accumulation model that better simulates the marine environment.

The method described below assumes that effluent sediment particles having a specific particle fall velocity settle uniformly within an elliptical area. This area depends on the plume height-of-rise relative to the seafloor (not the port depth), the particle fall velocity, and the average current speeds in four directions (upcoast, downcoast, onshore, and offshore) appropriate for an effluent wastefield at the plume height-of-rise. For the following sample calculations, the diffuser was assumed to have a single point of discharge. Use of this assumption may not produce reasonable estimates of sediment accumulation if the diffuser is long. If the diffuser is long, then estimates of the sediment accumulation from each diffuser port can be summed to obtain an estimate for the entire diffuser. This sum is approximately the same as that obtained from assuming that the sediment accumulation area is a ZID-like area (with ends the same as the similar elliptical halves computed for a single point discharge) and that the effluent suspended solids having the specific particle fall velocity uniformly settle in this area. The sediment accumulation due to the entire discharge is the sum of the accumulations for each particle fall velocity modeled.

To begin computations for a discharge at a single point of discharge, the applicant can create a table similar to Table B-1, showing the amount of organic solids that settle within each settling velocity group and the maximum distance from the outfall at which each group settles. If the applicant has current data for more than four quadrants, those data can be used. The maximum settling distances for each group in each direction are calculated using the formula shown in the footnote of Table B-1.

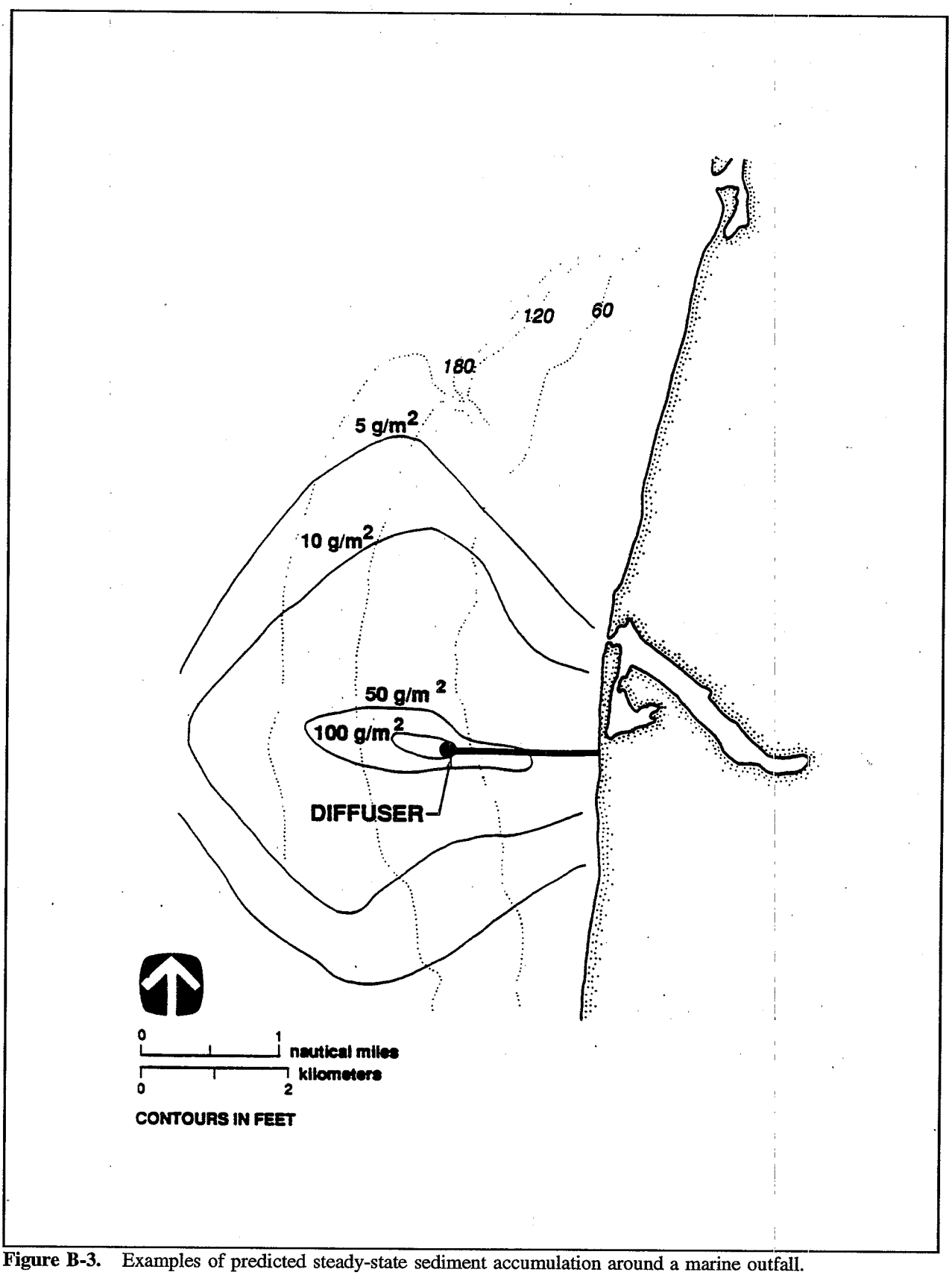


Figure B-3. Examples of predicted steady-state sediment accumulation around a marine outfall.

TABLE B-1. EXAMPLE TABULATIONS OF SETTLEABLE ORGANIC COMPONENTS BY GROUP AND MAXIMUM SETTLING DISTANCE BY GROUP

Mass Emission Rate = M_T

Organic Component = M_O = { 0.8 M_T for primary effluent; 0.5 M_T for raw effluent

Percent by Settling Velocity Group	Organic Component by Group	Maximum Settling Distance from Outfall[a]			
		Upcoast	Downcoast	Onshore	Offshore
Primary Effluent					
5 (V_s = 0.1 cm/sec)	0.04 M_T	D_1	D_2	D_3	D_4
15 (V_s = 0.01 cm/sec)	0.12 M_T	D_5	D_6	D_7	D_8
10 (V_s = 0.006 cm/sec)	0.08 M_T	D_9	D_{10}	D_{11}	D_{12}
20 (V_s = 0.001 cm/sec)	0.16 M_T	D_{13}	D_{14}	D_{15}	D_{16}
	Sum = 0.40 M_T				
Raw Sewage					
10 (V_s = 1.0 cm/sec)	0.05 M_T	R_1	R_2	R_3	R_4
10 (V_s = 0.5 cm/sec)	0.05 M_T	R_5	R_6	R_7	R_8
20 (V_s = 0.1 cm/sec)	0.10 M_T	R_9	R_{10}	R_{11}	R_{12}
20 (V_s = 0.01 cm/sec)	0.10 M_T	R_{13}	R_{14}	R_{15}	R_{16}
25 (V_s = 0.001 cm/sec)	0.125 M_T	R_{17}	R_{18}	R_{19}	R_{20}
	Sum = 0.425 M_T				

[a] The distance D (or R) is calculated as: ***D (or R)*** =

where:

V_a = Ambient velocity = 5 cm/sec upcoast and downcoast (default) and 3 cm/sec onshore and offshore (default)

H_T = Average trapping level of plume, measured above bottom

V_s = Appropriate settling velocity by group for primary or raw discharges

If the bottom slope is 5 percent or greater, D (or R) should be calculated as follows:

$$D = \frac{H_T}{S + \frac{V_s}{V_a}}$$

where:

S = Slope, m/m, positive if onshore, negative if offshore.

With a sufficiently detailed map (e.g., a NOAA bathymetric chart), each point D_1 through D_{16}, or R_1 through R_{20}, can be plotted with the center of the diffuser as the reference point. Depositional contours are formed by the four points that define the perimeter of a depositional field (e.g., D_1, D_2, D_3, and D_4). The applicant should join these points by smooth lines so that the contours are elliptically shaped. If the applicant has current data at 60° or 30° intervals, instead of the 90° intervals used here, then the contours can be created more accurately.

The deposition rates corresponding to each contour are determined as follows. First, the deposition rate within each contour due to each individual settling velocity group is predicted, as shown in Table B-2. This quantity is M_i/A_i, or the group deposition rate divided by the area within the contour. The area within any contour is a function of the four points (e.g., D_1, D_2, D_3, and D_4) and is denoted in the table by $f(D_1D_2D_3D_4)$. A planimeter is probably the most accurate method of finding the area. Once the deposition rates by group have been found, the total deposition rate can be calculated by summing all contributing deposition rates. For example, the innermost contour receives contributions from all groups, while the outermost contour receives a contribution from only one group.

So far, only the rates of organic deposition (in units of $g/m^2/yr$) have been predicted. The accumulation of the organic material (S_i) can be predicted by including decay as follows:

$$S_i\ (g/m^2) = \frac{f_i}{k_d},\ at\ steady\ state \qquad \text{B-2}$$

$$S_i\ (g/m^2) = \frac{f_i}{k_d}\left[1 - \exp\left(-90\ k_d\right)\right],\ for\ 90\ days$$

The f_i are the deposition rates in units of $g/m^2/day$, as contrasted to the units of $g/m^2/yr$ in Table B-2. The decay rate constant, k_d, has a typical value of 0.01/day. For example, if the organic deposition rate for annual conditions is 100 $g/m^2/yr$, the steady-state accumulation is:

$$100\ g/m^2/yr \times \frac{1\ yr}{365\ days} \times \frac{1}{0.01/day} = 27\ g/m^2 \qquad \text{B-3}$$

If the organic deposition rate for the critical 90-day period is 300 $g/m^2/yr$, the 90-day accumulation is:

TABLE B-2. EXAMPLE TABULATIONS OF DEPOSITION RATES AND ACCUMULATION RATES BY CONTOUR

Organic Mass Component by Group	Bottom Area	Mass Deposition Rate, by Group	Total Organic Deposition Rate Within Area ($g/m^2/yr$)	Accumulation (g/m^2)	
				Steady-State	90-Day
Primary Effluent					
$0.04\ M_T = M_1$	$A_1 = f(D_1D_2D_3D_4)$	N_1/A_1	$N_1/A_1+N_2/A_2+N_3/A_3+N_4/A_4 = f_1$	$\frac{f_i}{k_d}$	$\frac{f_i}{k_d}[1 - \exp(-90k_d)]$
$0.12\ M_T = M_2$	$A_2 = f(D_5D_6D_7D_8)$	N_2/A_2	$N_2/A_2+N_3/A_3+N_4/A_4 = f_2$		
$0.08\ M_T = M_3$	$A_3 = f(D_9D_{10}D_{11}D_{12})$	N_3/A_3	$N_3/A_3+N_4/A_4 = f_3$		
$0.16\ M_T = M_4$	$A_4 = f(D_{13}D_{14}D_{15}D_{16})$	N_4/A_4	$N_4/A_4 = f_4$		
Raw Sewage					
$0.05\ M_T = M_1$	$A_1 = f(R_1R_2R_3R_4)$	N_1/A_1	$N_1/A_1+N_2/A_2+N_3/A_3+N_4/A_4+N_5/A_5 = f_1$	$\frac{f_i}{k_d}$	$\frac{f_i}{k_d}[1 - \exp(-90k_d)]$
$0.05\ M_T = M_2$	$A_2 = f(R_5R_6R_7R_8)$	N_2/A_2	$N_2/A_2+N_3/A_3+N_4/A_4+N_5/A_5 = f_2$		
$0.10\ M_T = M_3$	$A_3 = f(R_9R_{10}R_{11}R_{12})$	N_3/A_3	$N_3/A_3+N_4/A_4+N_5/A_5 = f_3$		
$0.10\ M_T = M_4$	$A_4 = f(R_{13}R_{14}R_{15}R_{16})$	N_4/A_4	$N_4/A_4+N_5/A_5 = f_4$		
$0.125\ M_T = M_5$	$A_5 = f(R_{17}R_{18}R_{19}R_{20})$	N_5/A_5	$N_5/A_5 = f_5$		

Note: Units of f_i are $g/m^2/day$.

$$300\ g/m^2/yr \times \frac{1\ yr}{365\ days} \times \frac{1}{0.01/day} \times [1 - \exp(-90 \times 0.01)] = 49\ g/m^2 \qquad \text{B-4}$$

This example shows that input data for the 90-day and steady-state accumulations are different. Consequently, Tables B-1 and B-2 should each be completed twice. Also, the accumulation over a critical 90-day period can exceed the steady-state accumulation. This is caused by short-term deposition rates that are considerably higher than the long-term average. In the example, the maximum 90-day deposition rate of 300 g/m^2/yr would eventually decrease to values below 100 g/m^2/yr so that on a yearly basis the deposition rate is 100 g/m^2/yr.

B-II. DISSOLVED OXYGEN CONCENTRATION FOLLOWING INITIAL DILUTION

When wastewater is discharged through a single port or a diffuser, the effluent forms a buoyant plume that entrains ambient water as it rises. Because the initial dilution process occurs rapidly (i.e., on the order of minutes), BOD exertion (a relatively slow process) is negligible during this period. However, an immediate dissolved oxygen demand (IDOD), which represents the oxygen demand of reduced substances that are rapidly oxidized (e.g., sulfides to sulfates), might not be negligible. The dissolved oxygen concentration following initial dilution can be predicted using the following expression:

$$DO_f = DO_a + \frac{DO_e - IDOD - DO_a}{S_a} \qquad \text{B-5}$$

where:

DO_f = Final dissolved oxygen concentration of receiving water at the plume trapping level, mg/L

DO_a = Affected ambient dissolved oxygen concentration immediately upcurrent of the diffuser averaged over the tidal period (12.5 hours) and from the diffuser port depth to the trapping level, mg/L

DO_e = Dissolved oxygen of effluent, mg/L

IDOD = Immediate dissolved oxygen demand, mg/L

S_a = Initial dilution (flux-averaged).

The applicant should use the least favorable combination of values for effluent dissolved oxygen, IDOD, affected ambient dissolved oxygen, and initial dilution. The effluent dissolved oxygen concentration at the point of discharge from the treatment plant is often 0.0 mg/L. Because the critical case is desired, a concentration of 0.0 mg/L is a reasonable value. However, if data show that dissolved oxygen concentrations in the effluent are greater than 0.0 mg/L during the critical periods, then these data may be used.

The IDOD values typically vary from 0 to 10 mg/L, but can be higher depending on the level of treatment and presence of industrial flows. Table B-3 can be used to select reasonable IDOD values. Alternatively, the IDOD can be measured as discussed below. The influence of the effluent IDOD on ambient dissolved oxygen can be estimated from the following table (calculated as $-IDOD/S_a$):

TABLE B-3. TYPICAL IDOD VALUES

Treatment Level	Effluent BOD_5 (mg/L)	Travel Time (min)[a]	IDOD (mg/L)
Untreated or less than primary		<60	5
		60-200	10
		200-300	15
		>300	20
Primary	50-100	0-100	2
	50-100	100-300	3
	50-100	>300	4
	100-150	0-100	3
	100-150	100-300	4
	100-150	>300	5
	150-200	0-100	5
	150-200	100-300	7
	150-200	>300	8
Advanced primary	<50	0-60	0
	<50	>60	1

[a]Travel time should include the total travel time from the treatment plant through the diffuser, including any land portion of the outfall.
Note: Information compiled from 301(h) applications.

	Initial Dilution			
IDOD (mg/L)	10	30	50	100
1	-0.1	-0.03	-0.02	-0.01
2	-0.2	-0.07	-0.04	-0.02
5	-0.5	-0.17	-0.1	-0.05
10	-1.0	-0.33	-0.2	-0.10
20	-2.0	-0.67	-0.4	-0.20

At high initial dilutions, the IDOD contribution is small. Thus, the expense of laboratory tests may be unwarranted. If IDOD is to be determined experimentally, the procedures in *Standard Methods* (American Public Health Association et al, 1985, p. 530) should be generally followed except that the dilution water should be seawater from the discharge site instead of distilled water and the effluent sample should be incubated anaerobically for a length of time equal to the travel times from the plant through the diffuser for minimum, average, and maximum flow conditions. The effluent sample should be mixed with the dilution water after incubation. The dissolved

oxygen concentration of the effluent and dilution water should be measured separately after incubation and before mixing the samples. The dissolved oxygen of the mixture should be measured 15 minutes after preparation.

The IDOD is calculated using the following equation:

$$IDOD = \frac{(DO_D)(P_D) + (S)(P_S) - DO_M}{P_S} \qquad \text{B-6}$$

where:

IDOD	=	Immediate dissolved oxygen demand, mg/L
DO_D	=	Dissolved oxygen of dilution water (seawater), mg/L
P_D	=	Decimal fraction of dilution water used
S	=	Dissolved oxygen of effluent after incubation, mg/L
P_S	=	Decimal fraction of effluent used
DO_M	=	Dissolved oxygen of mixture after 15 minutes, mg/L.

Several dilutions should be used, preferably close to the actual initial dilution, unless the difference between the initial and mixed concentrations is less than 0.1 mg/L. All data used in the above calculations, the incubation times, and the computed results for each test should be included in the application.

The lowest initial dilution (flux-averaged) should be used for the final dissolved oxygen calculation. Usually, this dilution will correspond to the maximum flow rate at the end of the permit term. Low initial dilutions can also occur at smaller effluent flow rates if stratification is sufficiently severe. Typically, dilutions during periods of maximum stratification should be used for the final dissolved oxygen calculation.

The affected ambient dissolved oxygen concentrations should also represent critical conditions. Usually, critical conditions will occur during the maximum stratification period in the late summer or in the spring when upwelling of deep ocean water occurs. For existing discharges, the affected ambient data should be collected at locations directly upcurrent of the diffuser, thereby incorporating the potential effects of recirculation. For proposed new or relocated discharges, affected ambient dissolved oxygen levels upcurrent of the diffuser should be estimated from mathematical models of the discharge or by extrapolation from similar situations. Dissolved oxygen data, as well as any ambient water quality constituent, may be

averaged between the depth of the discharge ports and the plume trapping level, which corresponds to the lowest initial dilution that was used to predict the final dissolved oxygen concentrations. If applicants use a mathematical model that allows multiple vertical levels of input for ambient water quality instead of an average value, this should be noted.

The time period over which ambient data may be averaged may depend on specifications of intensity and duration factors in applicable water quality standards. For example, if certain numerical values should not be compromised over a period of 4 hours, a 4-hour average of input data may be reasonable. Absent any more stringent specification in locally applicable standards, an average over a half tidal cycle (approximately 12.5 hours) would provide a generally conservative estimate.

The affected ambient dissolved oxygen concentration can change substantially as a function of depth, depending on environmental characteristics and seasonal influences (e.g., upwelling). As the plume rises during initial dilution, water from deeper parts of the water column is entrained into the plume and advected to the plume trapping level. If the dissolved oxygen concentration is lower in the bottom of the water column than at the trapping level, the low-dissolved-oxygen water is advected to a region formerly occupied by water containing higher concentrations of dissolved oxygen. The result is an oxygen depression caused by entrainment.

This oxygen depression caused by the waste discharge and associated entrainment (ΔDO_1) should be computed as the difference between DO_f as defined in Equation B-5 and the affected ambient dissolved oxygen concentration at the trapping depth (DO_t).

$$\Delta DO_1 = DO_f - DO_t = DO_a - DO_t + \frac{(DO_e - IDOD - DO_a)}{S_a} \qquad \text{B-7}$$

The oxygen depression of the wastefield relative to the trapping depth, expressed in percent, is $(-\Delta DO_1/DO_t)100$.

For cases in which the effect of entraining low-dissolved-oxygen water can be neglected, the oxygen depletion (ΔDO_2) should be computed as the difference between the average affected ambient dissolved oxygen concentration (DO_a) in the entrained water and DO_f, as shown below.

$$\Delta DO_2 = DO_f - DO_a = \frac{(DO_e - IDOD - Do_a)}{S_a} \qquad \text{B-8}$$

The oxygen depletion of the wastefield relative to the average affected ambient dissolved oxygen concentration is $(-\Delta DO_2/DO_a)100$.

The equation of Baumgartner (1981) for the percentage depression is:

$$\frac{(DO_t - DO_e + IDOD)}{DO_t \times S_a} \times 100 \qquad \text{B-9}$$

This equation can be derived by assuming that $DO_a = DO_t$ in Equation B-7. Use of Equation B-9 has been allowed in the State of California.

These differences can be described as a percentage of the ambient concentration or as a numerical difference, depending on the requirements of the state. In some states, the final dissolved oxygen concentration must be above a specified limit or must be converted to percent saturation to determine whether the final concentration is above a prescribed limit. Dissolved oxygen saturation can be determined as a function of temperature and salinity using the method of Green and Carritt (1967) and Hyer et al. (1971), as tabulated in Table B-4. The applicant may want to consult with the state water quality agency to determine whether any other methods are used to determine compliance with the dissolved oxygen standards.

TABLE B-4. DISSOLVED OXYGEN SATURATION VALUES

Temperature (°C)	Dissolved Oxygen Saturation (mg/L) Salinity (ppt)								
	20	22	24	26	28	30	32	34	36
0	12.8	12.6	12.5	12.3	12.1	12.0	11.8	11.7	11.5
1	12.5	12.3	12.2	12.0	11.8	11.7	11.5	11.4	11.2
2	12.1	12.0	11.9	11.7	11.5	11.4	11.2	11.1	10.9
3	11.8	11.7	11.5	11.4	11.2	11.1	10.9	10.8	10.7
4	11.5	11.4	11.3	11.1	11.0	10.8	10.7	10.5	10.4
5	11.3	11.1	11.0	10.8	10.7	10.6	10.4	10.3	10.1
6	11.0	10.9	10.7	10.6	10.4	10.3	10.2	10.0	9.9
7	10.7	10.6	10.5	10.4	10.2	10.1	9.9	9.8	9.7
8	10.5	10.3	10.2	10.1	9.9	9.8	9.7	9.6	9.4
9	10.2	10.1	10.0	9.8	9.7	9.6	9.5	9.3	9.2
10	10.0	9.9	9.7	9.6	9.5	9.4	9.2	9.1	9.0
11	9.6	9.6	9.5	9.4	9.3	9.2	9.0	8.9	8.8
12	9.5	9.4	9.3	9.2	9.1	9.0	8.8	8.7	8.6
13	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.5	8.4
14	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3
15	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1
16	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	8.0
17	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8
18	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.6
19	8.2	8.1	8.0	8.0	7.9	7.8	7.6	7.6	7.5
20	8.1	8.0	7.9	7.7	7.7	7.6	7.6	7.5	7.4
21	7.9	7.9	7.7	7.7	7.6	7.5	7.5	7.4	7.3
22	7.8	7.7	7.6	7.6	7.5	7.4	7.4	7.3	7.2
23	7.7	7.6	7.5	7.5	7.4	7.3	7.3	7.2	7.1
24	7.6	7.5	7.4	7.4	7.3	7.2	7.2	7.1	7.1
25	7.5	7.4	7.3	7.3	7.2	7.1	7.1	7.0	7.0
26	7.4	7.3	7.2	7.2	7.1	7.1	7.0	7.0	7.0
27	7.2	7.2	7.2	7.1	7.0	7.0	6.9	6.9	6.9
28	7.2	7.1	7.1	7.0	7.0	6.9	6.9	6.9	6.8
29	7.1	7.1	7.0	7.0	6.9	6.9	6.8	6.8	6.8
30	7.1	7.1	7.0	6.9	6.9	6.8	6.8	6.8	6.7

B-III. FARFIELD DISSOLVED OXYGEN DEPRESSION

Subsequent to initial dilution, dissolved oxygen in the water column is consumed by the BOD in the wastefield. The effluent BOD_5 after initial dilution is needed to estimate farfield dissolved oxygen depletion. The final BOD_5 concentration can be estimated using the following expression:

$$BOD_f = BOD_a + \frac{(BOD_e - BOD_a)}{S_a} \qquad \text{B-10}$$

where:

BOD_f = Final BOD_5 concentration, mg/L

BOD_a = Affected ambient BOD_5 concentration immediately updrift of the diffuser averaged over one-half the tidal period (12.5 hours) and from the diffuser port depth to the trapping depth, mg/L

BOD_e = Effluent BOD_5 concentration, mg/L

S_a = Initial dilution (flux-averaged).

This equation provides an estimate of the total BOD_5 concentration in the receiving water. The maximum contribution due to the effluent alone can be determined by dividing the effluent BOD_5 concentration by the initial dilution. This value is used later to estimate farfield effects of the effluent. As a critical case, the maximum monthly average effluent BOD_5 concentration should be used with the monthly critical initial dilution. For existing plants, the previous 12 months of effluent BOD_5 data are used to support the selection of a BOD_5 concentration. For proposed or modified treatment plants where effluent data are not available, monthly average influent BOD_5 data should be provided along with the range of daily values. The average removal efficiency for the new or modified plant is also needed to compute estimated effluent BOD_5 concentrations.

Three approaches to assessing farfield dissolved oxygen demand are described below:

- Simplified mathematical models that predict dissolved oxygen depletion using calculation techniques that do not require computer support;
- Numerical models that predict dissolved oxygen depletion using a computer; and

- Evaluation of field data, using a data-intensive approach in which dissolved oxygen concentrations are measured in the water column and compared to ambient concentrations.

Before undertaking any analysis to determine whether farfield BOD exertion causes a violation of the dissolved oxygen standard, the applicant should first determine for critical conditions whether:

$$DO_{STD} \leq DO_f - BOD_{fu} \qquad \text{B-11}$$

where:

DO_{STD} = Dissolved oxygen standard
DO_f = Dissolved oxygen concentration at the completion of initial dilution
BOD_{fu} = Ultimate BOD at the completion of initial dilution (= BOD_f x 1.46).

If the above inequality is true, then the discharge will not violate the dissolved oxygen standard due to BOD exertion and no further analysis of farfield BOD exertion is required. If the inequality is not true, then further analysis is required.

SIMPLIFIED MATHEMATICAL MODELS

Oxygen depletion due to coastal or estuarine wastewater discharges is primarily caused by exertion of BOD, although increased nutrient levels can affect oxygen concentrations indirectly by altering algal photosynthesis and respiration rates. BOD consists of a carbonaceous component (CBOD) and nitrogenous component (NBOD). Both components can contribute to oxygen depletion.

The first phase of the BOD reaction involves the oxidation of the carbonaceous organic material. The nitrogenous stage includes conversion of organic nitrogen to ammonia and the subsequent oxidation of ammonia to nitrite and then to nitrate. By U.S. convention, BOD measurements are typically conducted for 5 days. In addition, many of the tests are run with a nitrification inhibitor so that the test measures the oxidation of carbonaceous material only. When total BOD is measured after 5 days (an inhibitor is not used), these tests are designated as BOD_5. When the 5-day test employs a nitrification inhibitor, the results are designated as $CBOD_5$ (U.S. EPA 1992). Long-term tests are also employed to measure ultimate BOD (BOD_L) to reflect the potential strength of the oxygen consumption.

The effluent $CBOD_L$-to-$CBOD_5$ ratio is required in dissolved oxygen modeling analyses to estimate POTW $CBOD_L$ from effluent $CBOD_5$ data. For in-stream CBOD arising from a wastewater inflow, the degree of treatment of the wastewater is important. Thomann and Mueller (1987) summarize the $CBOD_L$-to-$CBOD_5$ ratios for municipal wastes as 1.2 for no treatment, 1.6 for primary/secondary, 3.2 for activated sludge, and 2.84 for advanced primary (U.S. EPA 1992). Some computer models (e.g., QUAL-II, QUAL2EU) specify this ratio as 1.46. The ratios are a function of the deoxygenation rate coefficients and are wasteload- and receiving-water-specific. In general, the higher the degree of treatment, the greater the degree of waste stabilization and the lower the deoxygenation rate. The range of values reported as in-stream deoxygenation rates or simply decay rates is wide, spanning more than two orders of magnitude (U.S. EPA 1985).

Before using $CBOD_5$ to predict oxygen depletion, the applicant should convert it to $CBOD_L$, the ultimate CBOD, by the following relationship:

$$CBOD_L = 1.46\ CBOD_5 \qquad \text{B-12a}$$

where the $CBOD_L$-to-$CBOD_5$ ratio of 1.46 is calculated using a 0.23 day^{-1} decay rate at 20 °C (U.S. EPA 1985) by the equation (Sawyer et al. 1978):

$$\frac{CBOD_5}{CBOD_L} = 1 - e^{-k_c t} \qquad \text{B-12b}$$

where:

k_c = the CBOD decay rate coefficient at T (°C)
t = Travel time corresponding to BOD_5 (5 days).

A number of factors, including temperature, are known to influence the rate at which CBOD is removed from the water column. The influence of these factors has been described by both theoretical and empirical formulations. Like all biochemical processes, CBOD decay occurs at a rate that increases with increasing temperature. Therefore, a temperature correction should be made to account for the temperature dependence of the rate constant as follows:

$$k_c = 0.23 \times \Theta^{(T\ -20°C)} \qquad \text{B-13}$$

where:

k_c = CBOD decay rate at temperature T (°C)
0.23 = CBOD decay rate coefficient at 20 °C
Θ = Temperature correction factor.

Once the temperature-corrected decay rate, k_c, is calculated, the new $CBOD_L$-to-$CBOD_5$ ratio can be calculated using Equation B-12b. Studies indicate that the value of 1.047 for Θ is valid between 20 °C and 30 °C, but higher values are appropriate at lower temperatures (U.S. EPA 1985).

Data on the $CBOD_L$-to-$CBOD_5$ ratio can vary considerably, not only between different treatment levels but also between different sites with the same treatment levels. The consequence of using a ratio that has not been developed from field data could be to underestimate the effect of the wastewater on receiving water oxygen concentrations. Because of the importance of this parameter and the observed variability in the ratio from site to site, it is recommended that site-specific ratios be developed on a case-by-case basis (U.S. EPA 1984). In lieu of using average values for CBOD decay rates, the applicant can determine actual values by collecting data on effluent "bottle rates" using guidance found in *Rates, Constants, and Kinetics Formulations on Surface Water Quality Modeling* (U.S. EPA 1985).

The second phase of the BOD reaction involves the oxidation of the nitrogenous compounds in the waste or water body. The transformation of reduced forms of nitrogen to more oxidized forms (nitrification) consumes oxygen. Nitrification is a two-stage process facilitated by nitrifying bacteria. The first stage is the oxidation of ammonia to nitrite principally by *nitrosomonas* bacteria; the second stage is the oxidation of nitrite to nitrate principally by *nitrobacter* bacteria. NBOD might not always contribute to oxygen depletion. If the applicant discharges into open coastal waters where there are no other major discharges in the vicinity, the background population of nitrifying bacteria might be negligible. Under these circumstances, the NBOD will not be exerted immediately. In more enclosed estuarine waters, nitrification in the water column has been documented by numerous water quality studies. Applicants should analyze the potential impact of NBOD if they discharge into estuarine waters.

Although nitrification is a multistep process, a simplified approach to determining the oxygen demand uses an overall oxidation rate of the NBOD, k_N. The range of values of k_N is approximately the same as for the deoxygenation coefficient of the CBOD. For deep, large bodies of water, values of k_N of 0.1-0.5/day at 20 °C are typical (Thomann and Mueller 1987).

Assuming all reactions go to completion, the overall oxygen depletion can be estimated based on data for total Kjeldahl nitrogen (TKN is the sum of organic nitrogen and ammonia nitrogen) in the waste discharge using the following relationships:

$$NBOD_L = 4.57\ (TKN) \qquad \text{B-14a}$$

where $NBOD_L$ is the ultimate NBOD. As with carbonaceous BOD, if $NBOD_5$ is to be used to predict oxygen depletion, the applicant should convert it to $NBOD_L$, the ultimate NBOD, by the following relationship:

$$NBOD_L = 2.54\ NBOD_5 \qquad \text{B-14b}$$

where the $NBOD_L$-to-$NBOD_5$ ratio of 2.54 is calculated using a 0.1 day^{-1} nitrification rate at 20 °C (U.S. EPA 1985) by the equation (Thomann and Mueller 1987):

$$\frac{NBOD_5}{NBOD_L} = 1 - e^{-k_N t} \qquad \text{B-14c}$$

where:

k_N = the nitrification rate coefficient at T (°C)
t = Travel time corresponding to BOD_5 (5 days).

A number of factors, including temperature, are known to influence the rate of nitrification. The influence of these factors has been described by both theoretical and empirical formulations. Like all biochemical processes, NBOD decay occurs at a rate that increases with increasing temperature. Therefore, a temperature correction should be made to account for the temperature dependence of the rate constant as follows:

$$k_N = 0.10 \times \Theta^{(T\ -20\ ^\circ C)} \qquad \text{B-15}$$

where:

k_N = Nitrification rate coefficient at temperature T (°C)
0.10 = Nitrification rate coefficient at 20 °C
Θ = Temperature correction factor.

Once the temperature-corrected decay rate, K_N, is calculated, the new $NBOD_L$-to-$NBOD_5$ ratio can be calculated using Equation B-14c. Although temperature correction factors are available for both ammonia oxidation and nitrate oxidation, typically only one temperature correction factor is used. Studies indicate that the value of 1.08 for Θ is valid between 10 °C and 30 °C; beyond this temperature the nitrification rate is inhibited by the high temperature, so the relationship no longer holds (U.S. EPA 1985). At temperatures below 10 °C, the nitrifying bacteria apparently do not multiply in any significant amount. Therefore, the rate k_N is usually set equal to zero at about 5-10 °C (Thomann and Mueller 1987).

The influence of pH on rates of nitrification is also quite important. If pH is outside the range of 7.0 to 9.8, significant reductions in nitrification rates occur. The optimal pH for nitrification is approximately 8.5; at pH values below approximately 6.0, nitrification is not expected to occur (U.S. EPA 1985).

Simplified mathematical models are an acceptable alternative to the more complex numerical models. In the simplest model of oxygen depletion, the following assumptions are generally made:

- The wastewater plume is submerged at the completion of initial dilution for critical conditions (so that direct reaeration of atmospheric oxygen into the wastefield does not occur).

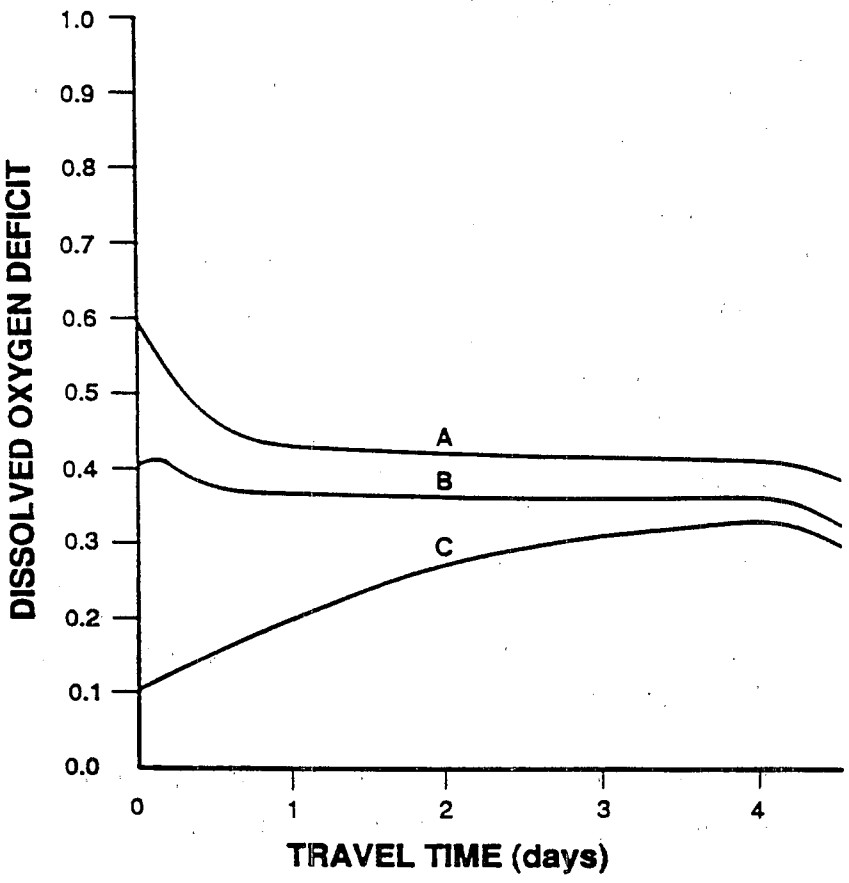
- Oxygen depletion is a function of distance from the discharge and is caused by carbonaceous oxygen demand and nitrogenous oxygen demand.

- The wastefield entrains ambient water as a function of travel time. Lateral dilution is the predominant mechanism of entrainment.

If the applicant demonstrates that the plume will always surface, then the effects of atmospheric reaeration can be included; otherwise, they should not be included.

When applying a model that predicts farfield oxygen depletion, it is suggested that the applicant plot dissolved oxygen depletion as a function of travel time so that the behavior of dissolved oxygen concentrations in the wastefield can be examined to locate minimum values.

Example oxygen depletion curves as a function of travel time are shown in Figure B-4. The depletion indicated at time, t = 0, denotes the depletion immediately following initial dilution. The dissolved oxygen deficits plotted in the figure are relative to the ambient concentration and tend to approach zero at travel times longer than those shown in the figure.



CURVE	BOD_f (ultimate) (mg/L)	INITIAL DO DEMAND (mg/L)
A	3.5	66.
B	3.5	44.
C	3.5	0.

Figure B-4. Dissolved oxygen deficit vs. travel time for a submerged wastefield.

For the three cases, the maximum deficits occur at the following travel times:

- 0.0 days for Curve A;
- Approximately 0.2 day for Curve B; and
- Approximately 4.0 days for Curve C.

The primary reason for the difference in magnitude and time of occurrence of the maximum deficits is the IDOD, which varies from a high of 66 mg/L for Curve A to 0.0 mg/L for Curve C. When the IDOD is 66 mg/L (a high value, but one that could be associated with an unusual discharge), the maximum depletion is caused by initial mixing processes and not by farfield BOD exertion. Conversely, when IDOD is 0.0 mg/L, the maximum depletion is caused by BOD exertion and occurs at some distance from the discharge.

The simplified farfield oxygen depletion model for coastal waters suggested herein is based on an approach developed by Brooks (1960) for predicting wastefield dilution subsequent to initial dilution. The dissolved oxygen concentration in the receiving waters can be expressed as a function of travel time as follows:

$$DO(t) = DO_a + \frac{DO_f - DO_a}{D_s} - \frac{L_{fc}}{D_s}\left(1 - \exp(-k_c t)\right) - \frac{L_{fn}}{D_s}\left(1 - \exp(k_n t)\right) \qquad \text{B-16}$$

where:

DO(t)	=	Dissolved oxygen concentration in a submerged wastefield as a function of travel time t, mg/L
DO_a	=	Affected ambient dissolved oxygen concentration immediately updrift of the diffuser, mg/L
DO_f	=	Dissolved oxygen concentration at the completion of initial dilution calculated using Equation B-5, mg/L
k_c	=	CBOD decay rate coefficient
k_n	=	NBOD nitrification rate coefficient
L_{fc}	=	Ultimate CBOD concentration above ambient at completion of initial dilution, mg/L
L_{fn}	=	Ultimate NBOD concentration above ambient at completion of initial dilution, mg/L

D_s = Dilution attained subsequent to initial dilution as a function of travel time.

The above equation expresses the dissolved oxygen deficit that arises because of an initial deficit at the completion of initial dilution (DO_a-DO_f) plus that caused by exertion of BOD in the water column. The last term in the equation estimates the exertion due to NBOD. The dissolved oxygen deficit tends to decrease at longer travel times as a result of subsequent dilution and to increase as a result of BOD exertion. Depending on the particular case being analyzed, one influence can dominate the other over a range of travel times so that a minimum dissolved oxygen level can occur either immediately following initial dilution or at a subsequent travel time, as previously shown in Figure B-4.

To predict farfield oxygen distribution, one must determine the dilution attained within the wastefield as a function of time following discharge. For open coastal areas, dilution is often predicted using the 4/3 law (Brooks 1960), which states that the lateral diffusion coefficient increases as the 4/3 power of the wastefield width. In mathematical form:

$$\varepsilon = \varepsilon_o \left(\frac{L}{b}\right)^{4/3} \qquad \text{B-17}$$

where:

ε = Lateral diffusion coefficient, ft^2/sec
ε_o = Diffusion coefficient when L = b
L = Width of sewage field at any distance from the ZID, ft
b = Initial width of sewage field (approximately as the longest dimension of the ZID), ft.

The initial diffusion coefficient can be predicted from:

$$\varepsilon_o = 0.001\ b^{4/3}\ ft^2/sec \qquad \text{B-18}$$

Based on the 4/3 law, the centerline dilution, D_S, is given by:

$$D_s = erf\left(\frac{1}{\left[\frac{1.5}{\left(1 + \frac{8\varepsilon_o t}{b^2}\right)^3} - 1\right]^{1/2}}\right) \qquad \text{B-19}$$

where:

t = Travel time, sec
erf = The error function.

The 4/3 law is not always applicable, especially in coastal areas or estuaries. In coastal areas, Grace (1978) suggests that the diffusion coefficient vary linearly with L. The subsequent dilution can be expressed as:

$$D_s = erf\left(\frac{1}{\left[\frac{1.5}{\left(1 + \frac{12\varepsilon_o t}{b^2}\right)^2} - 1\right]^{1/2}}\right) \qquad \text{B-20}$$

A more conservative choice is to assume the diffusion coefficient is a constant. The subsequent dilution can then be expressed as:

$$D_s = erf\left[\frac{1}{\left(\frac{b^2}{16\varepsilon_o t}\right)^{1/2}}\right] \qquad \text{B-21}$$

These three equations are cumbersome to use, especially if repeated applications are needed. To facilitate predicting subsequent dilutions, values of D_s as a function of $12\varepsilon_o t/b^2$ are shown in Figure B-5 for values of Brooks' n equal to 0, 1, and 4/3. For example, if b = 100 ft and t = 9,000 sec (2.5 h), then ε_o = 0.464 ft^2/sec and $12\varepsilon_o t/b^2$ = 5.0. Assuming that Brooks' n = 1, then use of Figure B-5 shows that D_s = 4.3 approximately.

The figure also reveals that the predicted dilutions are substantially different, depending on the relationship obeyed by the lateral diffusion coefficient. In some instances, the Brooks' n = 1 law might overestimate subsequent dilution, even if the outfall is in coastal waters. To attain the subsequent dilutions predicted at large travel times, a large amount of dilution water

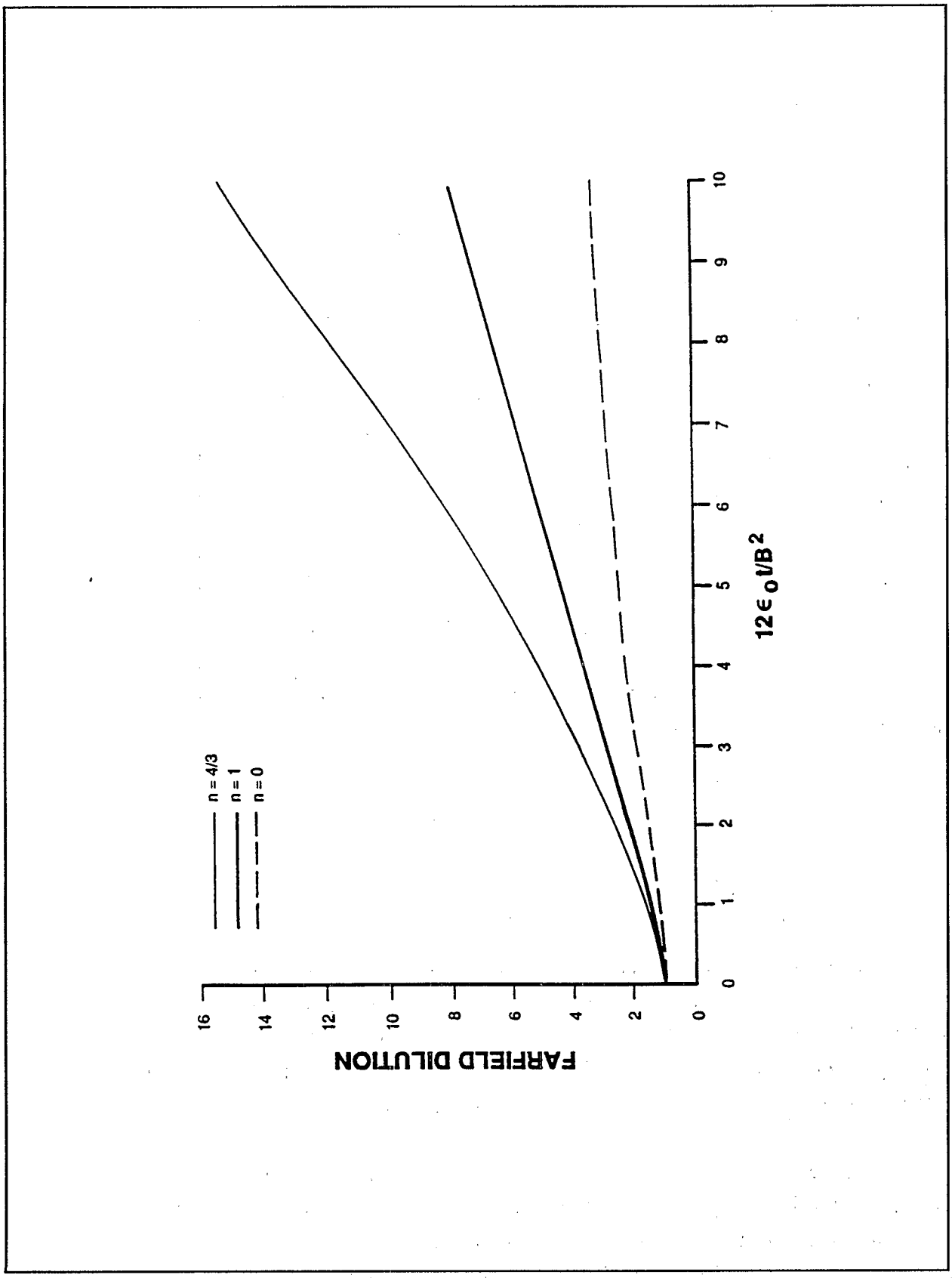


Figure B-5. Farfield dilution as a function of $12\varepsilon_o t/B^2$ (Brooks, 1960).

must be available. Because many outfalls, particularly small ones, are not far from shore, the entrainment rate of dilution water can be restricted by the presence of the shoreline and the depth of the water. As the wastefield widens substantially, the rate of entrainment could decrease, and neither the Brooks' n = 4/3 nor the Brooks' n = 1 law may be obeyed. It is suggested that applicants be conservative and base subsequent dilution on a constant lateral diffusion coefficient (i.e., Brooks' n = 0) rather than the Brooks' n = 1 or Brooks' n = 4/3 laws. However, if the applicant can show that the 4/3 law (or some other relationship) is applicable to the discharge site, then that relationship should be used.

If the applicant's discharge is near the mouth of a wide estuary, the approach just discussed can be used directly to predict oxygen depletion. If, however, the applicant discharges into a long, narrow estuary, then it is likely that the sides of the estuary will limit the lateral dilution that is attainable. Under these conditions, the maximum dissolved oxygen deficit with respect to saturation can be predicted as:

$$D = \frac{kw}{A(k_2 - k)} \left[\frac{1}{\sqrt{4kE_L}} - \frac{1}{\sqrt{4K_2E_L}} \right] \qquad \text{B-22}$$

where:

D	=	Dissolved oxygen deficit
A	=	Cross-sectional area of the estuary near the discharge site
k	=	CBOD decay rate constant
k_2	=	Reaeration rate constant
E_L	=	Longitudinal dispersion coefficient
W	=	Mass loading rate of CBOD.

The applicant can predict the deficits due to NBOD by using the appropriate k and W values and adding the two deficits to obtain the total. With reasonable values for the constants, the total dissolved oxygen deficit for discharge to narrow estuaries becomes:

$$D = \frac{(3.14\ W_c + 2.55\ W_n)\ 10^{-4}}{A} \qquad \text{B-23}$$

where:

A	=	Cross-sectional area in m^2

W_c = Mass emission rate of CBOD, g/day
W_n = Mass emission rate of NBOD, g/day
D = Dissolved oxygen deficit, mg/L.

The NBOD term can be added when data are available.

NUMERICAL MODELS

Numerical models are an acceptable method of predicting oxygen depletion caused by a discharge. Numerical models may consider the combined effect of farfield demand in the water column, as discussed above, and the oxygen demand associated with organic sediments. If not, the applicant may have to augment the numerical modeling analysis to address unanswered questions associated with sediment oxygen demand.

The applicant should try to isolate the impact of the outfall on dissolved oxygen concentrations by considering that the applicant's discharge is the sole source of oxygen depletion in the system being modeled. The applicant can then predict the dissolved oxygen depletion caused by the discharge by subtracting the background dissolved oxygen level from those predicted by the model. This approach also simplifies the applicant's analysis because data from other wastewater sources are not required.

Specific guidelines can be offered to applicants that choose to use numerical models. Typically, the most severe dissolved oxygen depletion due to BOD exertion occurs when the water column is density-stratified in the presence of tidally reversing currents and low nontidal currents, and the wastefield remains submerged following initial dilution. If such conditions occur at the applicant's outfall site, then the numerical model should be layered vertically, with a minimum of two layers. The plume should be discharged into the bottom layer to simulate the submerged discharge, with the consequence that direct atmospheric reaeration is not present in this layer.

The applicant should set up the grid system for the numerical model such that the smallest segments are located in the vicinity of the diffuser and gradually increase in size with distance from the diffuser. The volume of the segments in the immediate vicinity of the diffuser should approximate the volume of the ZID to prevent an initial dilution that is artificially high and that would cause the model to underestimate dissolved oxygen depletion. The applicant might choose to experiment with grid configuration by starting with a coarse grid and then decreasing grid size until the model results do not significantly change.

A steady-state numerical model is acceptable for the dissolved oxygen analysis because dynamic or unsteady analyses are generally more costly, are more difficult to implement, and require more data. The applicant should consider, however, whether intratidal variations can cause more severe depletions than are predicted by a steady-state model that calculates average oxygen depletions over a tidal cycle. Slack tide, for example, might be critical because oxygen-demanding materials can accumulate in the vicinity of the discharge. For existing discharges, the applicant might want to augment the steady-state modeling analysis by an abbreviated sampling program to determine dissolved oxygen depletions during slack-tide periods within a tidal cycle. Intratidal variations are likely to be more important in enclosed estuaries than along open coastal areas.

EVALUATION OF FIELD DATA

Extensive field data collection and analysis are required to fully implement this third approach. Limited samples of water column dissolved oxygen may be inadequate to demonstrate compliance with standards under critical conditions. Limited information should be supplemented with analyses based on numerical or simplified mathematical modeling.

These statements should not discourage applicants from collecting and submitting dissolved oxygen data from the vicinity of an existing discharge. To the contrary, such data, if available, should be submitted, particularly if the section 301(h) application is for a current discharge or for an improved or altered discharge at the same location. However, the data might reveal only a portion of the impact of the wastefield for the following reasons:

- The location of the maximum oxygen depletion might not be sampled.

- The sampling program could have been conducted during a period that was not critical with respect to the discharge or receiving water conditions. Critical discharge conditions are usually associated with high effluent BOD and high volumetric flow rates. Critical receiving water conditions are usually associated with minimum initial dilutions (maximum density stratification), maximum water temperatures, and possibly slack-tide or low nontidal current conditions.

- Ambient dissolved oxygen concentrations can vary spatially and temporally because of conditions unrelated to the discharge (e.g., upwelling effects). Consequently, dissolved oxygen depletions associated with the discharge can be masked by background variability.

Some applicants might have access to dissolved oxygen demand data collected adjacent to another outfall at a nearby coastal area and attempt to use those data to show that their own discharge will not violate dissolved oxygen standards. This approach can be, but is not always, reliable. The applicants should include in the application sufficient information such that the data collection program for the nearby area can be reviewed, and should then show that the predicted dissolved oxygen depletions are the maximum likely to be produced at the nearby discharge site. The applicant should also demonstrate that the results of the nearby discharge can be extrapolated to the applicant's discharge. Essentially, the dissolved oxygen depletion at the adjacent discharge (due to both BOD utilization and sediment oxygen demand) will need to be at least as severe as that at the applicant's discharge.

B-IV. SEDIMENT OXYGEN DEMAND

The oxygen depletion due to a steady sediment oxygen demand can be predicted by:

$$\Delta DO = \frac{\bar{S}_B \, X_M}{86{,}400 \; UHD} = \frac{a \, \bar{S} \, k_d \, X_M}{86{,}400 \; UHD} \qquad \text{B-24}$$

where:

ΔDO	=	Oxygen depletion, mg/L
$\bar{S}_B$	=	Average benthic oxygen demand over the deposition area, g O_2/m^2/day
X_M	=	Length of deposition area (generally measured in longshore direction), m
H	=	Average depth of water column influenced by sediment oxygen demand, measured above bottom, m
U	=	Minimum sustained current speed over deposition area, m/sec
k_d	=	Sediment decay rate constant, 0.01/day
a	=	Oxygen:sediment stoichiometric ratio, 1.07 mg O_2/mg sediment
$\bar{S}$	=	Average concentration of deposited organic sediments over the deposition area, g/m^2
D	=	Dilution caused by horizontal entrainment of ambient water as it passes over the deposition area (always ≥ 1).

Both $\bar{S}$ and X_M can be determined from the analysis performed in Chapter B-I, Suspended Solids Deposition. Figure B-3 in that chapter shows an example plot of seabed deposition. For that example, an estimate of $\bar{S}$ is the average of the maximum and minimum values, or

$$\frac{100 + 5}{2} = 52 \; g/m^2 \qquad \text{B-25}$$

The distance X_M, measured parallel to the coast and within the 5-g/m^2 contour, is 8,000 m.

The depth of water affected by the sediment oxygen demand is not really a constant value (as suggested by the previous formula) but varies as a function of the travel time across the zone of deposition. The affected depth H (in meters) is chosen to represent the average depth influenced by the sediment oxygen demand and can be estimated as:

$$H = 0.8 \left(\frac{\varepsilon_Z \, X_M}{U} \right)^{1/2} \qquad \text{B-26}$$

where:

ε_z = Vertical diffusion coefficient (cm^2/sec).

For the example case where U = 3 cm/sec, X_M = 8,000 m, and ε_z = 1 cm^2/sec,

$$H = 0.8 \times \left(\frac{1 \times 8{,}000 \times 100}{3}\right)^{1/2} \times \frac{1}{100}\ m = 4.1\ m \qquad \text{B-27}$$

If the applicant desires to compute a value of vertical diffusivity, the following empirical expression can be used:

$$\varepsilon_Z = \frac{10^{-4}}{\frac{1}{\rho}\frac{d\rho}{dz}} \qquad \text{B-28}$$

where:

ε_z = Vertical diffusion coefficient, cm^2/sec
ρ = Ambient water density, kg/m^3 (1,024)
$\frac{d\rho}{dz}$ = Ambient density gradient, kg/m^4.

The density gradient used should reflect the most severe stratification condition that is likely to occur during the critical period.

The dilution D that is used in Equation B-24 can be obtained from Table B-5, where the field width is the width of the deposition area. For the appropriate travel time and field width, the smaller of the two estimates shown in the table should be used.

In Chapter B-I (Suspended Solids Deposition), the applicant is asked to compute the long-term accumulation and the critical 90-day accumulation. Because the critical 90-day accumulation might exceed the long-term average, the applicant should use the more critical case when predicting sediment oxygen demand.

TABLE B-5. SUBSEQUENT DILUTIONS[a] FOR VARIOUS INITIAL FIELD WIDTHS AND TRAVEL TIMES

Travel Time (h)	Initial Field Width (ft)					
	10	50	100	500	1,000	5,000
0.5	2.3/5.5	1.5/2.0	1.3/1.6	1.0/1.1	1.0/1.0	1.0/1.0
1.0	3.1/13	2.0/3.9	1.6/2.6	1.2/1.3	1.1/1.1	1.0/1.0
2.0	4.3/32	2.7/8.5	2.2/5.1	1.4/1.9	1.2/1.5	1.0/1.0
4.0	6.1/85	3.7/21	3.0/11	1.9/3.5	1.5/2.3	1.1/1.2
8.0	8.5/>100	5.2/53	4.1/29	2.5/7.3	2.0/4.4	1.4/1.7
12	10/>100	6.3/95	5.1/50	3.0/12	2.4/6.8	1.6/2.3
24	15/>100	8.9/>100	7.1/100	4.2/30	3.4/16	2.1/4.4
48	21/>100	13/>100	10/>100	5.9/80	4.7/41	2.8/10
72	26/>100	15/>100	12/>100	7.3/>100	5.8/73	3.4/17
96	29/>100	18/>100	14/>100	8.4/>100	6.6/100	3.9/24

[a] The dilutions are entered in the table as N_1/N_2, where N_1 is the dilution assuming a constant diffusion coefficient and N_2 is the dilution assuming the 4/3 law.

Oxygen Demand Due to Resuspension of Sediments

It is more difficult to accurately predict oxygen demand due to resuspension than that due to either farfield BOD decay or a steady sediment oxygen demand. To simplify the analysis, the approach here considers a worst-case situation. The amount of sediment to be resuspended is equal to the critical 90-day accumulation, which is found using the methods discussed in the above guidance on suspended solids deposition (Chapter B-I).

For the material to remain suspended, the ambient current speed has to be sufficiently great that the volume of water containing the resuspended material increases over time as ambient water is entrained. It is assumed that this process continues for up to 24 hours.

The applicant should compute the oxygen depletion as a function of time during this period. This can be done using the following relationship:

$$\Delta DO = \frac{\bar{S}_r}{DH} \left[1 - \exp\left(\frac{-k_r t}{24}\right) \right] \qquad \text{B-29}$$

where:

ΔDO	=	Oxygen depletion, mg/L
$\bar{S}_r$	=	Average concentration (in g/m^2) of resuspended organic sediment (based on 90-day accumulation)
H	=	Depth of water volume containing resuspended materials, m
k_r	=	Decay rate of resuspended sediments, 0.1/day
t	=	Elapsed time following resuspension, h (t varies from 0 to 24 h)
D	=	Dilution as defined previously (generally set equal to 1).

The variable H is a function of travel time and can be predicted from:

$$H = \frac{1.6}{100} \left(3{,}600\ t\ \varepsilon'_z\right)^{1/2} \qquad \text{B-30}$$

where:

ε'_z	=	Vertical diffusion coefficient when resuspension is occurring (5 cm^2/sec)
t	=	Elapsed time following resuspension, h.

The applicant should check to be sure that H does not exceed the water depth. If it does, H should be set equal to the water depth.

The concentration of resuspended sediments $\bar{S}_r$ can be approximated as the average concentration over the width of the zone of deposition. This can be determined directly from the contour plots of sediment accumulation, developed in response to the guidance on suspended solids deposition in Chapter B-I.

The applicant should calculate ΔDO for 3-hour increments for a period of up to 24 hours. The results can be tabulated as shown below. Data and calculations should be included in the application.

t (h)	DO (mg/L)
0	0
3	
6	
9	
12	
15	
18	
21	
24	predictions

Most often, a maximum depletion will occur somewhere in the 24-hour period, with depletions decreasing for larger travel times.

B-V. SUSPENDED SOLIDS CONCENTRATION FOLLOWING INITIAL DILUTION

The concentration of suspended solids at the completion of initial dilution should be calculated using the following equation:

$$SS_f = SS_a + \frac{SS_e - SS_a}{S_a} \qquad \text{B-31}$$

where:

SS_f = Suspended solids concentration at completion of initial dilution, mg/L

SS_a = Affected ambient suspended solids concentration immediately upcurrent of the diffuser averaged over one-half the tidal period (12.5 hours) and from the diffuser port depth to the trapping level, mg/L

SS_e = Effluent suspended solids concentration, mg/L

S_a = Initial dilution (flux-averaged).

The maximum change, DS, due to the effluent can be computed as follows:

$$\Delta S = SS_e/S_a \qquad \text{B-32}$$

where the terms are as defined above. Equation B-32 is appropriate as long as the effluent suspended solids concentration is much greater than the background concentration. During spring runoff in some estuaries, the background suspended solids concentration may exceed the effluent concentration. In these cases, the final suspended solids concentration will be below the background concentration.

EPA requires data for periods of maximum stratification and for other periods when discharge characteristics, oceanographic conditions, water quality, or biological seasons indicate that more critical situations exist. The critical period generally occurs when water quality standards are most likely to be violated. If the standard is expressed as a maximum numerical limit, the critical period would be when the background concentrations are highest and the initial dilution is low. If the standard is expressed as a numerical difference from background, the critical period would be when effluent concentrations are high and initial dilution low. When the standard is expressed as a percent difference from background, the critical period could occur when background concentrations are low.

Because effluent suspended solids concentrations can vary with discharge flow rate, the concentration at the completion of initial dilution should be computed for the minimum, average dry- and wet-weather, and maximum flow rates, using the associated suspended solids concentration. The range and average effluent concentrations should be provided in the application by month, unless locally applicable standards require compliance over shorter durations. This information should be available from operating records.

The selection of an appropriate background suspended solids concentration may be difficult because of a general lack of data. A common problem for coastal sites is that measurements may be available only at the mouths of large rivers. Concentrations are often higher at such locations than farther offshore because of the solids contribution from runoff. Selected values of background suspended solids concentrations are shown in Table B-6. Suspended solids background data should be obtained at control stations, at the ZID boundary of the existing discharges, and at stations between the ZID-boundary and control stations. Data should be collected over the tidal cycle and at several depths so the average concentration over the height-of-rise of the plume over the tidal cycle can be calculated. This value should be used in Equation B-31.

Compliance with the water quality standard can be determined directly if the standard is expressed in the form of suspended solids concentrations. If only a general standard exists, the

TABLE B-6. SELECTED BACKGROUND SUSPENDED SOLIDS CONCENTRATIONS

Water Body	Suspended Solids Concentration, mg/L
Cook Inlet, AK	250-1,280
Southern California Bight	0.7-60
Pacific Ocean near San Francisco, CA	1-33
Broad Sound, MA	18.6-25.2
Massachusetts Bay near South Essex	1.2-30.5
New Bedford Harbor, MA	0.4-6.1
East River, NY	6.0-25.6
Ponce, PR (near shore)	13.5
Puget Sound, WA	0.5-2.0
Outer Commencement Bay, Tacoma, WA	33-51
Commencement Bay near Puyallup River, WA	23-136
Tacoma Narrows, WA	33-63

Note: Data are from 301(h) applications.

maximum increase due to the effluent should be computed. If the increase is less than 10 percent, then no substantial effect in the water column is likely. However, seabed deposition could still be substantial, depending on the mass emission rate of suspended solids and ambient currents at the discharge site, and thus should be evaluated.

The water quality standards may also specify limitations on the level of suspended solids removal. For example, California has a requirement that 75 percent of the solids entering POTWs must be removed. Compliance with this standard can be determined by estimating the average removal efficiency for each month based on the average monthly influent and effluent suspended solids concentrations. The removal efficiency should be equal to or greater than the required percentage in all months. The applicant should include the monthly average influent and effluent suspended solids concentrations along with the computed removal efficiencies.

B-VI. EFFLUENT pH AFTER INITIAL DILUTION

The calculation of effluent pH following initial dilution is chemically more sophisticated than other chemical calculations in this document. This chapter details the basis for Table 1 in the main text showing the ranges of probable effluent pH following initial dilution. The method for calculating effluent pH following initial dilution, assuming that all of the required variables are known, is described herein. These variables include initial dilution and the temperature, salinity, pH, and alkalinity of the effluent and the receiving water. Effluent and receiving water temperature, salinity, and pH are normally measured. The initial dilution (usually critical) is routinely calculated as part of either the section 301(h) waiver application process or the section 301(h) permit renewal process; however, neither the alkalinity of the receiving water nor that of the effluent is usually measured. The alkalinity of seawater is relatively constant, however, at a value of 2.3 meq/L (Stumm and Morgan 1981). The alkalinity of effluent varies from 0.1 to 6.0 meq/L.

The method described herein predicts pH at the completion of initial dilution of an effluent-receiving water mixture. Because the initial dilution process occurs over a short time period, mixing is considered to occur in a closed system. Also, in stratified receiving waters, the wastewater plume is often trapped below the surface. Thus, the plume does not equilibrate with the atmosphere, and carbon dioxide exchange between the atmosphere and mixture is considered negligible. This method is useful for the calculation of pH, alkalinity, and total inorganic carbon concentration in the plume after initial dilution.

The pH of the effluent receiving water mixture is calculated using the equations for aqueous carbonate equilibrium in a closed system (Stumm and Morgan 1981). For this condition, the five equations that describe the relationships between pH, the carbonate species, and alkalinity are:

$$[H^+]\left[HCO_3^-\right] / \left[H_2CO_3^*\right] = K_1 \qquad \text{B-33}$$

$$[H^+]\left[CO_3^{2-}\right] / \left[HCO_3^-\right] = K_2 \qquad \text{B-34}$$

$$[H^+][OH^-] = K_W \qquad \text{B-35}$$

$$C_T = \left[H_2CO_3^*\right] + \left[HCO_3^-\right] + \left[CO_3^{2-}\right] \qquad \text{B-36}$$

$$Alkalinity = \left[HCO_3^-\right] + 2\left[CO_3^{2-}\right] + [OH^-] - [H^+] \qquad \text{B-37}$$

where:

$[H_2CO_3^*]$ = The sum of aqueous CO_2 and true H_2CO_3 concentrations

C_T = Total carbonate concentration.

The carbonate species can also be expressed in terms of ionization fractions α_0, α_1, and α_2:

$$\left[H_2CO_3^*\right] = C_T\,\alpha_0 \qquad \text{B-38}$$

$$\left[HCO_3^-\right] = C_T\,\alpha_1 \qquad \text{B-39}$$

$$\left[CO_3^{2-}\right] = C_T\,\alpha_2 \qquad \text{B-40}$$

where:

$$\alpha_0 = \left[1 + \frac{K_1}{[H^+]} + \frac{K_1K_2}{[H^+]^2}\right]^{-1} \qquad \text{B-41}$$

$$\alpha_1 = \left[1 + \frac{[H^+]}{K_1} + 1 + \frac{K_2}{[H^+]}\right]^{-1} \qquad \text{B-42}$$

$$\alpha_2 = \left[\frac{[H^+]^2}{K_1K_2} + \frac{[H^+]}{K_2} + 1\right]^{-1} \qquad \text{B-43}$$

Substituting the hydroxide-hydrogen ion relationship and ionization fractions into the alkalinity equation yields:

$$Alkalinity = C_T\left(\alpha_1 + 2\alpha_2\right) + \frac{K_W}{[H^+]} - [H^+] \qquad \text{B-44}$$

Because total carbonate is conserved and α_1 and α_2 are functions solely of pH, the above equation has only one variable: hydrogen ion concentration. The model solves the equation to determine the pH of the effluent-receiving water mixture. The steps involved in the calculations are listed below:

- Determine input data.

- Calculate ion product of water, K_w, and carbonate dissociation constants, K_1 and K_2, of the effluent and receiving water based on temperature and salinity data.

- Check consistency between alkalinity and pH of both effluent and receiving water.

- Calculate total carbonate in effluent and receiving water separately.

- Calculate total carbonate, alkalinity, salinity, and temperature of the effluent-receiving water mixture following initial dilution (based on proportions of effluent and receiving water).

- Calculate K_w, K_1, and K_2 for the effluent-receiving water mixture following initial dilution.

- Use a stepping procedure to find pH based on the computed values for total carbonate and alkalinity of the effluent-receiving water mixture.

- Record results.

The ion product and dissociation constants are calculated for the appropriate temperature and salinity based on the equations given below. The equations for the receiving water have been revised so that salinity (in ppt) can be used.

For effluent:

$$pK_1 = \frac{3{,}407.7}{T} + 0.03279T - 14.8435 \qquad \text{(Kelts and Hsu 1978, p. 300)} \qquad \text{B-45}$$

$$pK_2 = \frac{2{,}902.4}{T} + 0.02379T - 6.498 \qquad \text{(Kelts and Hsu 1978, p. 300)} \qquad \text{B-46}$$

$$pK_w = \frac{4{,}471.0}{T} + 0.01706T - 6.0875 \qquad \text{(Stumm and Morgan 1981, p. 127)} \qquad \text{B-47}$$

For receiving water and the effluent-receiving water mixture:

$$pK_1 = \frac{3{,}404.7}{T} + 0.03279T - 14.712 - 9.1575S^{1/3}$$

(Stumm and Morgan 1981, p. 205) B-48

$$pK_2 = \frac{2{,}902.4}{T} + 0.02379T - 6.471 - 0.3855S^{1/3}$$

(Stumm and Morgan 1981, p. 206) B-49

$$pK_w = \frac{3{,}441.0}{T} + 2.241 - 0.0925S^{1/2}$$

(Dickson and Riley 1979, p. 97) B-50

where:

T = Temperature in degrees Kelvin
S = Salinity in ppt.

The receiving water equations are valid for salinities down to about 10 ppt.

B-VII. LIGHT TRANSMITTANCE

Increased suspended solids concentrations associated with municipal discharges can cause a decrease in light penetration within the water column. Reductions in light penetration can result in a decrease in phytoplankton productivity, as well as a reduction in the areal distribution of attached macroalgae such as kelp. Therefore, several states have enacted regulations governing the allowable levels of interference with light transmittance.

The evaluation of light transmittance may require the measurement of one or more water clarity variables and a comparison of values recorded in the vicinity of the outfall with those recorded in control areas. Variables that are widely measured to assess light transmittance include turbidity, Secchi disc depth, beam transmittance, and downward irradiance. While many of the state requirements are very specific in terms of the light transmittance measurements, others leave the selection of the sampling methods to the discretion of the applicant.

Turbidity is a measure of the optical clarity of water, and many standards are written in terms of nephelometric turbidity units (NTU). Measurements are made with a nephelometer, which provides a comparison of the light-scattering characteristics of the sample with a standard reference. Differences in the optical design of nephelometers can cause differences in measured values even when calibrated against the same turbidity standard. For this reason, caution must be exercised when comparing measurements of turbidity made from different field sampling programs.

A Secchi disc is used to make visual observations of water clarity. Records of the depth at which the Secchi disc is just barely visible can be used to make comparisons of light transmittance among sampling sites. Measurements of Secchi disc depth are probably the most widely used means of estimating light penetration. The Secchi disc is easy to use, is accurate over a wide range of conditions, and can be used to estimate the attenuation coefficients for collimated and diffuse light and, therefore, to estimate the depth of the euphotic zone. Since a wastewater plume can be held below the upper regions of this zone during periods of stratification, however, Secchi disc measurements may not be appropriate under all conditions.

Beam transmittance is measured with a transmissometer and is a measure of the attenuation of a collimated beam of artificial light along a fixed path length (usually 1 m). The attenuation is caused by suspended and dissolved material as well as the water itself. These measurements, therefore, provide information about both the absorption and scattering properties of the water. The attenuation of a collimated beam of light in a water path is described by the Beer-Lambert law:

$$T_d = e^{-\alpha d} \qquad \text{B-51}$$

where:

T_d = The proportion of light transmitted along a path of length d, m
α = Light attenuation coefficient, m^{-1}.

Measurements of beam transmittance are made *in situ* at any depth.

The intensity and attenuation of daylight penetration are measured with an irradiance meter, which uses a photovoltaic cell to record incident light levels. Measurements are made just below the surface and at selected depth intervals throughout the water column so that light attenuation over specific depths can be determined. Unlike beam transmittance measurements, irradiance measurements are influenced by sunlight as well as surface conditions.

Empirical relationships can be derived among the light transmittance variables measured by these methods, which permits the estimation of one based on recorded values of another. These values can also be predicted from suspended solids concentrations. The derivation of these relationships from existing data, in some instances, may be sufficient to allow for the demonstration of compliance with state standards. Existing data can also be used to predict the transparency characteristics in the vicinity of an improved discharge. Alternatively, a sampling program can be designed to assess compliance with light transmittance standards based on such empirical relationships.

Where standards are written in terms of maximum allowable turbidity or turbidity increase, predicted turbidity in the receiving water at the completion of initial dilution can be used to demonstrate compliance. By treating turbidity as a conservative variable, the turbidity in the receiving water at the completion of initial dilution can be predicted as:

$$T_f = T_a + \frac{T_e - T_a}{S_a} \qquad \text{B-52}$$

where:

T_f = Turbidity in receiving water at the completion of initial dilution, typically NTU or Jackson turbidity units (JTU)
T_a = Ambient or background turbidity

T_e = Effluent turbidity
S_a = Initial dilution.

Initial dilution can be predicted based on the methods presented in Appendix A. Equation B-52 can be used, then, to directly evaluate compliance with standards written in terms of maximum allowable turbidity or a turbidity increase.

Laboratory experimental work can also be used in lieu of field sampling to demonstrate compliance with standards written in terms of an allowable turbidity increase. These analyses consist of determining the turbidity of a seawater-effluent mixture prepared in proportions corresponding to the predicted concentrations following initial dilution. Experiments should be conducted to simulate worst-case conditions. Simulations of expected receiving water turbidity should be made for periods of highest effluent turbidity (greatest suspended solids concentrations) as well as lowest initial dilutions. Values of the initial turbidity of the seawater, the effluent mixture, and the simulated dilution should accompany all test results.

By deriving a relationship between turbidity and Secchi depth and using the method of prediction for turbidity in the receiving water following initial dilution (Equation B-52), compliance with state standards written in terms of Secchi depth can be evaluated. Secchi depth and turbidity can be related in the following manner. Assume that the extinction coefficient of visible light (α) is directly proportional to turbidity (T) and inversely proportional to Secchi depth, or:

$$\alpha = k_1 T \qquad \text{B-53}$$

and

$$\alpha = \frac{k_2}{SD} \qquad \text{B-54}$$

where k_1 and k_2 are constants that need not be specified since they cancel out in further calculations. These two relationships have theoretical bases, as discussed in Austin (1974) and Graham (1966). Combining those two expressions, the relationship between Secchi depth and turbidity becomes:

$$T = \left(\frac{k_2}{k_1}\right)\left(\frac{1}{SD}\right) \qquad \text{B-55}$$

When state standards are written in terms of Secchi depth, it is convenient to combine Equations B-52 and B-55 to yield:

$$\frac{1}{SD_f} = \frac{1}{SD_a} + \frac{\frac{1}{SD_e} - \frac{1}{SD_a}}{S_a} \qquad \text{B-56}$$

or

$$SD_e = \left[\left(\frac{1}{SD_f} - \frac{1}{SD_a}\right) S_a + \frac{1}{SD_a}\right]^{-1} \qquad \text{B-57}$$

where:

SD_f	=	Minimum allowable Secchi disc reading in receiving water such that the water quality standard is not violated
SD_a	=	Ambient Secchi disc reading
S_a	=	Minimum initial dilution that occurs when the plume surfaces
SD_e	=	Critical Secchi disc depth of effluent.

In this manner, the critical effluent Secchi depth (SD_e) can be calculated. An effluent reading higher than this value indicates that standards will not be violated. This method of predicting the final Secchi depth in the receiving water can be used to provide an estimate of the effect of the wastewater discharge on the receiving water. This method should be used only where the standard is exclusively in terms of the acceptable decrease in the Secchi depth.

Values of the critical effluent Secchi depth (SD_e) calculated using Equation B-57 are presented in Table B-7. In this example, the water quality standard for the minimum Secchi visibility is 1 m (3.3 ft). Effluent having a Secchi depth greater than those presented for the selected ambient conditions and initial dilution will not violate the clarity standard of the example receiving water. Primary effluents typically have Secchi disc values of 5-30 cm (2-12 in). For this case, with an initial dilution greater than 40 and an ambient Secchi depth of 2 m (6.6 ft) or greater, these calculations indicate that the standard would not be violated.

TABLE B-7. CALCULATED VALUES FOR THE CRITICAL EFFLUENT SECCHI DEPTH (cm) FOR SELECTED AMBIENT SECCHI DEPTHS, INITIAL DILUTIONS, AND A WATER QUALITY STANDARD FOR MINIMUM SECCHI DISC VISIBILITY OF 1 m

Initial Dilution	Ambient Secchi Depth (m)				
	2	3	4	5	10
10	18	14	13	12	11
20	10	7	7	6	6
40	5	4	3	3	3
60	3	2	2	2	2
100	2	1	1	1	1

Since Secchi disc measurements are made from the water surface downward, critical conditions (in terms of the Secchi disc standard) will occur when the initial dilution is just sufficient to allow the plume to surface. It is notable that maximum turbidity or light transmittance impacts of a wastewater plume will occur when the water column is stratified, the plume remains submerged, and initial dilution is at a minimum. Under these same conditions, however, Secchi disc readings might not be altered at all if the plume is trapped below the water's surface at a depth exceeding the ambient Secchi disc depth.

The ability to relate measurements of turbidity to the attenuation coefficient (α) for collimated light has been demonstrated by Austin (1974). The attenuation coefficient can be expressed in terms of turbidity as:

$$\alpha = k \times JTU \qquad \text{B-58}$$

where:

JTU = Turbidity, JTU
k = Coefficient of proportionality.

Combining Equations B-51 and B-58, turbidity can be expressed as:

$$JTU = \frac{-1n\ T_d}{kd} \qquad \text{B-59}$$

where:

T_d = Fraction of beam transmittance over distance d.

The coefficient of proportionality (k) takes on values 0.5-1.0. Therefore, to use these relationships to demonstrate compliance with a turbidity standard based on existing light transmittance data, the value of k must be determined empirically. This requires simultaneous measurements of beam transmittance and determination of turbidity covering the complete range of existing light transmittance records. If data are not available, the k value can be set equal to 1 as a conservative estimate.

Where a relationship between suspended solids concentration and beam transmittance data at a particular site can be derived, the suspended solids concentration at the completion of initial dilution from Equation B-31 can be used to predict compliance with standards written in terms of light transmittance.

B-VIII. OTHER WATER QUALITY VARIABLES

Other variables for which water quality standards may exist include total dissolved gases, coliform bacteria, chlorine residual, temperature, salinity, radioactivity, and nutrients. Variables concerned with aesthetic effects that also may be included are color, floating material, taste and odor, and hydrocarbons (i.e., grease and oil). For most dischargers, temperature, salinity, and radioactivity standards are unlikely to be violated. Aesthetic effects are more likely to occur when the plume surfaces and the dilution is low. Compliance with aesthetic standards can best be checked by field observations at the discharge site and along the shore.

TOTAL DISSOLVED GASES

Several states have a limit for total dissolved gases of 110 percent of saturation. Supersaturation of dissolved gases is not considered to be a likely problem for municipal wastewater discharges to the marine environment and is not discussed further.

CHLORINE RESIDUAL

Chlorine residual standards may be expressed as a concentration limit in the effluent or as a maximum concentration in the receiving water at the completion of initial dilution. If the effluent is not chlorinated, no further information is required. If the standard is expressed as an effluent limit, chlorine residual data from treatment plant operating reports, or other sources, should be presented in the application. If no data are available, then the procedure for chlorination, including the compound used, quantity, and occurrence of any operational problems, should be described. If the standard is expressed as a maximum limit at the completion of initial dilution, the concentration in the receiving water, assuming the ambient concentration is 0.0 mg/L, can be estimated as follows:

$$Cl_f = Cl_e \,/\, S_a \qquad \text{B-60}$$

where:

Cl_f = Chlorine residual at completion of initial dilution, mg/L
Cl_e = Chlorine residual in effluent, mg/L
S_a = Lowest flux-averaged initial dilution.

As a worst-case approach, the maximum observed chlorine residual in the effluent should be used with the lowest dilution. If violations are predicted, the applicable water quality standard may require information on the frequency of occurrence.

NUTRIENTS

Standards can be expressed as maximum receiving water concentrations of total nitrogen or total phosphorus or as a general prohibition on amounts that would cause objectionable aquatic life. In general, for small discharges when the initial dilution is large, nutrients are not likely to cause problems. Appropriate state agencies should be contacted to ascertain whether algal blooms, red tides, or other unusual biological activity has occurred near the discharge site in the past.

Receiving water and effluent nutrient data can be used to estimate concentrations at the completion of initial dilution. For screening purposes, the nutrients can be treated as conservative variables. The concentration is estimated as follows in a manner similar to that used for suspended solids:

$$C_f = C_a + \frac{C_e - C_a}{S_a} \qquad \text{B-61}$$

where:

C_a = Affected ambient concentration immediately upcurrent of diffuser, mg/L
C_e = Effluent concentration, mg/L
S_a = Initial dilution (flux-averaged)
C_f = Concentration at the completion of initial dilution, mg/L.

The predicted concentration can then be compared to the state standard.

Because water quality criteria are often prescribed as maximum values not to be exceeded following initial dilution, it is useful to rearrange the above equation to express the maximum allowable effluent concentration as follows:

$$(C_e)\text{max} = C_a + (S_a)\text{min}\ (C_c - C_a) \qquad \text{B-62}$$

where:

$(C_e)_{max}$ = Maximum allowable effluent concentration such that water quality criteria are not exceeded
C_c = Applicable water quality criterion
$(S_a)_{min}$ = Minimum expected initial dilution.

The maximum observed effluent concentration can then be compared to the predicted allowable concentration. This approach can be used for any conservative constituent. Thus, if other specific limits exist such as for color, effects due to the discharge can be determined as shown in Equations B-61 and B-62.

COLIFORM BACTERIA

Standards may exist for total or fecal coliform bacteria or enterococci and are usually expressed as a mean or median bacteria count and a maximum limit that cannot be exceeded by more than 10 percent of the samples. If the effluent is continuously disinfected using chlorination or an equivalent process, analyses for coliform bacteria may be needed only to verify the effectiveness of disinfection. If disinfection is done part of the year, analyses should be representative of conditions when the effluent is not so treated. The chemicals used, quantities, and frequency of use should be provided along with a discussion of the reliability of the system.

The coliform bacteria count at the completion of initial dilution due to the discharge can be estimated as follows:

$$B_f = B_e / S_a \qquad \text{B-63}$$

where:

B_e = Effluent coliform bacteria count, MPN/100 mL
S_a = Initial dilution.

As a conservative approach, the maximum effluent count and the lowest initial dilution should be used. If onshore currents occur only during a particular season, the coliform count at the completion of initial dilution can be estimated using the lowest initial dilution appropriate for that season. Effluent coliform data should be submitted to support the applicant's values. The

predicted value can be compared with the appropriate standard at the ZID boundary. This value can also be used to estimate the bacteria concentration at specific locations away from the ZID.

Because different limits may apply to specific areas (e.g., shellfish-harvesting areas, beaches, diving areas), the maximum bacteria count at a specified distance from the discharge may be of concern. This bacteria count can be estimated in a manner analogous to the estimation of the BOD exerted as the wastefield spreads out from the ZID. The maximum bacteria count at the centerline of the wastefield can be estimated as a function of distance from the discharge as follows:

$$B_x = B_a + \frac{B_f - B_a}{D_s D_b} \qquad \text{B-64}$$

where:

B_x = Bacteria count at distance x from ZID, #/100 mL
B_a = Affected ambient bacteria count immediately upcurrent of diffuser, #/100 mL
B_f = Bacteria count at completion of initial dilution, #/100 mL
D_s = Dilution attained subsequent to initial dilution at distance x
D_b = "Dilution" due to dieoff of bacteria caused by the combined effects of exposure to seawater and sunlight.

When $x = 0$, $B_x = B_f$. In cases where the background bacteria count is negligible or the effect of the discharge alone is desired, the terms for the ambient bacteria count can be dropped, simplifying Equation B-64 to:

$$B_x = \frac{B_f}{D_s D_b} \qquad \text{B-65}$$

Values for subsequent dilution as a function of $12\varepsilon_o t/B^2$ are shown in Figure B-5. Guidance on methods for estimating subsequent dilution for sites located in narrow estuaries or bays is included in Chapter B-III (Farfield Dissolved Oxygen Demand).

The decay rate of bacteria in the ocean is influenced by water temperature, incident light, salinity, and other factors. As a conservative estimate, the minimum decay rate should be used.

If no violations would occur, then further calculations are not needed. Flocculation and sedimentation can cause an apparent decrease in the coliform count in the water column, but the bacteria are retained in the sediment. Thus, this process is not included in the above approach. If the applicant has information indicating that the decay rate at the discharge site should be a different value, the revised decay rate may be used. The evidence for the revised decay rate, including any data or results of laboratory tests, should be included in the application.

In this report, dieoff due to the combined effects of exposure to saltwater and exposure to sunlight only are considered. The dieoff due to exposure to saltwater, D_{sw}, and the dieoff due to exposure to sunlight, D_{sl}, are (Gameson and Gould 1975):

$$D_{sw} = \exp(k_{sw} t) \qquad \text{B-66}$$

$$D_{sl} = \exp[\alpha I(t)] \qquad \text{B-67}$$

where:

k_{sw}	=	Bacteria decay rate due to exposure to saltwater, 1/h
α	=	Constant, m^2/MJ
I(t)	=	Total intensity of sunlight received by bacteria during the travel time, MJ/m^2
t	=	Travel time, h.

The bacteria dieoff due to the combined effects of saltwater and sunlight is $D_b = D_{sw}D_{sl}$. Gameson and Gould (1975) indicate that $\alpha = 1.24$ m^2/MJ *in situ* for Dorset, England, seawater. The total intensity of sunlight received at the water surface can be measured or can be estimated using site-specific data or general methods (Wallace and Hobbs 1977). If the wastefield is submerged, then the calculation of the total sunlight received should reflect the effect of turbidity on light transmission from the sea surface to the top of the wastefield.

The bacteria decay rate due to exposure to saltwater is known for both coliform bacteria and enterococcus bacteria. For coliform bacteria,

$$k_{sw} = 2.303 \exp[(0.0295T - 2.292)2.303] / h \qquad \text{B-68}$$

where

T = water temperature (in degrees Celsius), based on field measurements at Bridport (Dorset, England) (Gameson and Gould 1975).

The enterococcus bacteria dieoff rate due to exposure to saltwater is:

$$k_{sw} = 0.5262 / (24\ h) \qquad \text{B-69}$$

at a temperature of 20 °C (Hanes and Fragala 1967). [It should be noted that Hanes and Fragala (1967) determined that k_{sw} for coliform bacteria is 0.0424/h at 20 °C, a value slightly smaller than the value of 0.0457/h at 20 °C based on the formula from Gameson and Gould (1975).]

The estimated coliform count at the location of interest should be compared to the applicable standard. If a violation is predicted, the water quality standards may require that the approximate frequency should be discussed based on the percentage or likelihood of currents transporting the wastefield in the direction of interest.

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APPENDIX C
BIOLOGICAL ASSESSMENT

BIOLOGICAL ASSESSMENT

Because benthic infauna are sedentary and must adapt to pollutant stresses or perish, this assemblage is often used to define the spatial extent and magnitude of biological impacts in the vicinity of sewage discharges. The general changes in benthic community structure and function that occur under conditions of organic enrichment of the sediments (e.g., due to municipal sewage effluent) have been well documented (Pearson and Rosenberg 1978). Table C-1 lists biological assessment documents developed to support the activities of the 301(h) program. Slight to moderate enrichment results in slight increases in number of species, abundance, and biomass of benthic communities (see Figure 3 in main text), while species composition remains unchanged. As enrichment increases, the number of species declines because less tolerant species are eliminated. The total abundance of organisms increases as a few species adapted to disturbed environments or organically enriched sediments become very abundant. When enrichment levels are optimal for those few species, they become extremely abundant and overwhelmingly dominate the benthic community (corresponding to the "peak of opportunists" shown in Figure 3). Biomass generally decreases, however, because many of those opportunistic species are small. Further organic enrichment of the sediments drastically reduces the number of species and the abundance of benthic organisms as conditions become intolerable for most taxa.

TABLE C-1. TECHNICAL SUPPORT AND GUIDANCE DOCUMENTS FOR BIOLOGICAL ASSESSMENT

Document	EPA Document Number
Recommended biological indices for 301(h) monitoring programs.	EPA 430/9-86-002
Bioaccumulation monitoring guidance: 1. Estimating the potential for bioaccumulation of priority pollutants and 301(h) pesticides discharged into marine and estuarine waters.	EPA 503/3-50-001
Bioaccumulation monitoring guidance: 2. Selection of target species and review of available bioaccumulation data. Volume I.	EPA 430/9-86-005
Bioaccumulation monitoring guidance: 2. Selection of target species and review of available bioaccumulation data. Volume II.	EPA 430/9-86-006
Bioaccumulation monitoring guidance: 3. Recommended analytical detection limits.	EPA 503/6-90-001
Bioaccumulation monitoring guidance: 4. Analytical methods for U.S. EPA priority pollutants and 301(h) pesticides in tissue from estuarine and marine organisms.	EPA 503/6-90-002
Bioaccumulation monitoring guidance: 5. Strategies for sample replication and compositing.	EPA 430/9-87-003

Because the model developed by Pearson and Rosenberg (1978) has been shown to be valid in many benthic environments, it is often instructive to examine the abundance of species that the authors identify as opportunistic or pollution-tolerant. Those data, in conjunction with the applicant's data on numbers of species, total abundance, and biomass at stations in the vicinity of the outfall, are often sufficient to determine the relative degree of impact within and beyond the ZID.

Comparable models that describe changes in the structure and function of plankton and demersal fish communities in organically enriched receiving environments have not yet been developed. However, it may be instructive to examine the scientific literature that is available for the biogeographic region in which the outfall is located. That literature often contains information describing the responses of the local fauna and flora to organic materials and other pollutants, and identifying opportunistic and pollution-tolerant species. Such information is extremely useful for interpreting data collected in the vicinity of the outfall.

A variety of analytical tools can be used to conduct biological comparisons for section 301(h) applications. Applicants can analyze the data graphically or statistically or can use other mathematical tools such as multivariate analyses (e.g., classification and ordination procedures). Graphical analyses can be especially useful for presenting data in an easily understood format.

In Figure C-1, data on numbers of species in each replicate sample at stations in the vicinity of an outfall have been plotted to show the range of reference values in comparison with values at within-ZID, ZID-boundary, nearfield, and farfield stations. These data may be tested statistically to determine those test stations at which mean values differ from mean values at either reference station or both. Even without such tests, however, the data in Figure C-1 clearly indicate that a gradient of effects occurs near the outfall. Relative to reference conditions, numbers of species are depressed at the within-ZID and downcurrent ZID-boundary stations, and may be depressed at the nearfield and upcurrent ZID-boundary stations.

Graphical analyses are especially useful for presenting data on the physical characteristics of the habitat. For example, it is often instructive to plot water column or substrate characteristics in relation to distance from the outfall (see Figures C-2 and C-3). Gradients of effects (as in Figure C-3) are often revealed in such simple presentations. An especially useful method for presenting data on sediment grain size distributions that has proven useful in analyses of 301(h) data was developed by Shepard (1954). Sediments are classified by the proportions of their three major grain-size categories (Figure C-4). Sand, silt, and clay are often the most useful categories. However, the gravel, sand, and mud (silt plus clay) categories are useful where sediments are relatively coarse. [See Shepard (1963) for information on sediment grain size scales.]

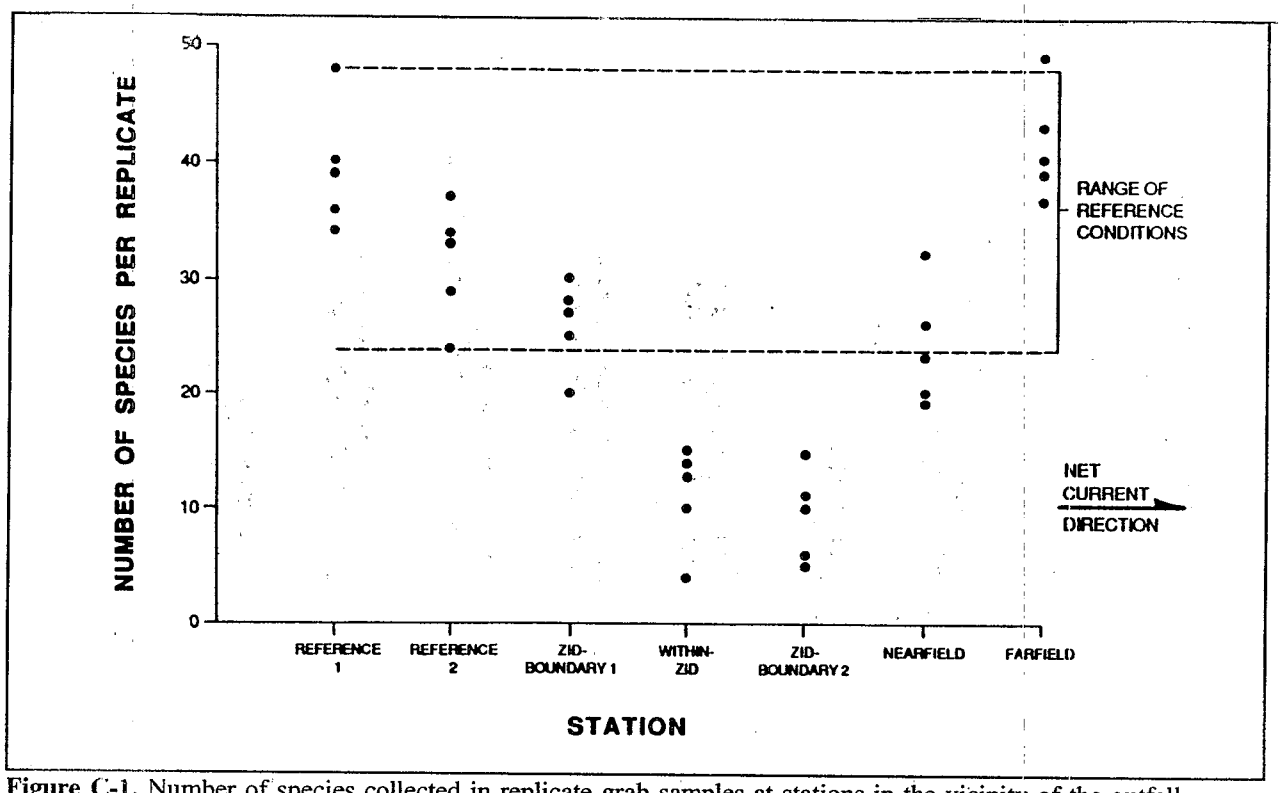

Figure C-1. Number of species collected in replicate grab samples at stations in the vicinity of the outfall.

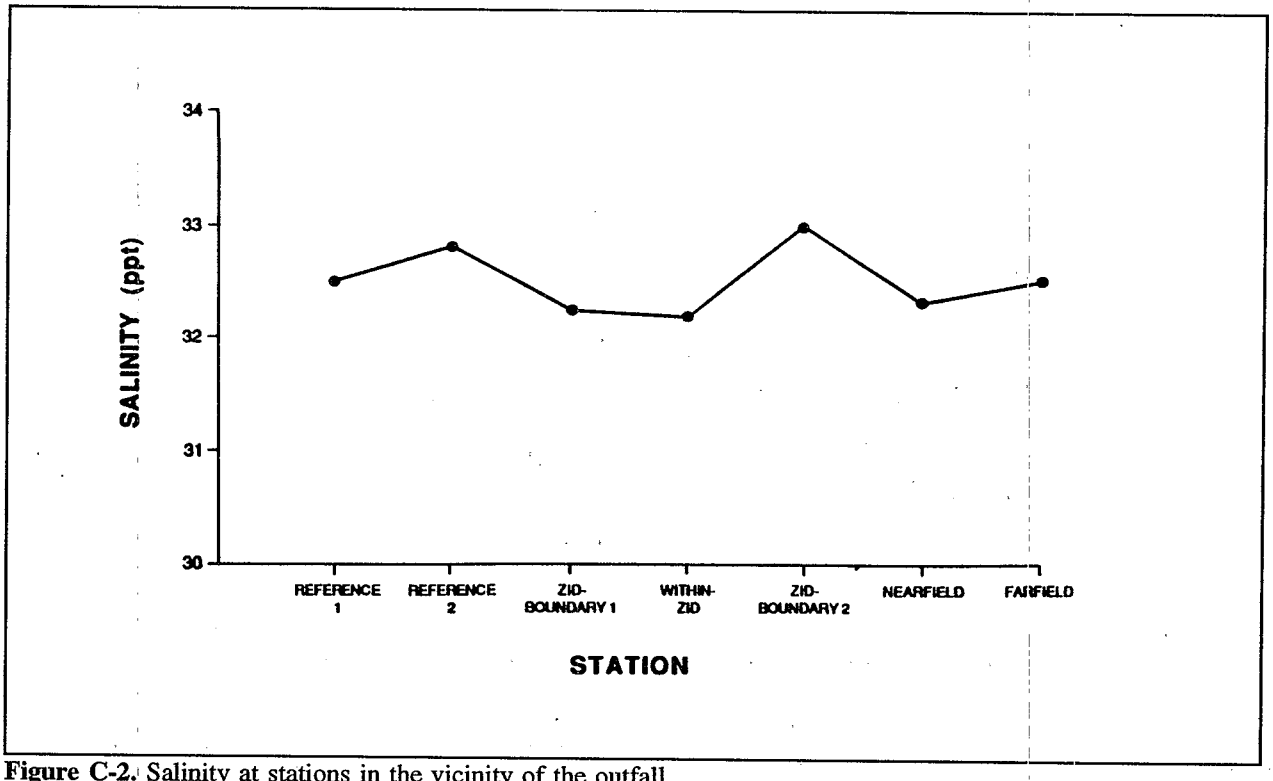

Figure C-2. Salinity at stations in the vicinity of the outfall.

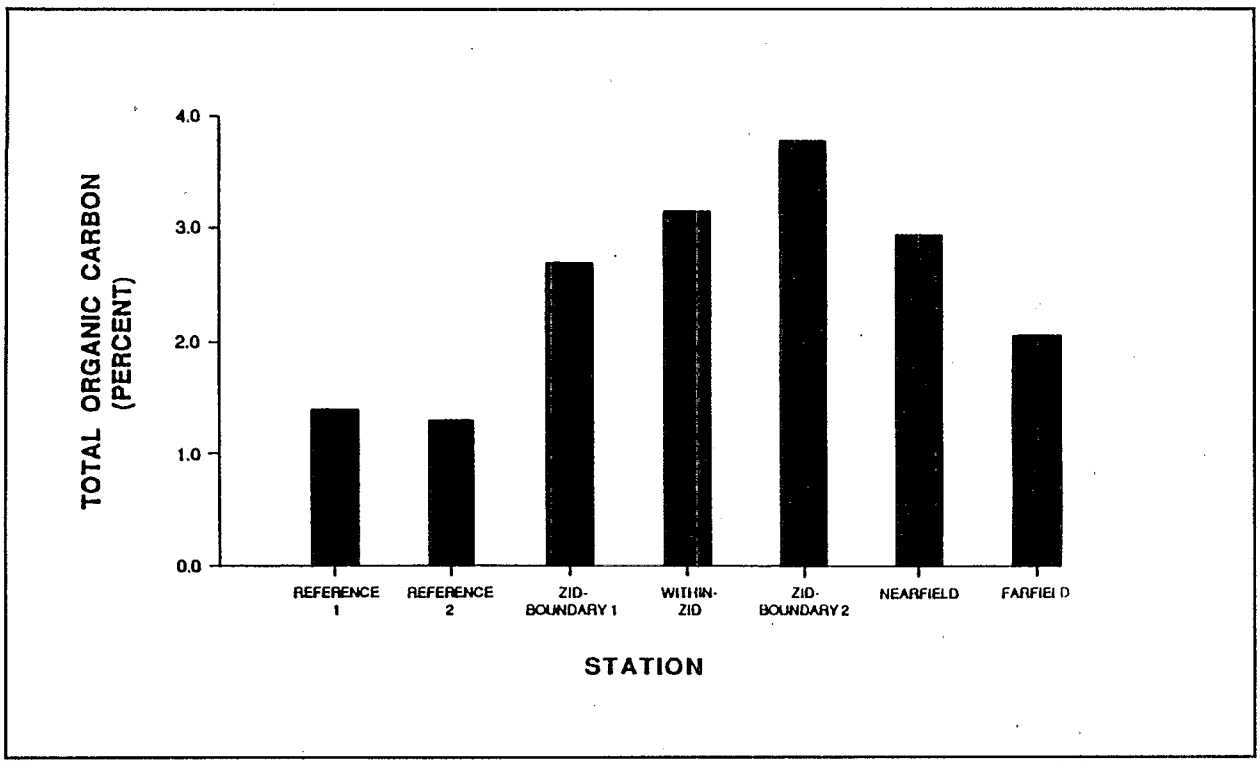

Figure C-3. Total organic carbon content of the sediments at stations in the vicinity of the outfall.

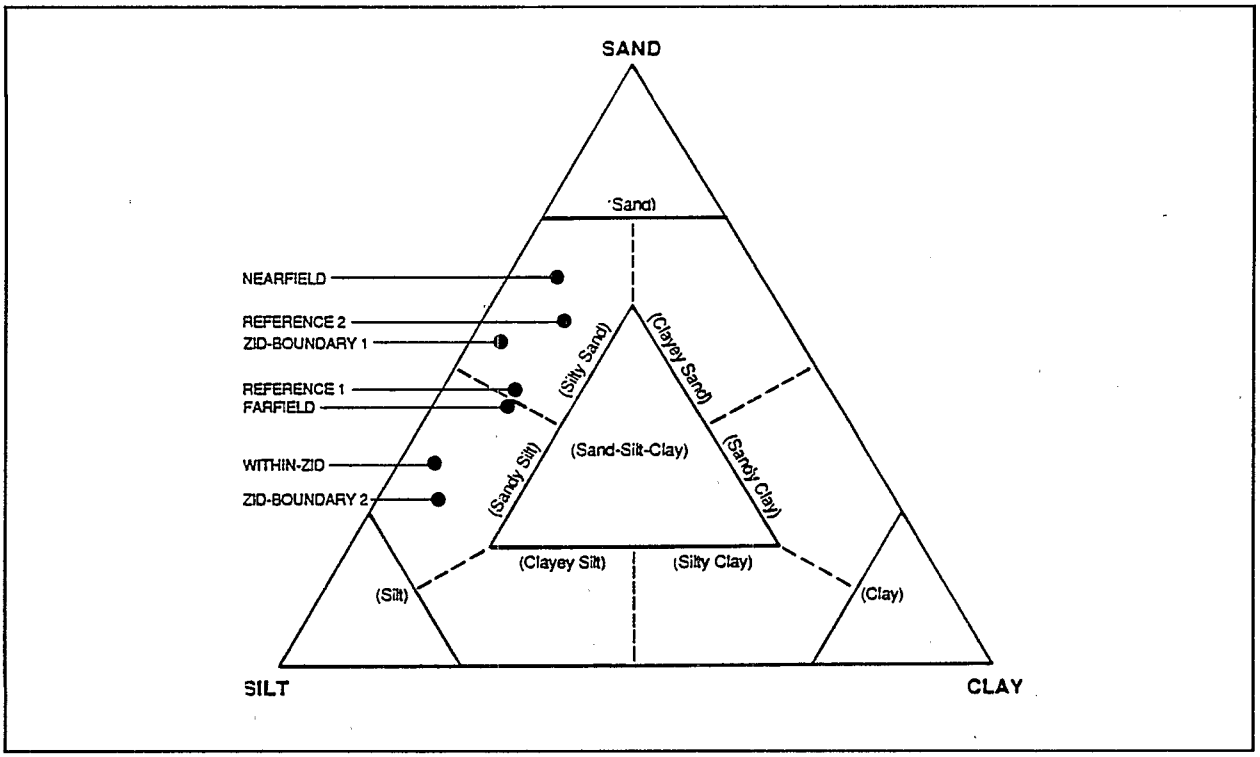

Figure C-4. Sediment grain size characterization at stations in the vicinity of the outfall.

Statistical tests are among the most effective tools for comparing biological communities among stations. A variety of statistical tests are available, the most widely used of which is one-way analysis of variance (ANOVA). ANOVA and other statistical tests have been used extensively for biological comparisons in the 301(h) program, but they have often been used improperly. For this reason, procedures for conducting statistical comparisons using biological data are discussed briefly below. Applicants are encouraged to consult references on biostatistics (e.g., Zar 1974, Sokal and Rohlf 1981) for more specific guidance on the application of these procedures.

The use of one-way ANOVA for biological comparisons is preferred because ANOVA is an efficient and robust test. ANOVA compares the mean values of a given variable among stations (or groups of stations) for the purpose of detecting significant differences at a predetermined probability level. ANOVA requires a minimum of three replicate values at each station to estimate the mean value and associated variance.

ANOVA is a parametric test based on three assumptions: (1) the error of an estimate is a random normal variate, (2) the data are normally distributed, and (3) the data exhibit homogeneous variances. Corrections for the first are not easily achieved, and an erroneous assumption can greatly affect the results of the test. Fortunately, error estimates in survey data are usually independent.

ANOVA is relatively robust with respect to the assumption that the data are normally distributed. Substantial departures from normality can occur before the value of the F-statistic is affected greatly (Green 1979). For this reason, tests for normality are not usually conducted before data are analyzed using ANOVA.

The third assumption, that variances are homogeneous, is critical to execution of ANOVA. Heterogeneous variances can greatly affect the value of the F-statistic, especially in cases where the statistical design is unbalanced (i.e., where numbers of replicate values vary among the stations or station groups being tested).

Several tests are available to determine whether variances are homogeneous. The Fmax test (see Zar 1974, Sokal and Rohlf 1981) and Cochran's C test (Winer 1971) are both appropriate, although the latter is preferred because it uses more of the information in the data set. Bartlett's test is not recommended because it is overly sensitive to departures from normality (Sokal and Rohlf 1981).

When sample variances are found to differ significantly ($P<0.01$), a transformation should be applied to the data. [A more conservative probability level (e.g., $P<0.05$) should be used when the statistical design is unbalanced. ANOVA is sensitive to unbalanced statistical designs.] Sokal and Rohlf (1981) describe several transformations that may be used. Because ANOVA on transformed data is usually a more efficient test for detecting departures from the null hypothesis than is the Kruskal-Wallis test (the nonparametric analog of ANOVA), the Kruskal-Wallis test should be used only when the appropriate transformation fails to correct for heterogeneous variances (Sokal and Rohlf 1981). The Kruskal-Wallis test requires a minimum of five replicate values per station because it is a test of ranks.

When ANOVA or a Kruskal-Wallis test is performed, significant differences ($P<0.05$) among individual stations or groups of stations may be determined using the appropriate *a posteriori* comparison. Of most importance in 301(h) demonstrations are differences among reference stations and stations within the ZID, at the ZID boundary, and beyond the ZID. It is primarily these comparisons on which determination of the presence or absence of a balanced indigenous population is based.

Classification analyses (e.g., cluster analyses) have also been used extensively in the 301(h) program. In the normal classification mode, stations are grouped by the attributes of the assemblages that occur there (e.g., species composition and abundance). This type of analysis is very useful for identifying the stations that are the most similar and least similar to one another in fauna and/or flora. Because biological communities respond to organic materials and other pollutants, stations at which pollutant impacts are occurring typically cluster together in interpretable groups. Inverse classification analysis, in which taxa are grouped by the stations at which they co-occur, is also helpful because it defines assemblages that are characteristic of different levels and types of pollutant impacts.

Classification analysis involves two analytical steps: (1) calculation of a matrix of similarity values for all possible station pairs and (2) grouping of stations based on those between-station similarity values. Many similarity indices and clustering strategies are available to perform these two tasks (see Boesch 1977, Green 1979, Gauch 1982, Pielou 1984, Romesburg 1984). However, only the Bray-Curtis similarity index and either the group average clustering strategy (i.e., the unweighted pair-group method using arithmetic averages) or the flexible sorting strategy has been used commonly in 301(h) demonstrations. Their continued use is recommended. The Bray-Curtis index is easily understood and has been used widely in ecological studies. Moreover, two comparisons of similarity indices (i.e., Bloom 1981, Hruby 1987) have shown it to be superior to many of the other commonly used resemblance measures. Both

the group average clustering strategy and the flexible sorting strategy are recommended because they produce little distortion of the original similarity matrix. [See U.S. EPA (1985) for additional rationale on the use of these three indices.]

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APPENDIX D
NAVIGATIONAL REQUIREMENTS AND METHODS

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NAVIGATIONAL REQUIREMENTS AND METHODS

The information presented below addresses navigational requirements and methods for section 301(h) dischargers. It summarizes more detailed discussions in U.S. EPA (1987, 1988).

MONITORING STATION LOCATIONS

Compliance with conditions of a secondary treatment variance requires monitoring at a site-specific array of sampling locations. The types of stations usually specified in 301(h) monitoring programs are depicted in Figure D-1. Positioning accuracy is most critical for the within-ZID and ZID-boundary stations (Stations Z_0, Z_1, Z_2 in Figure D-1). Applicants must be able to sample at a specific boundary location on any given occasion and to return to nearly the same location on subsequent trips. At gradient (G_1, G_2, G_3, G_4) and control or reference (C_1) stations, initial accurate location is not as critical. However, it is important to relocate these stations accurately during subsequent surveys to enable quantification of temporal changes in the variables sampled (e.g., benthic community characteristics). This requirement for high repeatable accuracy also applies to stations in or near special habitats (H_1, H_2). The ability to conduct sampling at the appropriate depth contour is also very important. Sampling programs for 301(h) typically include the requirement that a bottom sampling station can be relocated to within 10 m (32.8 ft).

ACCURACY LIMITATIONS

Both the procedures and equipment used to establish a navigational position contribute errors that affect the overall accuracy of a fix. Absolute or predictable accuracy is a measure of nearness to which a system can define a position by latitude and longitude (Bowditch 1984). Repeatable or relative accuracy is a measure of a system's ability to return the user to a given position with coordinates that were previously measured with the same system. The difference between these two accuracies can be substantial. For example, depending on one's location in the coverage area, Loran-C has a repeatable accuracy in offshore areas of 15-90 m (49-295 ft), but an absolute accuracy of 185-463 m (607-1,519 ft) (Dungan 1979). In many instances, repeatable accuracy is more important than absolute accuracy (e.g., retrieval of crab pots, return to desirable fishing grounds, avoidance of underwater obstructions, and reoccupation of reference stations).

For coastal outfall monitoring, both repeatable and absolute accuracy can be important, depending on the type of sampling site. For within-ZID and ZID-boundary stations, both accuracies are important because sampling stations must be located within or very near the

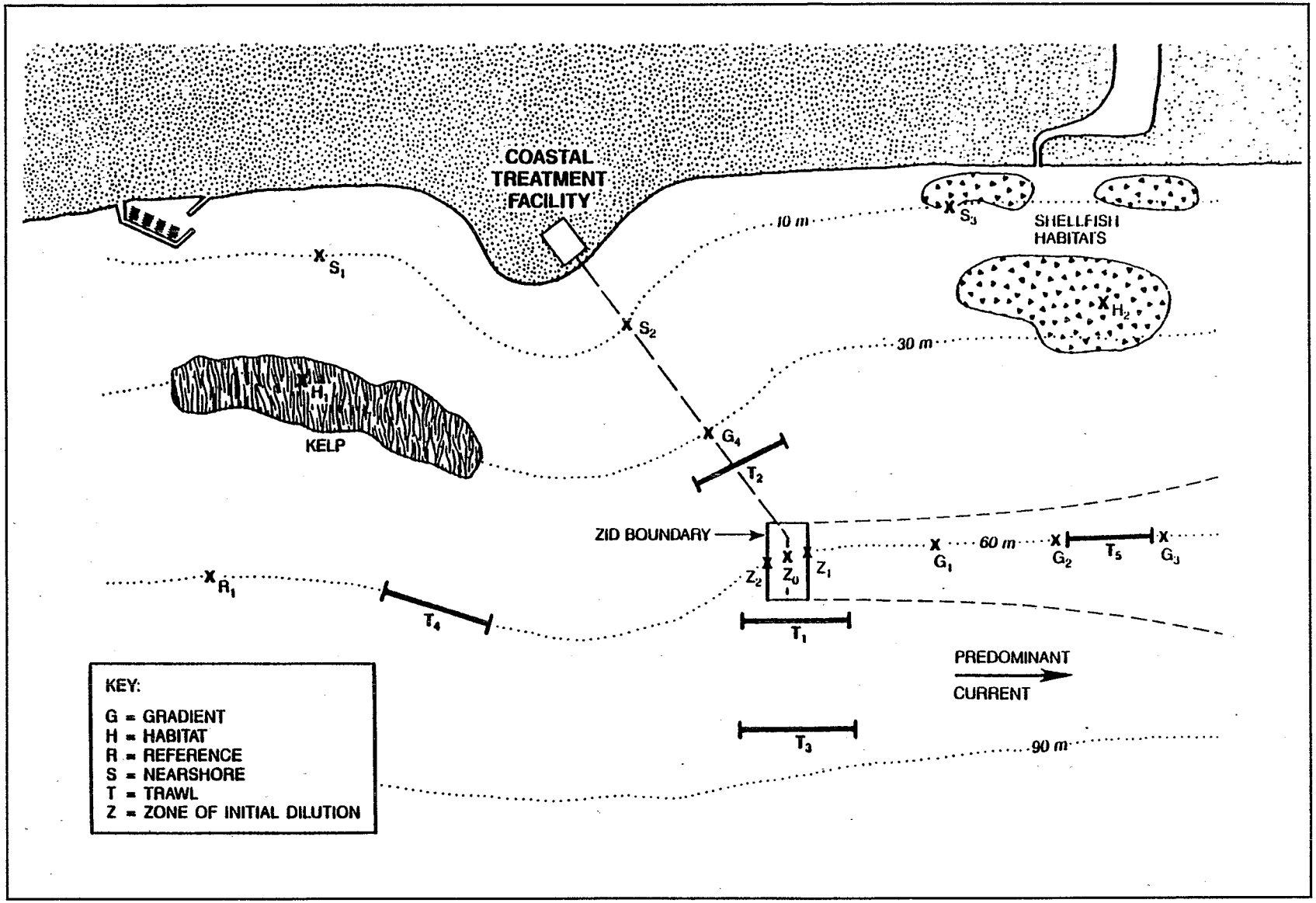

Figure D-1. Examples of some key 301(h) monitoring station locations for a medium-large marine municipal discharge.

boundary and must be repeatedly occupied during the program. For gradient, special habitat, and reference stations, repeatable accuracy is more important than absolute geographic location. Once such a station is established within a special habitat, it is often necessary to return to the same site to identify temporal variations in the previously sampled biological community. Thus, it is important to select navigational procedures and equipment with both the absolute and repeatable accuracies needed to meet the monitoring program objectives.

Because repeatable accuracy of navigational equipment is usually at least 1 order of magnitude better than absolute accuracy, the latter frequently limits the overall positioning accuracy of a sampling vessel during coastal monitoring programs. Therefore, the following discussion focuses on absolute accuracies that can be achieved by various procedures and associated equipment.

Practical considerations also limit the accuracy of an offshore positional fix. Resolution of a position to better than 1-2 m (3.3-6.6 ft) becomes meaningless when measuring the location of a moving vessel (e.g., during trawling) or a vessel that is on station but pitching and rolling. Antenna movement alone usually precludes higher resolution in position coordinates. Exceptions to this rule can occur when conditions are unusually calm.

POSITIONING ERROR

Many factors contribute to the total error in position of the water column or benthic sampling point. These factors include movement or drift of the "on-station" vessel, offsets between the deployment point of sampling equipment and the navigational system antenna, offsets between the deployment point and the subsurface location of the sampling or profiling equipment, and error in the ship's initial location. Most of these factors are site- or operationally specific and can be estimated with varying degrees of confidence. Because the accuracy to which the actual sampling point is known is highly dependent on all these factors, they should be carefully considered in both the design and conduct of monitoring programs.

A ZID-boundary error proportional to some percentage of the ZID dimension has been selected as the controlling parameter for 301(h) navigational requirements. Because ZID size is proportional to water depth, the allowable error in position is also proportional to depth. For example, ZID-boundary stations can be located at a distance from the diffuser axis equal to one-half the ZID width plus 20 percent of the water depth at mean tide level. The allowable maximum error in the location of these stations can then be ±20 percent of the water depth. As a result, the closest to the diffuser that sampling would occur is at the ZID boundary, and the farthest from the diffuser that sampling would occur is 40 percent of the water depth beyond this

boundary. Nominally, however, sampling would be performed within a distance from the ZID boundary equal to 20 percent of the water depth. Example ZID-boundary station locations using this approach for a variety of ZID sizes are listed in Table D-1. The ZID-boundary and sampling station locations for discharges at the 100-, 60-, and 20-m (328-, 197-, and 66-ft) depths are shown in Figure D-2.

When discharge depths are less than approximately 15 m (49 ft), the 20 percent error allowance results in an overly restrictive positional error [i.e., less than ±3 m (9.8 ft)]. Therefore, a positioning error of ±3 m (9.8 ft) is considered to be more appropriate when sampling station depths are less than 15 m (49 ft). Although the percent error as a function of water depth increases at shallower depths, this minimum error is considered reasonable given available navigating techniques for small sampling vessels in other than extremely calm waters. Stations beyond the ZID may be similarly located using the 20 percent of depth rule beyond the 15-m (49-ft) contour and the ±3-m (9.8-ft) error limitation for shallower locations. As indicated earlier, it is recognized that the ability to reoccupy a given site can be as important as knowing its exact geographical location. However, relocation beyond the ZID probably will not be a problem if the same navigational equipment used to locate ZID-boundary stations is also used elsewhere.

TABLE D-1. EXAMPLE ZID-BOUNDARY STATION LOCATIONS

Average Diffuser Depth (m)	Average Diffuser Diameter (m)	ZID Width (m)	Recommended Station Location[a] (m)	Recommended Allowable Error[b] (m)
100	4.0	204.0	122.0	±20
90	3.6	183.6	109.8	±18
80	3.4	163.4	87.7	±16
70	3.2	143.2	85.6	±14
60	3.0	123.0	73.5	±12
50	2.5	102.5	61.3	±10
40	2.2	82.2	49.1	±8
30	2.0	62.0	37.0	±6
20	1.8	41.8	24.9	±4
15	1.5	31.5	18.8	±3
10	1.5	21.5	13.8	±3
5	1.0	11.0	8.5	±3
3	0.5	6.5	6.3	±3

[a]Distance from the zone of initial dilution centerline to the station, based on 0.5 times the ZID width plus 20 percent of the average water depth of the diffuser when over 15 m (49 ft).
[b]Error magnitude is equal to ±20 percent of the average diffuser depth when over 15 m (49 ft).

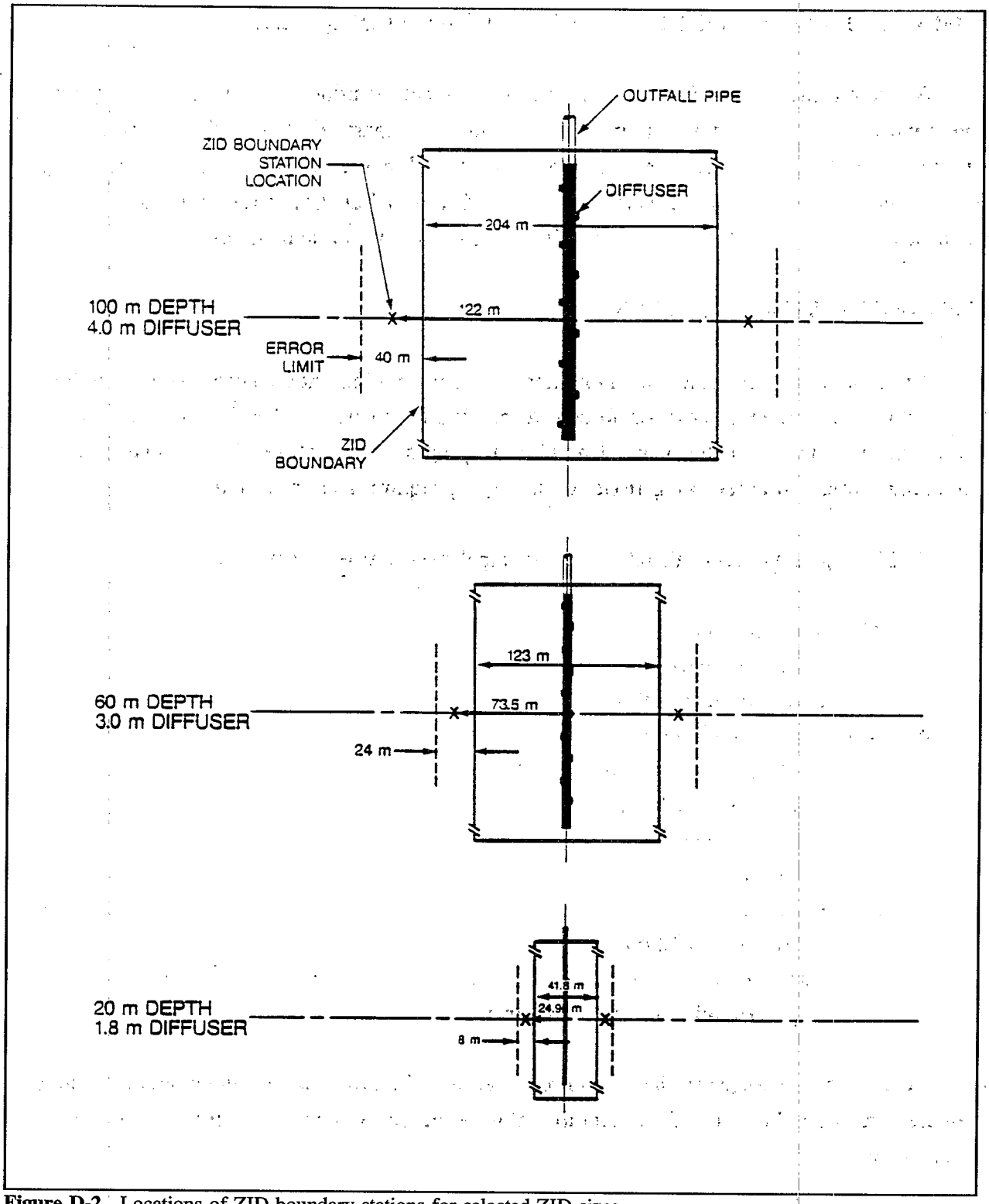

Figure D-2. Locations of ZID-boundary stations for selected ZID sizes.

SUMMARY OF RECOMMENDED PROCEDURES AND EQUIPMENT

Based on the U.S. EPA's evaluation of optional positioning methods, the systems recommended for coastal positioning include theodolites, sextants, electronic distance measuring instruments (EDMIs), total stations, and microwave and range-azimuth systems. Although satellite systems offer adequate accuracy (when used in a differential mode), their use may be limited because a sufficient number of satellites might not always be available.

CANDIDATE SYSTEM SELECTION

The details of positioning techniques and associated equipment are described in U.S. EPA (1988). No single system is best for all coastal monitoring purposes. Needs vary according to the size and complexity of the planned monitoring program, the nature of the immediate and surrounding areas, and other navigational or surveying requirements of a municipality.

Positioning techniques fall into three principal measurement categories:

- Multiple horizontal angles
  - Theodolite intersection
  - Sextant angle resection
- Multiple electronic ranges
  - Distance-measuring instruments
  - Range-range mode
  - Hyperbolic mode
  - Satellite ranging
- Range and angle
  - Theodolite and EDMI
  - Total station
  - Range-azimuth navigation systems

Systems within these categories that will meet or exceed the positional accuracy recommended herein are summarized in Table D-2. Additional information on the recommended categories is provided below.

TABLE D-2. SUMMARY OF RECOMMENDED SYSTEMS

Category	Representative Equipment[a]	Accuracy	Advantages	Disadvantages
Theodolite	Table B-1 Table B-2	10-30 sec ±1 m (3.3 ft)	Traditional method. Inexpensive. High accuracy. Successfully applied. Restricted areas.	Line-of-sight. Two manned shore stations. Simultaneous measurements. Limits on intersection angles. Area coverage; station movement.
Sextant	Table B-3	±10 ±2 m (6.6 ft)	Rapid. Easy to implement. Most widely used. Low cost. No shore party. High accuracy.	Simultaneous measurement of two angles. Target visibilities location, maintenance. Line-of-sight. Best in calm conditions. Limits on acceptable angles.
EDMI	Table B-4	1.5-3.0 cm	Extremely accurate. Usable for other surveying projects. Cost. Compact, portable, rugged.	Motion and directionality of reflectors. Visibility, unless microwave. Two shore stations Ground wave reflection.
Total stations	Table B-5	5-7 cm	Single onshore station. Other uses. Minimum logistics.	Reflector movement and directionality. Prism costs.
Microwave navigation systems	Table B-6	±1-3 m	No visibility restrictions. Multiple users. Highly accurate. Radio line-of-sight.	Cost. Multiple onshore stations Logistics. Security.
Range-azimuth systems	Table B-10	0.01° and 0.5 m	High accuracy. Single station. Circular coverage.	Single user. Cost.
Satellite systems	Table B-9	1-10 m	High accuracy. Minimum (initial units)logistics. Use in restricted/congested areas. Future cost. No shore stations.	Current coverage. Initial development cost.

[a] Table references refer to U.S. EPA (1987).

Multiple Horizontal Angles

In the multiple horizontal angles category, theodolites were found to have the angular accuracies required for the maximum ranges anticipated. They are relatively inexpensive, and they are readily available because they are widely used as a surveying instrument. At least two theodolites, two operators, a vessel siting target, and a three-way communications link to coordinate fixes are required. Visibility can be a limiting factor.

By comparison, sextant angle resection can be performed using one instrument if the vessel is stationary or using two instruments simultaneously if the vessel is moving. Achievable angular accuracy of ±10 seconds is adequate, and relatively inexpensive sextants are readily

available. Again, visible range can be limiting. Shooting an accurate fix from a nonstationary platform in any significant sea or swell could be more difficult than shooting with theodolites from shore. A distinct advantage of sextant angle resection is location of the navigators on the survey vessel. The method usually requires highly visible shore targets and a three-arm protractor for plotting positions.

Multiple Electronic Ranges

Positioning using multiple ranges can be accomplished with two staffed EDMI stations. Accuracies were found to be more than adequate, but ranges were found to be marginal [if needed beyond 3 km (1.9 mi)] unless multiple prisms are used. Because such prisms are directional, procurement of multiple clusters for more than one direction could result in substantial additional costs. Limitations include geometry of shore stations; position of the vessel in the coverage area (i.e., crossing angle limitations); and possible interferences due to line-of-sight obstructions, sea-surface reflective nulls, and land-sea boundaries. The hyperbolic mode provides multiple user capability, but at the cost of an additional shore station.

Satellite ranging holds promise because required accuracies should be achievable in the near future. Transit satellite-based systems do not offer sufficient accuracy, except with multiple passes, and multiple passes are impractical when a given sampling station is occupied only briefly. Accuracies needed will undoubtedly be achievable in the future using differential global positioning system (GPS) techniques.

Range and Angle

Systems in the range-azimuth category show great promise. Required angular and range accuracies are available, only one shore station is needed, and costs depend on system refinements. At the low end of the scale, an EDMI and theodolite could be paired with a communication link. Optical and infrared range limitations apply to these systems. The three range-azimuth navigational systems examined provide sufficient positional accuracy with a single station.

SHALLOW-WATER POSITIONING METHODS

When sampling stations are located in relatively shallow water, they can be identified by relatively inexpensive methods (in addition to those discussed earlier in this report). Provided the center of the ZID over the outfall can be located (e.g., by diver-positioned surface float), an optical range finder can be used to establish the required distances to nearby water quality or

biological sampling stations. An optical range finder is used by simply focusing a split image on the target float, enabling the slant distances to the target to be read from the instrument scale. When combined with a careful compass reading, this distance reading allows positioning of the sampling vessel.

A survey of accuracies claimed for commercially available instruments suggests that the ±3-m (9.8-ft) recommended minimum accuracy can be achieved for ranges up to approximately 100 m (328 ft) from the surface target. The Lietz Model 1200, for example, provides an accuracy of ±1 m (3.3 ft) at 100 m (328 ft). Beyond this distance, instrumental errors increase rapidly. For the instrument cited, a ±9 m (29.5 ft) accuracy is quoted at 300 m (984 ft).

An acceptable alternative method for collecting bottom samples from desired locations in shallow water is to use divers. If visibility is adequate, divers can measure radial distances to desired locations by holding a tape at the outfall and traversing the appropriate distance over the bottom in the proper direction.

Visual ranges have sometimes been used to establish a station position. This method requires that a minimum of two objects are in alignment, enabling the vessel to be placed on a common axis extending to the vessel's position. Simultaneous siting on a second set of at least two objects places the vessel at the intersection of the two common axes. The accuracy of each visual range is highly dependent on the quality of the visual range (e.g., alignment), the distance from the alignment objects to the vessel, and the angle between the ranges. Also, the number of visual ranges used affects the magnitude of the positional error. Although this technique is frequently used for positioning single sampling stations in bays, harbors, and other areas in which two or more conveniently alignable targets can be selected, the method is not considered acceptable for coastal monitoring at ZID-boundary stations. Also, it is not likely that a sufficient number of alignment target pairs will be present for all desired locations. In addition, the unpredictability of repeatable position error detracts from the value of this method.

Permanent installation of a marker buoy at the outfall terminus or midpoint of the diffuser allows easy return to this point on subsequent sampling trips. Using the previously discussed range-finder technique or a line of desired length enables positioning at desired distances from the marker buoy. It is not uncommon, however, to lose such a buoy due to vandalism, impact, or severe weather conditions. Therefore, it is necessary that the sampling party be prepared to relocate the outfall (e.g., by diver, sonar, or pinger mounted on the outfall itself) if location of stations is dependent on knowledge of the outfall location.

Because the techniques described here are inexpensive to implement (as is use of the sextant resection or theodolite intersection method), they are attractive to small coastal municipalities. However, use of more sophisticated and less labor-dependent techniques may be achievable at moderate costs by renting or leasing, rather than buying, such equipment.

USE OF LORAN-C

In its evaluation of positioning methods, U.S. EPA (1987) concluded that Loran-C did not provide the absolute and repeatable accuracies needed for the 301(h) program. However, because Loran-C is in such wide use and is relatively inexpensive, use of Loran-C in a special operating mode was reexamined in *Evaluation of Differential Loran-C for Positioning in Nearshore Marine and Estuarine Waters* (U.S. EPA 1988). The special operating mode, called differential Loran-C, requires an additional Loran-C receiver onshore at a known geographic location. At this location, the Loran-C signals are received, and a correction is generated and transmitted to the survey vessel, allowing the correction to be applied to signals received by the ship's Loran-C unit.

Use of differential Loran-C was found to significantly improve the positional accuracies achievable with Loran-C in the normal mode. During a simulated monitoring program near Newport Beach, California, normal Loran-C positional errors of 40-50 m (131-164 ft) were reduced to 7-15 m (23-49 ft) using differential Loran-C in conjunction with special vessel-operating procedures, a video display, and data-averaging techniques. Higher accuracies are expected in other coastal areas where improved lattice line crossing angles occur. Acceptability may depend on relative orientations of the diffuser and the error ellipse axes (Figure D-3, Table D-3). For those considering use of differential Loran-C, a procedure for determining the error in a ZID-boundary station location is provided in U.S. EPA (1988).

SYSTEM SELECTION PROCEDURE

A procedure for selecting an appropriate navigation system is described in detail in U.S. EPA (1987). The procedure involves definition of positioning requirements, establishment of screening criteria (e.g., range, accuracy, availability, and costs), review of candidate systems, and evaluation of purchase/lease options. As indicated in Figure D-4, a stepwise screening technique is recommended to identify an optimal system for a given monitoring program. At each step in the screening process, systems that cannot achieve the required criterion are removed from further consideration.

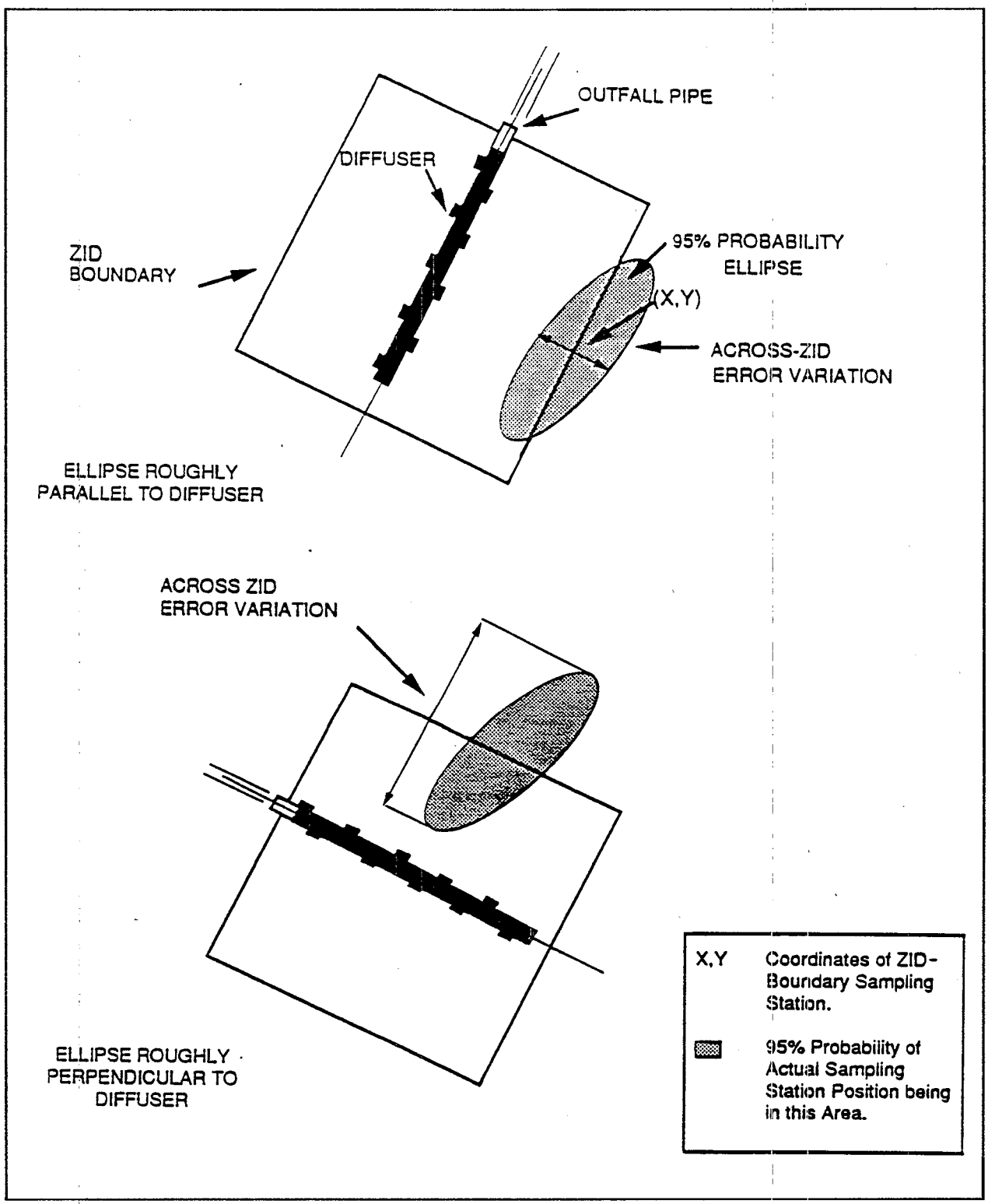

Figure D-3. Examples of differential Loran-C error ellipse orientation at a ZID-boundary sampling station.

TABLE D-3. THEORETICAL ERROR ELLIPSES OF DIFFERENTIAL LORAN-C FOR VARIOUS U.S. LOCATIONS

Location	Approximate Direction of Major Axis	Length of Major Axis[a]	Length of Minor Axis[a]
Anchorage, AK	NW/SE	70	20
Puget Sound, WA	NW/SE	180	40
San Francisco, CA	NE/SW	60	30
Los Angeles, CA	NE/SW	90	30
San Diego, CA	N/S	90	20
Mississippi Delta, LA	NW/SE	50	20
Panama City, FL	N/S	30	20
Chesapeake Bay, VA	W/E	40	20
Boston, MA	N/S	30	20

[a]Lengths are given to the nearest 10 m based on 95 percent confidence level error ellipses. Standard deviation of time differences is 25 nsec (achievable with differential Loran-C).

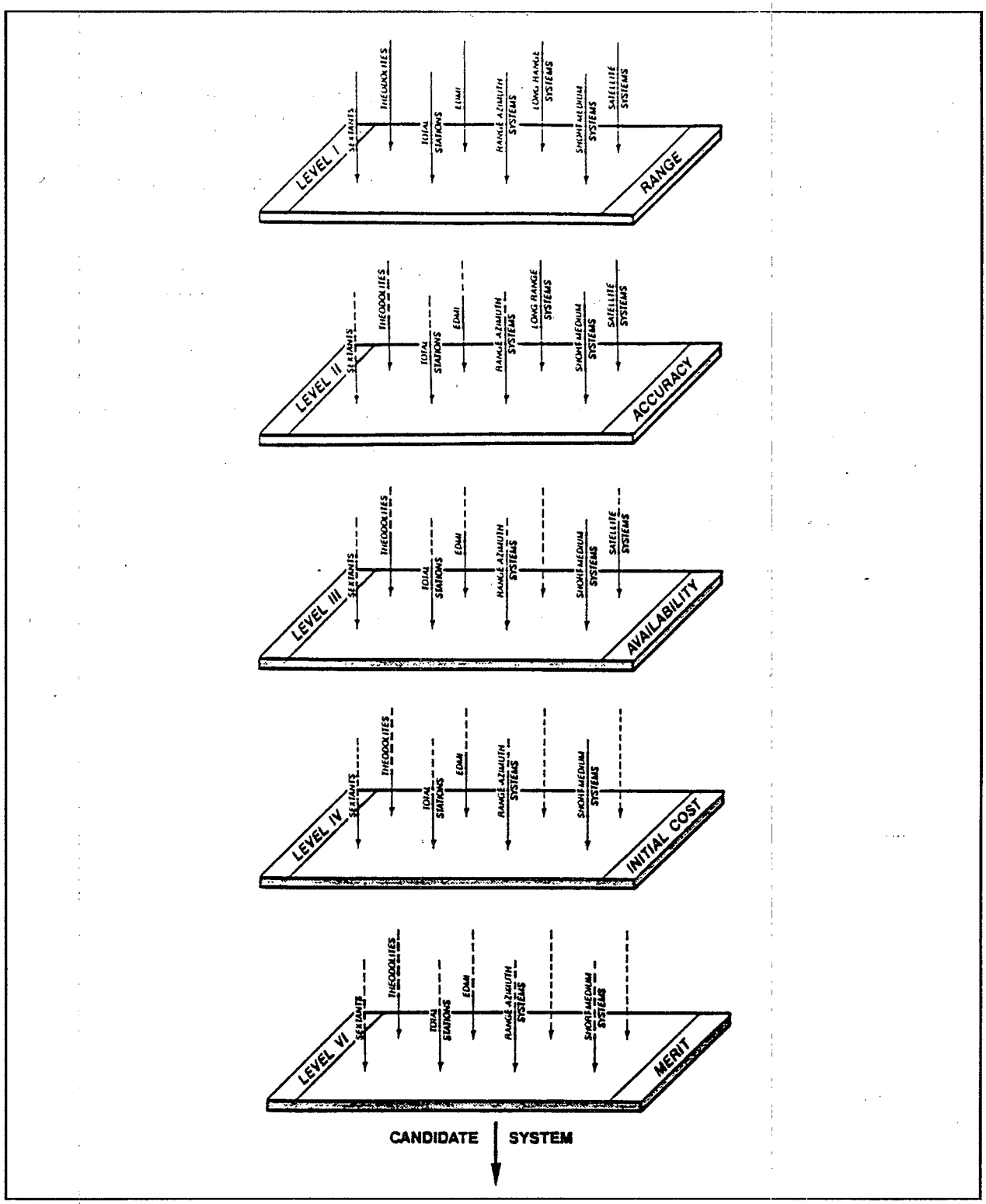

Figure D-4. Navigation system preliminary screening criteria.

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URBAN AREA PRETREATMENT REQUIREMENTS

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INTRODUCTION

Section 303(c) of the Water Quality Act of 1987 amended section 301(h) of the 1977 Clean Water Act by adding the "urban area pretreatment requirements." These requirements apply only to POTWs serving a population of at least 50,000 and only to toxic pollutants introduced by industrial dischargers. For each toxic pollutant introduced by an industrial discharger to an affected POTW, the applicant must demonstrate that it meets one of the following two conditions:

- It has an "applicable pretreatment requirement in effect."
- It achieves "secondary removal equivalency."

This new statutory requirement (§125.65) complements the toxics control program requirements in the section 301(h) regulations (§125.66) and other pretreatment requirements in 40 CFR Part 403.

The purpose of this appendix is to help 301(h) applicants interpret and comply with the new requirement. For site-specific reasons, concepts and procedures recommended herein may not necessarily apply to all 301(h) applicants. Issues that are not addressed by this appendix should be directed to EPA Regional offices. Applicants should also check with appropriate state and local agencies for any explicit requirements (e.g., water quality standards) that apply to them. The procedures to demonstrate compliance with the urban area pretreatment requirements must be formulated and implemented by each applicant with approval from the appropriate EPA Regional office. Compliance with the urban area pretreatment requirements is required before a 301(h) modified permit can be issued by EPA, although tentative approval may be granted on demonstration of the applicant's good faith effort to comply.

When a review of the 301(h) application indicates noncompliance with pretreatment requirements and shows that the applicant is not taking effective steps to ensure compliance, EPA may deny the permit. Factors relevant to such a decision include the number of noncomplying industrial sources, the nature of their toxic pollutant contribution to the POTW, and potential or actual POTW interference or pass-through.

For urban area POTWs with significant numbers of industrial users, at any given time it is reasonable to expect that at least one or more of those users might be out of compliance. EPA intends to determine a POTW's continuing eligibility for a 301(h) waiver under section 301(h)(6)

by measuring industrial user compliance and POTW enforcement activities against existing criteria in the Agency's National Pretreatment Program. In 1989, EPA established criteria for determining POTW compliance with pretreatment implementation obligations. One element of those criteria is the level of significant noncompliance of the POTW's industrial users. The General Pretreatment Regulations (40 CFR Part 403) identify the circumstances when industrial user noncompliance is significant. The industrial user significant noncompliance (SNC) criteria are set out in 40 CFR 403.8(f)(2)(vii) and address both effluent and reporting violations.

In enforcing the pretreatment programs, POTWs are expected to respond to industrial user noncompliance using local enforcement authorities in accordance with an approved enforcement response plan (ERP), which is required of all approved pretreatment programs (see 40 CFR 403.5). POTWs, including 301(h) POTWs, with greater than 15 percent of their users in SNC, or which fail to enforce appropriately against any single industrial user causing pass-through or interference, are deemed to be failing to enforce their pretreatment programs. Thus, the POTW is also deemed to be in SNC.

EPA will base its determination on data collected during site visits to the POTW and from the POTW's pretreatment program performance report required by 40 CFR 403.12(i). This report includes compliance information on industrial users gathered by the POTW as well as a description of the enforcement activities of the POTW. EPA believes that the combination of industrial user compliance and POTW enforcement provides an appropriate measurement of the POTW's eligibility for the 301(h) waiver under section 301(h)(6).

The process that an applicant must follow to achieve compliance is based on guidelines established by EPA's pretreatment program. The U.S. EPA Office of Wastewater Management (OWM) and Office of Science and Technology (OST) have issued the following guidance manuals to assist POTWs in implementing pretreatment regulations and developing technically based local limits:

- *Fate of Priority Toxic Pollutants in Publicly Owned Treatment Works* (U.S. EPA 1982d);
- *Guidance Manual for POTW Pretreatment Program Development* (U.S. EPA 1983a);
- *Procedures Manual for Reviewing a POTW Pretreatment Program Submission* (U.S. EPA 1983b);

- *NPDES Compliance Inspection Manual* (U.S. EPA 1984a);
- *Guidance Manual for Implementing Total Toxic Organics (TTO) Pretreatment Standards* (U.S. EPA 1985a);
- *Guidance Manual for the Use of Production-Based Pretreatment Standards and the Combined Wastestream Formula* (U.S. EPA 1985b);
- *Pretreatment Compliance Monitoring and Enforcement Guidance* (U.S. EPA 1986a);
- *Guidance Manual for Preventing Interference at POTWs* (U.S. EPA 1987a);
- *Guidance for Reporting and Evaluating POTW Noncompliance with Pretreatment Implementation Requirements* (U.S. EPA 1987b);
- *Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program* (U.S. EPA 1987c);
- *Supplemental Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program: Residential and Commercial Toxic Pollutant Loadings and POTW Removal Efficiency Estimation* (U.S. EPA 1991a); and
- *Training Manual for NPDES Permit Writers* (U.S. EPA 1993a).

CHARACTERIZATION OF DISCHARGE AND SELECTION OF APPROACH

Figure E-1 presents an overview of the process and decision points that the applicant should follow to comply with the urban area pretreatment requirements. Next to each step in the process are page numbers indicating sections in this appendix that explain the procedures for that step. Under the urban area pretreatment provisions, the applicant must select one of two basic approaches to demonstrate compliance:

- The Applicable Pretreatment Requirement Approach or
- The Secondary Removal Equivalency (Pilot Plant) Approach.

Figure E-1 presents the Applicable Pretreatment Requirement Approach in detail. Figures illustrating the details of the Pilot Plant Approach will be presented later in this appendix. There is a first step common to both approaches. Prior to making the selection, the applicant should adequately *characterize the industrial users* discharging waste to the POTW, as well as conduct representative sampling of the POTW *influent, effluent,* and *sludge* to identify any and all toxic pollutants introduced by industrial sources.

INDUSTRIAL WASTE SURVEY

A comprehensive survey of industrial users is critical to characterizing the types and concentrations of toxic pollutants being discharged to the POTW. All industrial users, including major or significant industries (including categorical users) and minor industries, including noncategorical users (small industries and some commercial users), should be included in the industrial waste survey (IWS). A typical IWS may require submission of some or all of the following information from each industrial user:

- Name
- Address
- Standard Industrial Classification (SIC) code
- Wastewater flow
- Types and concentrations of pollutants in discharge(s)

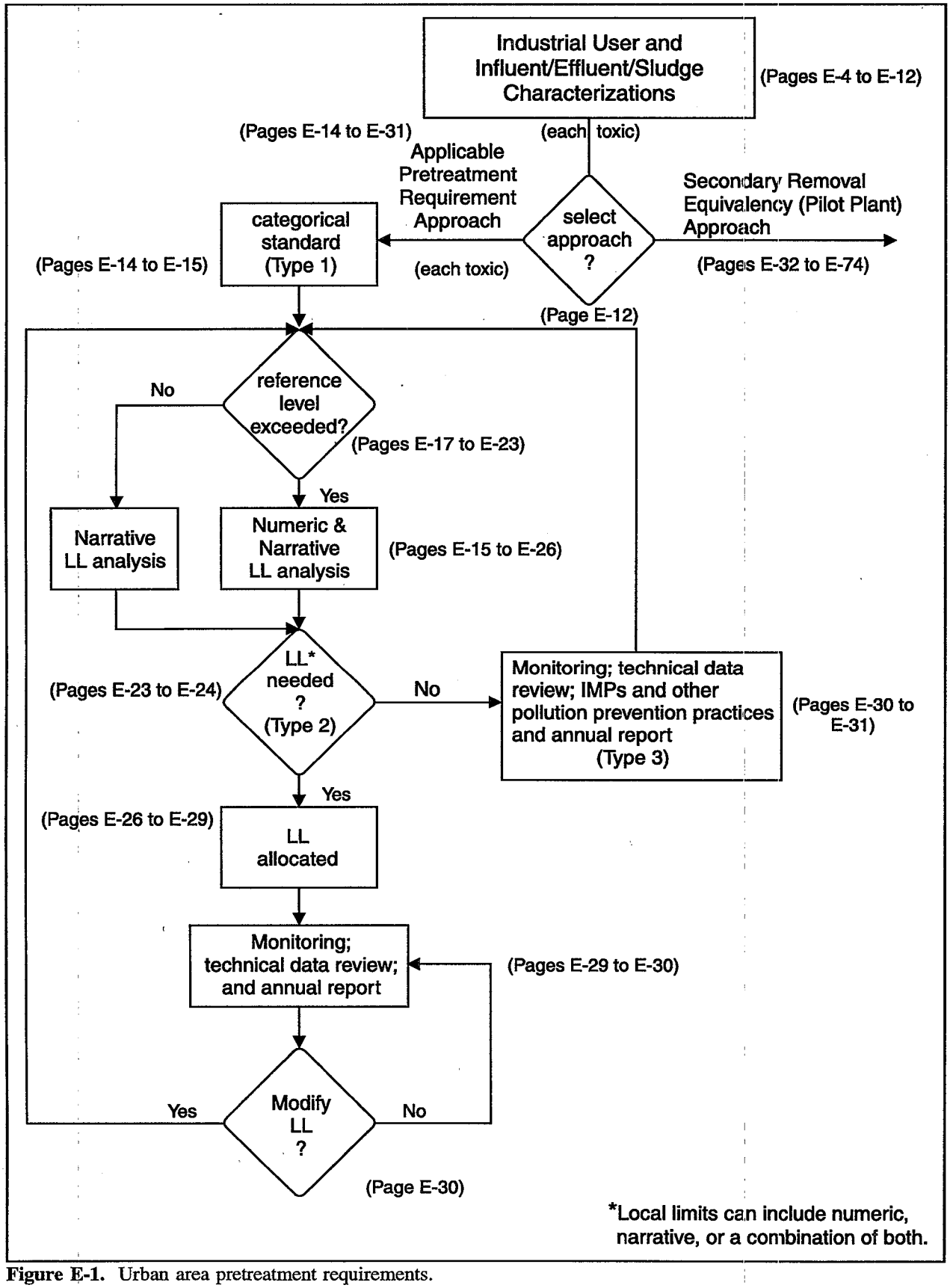


Figure E-1. Urban area pretreatment requirements.

- Major products manufactured and/or services rendered
- Locations of discharge points
- Process diagram and/or descriptions
- An inventory of raw feedstocks, including periodically used solvents, surfactants, pesticides, etc.
- Results of inspections, including documentation of spills, compliance history, general practices
- Treatment processes and management practices, such as spill prevention plans and solvent management plans, employed
- Discharge practices, such as batch versus continuous, variability in waste constituent concentrations and types, discharge volume
- Pollutant characteristics data (i.e., including carcinogenicity, toxicity, mutagenicity, neurotoxicity, volatility, explosivity, treatability, biodegradability, bioaccumulative tendency).

It is likely that this information has already been developed as part of the POTW's industrial pretreatment program. The IWS should be comprehensive and up-to-date, however, at the time the 301(h) application is submitted for review. Guidance on conducting an IWS is provided in Chapter 2 of EPA's *Guidance Manual for POTW Pretreatment Program Development* (U.S. EPA 1983a) and in Chapter 2 of *Guidance on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program* (U.S. EPA 1987c). IWS data may be reviewed in conjunction with the pollutant occurrence matrix provided in Table E-1. This table relates specific industries with the toxic pollutants commonly expected to occur with them. Other sources of information that will aid the POTW in identifying pollutants of concern are provided in the EPA guidance manuals listed on pages E-2 and E-3.

A classification scheme should be developed to assist in establishing a monitoring plan and conducting any local limits analyses. Industrial users can be initially grouped according to the following three broad categories (U.S. EPA 1983a):

TABLE E-1. POLLUTANT OCCURRENCE IN INDUSTRIAL WASTEWATER

	Adhesives	Aluminum Forming	Auto & Other Laundries	Battery Manufacturing	Coal Mining	Coil Coating	Copper Forming	Dye Manufacturing	Electrical & Electronic Components	Electroplating/Metal Finishing	Explosives Manufacturing	Foundries	Gum & Wood Chemicals	Hospitals	Inorganic Chemicals	Iron & Steel	Laboratories	Leather Tanning & Finishing	Mechanical Products	Non-Ferrous Metals	Ore Mining & Dressing	Organic Chemicals	Paint & Ink	Pesticides	Petroleum Refining	Pharmaceuticals	Photographic Supplies	Plastics & Synthetics	Plastics Processing	Porcelain Enameling	Printing & Publishing	Pulp, Paper, & Fiberboard	Rubber Manufacturing	Soaps & Detergents	Steam Electric	Stone, Clay, Glass, & Concrete Products	Textile Mills	Timber Products
Acenaphthene																						●			●														
Acenaphthylene																●						●														●			
Acrylonitrile																								●				●										
Aldrin																								●														
Anthracene			●		●				●		●					●						●			●							●					●	
Antimony					●			●							●	●	●			●							●							●			●		
Arsenic					●				●					●	●		●	●		●			●	●		●		●								●		●
Barium							●				●									●			●										●					
Benzo(a)anthracene																●			●						●													
Benzene					●			●	●					●			●		●	●		●	●					●										
Benzo(b)fluoranthene																						●			●													
Benzo(k)fluoranthene																●																						
Benzo(a)pyrene																				●		●			●													
Benzo(g,h,i)perylene																																						
Beryllium									●		●								●																			
Bis(2-chloroethoxy)methane																		●																				
Bis(2-ethylhexyl)phthalate		●			●							●								●		●		●				●								●		
Bromoform																																						
Bromomethane (methyl bromide)																						●																
Butyl benzyl phthalate		●										●								●		●						●										
Cadmium			●		●		●	●	●	●		●			●					●		●							●							●		
Carbon disulfide									●													●		●				●										
Carbon tetrachloride		●																	●			●	●															
Chlordane																								●														
p-Chloro-m-cresol																																					●	
Chlorobenzene					●				●													●		●														
Chlorodibromomethane																																						
Chloroethane (ethyl chloride)									●					●			●					●		●														

TABLE E-1. (Continued)

	Adhesives	Aluminum Forming	Auto & Other Laundries	Battery Manufacturing	Coal Mining	Coil Coating	Copper Forming	Dye Manufacturing	Electrical & Electronic Components	Electroplating/Metal Finishing	Explosives Manufacturing	Foundries	Gum & Wood Chemicals	Hospitals	Inorganic Chemicals	Iron & Steel	Laboratories	Leather Tanning & Finishing	Mechanical Products	Non-Ferrous Metals	Ore Mining & Dressing	Organic Chemicals	Paint & Ink	Pesticides	Petroleum Refining	Pharmaceuticals	Photographic Supplies	Plastics & Synthetics	Plastics Processing	Porcelain Enameling	Printing & Publishing	Pulp, Paper, & Fiberboard	Rubber Manufacturing	Soaps & Detergents	Steam Electric	Stone, Clay, Glass, & Concrete Products	Textile Mills	Timber Products
Chloroform	●	●			●				●								●	●				●		●		●		●	●			●	●					
Chloromethane (methyl chloride)									●					●			●					●		●				●					●		●			
2-Chlorophenol								●	●					●	●							●				●									●			
Chromium	●	●			●	●	●	●	●	●		●	●		●	●		●	●	●		●	●		●	●	●	●		●				●		●	●
Cobalt																																					
Copper	●	●	●		●		●		●	●		●	●		●			●	●	●	●	●	●					●	●	●				●		●	
Cyanide	●					●				●					●	●		●		●	●			●	●	●	●								●		
DDE (dichlorodiphenyl dichloroethylene)																								●													
DDT (dichlorodiphenyl trichloroethane)																								●													
Di-n-butyl phthalate	●	●	●		●				●	●										●		●	●								●	●			●		
Di-n-octyl phthalate																				●		●							●								
Dibromomethane (methylene bromide)																						●															
1,2-Dichlorobenzene								●	●	●				●	●			●				●		●													
1,3-Dichlorobenzene									●									●																			
1,4-Dichlorobenzene									●						●			●				●															
Dichlorobromoethane																				●		●															
Dichlorodifluoroethane									●																			●									
1,1-Dichloroethane																			●	●		●															
trans-1,2-Dichloroethylene					●														●																		
2,4-Dichlorophenol														●								●		●								●	●				
2,4-Dichlorophenoxyacetic acid (2,4-D)																								●									●				
1,2-Dichloropropane																																					
1,3-Dichloropropene																						●		●													
Dieldrin																								●													
Diethyl phthalate	●				●										●				●	●								●				●					
Dimethyl phthalate	●																						●					●									
2,4-Dimethylphenol (2,4-xylenol)																●						●			●								●				
2,4-Dinitrotoluene								●			●				●							●															

TABLE E-1. (Continued)

	Adhesives	Aluminum Forming	Auto & Other Laundries	Battery Manufacturing	Coal Mining	Coil Coating	Copper Forming	Dye Manufacturing	Electrical & Electronic Components	Electroplating/Metal Finishing	Explosives Manufacturing	Foundries	Gum & Wood Chemicals	Hospitals	Inorganic Chemicals	Iron & Steel	Laboratories	Leather Tanning & Finishing	Mechanical Products	Non-Ferrous Metals	Ore Mining & Dressing	Organic Chemicals	Paint & Ink	Pesticides	Petroleum Refining	Pharmaceuticals	Photographic Supplies	Plastics & Synthetics	Plastics Processing	Porcelain Enameling	Printing & Publishing	Pulp, Paper, & Fiberboard	Rubber Manufacturing	Soaps & Detergents	Steam Electric	Stone, Clay, Glass, & Concrete Products	Textile Mills	Timber Products
1,2-Diphenylhydrazine																																					
Endosulfan																								●													
Endrin																								●													
Ethyl benzene	●		●		●				●				●		●			●	●			●	●		●			●				●	●			●	●
Ethylene dibromide (EDB)																						●		●	●												
Ethylene dichloride																																					
Fluoranthene																●			●	●		●			●												
Fluorene																●				●		●			●												●
Heptachlor																								●													
Heptachlor epoxide																								●													
Hexachloro-1,3-butadiene									●															●	●												
Hexachlorobenzene																				●		●		●													
Hexachlorocyclohexane (Lindane)																								●													
Hexachloroethane											●			●								●		●				●						●			
Indeno(1,2,3-cd)pyrene																									●												
Isobutyl alcohol																	●					●	●					●									
Isophorone																							●	●				●									
Lead	●	●	●	●	●		●		●	●	●			●	●	●		●	●	●	●	●	●		●	●	●	●	●	●			●	●		●	
Malathion																								●													
Mercury	●			●	●				●	●				●	●		●			●		●	●		●	●									●	●	
Methoxychlor																								●													
Methyl ethyl ketone																						●						●			●				●		
Methylene chloride	●	●			●				●									●		●		●	●			●	●	●									
4,4-Methylenebis(2-chloroaniline)																												●									
Naphthalene			●		●				●		●	●			●	●		●	●	●	●	●	●		●							●	●				
Nickel		●		●	●				●	●			●		●	●		●	●	●			●			●	●	●		●				●	●		
Nitrobenzene															●							●			●												
2-Nitrophenol									●													●					●										

TABLE E-1. (Continued)

	Adhesives	Aluminum Forming	Auto & Other Laundries	Battery Manufacturing	Coal Mining	Coil Coating	Copper Forming	Dye Manufacturing	Electrical & Electronic Components	Electroplating/Metal Finishing	Explosives Manufacturing	Foundries	Gum & Wood Chemicals	Hospitals	Inorganic Chemicals	Iron & Steel	Laboratories	Leather Tanning & Finishing	Mechanical Products	Non-Ferrous Metals	Ore Mining & Dressing	Organic Chemicals	Paint & Ink	Pesticides	Petroleum Refining	Pharmaceuticals	Photographic Supplies	Plastics & Synthetics	Plastics Processing	Porcelain Enameling	Printing & Publishing	Pulp, Paper, & Fiberboard	Rubber Manufacturing	Soaps & Detergents	Steam Electric	Stone, Clay, Glass, & Concrete Products	Textile Mills	Timber Products
PCB (polychlorinated biphenyls)																				●									●				●					
Pentachloroethane					●																																	
Pentachlorophenol	●																	●	●			●	●	●												●	●
Phenanthrene					●				●		●				●	●				●		●	●		●	●						●				●	●
Phenol	●	●	●						●			●	●			●		●	●	●	●	●	●	●	●	●	●	●				●				●	●
Pyrene														◐		◐			◐	◐		◐										◐					
Pyridine								●						●	●							●		●		●							●				●	
Selenium							●		●						●	●				●							●						●			●	●	
Silver									●	●				●	●		●		●	●							●									●	
1,1,1,2-Tetrachloroethane									●						●							●															
1,1,2,2,-Tetrachloroethane																						●	●				●	●									
Tetrachloroethylene (perchloroethylene)				◐		◐												◐	◐	◐		◐	◐	◐	◐			◐			◐	◐	◐	◐		◐	◐
Tetrachlorophenol									●										●			●	●	●													
Thallium					●				●						●					●				●											●		
Toluene			●		●			●	●		●		●		●			●	●			●	●		●	●	●	●	●				●				●	
Toxaphene																								●													
1,2,4-Trichlorobenzene								●	●											●		●		●							●					●	
1,1,1-Trichloroethane					●				●										●					●								●				●	
1,1,2-Trichloroethane																			●			●						●									
Trichloroethylene	●	●	●											●								●	●	●		●										●	
Trichlorofluoromethane					●			●						●								●															
2,4,5-Trichlorophenol									●						●			●				●		●								●					
2,4,6-Trichlorophenol																		●			●	●		●													
Trichlorophenoxy-2-propionic acid																								●													
Vinyl chloride (chloroethylene)																						●						●									
Vinylidene chloride																			●																		
Zinc	●	●	●	●	●	●	●		●	●		●	●		●	●		●	●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	

Source: U.S. EPA (1987c).

- Group 1: Major or significant industries, defined as:
  - All categorical industrial users;
  - Noncategorical industrial users that discharge a nondomestic waste stream of 25,000 gallons per day (0.025 MGD) or more;
  - Noncategorical industrial users that contribute a nondomestic waste stream that makes up 5 percent or more of the average dry-weather hydraulic or organic (BOD, TSS, etc.) capacity of the treatment plant; or
  - Noncategorical industrial users that have a reasonable potential, in the opinion of the POTW applicant, to adversely affect the POTW treatment plant (inhibition, pass-through of toxic pollutants, sludge contamination, or endangerment of POTW workers).

  These industries would be regulated individually and would most likely have specific effluent limitations (categorical standards, numeric local limits, or both) placed on their discharges. They should also be monitored and inspected periodically to ensure compliance with their limitations.

- Group 2: Minor industrial users, defined as small industries (all noncategorical) and some commercial users (restaurants, auto repair shops, car and truck washes, etc.), as well as any hauled waste and/or landfill leachate, whose individual discharges are not likely to significantly impact the POTW treatment system, degrade receiving water quality, or contaminate sludge, but which have the potential as a group or as subgroups to represent a significant source of toxic pollutants to the POTW. The POTW may choose to apportion numeric local limits among minor industrial users when these industries as a group represent a significant source of toxic pollutants to the POTW; otherwise, the POTW should determine the need to set narrative local limits, which may include industrial management practices and best management practices (such as through a sewer ordinance or general permit) to control and reduce levels of toxic pollutants.

  Industries in this classification should be monitored and inspected periodically to determine whether their status as minor industrial users has changed. EPA's *Supplemental Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program: Residential and Commercial Toxic Pollutant Loadings and POTW*

Removal Efficiency Estimation (U.S. EPA 1991a) provides data on toxic pollutant types and levels for a variety of minor industrial users.

- Group 3: Insignificant industrial users, defined as those industries which do not discharge to the POTW or do not have any reasonable likelihood of discharging a nondomestic waste stream to the POTW. These industries would be randomly monitored to ensure their status has not changed.

REPRESENTATIVE SAMPLING PROGRAM AT POTW

At this point the applicant must conduct sufficient monitoring at the treatment plant to identify and characterize influent, effluent, and sludge concentrations of toxic pollutants. Monitoring of the treatment plant influent, effluent, and sludge should represent a minimum of 5 consecutive days (Monday through Friday), preferably under dry weather conditions (U.S. EPA 1987c). Guidance on sampling techniques and QA/QC requirements are provided later in this appendix. Results of these analyses, along with historic data (if available) and data and information gathered during the IWS, should be tabulated in a summary form that allows the toxic quality of the discharge to be evaluated. The applicant must report all toxic pollutants (40 CFR 401.15) that are identified in any analysis at or above detection limits in the influent, effluent, and sludge as well as toxic pollutants known or suspected to be discharged by industry to the POTW (based on historic data and information collected during the IWS). Sources of detected and/or known or suspected toxic pollutants must be identified and, to the extent practicable, categorized according to industrial and nonindustrial origins, using the results of the IWS.

SELECTION OF APPROACH

Once the toxic pollutants being introduced by industrial sources have been identified, the applicant can choose between two methods to comply with the urban area pretreatment requirements for each toxic pollutant introduced by an industrial source. In the first method, called the Applicable Pretreatment Requirement Approach, the applicant would demonstrate that it has in effect applicable pretreatment requirements for each toxic pollutant discharged to the POTW from an industrial source. Applicable pretreatment requirements may take the form of (1) federal categorical pretreatment standards or (2) local limits developed in accordance with 40 CFR Part 403, or a combination of (1) and (2). A third applicable pretreatment requirement exists where it is determined that local limits are not necessary for a toxic pollutant. In this case, the POTW should implement a program of periodic monitoring and/or technical review of data on

industrial discharges and require industrial management practices plans (IMPs) and other pollution prevention practices where appropriate. The POTW should also determine on an annual basis over the permit term the need to revise local limits and/or demonstrate that there is no need for a local limit for each specific toxic pollutant.

In the second method, called the Secondary Removal Equivalency Approach (Pilot Plant Approach), the applicant would demonstrate that the POTW's treatment process, in combination with pretreatment, removes at least the same amount of that toxic pollutant as would have been removed by secondary treatment (as defined in 40 CFR Part 133) without industrial pretreatment for that toxic pollutant. These methods are detailed in the following sections. The applicant should review these procedures fully prior to selecting the method for addressing the urban area pretreatment requirements for each toxic pollutant introduced by industrial discharges.

APPLICABLE PRETREATMENT REQUIREMENT APPROACH

BACKGROUND AND GENERAL APPROACH

Applicable pretreatment requirements for each toxic pollutant may take the form of categorical standards, local limits (numeric or narrative), or a combination of both. They should include periodic monitoring and technical review of industrial discharges and POTW influent/effluent/sludge to determine the need for revising local limits and/or to demonstrate that there is no need for a local limit for a specific toxic pollutant. When an industrial discharger is subject to both a categorical standard (Type 1) and a local limit for a specific toxic pollutant (Type 2), the more stringent of the two limits applies. For toxic pollutants for which the POTW determines that a local limit is not needed (Type 3), the POTW can show that it has an applicable pretreatment requirement in effect by the following:

(1) Implement a periodic monitoring program and annual technical review of industrial discharges.

(2) Institute industrial management practices plans (IMPs), best management practices (BMPs), and other pollution prevention activities, where appropriate.

(3) Provide a determination on an annual basis of the need to develop local limits and/or to demonstrate that there is no need for a local limit for those toxic pollutants.

Categorical standards (see 40 CFR 403.6) are nationally uniform, technology-based limits developed for specific industries and for specific toxic pollutants. All categorical industries must comply with categorical standards, even if they discharge to a POTW without a federally approved local pretreatment program. By contrast, local limits are developed by the POTW, among other purposes, to prevent interference with the treatment works or pass-through of toxic pollutants, as required by 40 CFR 403.5(b).

A specific categorical industry may be subject to categorical standards for some pollutants and local limits for other pollutants. When both local limits and categorical standards address a particular pollutant for a specific industry, the more stringent requirement applies. Furthermore, local limits for specific toxic pollutants found in the POTW waste stream can apply to both categorical and noncategorical industries when the toxic pollutants cannot be entirely attributed

to categorical industries and/or when categorical standards alone are not sufficient to satisfy the requirements of 40 CFR Part 403.

Local limits (see 40 CFR 403.5) are requirements developed by a POTW based on local conditions and unique requirements at the POTW. These limits are primarily intended to protect the treatment plant from industrial discharges that could interfere with POTW treatment processes or pass through the treatment plant to receiving waters and adversely affect water quality. Local limits are also designed to prevent sludge contamination and protect workers at the treatment POTW.

Under the Applicable Pretreatment Requirement Approach, the applicant must address each toxic pollutant introduced by industry. After conducting a local limits analysis, the POTW may apportion the allocation of the *numeric local limit* (if any) to any number of industrial sources of the toxic pollutant (categorical and/or noncategorical) that the POTW deems appropriate, subject to the approval of the applicable EPA Regional office. Moreover, when it is not appropriate or practical to develop and implement numeric local limits to prevent pollutant pass-through or interference, the EPA pretreatment program has provided for *narrative local limits* (i.e., industrial management and best management practices) as useful supplements to numeric limits. Narrative local limits are most appropriate where management plans are needed to help control or eliminate chemical spills or leaks, slug discharges, or the handling of hazardous or toxic materials from both categorical and noncategorical industries.

For toxic pollutants for which the POTW determines that neither numeric nor narrative local limits are necessary (e.g., categorical or noncategorical industries where not all toxic pollutants discharged require a categorical standard or local limit), a program of periodic POTW monitoring and annual technical review of data on industrial discharges would be conducted by the POTW and, where appropriate, would include industrial management practices plans (IMPs) and other pollution prevention activities. The permit for this latter case will require the applicant to demonstrate on an annual basis over the permit term that a local limit is not necessary and where appropriate will require the applicant to institute IMPs. If such monitoring and technical review of data indicate that a local limit is needed, the POTW shall establish and implement a local limit.

IMPs are intended to minimize the discharge of toxic pollutants to the sewer, or reduce the impact of toxic pollutant discharges by avoiding short-term, high-concentration discharges. IMPs can be applied to all classes of industrial users, e.g., major and minor industrial users. Examples of appropriate uses of IMPs include control of chemical spills and slug discharges to

the POTW through formal chemical or waste management plans (including BMPs), solvent management plans, batch discharge policies, waste recycling, and waste minimization. It would also be appropriate to consider IMPs in cases where the POTW does not include biological treatment processes, or provides less treatment, e.g., primary treatment. In these cases, IMPs can be tailored for industrial sources of toxic pollutants that might otherwise interfere with biological treatment or would be degraded or removed through additional treatment.

POTWs must demonstrate that the local limits developed are adequate and enforceable. Section 301(h)(6) and §125.65(b)(2) also require POTWs to demonstrate that industrial sources are in compliance with all of their pretreatment requirements, including numerical standards set by local limits, and that those requirements will be enforced (see previous discussion regarding compliance and enforcement).

U.S. EPA PROCEDURES FOR DEVELOPING TECHNICALLY BASED LOCAL LIMITS

Details on the various approaches for developing technically based local limits are provided in U.S. EPA's *Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program* (December 1987) (hereafter called "EPA's Local Limits Guidance"). Questions about this guidance should be directed to the U.S. EPA Regional Pretreatment Coordinators or to EPA's Office of Wastewater Management in Washington, DC.

Several methods are available to develop local limits, including the Maximum Allowable Headworks Loading (MAHL) Method, the Collection System Approach, Industrial User Management Practice Plans, and Case-by-Case Permitting (U.S. EPA 1987c). The Collection System Approach is most appropriate to address pollutants that may cause air releases or explosive conditions or may otherwise endanger POTW worker health and safety. Case-by-Case Permitting is based on best professional judgment and is most appropriate where data on pollutant effects are insufficient to use other methods (e.g., the MAHL method or Collection System Approach). It largely relies on pollutant removal efficiencies and economic achievability data for pollution control from comparable industries/discharges.

The predominant approach used by POTWs and advocated in EPA's Local Limits Guidance is a chemical-specific approach known as the Maximum Allowable Headworks Loading (MAHL) Method. This method involves back-calculating from environmental and plant protection criteria to a maximum allowable headworks loading. This is accomplished pollutant by pollutant for each environmental criterion or plant requirement, and the lowest or most

limiting value for each pollutant serves as the basis for allocation to industry and ultimate numeric local limits. Industrial User Management Practices Plans may be used in conjunction with the MAHL method through narrative local limits to address toxic pollutants and/or industries for which numeric local limits may not be applicable or adequate alone to achieve control of toxic chemical discharges. Narrative local limits may be required because the nature of the industrial activity (slug discharges, chemical handling, etc.) requires pollution prevention activities to ensure adequate control of accidental or haphazard toxic chemical releases. Narrative local limits are discussed later and in Attachment 1 to this appendix. The steps of the MAHL method are discussed below.

Maximum Allowable Headworks Loading Method

a) Determine Pollutants of Concern (U.S. EPA 1987c)--

The first step of the MAHL method is to determine the pollutants of concern. Prior to this step, the applicant will have completed the IWS and will have identified the toxic pollutants that its industrial users are reasonably expected to be discharging to the POTW. The applicant should then design a sampling and monitoring program that is thorough enough to verify the actual concentration levels of toxic pollutants expected to be discharged in significant quantities and broad enough to detect any toxic pollutants that were not detected by the IWS or representative sampling activities. Before designing the sampling program, the POTW may want to review environmental quality criteria/effects data for pollutants that are potentially of concern (U.S. EPA 1987c). The applicant should perform at least one priority pollutant scan and one RCRA Appendix 9 scan (refer to Tables E-2 and E-3, respectively) to identify potential pollutants of concern in the influent, effluent, and sludge.

Figure E-2 is a detailed decision diagram of one possible approach for determining pollutants of concern that may require numeric local limits through the MAHL method (U.S. EPA 1987c). This approach is based primarily on analysis of the POTW's influent, with limited effluent and sludge sampling to screen for pollutants that may not be detectable in the influent but may have been concentrated in the effluent or sludge. Figure E-2 provides a series of reference levels that POTWs can use in assessing influent wastewater data and determining the need to proceed with a headworks analysis. These reference levels, provided as guidance for each of the protection criteria, are intended to be conservative in order to account for the daily fluctuations in pollutant loadings experienced by POTWs and for the fact that decisions are usually made on the basis of limited data. The reason for emphasizing the use of influent data in this example in which only limited effluent and sludge data are used is to conserve resources

TABLE E-2. LIST OF PESTICIDES AND TOXIC POLLUTANTS

Pesticides

- Demeton
- Guthion
- Malathion
- Methoxychlor
- Mirex
- Parathion

Toxic Pollutants[a]

Chlorinated Benzenes
- Chlorobenzene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2,4-Trichlorobenzene
- Hexachlorobenzene

Chlorinated Ethanes
- Chloroethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- Hexachloroethane

Chlorinated Phenols
- 2-Chlorophenol
- 2,4-Dichlorophenol
- 2,4,6-Trichlorophenol
- 4-Chloro-3-methyl phenol

Other Chlorinated Organics
- Chloroform (trichloromethane)
- Carbon tetrachloride (tetrachloromethane)
- bis(2-chloroethoxy)methane
- bis(2-chloroethyl)ether
- 2-Chloroethyl vinyl ether (mixed)
- 2-Chloronaphthalene
- 3,3-Dichlorobenzidine
- 1,1-Dichloroethylene
- trans-1,2-dichloroethylene
- 1,2-Dichloropropane
- 1,2-Dichloropropylene (1,3-dichloropropene)
- Tetrachloroethylene
- Trichloroethylene
- Vinyl chloride (chloroethylene)
- Hexachlorobutadiene
- 2,3,7,8-Tetrachloro-dibenzo-p-dioxin (TCDD)

Haloethers
- 4-Chlorophenyl phenyl ether
- 2-Bromophenyl phenyl ether
- bis(2-Chloroisopropyl) ether

Halomethanes
- Methylene chloride (dichloromethane)
- Methyl chloride (chloromethane)
- Methyl bromide (bromomethane)
- Bromoform (tribromomethane)
- Dichlorobromomethane
- Chlorodibromomethane

Nitrosamines
- N-Nitrosodimethylamine
- N-Nitrosodiphenylamine
- N-Nitrosodi-n-propylamine

Phenols (other than chlorinated)
- 2-Nitrophenol
- 4-Nitrophenol
- 2,4-Dinitrophenol
- 4,6-Dinitro-o-cresol (4,6-dinitro-2-methylphenol)
- Pentachlorophenol
- Phenol
- 2,4-dimethylphenol

Phthalate Esters
- bis(2-Ethylhexyl)phthalate
- Butyl benzyl phthalate
- Di-n-butyl phthalate
- Di-n-octyl phthalate
- Diethyl phthalate
- Dimethyl phthalate

Polynuclear Aromatic Hydrocarbons (PAHs)
- Acenaphthene
- 1,2-Benzanthracene (benzo(a)anthracene)
- 3,4-Benzo(a)pyrene (benzo(a)pyrene)

TABLE E-2. (Continued)

PAHs (continued)
- 3,4-Benzofluoranthene (benzo(b)fluoranthene)
- 11,12-Benzofluoranthene (benzo(k) fluoranthene)
- Chrysene
- Acenaphthalene
- Anthracene
- 1,12-Benzoperylene (benzo(g,h,i)perylene)
- Fluorene
- Fluoranthene
- Phenanthrene
- 1,2,5,6-Dibenzanthracene (dibenzo(a,h) anthracene)
- Indeno(1,2,3-cd)pyrene (2,3-o-phenylene pyrene)
- Pyrene

Pesticides and Metabolites
- Aldrin
- Dieldrin
- Chlordane (technical mixture and metabolites)
- alpha-Endosulfan
- beta-Endosulfan
- Endosulfan sulfate
- Endrin
- Endrin aldehyde
- Heptachlor
- Heptachlor epoxide (BHC-hexachlorocyclohexane)
- alpha-BHC
- beta-BHC
- gamma-BHC (Lindane)
- delta-BHC
- Toxaphene

DDT and Metabolites
- 4,4-DDT
- 4,4-DDE (p,p-DDX)
- 4,4-DDD (p,p-TDE)

Polychlorinated Biphenyls (PCBs)
- PCB-1242 (Arochlor 1242)
- PCB-1254 (Arochlor 1254)
- PCB-1221 (Arochlor 1221)
- PCB-1232 (Arochlor 1232)
- PCB-1248 (Arochlor 1248)
- PCB-1260 (Arochlor 1260)
- PCB-1016 (Arochlor 1016)

Other Organics
- Acrolein
- Acrylonitrile
- Benzene
- Benzidine
- 2,4-Dinitrotoluene
- 2,6-Dinitrotoluene
- 1,2-Diphenylhydrazine
- Ethylbenzene
- Isophorone
- Naphthalene
- Nitrobenzene
- Toluene

Inorganics
- Antimony
- Arsenic
- Asbestos
- Beryllium
- Cadmium
- Chromium
- Copper
- Cyanide, total
- Lead
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

[a]Source: U.S. EPA 1993b.

TABLE E-3. RESOURCE CONSERVATION AND RECOVERY ACT (RCRA)
APPENDIX 9 CONSTITUENTS

Acenaphthene
Acenaphthylene
Acetone
Acetonitrile
2-Acetylaminofluorene
Acrolein
Acrylonitrile
Aldrin
alpha-BHC
4-Aminobiphenyl
Aniline
Anthracene
Antimony (6010)
Aramite
Arsenic (7061)
Barium (6010)
Benzene
Benzo[a]anthracene
Benzo[a]pyrene
Benzo[b]fluoranthene
Benzo[g,h,i]perylene
Benzo[k]fluoranthene
Benzyl alcohol
Beryllium (6010)
beta-BHC
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-Ethylhexyl)phthalate
Bromodichloromethane
Bromoform
Bromomethane
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
2-sec-Butyl-4,6-dinitrophenol
Cadmium (6010)
Carbon disulfide
Carbon tetrachloride
4-Chlorophenyl phenyl ether
Chlordane
2-Chloro-1,3-butadiene
p-Chloro-m-cresol
p-Chloroaniline
Chlorobenzilate
Chlorodibromomethane
Chlorobenzene
Chloroethane
Chloroform
2,4-Dimethylphenol
4,6-Dinitro-o-cresol
Chloromethane
2-Chloronaphthalene
2-Chlorophenol
3-Chloropropene
Chromium (6010)
Chrysene
Cobalt (6010)
Copper (6010)
o, m, p-Cresol
Cyanide (9010)
2,4-D
4,4-DDD
4,4-DDE
4,4-DDT
Di-n-butyl phthalate
Di-n-octyl phthalate
Di-n-propylnitrosamine
Diallate
Dibenzofuran
Dibenz[a,h]anthracene
1,2-Dibromo-3-chloropropane
Dibromoethane
Dibromomethane
trans-1,4-Dichloro-2-butene
3,3-Dichlorobenzidine
m-Dichlorobenzene
o-Dichlorobenzene
p-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
trans-1,2-Dichloroethene
1,1-Dichloroethylene
Dichloromethane
2,4-Dichlorophenol
2,6-Dichlorophenol
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Dieldrin
Diethyl phthalate
Dimethoate
3,3-Dimethyl benzidine
Dimethyl phthalate
p-(Dimethylamino)azobenzene
7,12-Dimethylbenz[a]anthracene
α,α-Dimethylphenethylamine
m-Dinitrobenzene
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,4-Dioxane
Diphenylamine
Disulfoton
Endosulfan I
Endosulfan sulfate
Endosulfan II
Endrin

TABLE E-3. (Continued)

Endrin aldehyde
Ethyl benzene
Ethyl cyanide
Ethyl methacrylate
Ethyl methanesulfonate
Famphur
Fluoranthene
Fluorene
Heptachlor epoxide
Heptachlor
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Hexachloropropene
Hexachlorophene
2-Hexanone
Hexchlorobenzene
Indeno(1,2,3-cd)pyrene
Isobutyl alcohol
Iodomethane
Isodrin
Isophorone
Isosafrole
Kepone
Lead (7421)
Lindane
Mercury (7470)
Methacrylonitrile
Methapyrilene
Methoxychlor
Methyl parathion
Methyl ethyl ketone
Methyl methanesulfonate
Methyl methacrylate
4-Methyl-2-pentanone
3-Methylcholanthrene
2-Methylnaphthalene
Naphthalene
1,4-Naphthoquinone
1-Naphthylamine
2-Naphthylamine
Nickel (6010)
o-Nitroaniline
5-Nitro-o-toluidine
m-Nitroaniline
p-Nitroaniline
Nitrobenzene
o-Nitrophenol
p-Nitrophenol
4-Nitroquinoline-1-oxide
N-Nitrosodi-n-butylamine
N-Nitrosodimethylamine
N-Nitrosodiethylamine
N-Nitrosodiphenylamine
N-Nitrosomethylethylamine
N-Nitrosomorpholine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
Parathion
PCBs
Pentachlorobenzene
Pentachloroethane
Pentachloronitrobenzene
Pentachlorophenol
Phenacetin
Phenanthrene
Phenol
p-Phenylenediamine
Phorate
2-Picoline
Polychlorinated Dibenzofurans (PCDFs)
Polychlorinated Dibenzo-p-dioxins (PCDDs)
Pronamide
Pyrene
Pyridine
Safrole
Selenium (7741)
Silver (6010)
Styrene
Sulfide (9030)
2,4,5-T
2,3,7,8-TCDD
1,2,4,5-Tetrachlorobenzene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
2,3,4,6-Tetrachlorophenol
Tetraethyldithiopyrothosphate
Thallium (7841)
Thionazin
Tin (6010)
Toluene
o-Toluidine
Toxaphene
2,4,5-TP (Silvex)
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
1,2,3-Trichloropropane
O,O,O-Triethyl phosphorothioate
sym-Trinitrobenzene
Vanadium (6010)
Vinyl Chloride
Vinyl Acetate
Xylene
Zinc (6010)

Source: 40 CFR Part 264.

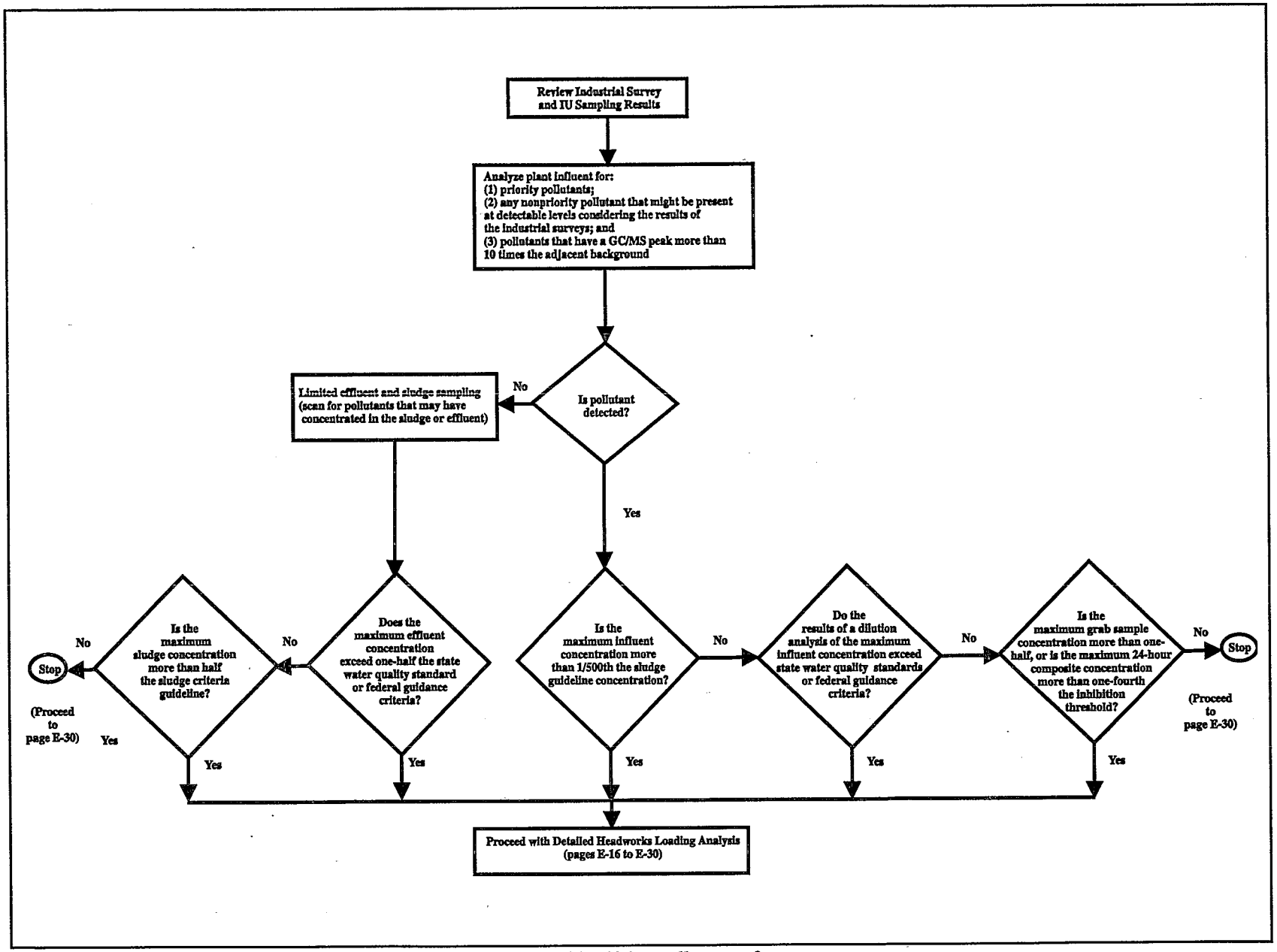


Figure E-2. Detailed flow sheet for a chemical-specific approach to identifying pollutants of concern to treatment plant operations (U.S. EPA 1987c).

during the preliminary screening and allow more resources to be used for the detailed headworks analysis of specific pollutants. The need to proceed with a headworks analysis for particular pollutants is indicated when:

- The maximum concentration of the pollutant in the POTW's effluent is more than one-half the allowable effluent concentration required to meet water quality criteria/standards or the maximum sludge concentration is more than one-half the applicable sludge criteria guidelines or

- The maximum concentration of the pollutant in a grab sample from the POTW's influent is more than half the inhibition threshold or the maximum concentration of the pollutant in a 24-hour composite sample from the POTW's influent is more than one-fourth the inhibition threshold.

- The maximum concentration of the pollutant in the POTW's influent is more than 1/500th of the applicable sludge use criteria [with the use of a "1/500th" reference level being suggested based on a review of POTW data (*Fate of Priority Toxic Pollutants in Publicly Owned Treatment Works*, U.S. EPA 1982d) indicating that a 500-fold concentration of pollutants can occur in digested sewage sludges as compared to the wastewater influent to the treatment plant] or

- The concentration of the pollutant in the plant influent exceeds water quality criteria adjusted through a simple dilution analysis.

Decisions as to whether to conduct a detailed headworks loading analysis are represented by the diamonds in Figure E-2. If a pollutant level exceeds the reference levels, the POTW should conduct a detailed headworks loading analysis for that pollutant to assess whether a numeric and/or narrative *local limit is needed.* The headworks loading analysis should be based on comprehensive influent, effluent, and sludge sampling and industrial contribution as discussed in the following section. If the reference-level analysis above does not point to the need for a detailed headworks loading analysis, the POTW should evaluate the need to set narrative limits (i.e., industrial management practices plans and best management practices) to control and reduce levels of these toxic pollutants from industrial sources, and determine on an annual basis the need to revise local limits and/or to demonstrate that there is no need for a local limit for a specific toxic pollutant.

Furthermore, for toxic pollutants for which the POTW determines [after completing the IWS, screening analysis, and MAHL (if applicable)] that neither numeric nor narrative local limits are necessary (e.g., insignificant industrial contribution), a program of periodic POTW monitoring and annual technical review of data on industrial discharges would be conducted by the POTW and, where appropriate, would require industrial users to institute industrial management practices plans and other pollution prevention activities. For these toxic pollutants, the POTW would report annually to EPA on the status of the need for development of local limits. (For further discussion of these requests, see section below entitled Ongoing Analysis of Other Toxic Pollutants Not Addressed by Local Limits).

b) Characterize Existing Loadings (U.S. EPA 1987c)--

Industrial Users--During the local limits development process, the POTW must characterize existing loadings to the treatment plant. Local limits should be based on site-specific monitoring data. This is especially important where a discharge makes up a large percentage of the total industrial pollutant loading to the system, or when toxic pollutants are known or suspected to be discharged in large quantities or concentrations. This loading characterization can be accomplished by conducting monitoring of all industrial users. Either POTW monitoring or self-monitoring data are acceptable, and information from the POTW's industrial waste survey may also be of use.

Hauled Waste--If hauled wastes are accepted at the POTW, they may be a significant source of toxic pollutant loadings. In such a case the POTW should consider them as a significant nondomestic source in the determination of local limits.

Domestic Loadings--The POTW must also characterize domestic loadings. Site-specific monitoring of a representative portion of the POTW's collection system should form the basis for loadings from domestic/background sources. Use of literature values must be justified by the POTW.

Treatment Plant Monitoring--The POTW must conduct sufficient monitoring at the treatment plant to characterize influent, effluent, and sludge loadings. Treatment plant influent and effluent sampling must be conducted to obtain data for use in calculating overall POTW removal efficiencies. The POTW should also monitor its sludge at the influent to the sludge digesters and at the point of disposal of the processed sludge. The resulting sludge monitoring data are used to derive digester removal efficiencies and sludge partitioning constants necessary for converting of sludge disposal criteria/standards and digester inhibition threshold data into

corresponding headworks loadings. Specific guidance on sludge sampling and analysis can be found in *POTW Sludge Sampling and Analysis Guidance Document* (U.S. EPA 1989).

The initial monitoring program should include (as a minimum) at least 5 consecutive days of sampling for both metals and toxic organics. A minimum of 5 consecutive days (Monday through Friday) is necessary to adequately characterize the typical short-term range and variability in toxic quality of the POTW and industrial user wastewater discharge activity. Preferably, longer-term monitoring should also be conducted to include data for at least 1 day of sampling per month over at least 1 year for metals and other inorganic pollutants and 1 day of sampling per year for toxic organics to assess long-term variations in wastewater composition. To ensure valid data, representative measurements of flow rates must be taken at the point and time of sample collection. Flow measurements and sampling can be conducted either manually or with automatic devices.

The method for analysis of a toxic pollutant should be selected according to the type of pollutant to be analyzed (i.e., grab samples over 24 hours for volatile organic compounds, total recoverable phenolic compounds, and cyanide and flow-proportioned 24-hour composite samples for all other toxic pollutants). Guidance on sampling techniques and QA/QC requirements are provided later in this appendix.

c) Determine Applicable Environmental Criteria (U.S. EPA 1987c)--

Environmental criteria usually include NPDES permit limits, water quality standards or criteria, sludge disposal requirements, and unit process inhibition values. The POTW should use all applicable environmental criteria when developing local limits. Other appropriate requirements may include worker health and safety criteria; collection system effects; incinerator emission requirements; or other applicable federal, state, or local environmental protection requirements. Further information on how to incorporate applicable environmental criteria into the local limits development process is contained in EPA's Local Limits Guidance.

Another environmental criterion is biological toxicity of whole effluents. POTWs that have conducted biological toxicity testing indicating toxicity of whole effluents should develop local limits to correct the toxicity. Although there is no method in EPA's Local Limits Guidance for calculating maximum allowable headworks loadings based on the results of toxicity testing, the manual provides guidance and additional references on the Toxicity Reduction Evaluation (TRE) process. (Also, refer to U.S. EPA 1988 and U.S. EPA 1991b for additional information.)

d) Calculate Maximum Headworks Loadings (U.S. EPA 1987c)--

The POTW must calculate the maximum amount (lb/day) of each toxic pollutant contributed by an industrial user or received at the headworks of the treatment plant that will allow the POTW to achieve all of the above applicable environmental criteria. Figure E-3 presents the formulas and data elements necessary to perform these calculations. In addition, Attachment 2 to this appendix presents a sample local limits headworks loading calculation. If the POTW does not calculate the maximum allowable headworks loading to the POTW for each toxic pollutant, it must provide justification why it has not done so. The nonconservative pollutants (volatiles) require special consideration when conducting headworks analysis (e.g., alternative formulas and allocation methods). All calculations should be consistent with the approach outlined in EPA's Local Limits Guidance.

During this step of the local limits development process, the POTW should demonstrate that an acceptable mass balance exists between the actual loadings of pollutants at the headworks and the estimated loadings of pollutants from specific source discharges. This mass balance can be determined by calculating the actual loading of each pollutant from influent monitoring data and comparing this value with the sum of the estimated loadings from all individual sources (e.g., domestic, industrial, hauled waste). The resulting calculated loadings from various sources should be within 80 to 120 percent of the actual total influent loading and flow.

e) Calculate Allowable Industrial Loadings (U.S. EPA 1987c)--

Once the POTW has calculated the maximum allowable headworks loading, a safety factor must be applied and the value discounted for domestic/background loadings in order to determine the maximum allowable allocation available for industrial users. A safety factor is incorporated into the calculations to allow for future industrial growth and other discrepancies that may enter into the calculations because of the use of default data or variations in analytical procedures. The POTW should provide justification for the selected safety factor, which will usually range from 10 to 30 percent.

f) Allocate Allowable Industrial Loading (*allocation of local limits*) (U.S. EPA 1987c)--

After the POTW has calculated the allowable industrial loading, the method chosen to allocate this loading depends on the number and types of industrial users and the method of application (permits, contract, or sewer use ordinance) employed by the POTW. Where the

In-Plant Criterion	Mass Balance Equation
NPDES permit limit	$L_{IN} = \frac{(8.34)(C_{CRIT})(Q_{POTW})}{(1 - R_{POTW})}$
Water quality standard	$L_{IN} = \frac{(8.34)[C_{WQ}(C_{STR} + Q_{POTW}) - (C_{STR})(Q_{STR})]}{(1 - R_{POTW})}$
Secondary treatment (e.g., activated sludge) threshold inhibition level	$L_{IN} = \frac{(8.34)(C_{CRIT})(Q_{POTW})}{(1 - R_{PRIM})}$
Tertiary treatment (e.g., nitrification) threshold inhibition level	$L_{IN} = \frac{(8.34)(C_{CRIT})(Q_{POTW})}{(1 - R_{SEC})}$
Sludge digester threshold inhibition level	$L_{IN} = \frac{(8.34)(C_{CRIT})(Q_{DIG})}{(R_{POTW})}$
Sludge disposal criterion/standard	$L_{IN} = \frac{(8.34)(C_{SLCRIT})(PS/100)(Q_{DISP})}{(R_{POTW})}$

where:

- L_{IN} = Allowable influent loading, lb/day
- C_{CRIT} = In-plant criterion, mg/L
- C_{SLCRIT} = Sludge disposal criterion/standard, mg/kg dry sludge
- Q_{POTW} = POTW flow, millions of gallons per day (mgd)
- R_{POTW} = Removal efficiency across POTW, as a decimal
- Q_{STR} = Receiving stream (upstream) flow, mgd
- C_{STR} = Receiving stream background level, mg/L
- C_{WQ} = Receiving stream water quality standard, mg/L
- R_{PRIM} = Removal efficiency across primary treatment, as a decimal
- R_{SEC} = Removal efficiency across secondary treatment, as a decimal
- Q_{DIG} = Sewage sludge flow rate to digester, mgd
- Q_{DISP} = Sewage sludge flow rate to disposal, mgd
- PS = Percent of sludge to disposal

Uniform concentration local limits can be derived through the use of the following equation:

$$C_{LIM} = \frac{(1 - SF)(L_{IN}) - L_{DOM}}{(8.34)(Q_{IND})}$$

where:

- C_{LIM} = Uniform concentration local limit, mg/L
- L_{IN} = Maximum allowable influent loading, lb/day
- SF = Safety factor, as a decimal
- L_{DOM} = Loading for domestic/uncontrollable sources, lb/day
- Q_{IND} = Total industrial flow, mgdlevel). The discharge limit derived is applied only to those industrial users which contribute the pollutant.

Figure E-3. Equation for deriving allowable POTW influent loadings from in-plant criteria.

current loading of a pollutant exceeds the MAHL, the POTW must establish a numeric local limit to reduce loadings to within the range of the MAHL. Where the current loading is below the MAHL, the POTW is encouraged, but not required, to set industrial discharge limits at current loadings to provide a safety factor.

A variety of procedures for the allocation of the allowable industrial loading exist. The four allocation methods most frequently used by POTWs are:

- Uniform concentration — The MAHL for each pollutant is divided by the total flow for *all* industrial users (even those which do not discharge the pollutant). The resultant discharge concentration for each pollutant is applied to all industrial user discharges.

- Concentration based on industrial contributory flow — The MAHL for each pollutant is divided by the flow from only those industrial users which actually have the pollutant in their untreated wastewaters (in concentration greater than the background concentration.

- Mass production — The ratio of the MAHL to the current loading for each industrial user contributing a particular pollutant is calculated, and the mass loading limit is derived by multiplying this ratio by the industry's current pollutant loading. The limit derived is unique for each industry, and limits are developed and applied only to industries that contribute the pollutant.

- Selected industrial reduction — Individual pollutant loading reductions for each industry are determined; typically the loading reductions are based on the treatability of the industrial wastewater for each pollutant.

The POTW should ensure that it has selected local limits that are reasonable (i.e., they incorporate appropriate safety factors, account for domestic/background loadings, and consider appropriate environmental and plant protection criteria). All numeric local limits should be at or above detection limits and should not be so lenient as to provide industry additional opportunity to pollute or encourage discharge of hazardous waste to the POTW. Under the applicable pretreatment requirement approach, the applicant must address each toxic pollutant introduced by industry. After conducting the local limits analysis, the POTW may allocate the allowable industrial loading among any number of industrial sources of the toxic pollutant (categorical and/or noncategorical) that the POTW deems appropriate, subject to the approval of

the applicable EPA Regional office. Local limits could be allocated, for example, according to the classification scheme developed under the industrial waste survey. For the major or significant industries, the POTW would most likely set specific effluent limitations (categorical standards, numeric local limits, or both). For the minor industries, the POTW may choose to apportion numeric local limits among minor industrial users when these industries as a group represent a significant source of toxic pollutants to the POTW; otherwise, the POTW should determine the need to set narrative local limits (i.e., industrial management practice plans and best management practices; see Attachment 1 to this appendix) where appropriate to control and reduce levels of toxic pollutants. Narrative local limits may also be implemented in conjunction with numeric local limits for the same industry, if deemed appropriate.

If the initial screening process described in step (a) of the MAHL process (see Figure E-2) does not point to the need for a detailed headworks loading analysis for a specific toxic pollutant, the POTW should evaluate the need to set narrative local limits (i.e., industrial management practices plans and best management practices) where appropriate to control and reduce levels of these toxic pollutants from selected industries. Guidance on how to identify industries for which narrative local limits may be appropriate is given in Attachment 1 to this appendix.

Once local limits have been developed for a toxic pollutant (numeric, narrative, or a combination of both), they must be effectively implemented. Local limits should be incorporated into the sewer use ordinance or some form of individual control mechanism.

g) Ongoing Review/Revision of Local Limits (numeric/narrative)(U.S. EPA 1987c)--

Local limits must be revised on a periodic basis to reflect changes in conditions or assumptions. Conditions that might require that local limits be revised include, but are not limited to, changes in environmental criteria, changes in the industrial users, availability of additional monitoring data, changes in plant processes, and changes in POTW capacity or configuration.

For those toxic pollutants for which numeric or narrative local limits were developed through the MAHL analysis (or other method as appropriate), the POTW must demonstrate to EPA on an annual basis, through *annual monitoring* and appropriate *technical review of data* on discharges from industrial sources, that levels of these toxic pollutants in the POTW influent do not exceed the maximum allowable headworks loading (MAHL) determined in the analysis of local limits described above. Annual monitoring should follow the guidelines discussed previously in this appendix for long-term treatment plant monitoring.

The results of the monitoring and data review must be made available in the annual report required under 40 CFR 403.12. If the POTW determines, based on results of annual monitoring of the POTW influent/effluent/sludge and/or technical review of data on discharges from industrial sources (also updated annually), that the level of a toxic pollutant is expected to exceed the maximum allowable level determined through the local limits analysis, the POTW should *modify the local limit* and the individual control mechanism or sewer use ordinance, as appropriate, to implement the new local limit. Furthermore, the POTW should update the initial screening of toxic pollutants based on results of the same technical review to determine the need for inclusion of any new toxic pollutants/industries in the local limits analysis (either numeric or narrative).

Ongoing Analysis of Other Toxic Pollutants Not Addressed by Local Limits

For those toxic pollutants which the POTW determines that neither numeric nor narrative local limits are necessary (e.g., insignificant industrial contribution) the POTW must continue to conduct periodic *monitoring* of the POTW influent and effluent and conduct annual *technical reviews* of data on discharges from industrial sources during the term of the permit, to determine any change in status of the toxic quality of the POTW wastewater and industrial sources. Further, where appropriate the POTW should require industrial users to institute industrial management practices plans (*IMPs*) and *other pollution prevention activities* such as through individual control mechanisms or local sewer ordinances, to reduce or control the levels of these toxic pollutants from industrial sources. These plans and activities could include best management practices (BMPs). For more information, see Attachment 1 to this appendix and EPA's *Guidance Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program* (U.S. EPA 1987c) and *Supplemental Manual on the Development and Implementation of Local Discharge Limitations Under the Pretreatment Program: Residential and Commercial Toxic Pollutant Loadings and POTW Removal Efficiency Estimation* (U.S. EPA 1991a). If such monitoring and technical review of data indicate that a local limit is needed, the POTW would establish and implement a local limit. The monitoring program should follow the guidelines discussed previously in this appendix.

The basic philosophy of instituting management practices (IMPs) is to minimize the discharge of toxic or hazardous pollutants to the sewer, or reduce the impact of toxic/hazardous pollutant discharges by avoiding short-term, high-concentration discharges. Examples of appropriate uses of IMPs include the control of chemical spills and slug discharges to the POTW through formal chemical or waste management plans, including BMPs, solvent management plans, batch discharge policies, waste recycling, and waste minimization. It would also be

appropriate to consider IMPs in cases where the POTW does not include biological treatment processes, or provides less treatment, e.g., primary treatment. In these cases, IMPs can be tailored for industrial sources of toxic pollutants that might otherwise interfere with biological treatment or would be degraded or removed through additional treatment.

SECONDARY REMOVAL EQUIVALENCY APPROACH

The second approach that 301(h) applicants may use to satisfy the new urban area pretreatment requirements is to demonstrate secondary removal equivalency. As noted in §125.65(d):

> An applicant shall demonstrate that it achieves secondary removal equivalency through the use of a secondary treatment pilot plant at the applicant's facility which provides an empirical determination of the amount of a toxic pollutant removed by the application of secondary treatment to the applicant's discharge, where the applicant's influent has not been pretreated. Alternatively, an applicant may make this determination using influent that has been pretreated, notwithstanding §125.58(w).

In effect, the applicant's existing treatment processes and industrial pretreatment program must remove at least as much of a toxic pollutant as would be removed if the applicant applied secondary treatment and did not have an industrial pretreatment requirement for that pollutant.

To demonstrate secondary removal equivalency, an applicant would need to use a secondary treatment pilot plant. By diverting part of its primary effluent (secondary influent) to the pilot plant (see Figure E-4), the applicant would empirically determine the incremental amount of each toxic pollutant that would be removed from the primary effluent (secondary influent) if secondary treatment were applied. Having determined the amount of each toxic pollutant removed, the applicant would then demonstrate that its existing less-than-secondary treatment plus existing industrial pretreatment removes at least the same amount of each toxic pollutant as did the secondary treatment pilot plant (including removals in the primary effluent) without any industrial pretreatment.

Figure E-4 schematically represents how the secondary removal equivalency test would work for a POTW that has an existing industrial pretreatment program. Toxic pollutant scans would be conducted on the effluent from the existing POTW (SCAN E1) and from the secondary pilot plant (SCAN E2). To achieve secondary removal equivalency for a toxic pollutant, the following must hold:

$$\text{E1 concentration} \leq \text{E2 concentration}$$

Figure E-4. Secondary pilot plant demonstration.

The above relationship is equivalent to the following, restated in terms of removals of a toxic pollutant:

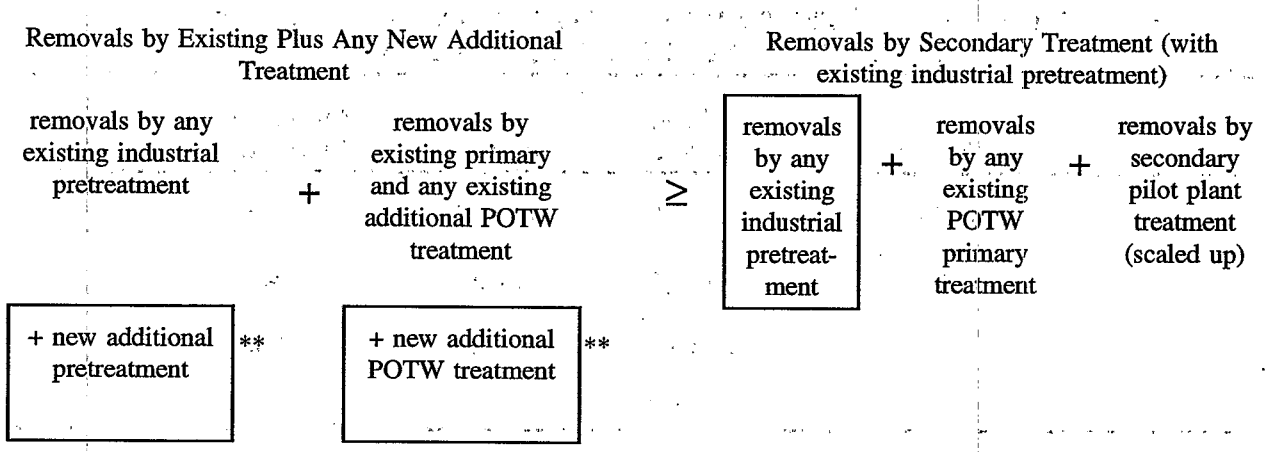
Removals by Existing Treatment				Removals by Secondary Treatment (and no industrial pretreatment)		
removals by any existing industrial pretreatment*	+	removals by existing primary and any existing additional POTW treatment	≥	removals by any existing POTW primary treatment	+	removals by secondary pilot plant treatment (scaled up)

If the POTW is able to estimate the amount of a toxic pollutant removed by its existing industrial pretreatment (*), then secondary equivalency demonstration using the above formula is straightforward. In many instances, however, the POTW will not have the necessary data with which to estimate removals of toxic pollutants by existing industrial pretreatment. In those instances, the above equation is revised as follows:

Removals by Existing Treatment				Removals by Secondary Treatment (with existing industrial pretreatment)				
removals by any existing industrial pretreatment	+	removals by existing primary and any existing additional POTW treatment	≥	removals by any existing industrial pretreatment	*	+ removals by any existing POTW primary treatment	+	removals by secondary pilot plant treatment (scaled up)

Ideally the (*) term should not appear on the right side of the equation, but this cannot be avoided unless the POTW can factor out this term by knowing, through independent means (e.g., a rigorous industrial wastewater pretreatment survey) the amount of a toxic pollutant removed by existing industrial pretreatment. Otherwise, the POTW may choose to perform the empirical (pilot plant) secondary removal equivalency demonstration using influent that has been subject to that existing industrial pretreatment. Such a demonstration may then be conservative because it may overstate the amount of toxic pollutant that would be removed by applying only primary and secondary treatment.

If the POTW's above demonstration fails to demonstrate attainment of secondary removal equivalency, then the POTW must evaluate the need for additional industrial pretreatment, additional POTW treatment, or a combination of the two to achieve the necessary additional removals, as defined in the revised equation shown below:



The "new" removals shown on the left side of the equation (**) represent additional future removals by any new industrial pretreatment or new POTW treatment added to achieve secondary equivalency. The applicant will be required to develop effluent limits based on data from the secondary removal equivalency demonstration when these values are more stringent than effluent limits based on state water quality standards or water quality criteria or will be required to ensure that all applicable environmental protection criteria are met. Once the effluent limits are established, the applicant may either develop local limits (as described earlier) or perform additional treatment at the POTW, or combine the two to achieve the permit limit.

Secondary treatment at POTWs typically involves biological processes that remove organic matter through biochemical oxidation, usually variations of the activated sludge process. Other physical-chemical secondary treatment processes (e.g., coagulation, filtration, carbon adsorption) may also be used, particularly for nonbiodegradable wastewaters. The specific secondary treatment process used by a POTW is dependent on numerous factors such as wastewater quantity, waste biodegradability, and available space at the POTW site. Each POTW must determine the best strategy and the most applicable treatment process for complying with the secondary removal equivalency requirements.

The level of effluent quality attainable through the application of secondary treatment is defined in 40 CFR Part 133 (Table E-4). Treatment processes that are considered equivalent to secondary treatment (e.g., trickling filter, waste stabilization pond) are discussed in 40 CFR 133.105. Minimum levels of effluent quality attainable from these equivalent treatment processes differ from those shown in Table E-4.

Because secondary treatment levels were defined only for BOD, suspended solids, and pH, POTWs were usually not required to institute technology specifically to control toxic pollutants. Under the 1977 Clean Water Act, toxic pollutants in the POTW effluents were

TABLE E-4. EFFLUENT WATER QUALITY VALUES THAT SHALL NOT BE EXCEEDED UNDER SECONDARY TREATMENT

Variable[a]	30-Day Average	7-Day Average	30-Day Average (Percent Removal)
BOD_5	30 mg/L	45 mg/L	>85
$CBOD_5$[b]	25 mg/L	40 mg/L	>85
SS	30 mg/L	45 mg/L	>85
pH	6.0 to 9.0		

[a] BOD_5 = 5-day measure of biochemical oxygen demand; $CBOD_5$ = 5-day measure of carbonaceous biochemical oxygen demand; SS = suspended solids.
[b] At the option of the NPDES permitting authority, $CBOD_5$ may be substituted for BOD_5.

controlled predominantly through pretreatment programs, categorical standards, and local POTW limits required by the issuance of NPDES permits.

SECONDARY TREATMENT PILOT PLANT DESIGN CRITERIA

A secondary treatment pilot plant should be designed for an average flow of approximately 150 GPD. The flow rate should remain constant over a 24-hour period. The pilot plant should require minimum operation and maintenance time and must be able to operate unattended for 16-24 hours. The organic loading will vary with the diurnal and seasonal fluctuations in the BOD_5 concentration in the existing POTW effluent. Design criteria for the secondary treatment pilot plant are shown in Table E-5.

A conventional activated sludge system (Figure E-5) for a POTW includes the following related components:

- Single or multiple reactor basins (i.e., aeration tanks) in which microorganisms consume the organic wastes. These basins are designed to allow for complete mixing of their contents, which are defined as mixed liquor suspended solids (MLSS). Each basin must provide typical hydraulic retention times of 2-24 hours.

- Pressurized or atmospheric oxygen-containing gases that are dispersed into the reactor basin.

TABLE E-5. SECONDARY TREATMENT PILOT PLANT DESIGN CRITERIA

Reactor Basin (Aeration Tank)	
Volume	50 gal (189 L)
Detention time	8 h
Organic loading	25-60 lb BOD/1,000 ft^3/day (0.4-1.0 kg/m^3/day)
Air requirement	0.20-0.44 ft^3/min (0.33-0.75 m^3/h)
Settling Basin (Final Clarifier)	
Volume	20 gal (76 L)
Surface area	0.375 ft^2 (0.035 m^2)
Overflow area	400 gal/ft^2/day (16.3 m^3/m^2/day)
Solids loading	14 lb/ft^2/day (68.4 kg/m^2/day)
Weir length	0.5 ft (0.152 m)
Detention time	3 h
Influent Feed Pump	
Capacity	0-290 gal/day (0-12.7 L/sec)
Type	Peristaltic
Return Activated Sludge Pump	
Capacity	0-130 gal/day (0-5.7 L/sec)

- Settling basin (i.e., final clarifier) to separate the MLSS from the treated wastewater.

- Equipment to collect the solids in the settling basin and to recycle the active biological solids (i.e., activated sludge) to the reactor basin.

- Equipment to remove excess active biological solids from the system.

Typical design variables for the conventional activated sludge process are shown in Table E-6. Additional information on activated sludge systems is provided by the Water Pollution Control Federation, or WPCF (1976, 1987) and WPCF/American Society for Civil Engineers (1977).

SECONDARY TREATMENT PILOT PLANT START-UP

In the activated sludge process, microorganisms metabolize nearly all soluble organic matter in the influent. The microorganisms (i.e., active biological solids) must be removed from

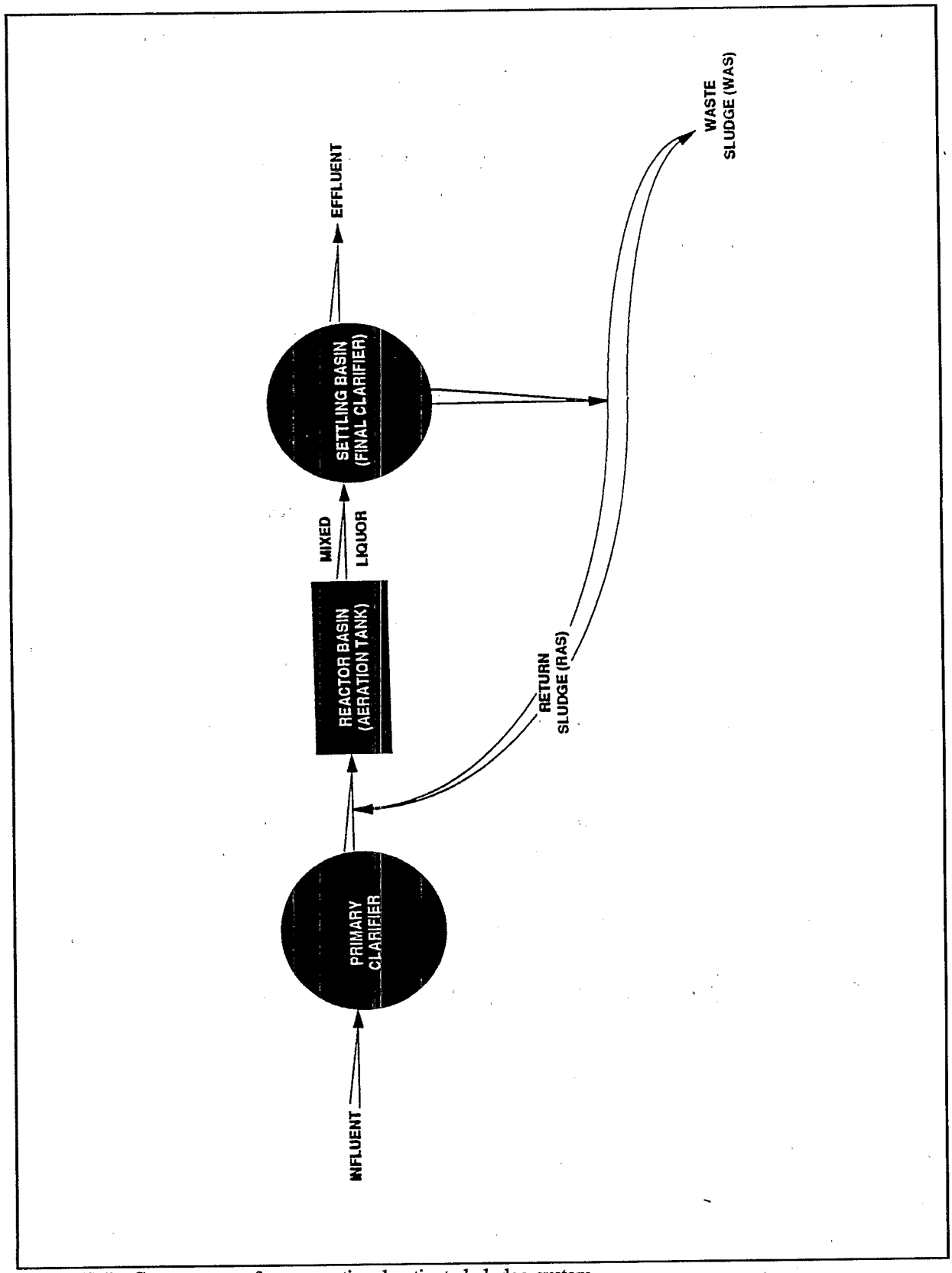


Figure E-5. Components of a conventional activated sludge system.

TABLE E-6. CONVENTIONAL ACTIVATED SLUDGE DESIGN PARAMETERS

Food-to-microorganism ratio	0.15-0.4 lb BOD_5/lb MLSS/day
Mean cell residence time	5-15 days
Aeration detention time	4-8 h
Oxygen requirements	0.8-1.1 lb (kg) 0_2/lb (kg) BOD_5 removed
Return activated sludge flow rate	30-100 percent influent flow
Mixed liquor suspended solids (MLSS)	1,500-4,000 mg/L
Organic loading at 3,000 mg/L MLSS	20-60 lb BOD/1,000 ft^3 (0.3-1.0 kg BOD/m^3)
Respiration (oxygen uptake) rate at 3,000 mg/L MLSS	15-45 mg oxygen/L/h
Sludge volume index	90-150
Waste activated sludge	0.4-0.6 lb (kg)/lb (kg) BOD removed

the settling basin to produce an acceptable effluent, and the proper operation of the settling basin is critical. The following process control parameters should be monitored to ensure proper operation of the activated sludge system:

- Mixed liquor suspended solids (MLSS);
- Mixed liquor volatile suspended solids (MLVSS);
- Dissolved oxygen;
- Sludge volume index (SVI);
- Sludge density index (SDI);
- Organic loading;
- Return activated sludge (RAS) flow rate;

- Waste activated sludge (WAS) flow rate;
- Mean cell residence time (MCRT)/solids retention time (SRT);
- Food-to-microorganism (F/M) ratio;
- Temperature;
- Hydrogen ion concentration (pH); and
- Respiration rate (RR).

In addition to monitoring these process control parameters, microscopic examination of the MLSS should be performed.

An initial food-to-microorganism (F/M) ratio of 0.2 should be achieved. Field operators should adjust the F/M ratio by changing the MLSS concentration in the reactor basin if the required 30-day average effluent quality (i.e., 30 mg/L BOD, 30 mg/L suspended solids) cannot be achieved. If temperature varies substantially between summer and winter, the F/M ratio will probably need to be lowered during winter to achieve the required effluent quality.

The pilot plant should be seeded with MLSS from a local domestic wastewater treatment facility. Acclimation of the pilot plant will require about 4-6 weeks. If there is no local source of MLSS, the pilot plant may be started using the POTW's effluent. An additional 4-6 weeks may be needed to ensure that the MLSS meets the desired design concentration.

The MLSS should be fed with domestic wastewater for the first 2-3 days. The volumetric proportion of the effluent should then be adjusted to 10 percent of the total feed for 4-5 days. After the initial week of operation, the volumetric proportion of the regular POTW effluent in the pilot plant feed can be increased approximately 5 percent per day until the system is receiving 100 percent POTW effluent.

Sampling for BOD_5 and suspended solids should be conducted daily during and after the acclimation period. Sampling for toxic pollutants should not be started until 2 weeks after the pilot plant is receiving 100 percent POTW effluent.

SECONDARY TREATMENT PILOT PLANT OPERATING CRITERIA

The process control parameters identified in the preceding section should be monitored to provide information for process control and to determine treatment efficiency. A monitoring schedule is shown in Table E-7. The frequency of sample collection and analysis may vary for each POTW, however, depending on the size of the POTW, available laboratory facilities, available staff, and the technical skills of the personnel. Additional sampling and analysis may be required for abnormal conditions or during periods of process upsets. Implementation of the monitoring program, data interpretation, and pilot plant operation and maintenance is estimated to require about 5 labor hours per day. Each process control parameter is discussed below.

TABLE E-7. PILOT PLANT MONITORING SCHEDULE

Sampling Point	Parameters[a]	Frequency
Primary Effluent	Temperature	1 grab daily
	pH	1 grab daily
	SS	4 grabs weekly and 3 24-h composites weekly
	BOD_5	3 24-h composites weekly
	Overflow rate	1 grab daily
	$CBOD_5$	1 24-h composite weekly
MLSS	Temperature	1 grab daily
	pH	1 grab daily
	Dissolved oxygen	2 grabs daily
	Respiration rate	2 grabs daily
	Sludge volume index	2 grabs daily
	SS	1 grab daily
	VSS	1 grab daily
	Microscopic examination	1 grab daily
WAS/RAS	SS	1 grab daily
Secondary Clarifier	Sludge blanket depth	2 grabs daily
Final Effluent	Temperature	1 grab daily
	pH	1 grab daily
	Settleable solids	1 grab daily
	SS	4 grabs weekly and 3 24-h composites weekly
	BOD_5	3 24-h composites weekly
	$CBOD_5$	1 24-h composite weekly

[a]SS = Suspended solids; BOD_5 = 5-day biochemical oxygen demand; $CBOD_5$ = 5-day carbonaceous biochemical oxygen demand; VSS = volatile suspended solids.

Mixed Liquor Suspended Solids (MLSS)

Samples of MLSS should be collected from the effluent end of the reactor basin twice daily and analyzed for suspended solids. This analysis will measure the total amount of solids in the aeration system. The concentration of the MLSS, which depends on the influent BOD_5 concentration, should be adjusted based on the daily average.

Mixed Liquor Volatile Suspended Solids (MLVSS)

Each MLSS sample should be analyzed for MLVSS. This analysis indirectly measures the living biological percentage of the MLSS. The concentration of MLVSS is normally 70 to 80 percent of the concentration of the MLSS.

Dissolved Oxygen

The concentration of dissolved oxygen in the reactor basins should be measured twice daily to ensure that a concentration of 1-3 mg/L is maintained. Samples should be collected about 2 ft below the surface of the reactor basin, near the effluent weir. The plant operator should adjust the air supply to provide more air if the dissolved oxygen concentration is less than 1 mg/L and less air if it is greater than 3 mg/L.

Sludge Volume Index (SVI)

The rate at which the MLSS settles in the settling basin depends on the sludge characteristics. These characteristics are described by a simple settling test: 1,000 mL of the MLSS effluent is collected and allowed to settle for 30 minutes in a Mallory settleometer. At the end of 30 minutes, the volume of the settled sludge is measured. The SVI (mL/g) is calculated as follows:

$$SVI = \frac{\textit{sludge volume after settling (mL/L)} \times 1{,}000}{\textit{MLSS (mg/L)}}$$

The lower the SVI, the more dense the sludge. An SVI of 150 or less is usually considered good.

Sludge Density Index (SDI)

The SDI test is also used to indicate the settling characteristics of the sludge, and it is arithmetically related to the SVI:

$$SDI = \frac{100}{SVI}$$

The SDI (g/mL) of a "good settling sludge" is about 1.0. A value of less than 1.0 indicates light sludge that settles slowly, and a value greater than 1.5 indicates dense sludge that settles rapidly.

Organic Loading

From routine laboratory BOD_5 analysis, the plant operator can determine organic loading in the reactor basin.

$$Organic\ loading\ (lb\ BOD/1{,}000\ ft^3/day) =$$

$$POTW\ effluent\ BOD\ (mg/L) \times \frac{POTW\ effluent\ flow\ (MGD) \times 0.0624}{reactor\ basin\ volume\ (MG)}$$

Return Activated Sludge (RAS) Flow Rate

To properly operate the activated sludge process, MLSS that settle adequately must be achieved and maintained. The MLSS are settled in the settling basin and then returned to the reactor basin as RAS. The RAS allows the microorganisms to remain in the treatment system longer than the flowing wastewater. Changes in the activated sludge quality and settling characteristics will require different RAS flow rates.

Two basic approaches can be used to control the RAS flow rate. One approach establishes a constant RAS flow rate, independent of the influent flow. This approach is simple (i.e., maximum solids loading in the settling basin occurs at the start of the peak flow periods), and less operator attention is needed. A disadvantage of this approach is that the F/M ratio is constantly changing. However, because of short-term variation in the MLSS due to hydraulic loading, the range of fluctuation in the F/M ratio is usually small enough to ensure that no significant problems arise.

A second approach establishes the RAS flow rate as a constant percentage of the influent flow. This approach reduces variations in the MLSS concentration and the F/M ratio, and the MLSS remain in the settling basin for shorter time periods (which may reduce the possibility of denitrification in the basin). The most significant disadvantage of this approach is that the settling basin is subjected to maximum solids loading when the basin contains the maximum amount of sludge, which produces excessive solids in the effluent.

Two methods are commonly used to determine the RAS flow rate. The settleability method uses the settled sludge volume from the SVI test to calculate the RAS flow rate:

$$\textit{RAS Flow Rate (MGD)} =$$

$$\textit{Volume of Settled Sludge (mL/L)} \times \frac{[\textit{POTW Effluent Flow (MGD)}]}{1{,}000\ \textit{mL/L}}$$

The second and more direct method is to monitor the depth of the sludge blanket in the settling basin. The depth of the sludge blanket should be less than one-fourth the water depth of the settling basin sidewall. The operator must check the sludge blanket depth twice daily, adjusting the RAS flow to control the blanket depth. If the depth of the sludge blanket is increasing, increasing the RAS flow is only a short-term solution. Increases in sludge blanket depth may result from too much activated sludge in the treatment system, a poorly settling sludge, or both. If the sludge is settling poorly, increasing the RAS flow may cause even more problems by further increasing the flow through the settling basin. The long-term corrections noted below must be made to improve the settling characteristics of the sludge or remove the excess solids from the treatment system:

- If the sludge is settling poorly because of bulking, the environmental conditions for the microorganisms must be improved.

- If there is too much activated sludge in the treatment system, the excess sludge must be wasted.

The best time to measure RAS flow is during the period of maximum daily flow because at that time the clarifier is operating under the highest solids loading rate. Adjustments in the RAS flow rate should be needed only occasionally if the activated sludge process is operating properly.

Waste Activated Sludge (WAS) Flow Rate

The increase of activated sludge is a cumulative process that eventually produces surplus WAS. This surplus has to be permanently removed from the treatment process and collected for ultimate disposal. The WAS flow rate should be determined and adjusted daily to maintain the desired mean cell residence time (MCRT), based on the MLSS in the entire secondary system, and RAS suspended solids concentration:

$$WAS\ flow\ rate\ (MGD) = MLSS\ (mg/L) \times \frac{[aeration\ tank\ volume\ (MG) + clarifier\ volume\ (MG)]}{[desired\ MCRT\ (days)] \times [RAS\ suspended\ solids\ (mg/L)]}$$

Mean Cell Residence Time (MCRT)/Solids Retention Time (SRT)

The MCRT, which is also called the SRT, is a measure of the age of sludge. Under normal conditions, the MCRT is 5-15 days. MCRT is defined as:

$$MCRT = \frac{Suspended\ solids\ in\ total\ secondary\ system\ (lb)}{Solids\ wasted\ (lb/day) + effluent\ solids\ (lb/day)} =$$

$$\frac{[MLSS\ (mg/L) \times [aeration\ tank\ volume\ (MG) + secondary\ clarifier\ volume\ (MG)]}{[WAS\ suspended\ solids\ (mg/L) \times WAS\ flow\ (MGD)] + [Effluent\ suspended\ solids\ (mg/L) \times effluent\ flow\ (MGD)]}$$

The MCRT is the best process control technique available to the plant operator. By using the MCRT, the operator can control the quantity of food available to the microorganisms and calculate the amount of activated sludge that should be wasted.

Food-to-Microorganism (F/M) Ratio

The F/M ratio is the ratio of BOD in the POTW effluent to the MLVSS. An F/M ratio of 0.15 to 0.4 is desirable. F/M is defined as:

$$F/M = \frac{POTW\ effluent\ BOD\ (mg/L)}{MLVSS\ (mg/L)}$$

To control the F/M ratio, the operator must adjust the MLSS by wasting more or less sludge.

Temperature

In process control, accurate temperature measurements are required to predict and evaluate process performance, thereby enhancing microbial growth. Typically, the rate of microbial growth doubles for every 10 °C increase in temperature within the specific temperature range of the microbe.

Hydrogen Ion Concentration (pH)

The activity and health of microorganisms are affected by pH. Sudden changes or abnormal pH values may indicate an adverse industrial discharge. A pH drop also results when nitrification is occurring in a biological process; alkalinity is destroyed and carbon dioxide is produced during the nitrification process.

Respiration Rate (RR)

The efficiency of the activated sludge process depends primarily on the activity of bacteria that use organic compounds in sewage for energy and reproduction. When in contact with an adequate food supply, viable bacteria have a respiration rate (i.e., oxygen uptake rate) of 5-15 mg oxygen/h/g MLSS. Respiration rate data provide immediate information concerning viability, nitrification, organic loading, nutrient levels, and toxicity in the activated sludge.

The respiration rate, or oxygen uptake rate, is monitored with a dissolved oxygen meter over a time interval (t) (e.g., 6-10 minutes). The respiration rate is a measure of the decrease in dissolved oxygen (DO) concentration:

$$RR\ (mg\ oxygen/h/g\ MLSS) = \frac{[DO\ change\ over\ \ t\ (mg/L)] \times [60{,}000]}{[MLSS\ (mg/L)] \times [t\ (\text{min})]}$$

Microscopic Examination

Microscopic examination of the MLSS can be used to evaluate the effectiveness of the activated sludge process. The most important microorganisms are the protozoa, heterotrophic bacteria, and autotrophic bacteria responsible for purifying the wastewater. Both protozoa (e.g., ciliates) and rotifers are indicators of treatment performance, and large numbers of these organisms in the MLSS indicate good-quality sludge. Large numbers of filamentous organisms and certain ciliates indicate poor sludge quality, a condition commonly associated with a sludge

that settles poorly (i.e., the sludge floc is usually light and fluffy because it has a low density). Many other organisms (e.g., nematodes, waterborne insect larvae) may be found in the sludge, but these organisms are not significant to the activated sludge process.

TOXIC POLLUTANT MONITORING PROGRAM, TESTING PROCEDURES, AND QUALITY ASSURANCE/QUALITY CONTROL

A sampling strategy must be developed to estimate the difference between toxic pollutant concentrations in the existing discharge and those in the secondary treatment pilot plant discharge. Samples must be collected using proper techniques and analyzed using appropriate analytical methods. Both field and laboratory methods must be performed under defined QA/QC procedures.

Applicants are referred to the following documents for guidance on specific topics relevant to the design and execution of 301(h) monitoring programs:

- Sampling/Monitoring Program:
  - *NPDES Compliance Sampling Manual* (U.S. EPA 1979a);
  - *Design of 301(h) Monitoring Programs for Municipal Wastewater Discharges to Marine Waters* (U.S. EPA 1982a); and
  - *Handbook for Sampling and Sample Preservation of Water and Wastewater* (U.S. EPA 1982c);
- Chemical Analytical Methods:
  - *Methods for Chemical Analysis of Water and Wastes* (U.S. EPA 1979b, revised 1983);
  - *Guidelines Establishing Test Procedures for the Analysis of Pollutants* (40 CFR Part 136);
  - *Standard Methods for the Examination of Water and Wastewater*, 16th ed. (American Public Health Association et al. 1985);
  - *Analytical Methods for EPA Priority Pollutants and 301(h) Pesticides in Estuarine and Marine Sediments* (U.S. EPA 1986d); and
  - *Analytical Methods for EPA Priority Pollutants and 301(h) Pesticides in Tissues from Estuarine and Marine Organisms* (U.S. EPA 1986e).

- Quality Assurance/Quality Control (QA/QC):

  - *Handbook for Analytical Quality Control in Water and Wastewater Laboratories* (U.S. EPA 1979c) and

  - *Quality Assurance/Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods* (U.S. EPA 1987d).

Information from these documents is summarized below.

SAMPLING FREQUENCY

The frequency of sampling is dependent on the characteristics of the discharge (e.g., influent and effluent toxic pollutant variability, flow, size and location of the discharge). For example, large applicants with substantial quantities of toxic pollutants should conduct more frequent sampling than small dischargers with fewer toxic pollutants. Also, if existing toxic pollutant data are minimal, and estimates of periods of maximum pollutant loadings and peak concentrations are not known, then more frequent monitoring is needed.

The concentrations of toxic pollutants in the discharge may vary in response to periodic peak inflows. If a fixed periodic trend is observed (e.g., a sine curve), then the sampling plan could be designed to collect samples during the peak period.

If a fixed sampling interval that is equal to or a multiple of the period is chosen, every sample would be taken at the same inflow condition and the estimate of the mean difference in toxic pollutant concentrations between samples would not take into account all possible inflows. The most favorable sampling situation occurs when the fixed sampling interval is an odd multiple of the half-period (i.e., successive deviations above and below the mean inflow would mathematically cancel one another, and the mean difference in concentration between samples would take into account the mean inflow). However, toxic pollutant effluent data from the applicant may not be sufficient to identify the odd multiple of the half-period. In this case, a fixed sampling interval would not be recommended.

Assuming that the toxic pollutant limits for the POTW will be based on the pollutant concentrations measured in the secondary treatment effluents, a flexible sampling scheme for secondary treatment pilot plant effluents may involve sample collection for 1 day/week (over

24 hours) on different days of the week over a 1-year period of pilot plant operation. This flexible sampling frequency would generate a data set that represents an acclimated biological treatment system. It would also address the day/night, weekday/weekend, and seasonal variations in domestic, industrial/commercial, and wet- and dry-weather discharges.

SAMPLE COLLECTION AND ANALYSIS

Representative samples must be collected to ensure that data are reliable. Care must be taken to select appropriate sampling devices and procedures. Depending on the toxic pollutant to be analyzed, three types of samples may be collected:

- Grab sample — A discrete sample volume is collected. (This type of sample will not always provide an accurate measure of wastewater characteristics, particularly when the flow or pollutants are heterogeneous or vary with time.)

- Simple composite sample — Equal sample volumes are collected sequentially over time and combined in a single reservoir. (This type of sample does not measure the mass of pollutants discharged because pollutant loading is a flow-related value.)

- Flow-proportioned composite sample — Incremental samples are collected over time and sample volumes are proportional to flow. Incremental samples are combined in a single reservoir. (This type of sample provides the most accurate measurement of wastewater quality and pollutant loading.)

The methods to be used for the analysis of toxic pollutants are summarized in Tables E-8, E-9, and E-10. Grab samples for volatile organic compounds, total recoverable phenolic compounds, and cyanide should be collected manually at least four times during the discharging period of the POTW during a 24-hour period (e.g., at least every 6 hours within a 24-hour period, assuming continuous discharge). Samples for all other variables should be collected using an automatic sampler. The automatic sampler should collect a selected number of sample aliquots (minimum of 100 mL each) during the discharging period of the POTW. Recommended sample sizes, containers, preservation techniques, and holding times are shown in Table E-11. Sample analyses will generally be completed by the analytical laboratory within 4-6 weeks; data analyses will generally require an additional week. Interpretation of all data collected at the pilot plant during 1 year will require about 2 weeks.

TABLE E-8. LIST OF TEST PROCEDURES APPROVED BY U.S. EPA FOR INORGANIC COMPOUNDS IN EFFLUENT

NOTE: This table is an exact reproduction of Table 1B in 40 CFR 136.3.

Parameter, units, and method	Reference (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
1. Acidity, as $CaCO_3$ mg/L: Electrometric end point or phenolphthalein end point.	305.1	402(4.a)	1067-82(E)		
2. Alkalinity, as $CaCO_3$ mg/L:					
Electrometric or colorimetric titration to pH 4.5, manual, or.	310.1	403	D1067-82(B)	I-1030-84	33.014[2].
Automated	310.2			I-2030-84	
3. Aluminum—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	202.1	303C		I-3051-85	
AA furnace	202.2	304			
Inductively coupled plasma (ICP)					200.7.[4]
Direct current plasma (DCP) or					Note 33.
Colorimetric (Eriochrome cyanine R)		306B			
4. Ammonia (as N), mg/L: Manual distillation (at pH 9.5) [5] followed by:	350.2	417A			33.057.[2]
Nesslerization	350.2	417B	D1426-79(A)	I-3520-84	33.057.[2]
Titration	350.2	417D			
Electrode	350.3	417 E or F	D1426-79(D)		
Automated phenate or	350.1	417G	D1426-79(C)	I-4523-84	
Automated electrode					Note 6.
5. Antimony—Total [3], mg/L: Digestion [3] followed by:					
AA direct aspiration	204.1	303A			
AA furnace, or	204.2	304			
Inductively coupled plasma					200.7.[4]
6. Arsenic—Total [3], mg/L: Digestion [3] followed by	206.5				
AA gaseous hydride	206.3	303E	D2972-84(B)	I-3062-84	
AA furnace	206.2	304			
Inductively coupled plasma, or					200.7.[4]
Colorimetric (SDDC)	206.4	307B	D2972-84(A)	I-3060-84	
7. Barium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	208.1	303C		I-3084-85	
AA furnace	208.2	304			
ICP, or					200.7.[4]
DCP					Note 33.
8. Beryllium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	210.1	303C	D3645-84(A)	I-3095-85	
AA furnace	210.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (aluminon)		309B			
9. Biochemical oxygen demand (BOD_5), mg/L:					
Dissolved Oxygen Depletion	405.1	507		I-1578-78 [7]	33.019 [8], p. 17.[9]
10. Boron—Total, mg/L:					
Colorimetric (curcumin)	212.3	404A		I-3112-85	
ICP, or					200.7.[4]
DCP					Note 33.
11. Bromide, mg/L: Titrimetric	320.1		D1246-82(C)	I-1125-84	p. S44.[9]
12. Cadmium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	213.1	303 A or B	D3557-84 (A or B).	I-3135-85 or I-3136-85.	33.089.[2] p. 37.[9]
AA furnace	213.2	304			
ICP					200.7.[4]
DCP					Note 33.
Voltametry,[10] or			D3557-84(C)		
Colorimetric (Dithizone)		310B			

TABLE E-8. (Continued)

Parameter, units, and method	Reference (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
13. Calcium—Total,[3] mg/L; Digestion [4] followed by:					
AA direct aspiration	215.1	303A	D511-84(B)	I-3152-85	
ICP					200.7.[6]
DCP, or					Note 33.
Titrimetric (EDTA)	215.2	311C	D511-84(A)		
14. Carbonaceous biochemical oxygen demand ($CBOD_5$), mg/L [11]: Dissolved Oxygen Depletion with nitrification inhibitor.		507(5.e.6)			
15. Chemical oxygen demand (COD), mg/L:					
Titrimetric, or	410.1, 410.2, or 410.3	508A	D1252-83	I-3560-84 or I-3562-84.	33.034 [2], p. 17.[8]
Spectrophotometric, manual or automated.	410.4			I-3561-84	Notes 12 or 13.
16. Chloride, mg/L:					
Titrimetric (silver nitrate)		407A	D512-81(B)	I-1183-84	
or (Mercuric nitrate), or	325.3	407B	D512-81(A)	I-1184-84	33.067.[2]
Colorimetric, manual or			D512-81(C)	I-1187-84	
Automated (Ferricyanide)	325.1, or 325.2	407D		I-2187-84	
17. Chlorine—Total residual, mg/L:					
Titrimetric:					
Amperometric direct	330.1	408C	D1253-76(A)		
Starch end point direct	330.3	408A	D1253-76(B)		
			Part 18.3		
Back titration either end point [14], or.	330.2	408B			
DPD-FAS	330.4	408D			
Spectrophotometric, DPD	330.5	408E			
Or Electrode					Note 15.
18. Chromium VI dissolved, mg/L; 0.45 micron filtration followed by:					
AA chelation-extraction, or	218.4	303B		I-1232-84	
Colorimetric (Diphenylcarbazide)				I-1230-84	307B.[16]
19. Chromium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	218.1	303A	D1687-84(D)	I-3236-85	33.089.[8]
AA chelation-extraction	218.3	303B			
AA furnace	218.2	304			
ICP					200.7.[6]
DCP, or					Note 33.
Colorimetric (Diphenylcarbazide)		312B	D1687-84(A)		
20. Cobalt—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	219.1	303 A or B	D3558-84 (A or B).	I-3239-85 or I-3240-85b.	p. 37.[8]
AA furnace	219.2	304			
ICP, or					200.7.[6]
DCP					Note 33.
21. Color platinum cobalt units or dominant wavelength, hue, luminance purity:					
Colorimetric (ADMI), or	110.1	204D			Note 17.
(Platinum cobalt), or	110.2	204A		I-1250-84	
Spectrophotometric	110.3	204B			
22. Copper—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	220.1	303 A or B	D1688-84 (D or E).	I-3270-85 or I-3271-85.	33.089.[2] p. 37.[8]
AA furnace	220.2	304			
ICP					200.7.[6]
DCP, or					Note 33.
Colorimetric (Neocuproine), or (Bicinchoninate).		313B	D1688-84(A)		Note 18.

TABLE E-8. (Continued)

Parameter, units, and method	Reference (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
23. Cyanide—Total, mg/L: Manual distillation with $MgCl_2$ followed by		412B			
Titrimetric, or		412C			p. 22.[6]
Spectrophotometric, manual or	335.2	412D	D2036-82(A)	I-3300-84	
Automated.[19]	335.3		D2036-82(A)		
24. Cyanide amendable to chlorination, mg/L: Manual distillation with $MgCl_2$ followed by titrimetric or spectrophotometric.	335.1	412F	D2036-82(B)		
25. Fluoride—Total, mg/L: Manual distillation[5] followed by:		413A			
Electrode, manual or	340.2	413B	D1179-80(B)		
Automated,				I-4327-84	
Colorimetric (SPADNS),	340.1	413C	D1179-80(A)		
Or Automated complexone	340.3	413E			
26. Gold—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	231.2	303A			
AA furnace, or	231.2	304			
DCP					Note 33.
27. Hardness—Total, as $CaCO_3$ mg/L:					
Automated colorimetric	130.1				
Titrimetric (EDTA), or Ca plus Mg as their carbonates, by inductively coupled plasma or AA direct aspiration. (See Parameters 13 and 33.).	130.2	314B	D1126-80	I-1338-84	33.082.[2]
28. Hydrogen ion (pH), pH units:					
Electrometric, measurement, or	150.1	423	D1293-84 (A or B).	I-1586-84	33.006.[2]
Automated electrode					Note 20.
29. Iridium—Total[3], mg/L; Digestion[3] followed by:					
AA direct aspiration, or	235.1	303A			
AA furnace	235.2	304			
30. Iron—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	236.1	303 A or B	D1068-84 (C or D).	I-3381-85	33.089.[2]
AA furnace	236.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (Phenanthroline)		315B	D1068-84(A)		Note 21.
31. Kjeldahl nitrogen—Total, (as N), mg/L: Digestion and distillation followed by:	351.3	420 A or B	D3590-84(A)		
Titration	351.3	417D	D3590-84(A)		33.051.[2]
Nesslerization	351.3	417B	D3590-84(A)		
Electrode	351.3	417 E or F			
Automated phenate	351.1			I-4551-78 [7]	
Semi-automated block digestor, or	351.2		D3590-84(A)		
Potentiometric	351.4		D3590-84(A)		
32. Lead—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	239.1	303 A or B	D3559-84 (A or B).	I-3399-85	33.089.[2]
AA furnace	239.2	304			
ICP					200.7.[4]
DCP					Note 33.
Voltametry,[10] or			D3559-85(C)		
Colorimetric (Dithizone)		316B			
33. Magnesium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	242.1	303A	D511-84(B)	I-3447-85	33.089.[2]
ICP					200.7.[4]
DCP, or					Note 33.
Gravimetric		318B	D511-77(A)		

TABLE E-8. (Continued)

Parameter, units, and method	Reference (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
34. Manganese—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	243.1	304 A or B	D858-84 (B or C).	I-3454-85	33.089.[5]
AA furnace	243.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (Persulfate) or		319B	D858-84(A)		33.126.[5]
(Periodate)					Note 22.
35. Mercury—Total [3], mg/L:					
Cold vapor, manual or	245.1	303F	D3223-80	I-3462-84	33.095.[5]
Automated	245.2				
36. Molybdenum—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	246.1	303C		I-3490-85	
AA furnace	246.2	304			
ICP, or					200.7.[4]
DCP					Note 33.
37. Nickel—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	249.1	303 A or B	D1886-84 (C or D).	I-3499-85	
AA furnace	249.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (Heptoxime)		321B			
38. Nitrate (as N), mg/L: Colorimetric (Brucine sulfate), or Nitrate-nitrite N minus Nitrite N (See parameters 39 and 40).	352.1		D992-71		33.063 [5], 419D [16], p. 28.[6]
39. Nitrate-nitrite (as N), mg/L: Cadmium reduction, Manual or	353.3	418C	D3867-85(B)		
Automated, or	353.2	418F	D3867-85(A)	I-4545-84	
Automated hydrazine	353.1				
40. Nitrite (as N), mg/L: Spectrophotometric:					
Manual or	354.1	419	D1254-67		Note 24.
Automated (Diazotization)				I-4540-84	
41. Oil and grease—Total recoverable, mg/L: Gravimetric (extraction).	413.1	503A			
42. Organic carbon—Total (TOC), mg/L: Combustion or oxidation.	415.1	505	D2579.85 (A or B).		33.044 [5], p. 4.[23]
43. Organic nitrogen (as N) mg/L: Total Kjeldahl N (Parameter 31) minus ammonia N (Parameter 4.).					
44. Orthophosphate (as P), mg/L: Ascorbic acid method:					
Automated or	365.1	424G		I-4601-84	33.116. [5]
Manual single reagent	365.2	424F	D515-82(A)		33.111. [5]
or Manual two reagent	365.3				
45. Osmium—Total [3], mg/L: Digestion [3] followed by:					
AA direct aspiration, or	252.1	303C			
AA furnace	252.2	304			
46. Oxygen dissolved, mg/L: Winkler (Azide: modification), or	360.2	421B	D888-81(C)	I-1575-78 [7]	33.028. [5]
Electrode	360.1	421F		I-1576-78 [7]	
47. Palladium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	253.1				p. S27.[9]
AA furnace	253.2				p. S28.[9]
DCP					Note 33.
48. Phenols, mg/L:					
Manual distillation [25]	420.1		D1783-80 (A or B).		Note 26.
Followed by:					
Colorimetric (4AAP) manual, or	420.1				Note 26.
Automated [19]	420.2				

TABLE E-8. (Continued)

Parameter, units, and method	Reference (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
49. Phosphorus (elemental) mg/L: Gas-liquid chromatography.					Note 27.
50. Phosphorus—Total, mg/L: Persulfate digestion followed by	365.2	424C(III)			33.111.[2]
Manual or	365.2 or 365.3.	424F	D515-82(A)		
Automated ascorbic acid reduction, or.	365.1	424G		I-4600-84	33.116.[2]
Semi-automated block digestor	365.4				
51. Platinum—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	255.1	303A			
AA furnace	255.2	304			
DCP					Note 33.
52. Potassium—total [3], mg/L: Digestion followed by:					
AA direct aspiration	258.1	303A		I-3630-84	33.103.[2]
Inductively coupled plasma					200.7.[4]
Flame photometric, or		322B	D1428-82(A)		
Colorimetric (Cobaltinitrate)					317B.[16]
53. Residue—Total, mg/L: Gravimetric, 103-105°C.	160.3	209A		I-3750-84	
54. Residue—filterable, mg/L: Gravimetric, 180°C.	160.1	209B		I-1750-84	
55. Residue—nonfilterable, (TSS), mg/L: Gravimetric, 103-105°C post washing of residue.	160.2	209C		I-3765-84	
56. Residue—settleable, mg/L: Volumetric, (Imhoff cone) or gravimetric.	160.5	209E		1	
57. Residue—Volatile, mg/L: Gravimetric, 550°C.	160.4	209D		I-3753-84	
58. Rhodium—Total [3], mg/L: Digestion [3] followed by:.					
AA direct aspiration, or	265.1	303A			
AA furnace	265.2	304			
59. Ruthenium—Total [3], mg/L: Digestion [3] followed by:					
AA direct aspiration, or	267.1	303A			
AA furnace	267.2	304			
60. Selenium—Total [3], mg/L: Digestion [3] followed by:					
AA furnace	270.2	304			
Inductively coupled plasma, or					200.7.[4]
AA gaseous hydride	270.3	303E	D3859-84(A)	I-3667-84	
61. Silica—Dissolved, mg/L: 0.45 micron filtration followed by:					
Colorimetric, Manual or	370.1	425C	D859-80(B)	I-1700-84	
Automated (Molybdosilicate), or				I-2700-84	
Inductively coupled plasma					200.7.[4]
62. Silver—Total,[28] mg/L; Digestion [3] followed by:					
AA direct aspiration	272.1	303 A or B		I-3720-85	33.089.[2] p. 37.[5]
AA furnace	272.2	304			
Colorimetric (Dithizone)					319B.[16]
ICP, or					200.7.[4]
DCP					Note 33.
63. Sodium—Total,[3] mg/L; Digestion [3] followed by:					
AA direct aspiration	273.1	303A		I-3735-85	33.107.[2]
ICP					200.7.[4]
DCP, or					Note 33.
Flame photometric		325B	D1428-82(A)		
64. Specific conductance, micromhos/cm at 25°C: Wheatstone bridge	120.1	205	D1125-82(A)	I-1780-84	33.002.[2]
65. Sulfate (as SO_4), mg/L:					
Automated colorimetric (barium chloranilate).	375.1				
Gravimetric, or	375.3	426 A or B	D516-82(A)		33.124.[2]
Turbidimetric	375.4		D516-82(B)		426C.[29]

TABLE E-8. (Continued)

Parameter, units, and method	References (method No. or page)				
	EPA 1979	Standard methods 16th Ed.	ASTM	USGS [1]	Other
66. Sulfide (as S), mg/L:					
Titrimetric (iodine) or	376.1	427D		I-3840-84	228A.[30]
Colorimetric (methylene blue)	376.2	427C			
67. Sulfite (as SO_3), mg/L: Titrimetric (iodine-iodate).	377.1	428A	D1339-84(C)		
68. Surfactants, mg/L: Colorimetric (methylene blue).	425.1	512B	D2330-82(A)		
69. Temperature, °C.: Thermometric	170.1	212			Note 31.
70. Thallium—Total [3], mg/L: Digestion [3] followed by:					
AA direct aspiration	279.1	303A			
AA furnace, or	279.2	304			
Inductively coupled plasma					200.7.[4]
71. Tin—Total [3], mg/L: Digestion [3] followed by:					
AA direct aspiration, or	282.1	303A		I-3850-78 [7]	
AA furnace,	282.2	304			
72. Titanium—Total,[3] mg/L: Digestion [3] followed by:					
AA direct aspiration	283.1	303C			
AA furnace	283.2	304			
DCP					Note 33.
73. Turbidity, NTU: Nephelometric	180.1	214A	D1889-81	I-3860-84	
74. Vanadium—Total,[3] mg/L: Digestion [3] followed by:					
AA direct aspiration	286.1	303C			
AA furnace	286.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (Gallic acid)		327B	D3373-84(A)		
75. Zinc—Total,[3] mg/L: Digestion [3] followed by:					
AA direct aspiration	289.1	303 A or B	D1691-84 (C or D).	I-3900-85	33.089.[2] p. 37.[6]
AA furnace	289.2	304			
ICP					200.7.[4]
DCP, or					Note 33.
Colorimetric (Dithizone) or		328C			
(Zincon)					Note 32.

[1] "Methods for Analysis of Inorganic Substances in Water and Fluvial Sediments," U.S. Department of the Interior, U.S. Geological Survey, Open-File Report 85-495, 1986, unless otherwise stated.

[2] "Official Methods of Analysis of the Association of Official Analytical Chemists," methods manual, 14th ed. (1985).

[3] For the determination of total metals the sample is not filtered before processing. A digestion procedure is required to solubilize suspended material and to destroy possible organic-metal complexes. Two digestion procedures are given in "Methods for Chemical Analysis of Water and Wastes, 1979." One (section 4.1.3), is a vigorous digestion using nitric acid. A less vigorous digestion using nitric and hydrochloric acids (section 4.1.4) is preferred; however, the analyst should be cautioned that this mild digestion may not suffice for all sample types. Particularly, if a colorimetric procedure is to be employed, it is necessary to ensure that all organo-metallic bonds be broken so that the metal is in a reactive state. In those situations, the vigorous digestion is to be preferred making certain that at no time does the sample go to dryness. Samples containing large amounts of organic materials would also benefit by this vigorous digestion. Use of the graphite furnace technique, inductively coupled plasma, as well as determinations for certain elements such as arsenic, the noble metals, mercury, selenium, and titanium require a modified digestion and in all cases the method write-up should be consulted for specific instruction and/or cautions.

NOTE: If the digestion included in one of the other approved references is different than the above, the EPA procedure must be used.

Dissolved metals are defined as those constituents which will pass through a 0.45 micron membrane filter. Following filtration of the sample, the referenced procedure for total metals must be followed. Sample digestion for dissolved metals may be omitted for AA (direct aspiration or graphite furnace) and ICP analyses provided the sample solution to be analyzed meets the following criteria:

a. has a low COD (<20)
b. is visibly transparent with a turbidity measurement of 1 NTU or less.
c. is colorless with no perceptable odor, and
d. is of one liquid phase and free of particulate or suspended matter following acidification.

[4] The full text of Method 200.7, "Inductively Coupled Plasma Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," is given at Appendix C of this Part 136.

[6] Manual distillation is not required if comparability data on representative effluent samples are on company file to show that this preliminary distillation step is not necessary; however, manual distillation will be required to resolve any controversies.

TABLE E-8. (Continued)

[6] Ammonia, Automated Electrode Method, Industrial Method Number 379-75 WE, dated February 19, 1976, Technicon AutoAnalyzer II, Technicon Industrial Systems, Tarrytown, NY. 10591.

[7] The approved method is that cited in "Methods for Determination of Inorganic Substances in Water and Fluvial Sediments", USGS TWRI, Book 5, Chapter A1 (1979).

[8] American National Standard on Photographic Processing Effluents, Apr. 2, 1975. Available from ANSI, 1430 Broadway, New York, NY 10018.

[9] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).

[10] The use of normal and differential pulse voltage ramps to increase senstivity and resolution is acceptable.

[11] Carbonaceous biochemical oxygen demand ($CBOD_5$) must not be confused with the traditional BOD_5 test which measures "total BOD." The addition of the nitrification inhibitor is not a procedural option, but must be included to report the $CBOD_5$ parameter. A discharger whose permit requires reporting the traditional BOD_5 may not use a nitrification inhibitor in the procedure for reporting the results. Only when a discharger's permit specifically states $CBOD_5$ is required, can the permittee report data using the nitrification inhibitor.

[12] OIC Chemical Oxygen Demand Method, Oceanography International Corporation, 512 West Loop, P.O. Box 2980, College Station, TX 77840.

[13] Chemical Oxygen Demand, Method 8000, Hach Handbook of Water Analysis, 1979, Hach chemical Company, P.O. Box 389, Loveland, CO 80537.

[14] The back titration method will be used to resolve controversy.

[15] Orion Research Instruction Manual, Residual Chlorine Electrode Model 97-70, 1977, Orion Research Incorporated, 840 Memonal Drive, Cambridge, MA 02138.

[16] The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 14th Edition, 1976.

[17] National Council of the Paper Industry for Air and Stream Improvement, (Inc.) Technical Bulletin 253, December 1971.

[18] Copper, Biocinchoinate Method, Method 8506, Hach Handbook of Water Analysis, 1979, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[19] After the manual distillation is completed, the autoanalyzer manifolds in EPA Methods 335.3 (cyanide) or 420.2 (phenols) are simplified by connecting the re-sample line directly to the sampler. When using the manifold setup shown in Method 335.3, the buffer 6.2 should be replaced with the buffer 7.6 found in Method 335.2.

[20] Hydrogen Ion (pH) Automated Electrode Method, Industrial Method Number 378-75WA, October 1976, Technicon Auto-Analyzer II, Technicon Industrial Systems, Tarrytown, NY 10591.

[21] Iron, 1,10-Phenanthroline Method, Method 8008, 1980, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[22] Manganese, Periodate Oxidation Method, Method 8034, Hach Handbook of Wastewater Analysis, 1979, pages 2-113 and 2-117, Hach Chemical Company, Loveland, CO 80537.

[23] Goerlitz, D., Brown, E., "Methods for Analysis of Organic Substances in Water," U.S. Geological Survey Techniques of Water-Resources Inv., book 5, ch. A3, page 4 (1972).

[24] Nitrogen, Nitrite, Method 8507, Hach Chemical Company, P.O. Box 389, Loveland, CO 80537.

[25] Just prior to distillation, adjust the sulfuric-acid-preserved sample to pH 4 with 1 + 9 NaOH.

[26] The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 14th Edition. The colorimetric reaction is conducted at a pH of 10.0±0.2. The approved methods are given on pp. 576-81 of the 14th Edition: Method 510A for distillation, Method 510B for the manual colorimetric procedure, or Method 510C for the manual spectrophotometric procedure.

[27] R. F. Addison and R. G. Ackman, "Direct Determination of Elemental Phosphorus by Gas-Liquid Chromatography," *Journal of Chromatography*, vol. 47, No. 3, pp. 421-426, 1970.

[28] Approved methods for the analysis of silver in industrial wastewaters at concentrations of 1 mg/L and above are inadequate where silver exists as an inorganic halide. Silver halides such as the bromide and chloride are relatively insoluble in reagents such as nitric acid but are readily soluble in an aqueous buffer of sodium thiosulfate and sodium hydroxide to a pH of 12. Therefore, for levels of sliver above 1 mg/L, 20 mL of sample should be diluted to 100 mL by adding 40 mL each of 2 M $Na_2S_2O_3$ and 2M NaOH. Standards should be prepared in the same manner. For levels of silver below 1 mg/L the approved method is satisfactory.

[29] The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 15th Edition.

[30] The approved method is that cited in *Standard Methods for the Examination of Water and Wastewater*, 13th Edition.

[31] Stevens, H. H., Ficke, J. F., and Smoot, G. F., "Water Temperature—Influential Factors, Field Measurement and Data Presentation," U.S. Geological Survey, Techniques of Water Resources Investigations, Book 1, Chapter D1, 1975.

[32] Zinc, Zincon Method, Method 8009, Hach Handbook of Water Analysis, 1979, pages 2-231 and 2-333, Hach Chemical Company, Loveland, CO 80537.

[33] "Direct Current Plasma (DCP) Optical Emission Spectometric Method for Trace Elemental Analysis of Water and Wastes, Method AES0029." 1986, Applied Research Laboratories, Inc., 24911 Avenue Stanford, Valencia, CA 91355.

TABLE E-9. LIST OF TEST PROCEDURES APPROVED BY U.S. EPA FOR NON-PESTICIDE ORGANIC COMPOUNDS

NOTE: This table is an exact reproduction of Table 1C in 40 CFR 136.3.

Parameter [1]	EPA Method Number [2, 7]			Other
	GC	GC/MS	HPLC	
1. Acenaphthene	610	625, 1625	610	
2. Acenaphthylene	610	625, 1625	610	
3. Acrolein	603	[4]624, 1624		
4. Acrylonitrile	603	[4]624, 1624		
5. Anthracene	610	625, 1625	610	
6. Benzene	602	624, 1624		
7. Benzidine		[5]625, 1625	605	Note 3, p. 1;
8. Benzo(a)anthracene	610	625, 1625	610	
9. Benzo(a)pyrene	610	625, 1625	610	
10. Benzo(b)fluoranthene	610	625, 1625	610	
11. Benzo(g,h,i)perylene	610	625, 1625	610	
12. Benzo(k)fluoranthene	610	625, 1625	610	
13. Benzyl chloride				Note 3, p. 130; Note 6, p. S102.
14. Benzyl butyl phthalate	606	625, 1625		
15. Bis(2-chloroethoxy) methane	611	625, 1625		
16. Bis(2-chloroethyl) ether	611	625, 1625		
17. Bis(2-ethylhexyl) phthalate	606	625, 1625		
18. Bromodichloromethane	601	624, 1624		
19. Bromoform	601	624, 1624		
20. Bromomethane	601	624, 1624		
21. 4-Bromophenylphenyl ether	611	625, 1625		
22. Carbon tetrachloride	601	624, 1624		Note 3, p. 130;
23. 4-Chloro-3-methylphenol	604	625, 1625		
24. Chlorobenzene	601, 602	624, 1624		Note 3, p. 130;
25. Chloroethane	601	624, 1624		
26. 2-Chloroethylvinyl ether	601	624, 1624		
27. Chloroform	601	624, 1624		Note 3, p. 130;
28. Chloromethane	601	624, 1624		
29. 2-Chloronaphthalene	612	625, 1625		
30. 2-Chlorophenol	604	625, 1625		
31. 4-Chlorophenylphenyl ether	611	625, 1625		
32. Chrysene	610	625, 1625	610	
33. Dibenzo(a,h)anthracene	610	625, 1625	610	
34. Dibromochloromethane	601	624, 1624		
35. 1,2-Dichlorobenzene	601, 602, 612	624, 625, 1625		
36. 1,3-Dichlorobenzene	601, 602, 612	624, 625, 1625		
37. 1,4-Dichlorobenzene	601, 602, 612	625, 1624, 1625		
38. 3,3'-Dichlorobenzidine		625, 1625	605	
39. Dichlorodifluoromethane	601			
40. 1,1-Dichloroethane	601	624, 1624		
41. 1,2-Dichloroethane	601	624, 1624		
42. 1,1-Dichloroethene	601	624, 1624		
43. trans-1,2-Dichloroethene	601	624, 1624		
44. 2,4-Dichlorophenol	604	625, 1625		
45. 1,2-Dichloropropane	601	624, 1624		
46. cis-1,3-Dichloropropene	601	624, 1624		
47. trans-1,3-Dichloropropene	601	624, 1624		
48. Diethyl phthalate	606	625, 1625		
49. 2,4-Dimethylphenol	604	625, 1625		
50. Dimethyl phthalate	606	625, 1625		
51. Di-n-butyl phthalate	606	625, 1625		
52. Di-n-octyl phthalate	606	625, 1625		
53. 2,4-Dinitrophenol	604	625, 1625		
54. 2,4-Dinitrotoluene	609	625, 1625		
55. 2,6-Dinitrotoluene	609	625, 1625		
56. Epichlorohydrin				Note 3, p. 130; Note 6, p. S102.

TABLE E-9. (Continued)

Parameter [1]	EPA Method Number [2, 7]			Other
	GC	GC/MS	HPLC	
57. Ethylbenzene	602	624, 1624		
58. Fluoranthene	610	625, 1625	610	
59. Fluorene	610	625, 1625	610	
60. Hexachlorobenzene	612	625, 1625		
61. Hexachlorobutadiene	612	625, 1625		
62. Hexachlorocyclopentadiene	612	[5] 625, 1625		
63. Hexachloroethane	612	625, 1625		
64. Ideno(1,2,3-cd)pyrene	610	625, 1625	610	
65. Isophorone	609	625, 1625		
66. Methylene chloride	601	624, 1624		Note 3, p. 130;
67. 2-Methyl-4,6-dinitrophenol	604	625, 1625		
68. Naphthalene	610	625, 1625	610	
69. Nitrobenezene	609	625, 1625		
70. 2-Nitrophenol	604	625, 1625		
71. 4-Nitrophenol	604	625, 1625		
72. N-Nitrosodimethylamine	607	625, 1625		
73. N-Nitrosodi-n-propylamine	607	[5] 625, 1625		
74. N-Nitrosodiphenylamine	607	[5] 625, 1625		
75. 2,2'-Oxybis(1-chloropropane)	611	625, 1625		
76. PCB-1016	608	625		Note 3, p. 43;
77. PCB-1221	608	625		Note 3, p. 43;
78. PCB-1232	608	625		Note 3, p. 43;
79. PCB-1242	608	625		Note 3, p. 43;
80. PCB-1248	608	625		Note 3, p. 43;
81. PCB-1254	608	625		Note 3, p. 43;
82. PCB-1260	608	625		Note 3, p. 43;
83. Pentachlorophenol	604	625, 1625		Note 3, p. 140;
84. Phenanthrene	610	625, 1625	610	
85. Phenol	604	625, 1625		
86. Pyrene	610	625, 1625	610	
87. 2,3,7,8-Tetrachlorodibenzo-p-dioxin		[5a] 613		
88. 1,1,2,2-Tetrachloroethane	601	624, 1624		Note 3, p. 130;
89. Tetrachloroethene	601	624, 1624		Note 3, p. 130;
90. Toluene	602	624, 1624		
91. 1,2,4-Trichlorobenzene	612	625, 1625		Note 3, p. 130;
92. 1,1,1-Trichloroethane	601	624, 1624		
93. 1,1,2-Trichloroethane	601	624, 1624		Note 3, p. 130;
94. Trichloroethene	601	624, 1624		
95. Trichlorofluoromethane	601	624		
96. 2,4,6-Trichlorophenol	604	625, 1625		
97. Vinyl chloride	601	624, 1624		

Table IC Notes

[1] All parameters are expressed in micrograms per liter (μg/L).

[2] The full text of Methods 601–613, 624, 625, 1624, and 1625, are given at Appendix A, "Test Procedures for Analysis of Organic Pollutants," of this Part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit," of this Part 136.

[3] "Methods for Benzidine; Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978.

[4] Method 624 may be extended to screen samples for Acrolein and Acrylonitrile. However, when they are known to be present, the preferred method for these two compounds is Method 603 or Method 1624.

[5] Method 625 may be extended to include benzidine, hexachlorocyclopentadiene, N-nitrosodiumethylamine, and N-nitrosodiphenylamine. However, when they are known to be present, Methods 605, 607, and 612, or Method 1625, are preferred methods for these compounds.

[5a] 625, Screening only.

[6] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).

[7] Each analyst must make an initial, one-time, demonstration of their ability to generate acceptable precision and accuracy with Methods 601–613, 624, 625, 1624, and 1625 (See Appendix A of this Part 136) in accordance with procedures each in section 8.2 of each of these Methods. Additionally, each laboratory, on an on-going bases must spike and analyze 10% (5% for Methods 624 and 625 and 100% for methods 1624, and 1625) of all samples to monitor and evaluate laboratory data quality in accordance with sections 8.3 and 8.4 of these Methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance.

NOTE: These warning limits are promulgated as an "interim final action with a request for comments."

TABLE E-10. LIST OF TEST PROCEDURES APPROVED BY U.S. EPA FOR PESTICIDES[1]

NOTE: This table is an exact reproduction of Table 1D in 40 CFR 136.3.

Parameter µg/L)	Method	EPA [2,7]	Standard Methods 15th Ed	ASTM	Other
1. Aldrin	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			
2. Ametryn	GC				Note 3, p. 83; Note 6, p. S68.
3. Aminocarb	TLC				Note 3, p. 94; Note 6, p. S16.
4. Atraton	GC				Note 3, p. 83; Note 6, p. S68.
5. Atrazine	GC				Note 3, p. 83; Note 6, p. S68.
6. Azinphos methyl	GC				Note 3, p. 25; Note 6, p. S51.
7. Barban	TLC				Note 3, p. 104; Note 6, p. S64.
8. α-BHC	GC	608	509A	D3086	Note 3, p. 7.
	GC/MS	[5] 625			
9. β-BHC	GC	608		D3086	
	GC/MS	625			
10. δ-BHC	GC	608		D3086	
	GC/MS	[5] 625			
11. γ-BHC (Lindane)	GC	608	509A	D3086	Note 3, p. 7; Note 4, p, 30.
	GC/MS	625			
12. Captan	GC		509A		Note 3, p. 7.
13. Carbaryl	TLC				Note 3, p. 94; Note 6, p. S60.
14. Carbophenothion	GC				Note 4, p. 30; Note 6, p. S73.
15. Chlordane	GC	608	509A	D3086	Note 3, p. 7.
	GC-MS	625			
16. Chloropropham	TLC				Note 3, p. 104; Note 6, p. S64.
17. 2,4–D	GC		509B		Note 3, p. 115; Note 4, p. 35.
18. 4,4'–DDD	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC-MS	625			
19. 4,4'–DDE	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			
20. 4,4'–DDT	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			
21. Demeton-O	GC				Note 3, p. 25; Note 6, p. S51.
22. Demeton-S	GC				Note 3, p. 25; Note 6, p. S51.
23. Diazinon	GC				Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
24. Dicamba	GC				Note 3, p. 115.
25. Dichlofenthion	GC				Note 4, p. 30; Note 6, p. S73.
26. Dichloran	GC		509A		Note 3, p. 7.
27. Dicofol	GC			D3086	
28. Dieldrin	GC	608	509A		Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			
29. Dioxathion	GC				Note 4, p. 30; Note 6, p. S73.
30. Disulfoton	GC				Note 3, p. ; Note 6, p. S51.
31. Diuron	TLC				Note 3, p. 104; Note 6, p. S64.
32. Endosulfan I	GC	608	509A	D3086	Note 3, p. 7.
	GC/MS	[5] 625			
33. Endosulfan II	GC	608	509A	D3086	Note 3, p. 7.
	GC/MS	[5] 625			
34. Endosulfan sulfate	GC	608			
	GC/MS	625			
35. Endrin	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	[5] 625			
36. Endrin aldehyde	GC	608			
	GC/MS	625			
37. Ethion	GC				Note 4, p. 30; Note 6, p. S73.
38. Fenuron	TLC				Note 3, p. 104; Note 6, p. S64.
39. Fenuron-TCA	TLC				Note 3, p. 104; Note 6, p. S64.
40. Heptachlor	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			

TABLE E-10. (Continued)

Parameter µg/L)	Method	EPA [2,7]	Standard Methods 15th Ed	ASTM	Other
41. Heptachlor epoxide	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30; Note 6, p. S73.
	GC/MS	625			
42. Isodrin	GC				Note 4, p. 30; Note 6, p. S73.
43. Linuron	TLC				Note 3, p. 104; Note 6, p. S64.
44. Malathion	GC		509A		Note 3, p. 25; Note 4, p. 30; Note 6, p. S51.
45. Methiocarb	TLC				Note 3, p. 94; Note 6, p. S60.
46. Methoxychlor	GC		509A	D3086	Note 3, p. 7; Note 4, p. 30.
47. Mexacarbate	TLC				Note 3, p. 94; Note 6, p. S60.
48. Mirex	GC		509A		Note 3, p. 7.
49. Monuron	TLC				Note 3, p. 104; Note 6, p. S64.
50. Monuron-TCA	TLC				Note 3, p. 104; Note 6, p. S64.
51. Neburon	TLC				Note 3, p. 104; Note 6, p. S64.
52. Parathion methyl	GC		509A		Note 3, p. 25; Note 4, p. 30.
53. Parathion ethyl	GC		509A		Note 3, p. 25.
54. PCNB	GC		509A		Note 3, p. 7.
55. Perthane	GC			D3086	
56. Prometron	GC				Note 3, p. 83; Note 6, p. S68.
57. Prometryn	GC				Note 3, p. 83; Note 6, p. S68.
58. Propazine	GC				Note 3, p. 83; Note 6, p. S68.
59. Propham	TLC				Note 3, p. 104; Note 6, p. S64.
60. Propoxur	TLC				Note 3, p. 94; Note 6, p. S60.
61. Secbumeton	TLC				Note 3, p. 83; Note 6, p. S68.
62. Siduron	TLC				Note 3, p. 104; Note 6, p. S64.
63. Simazine	GC				Note 3, p. 83; Note 6, p. S68.
64. Strobane	GC		509A		Note 3, p. 7.
65. Swep	TLC				Note 3, p. 104; Note 6, p. S64.
66. 2,4,5-T	GC		509B		Note 3, p. 115; Note 4, p. 35.
67. 2,4,5-TP (Silvex)	GC		509B		Note 3, p. 115.
68. Terbuthylazine	GC				Note 3, p. 83; Note 6, p. S68.
69. Toxaphene	GC	608	509A	D3086	Note 3, p. 7; Note 4, p. 30.
	GC/MS	625			
70. Trifluralin	GC		509A		Note 3, p. 7

Table ID Notes

[1] Pesticides are listed in this table by common name for the convenience of the reader. Additional pesticides may be found under Table IC, where entries are listed by chemical name.

[2] The full text of methods 608 and 625 are given at Appendix A, "Test Procedures for Analysis of Organic Pollutants," of this Part 136. The standardized test procedure to be used to determine the method detection limit (MDL) for these test procedures is given at Appendix B, "Definition and Procedure for the Determination of the Method Detection Limit", of this Part 136.

[3] "Methods for Benzidine, Chlorinated Organic Compounds, Pentachlorophenol and Pesticides in Water and Wastewater," U.S. Environmental Protection Agency, September, 1978. This EPA publication includes thin-layer chromatography (TLC) methods.

[4] "Methods for Analysis of Organic Substances in Water," U.S. Geological Survey, Techniques of Water-Resources Investigations, Book 5, Chapter A3 (1972).

[5] The method may be extended to include α-BHC, δ-BHC, endosulfan I, endosulfan II, and endrin. However, when they are known to exist, Method 608 is the preferred method.

[6] "Selected Analytical Methods Approved and Cited by the United States Environmental Protection Agency," Supplement to the Fifteenth Edition of *Standard Methods for the Examination of Water and Wastewater* (1981).

[7] Each analyst must make an initial, one-time, demonstration of their ability to generate acceptable precision and accuracy with Methods 608 and 625 (See Appendix A of this Part 136) in accordance with procedures given in section 8.2 of each of these methods. Additionally, each laboratory, on an on-going basis, must spike and analyze 10% of all samples analyzed with Method 608 or 5% of all samples analyzed with Method 625 to monitor and evaluate laboratory data quality in accordance with Sections 8.3 and 8.4 of these methods. When the recovery of any parameter falls outside the warning limits, the analytical results for that parameter in the unspiked sample are suspect and cannot be reported to demonstrate regulatory compliance.

NOTE: These warning limits are promulgated as an "interim final action with a request for comments."

TABLE E-11. RECOMMENDED SAMPLE SIZES, CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR EFFLUENT SAMPLES

Measurement	Minimum Sample Size[a] (mL)	Container[b]	Preservative[c]	Maximum Holding Time
pH	25	P, G	None	Analyze immediately[d]
Temperature	1,000	P, G	None	Measure immediately[d]
Turbidity	100	P, G	Cool, 4 °C	48 h
Total suspended solids	1,000	P, G	Cool, 4 °C	7 days
Settleable solids	1,000	P, G	Cool, 4 °C	48 h
Floating particulates	5,000	P, G	None	Analyze immediately[d,e]
Dissolved oxygen				
Probe	300	G bottle and top	None	Analyze immediately[d]
Winkler	300	G bottle and top	Fix onsite; store in dark	8 h
Biochemical oxygen demand	1,000	P, G	Cool, 4 °C	48 h
Total chlorine residual	200	P, G	None	Analyze immediately[d]
Oil and grease	1,000	G only	Cool, 4 °C H_2SO_4 to pH<2	28 days
Nitrogen				
Ammonia-N	400	P, G	Cool, 4 °C H_2SO_4 to pH<2	28 days
Total Kjeldahl-N	500	P, G	Cool, 4 °C H_2SO_4 to pH<2	28 days
Nitrate+Nitrite-N	100	P, G	Cool, 4 °C H_2SO_4 to pH<2	28 days
Phosphorus (total)	50	P, G	Cool, 4 °C H_2SO_4 to pH<2	28 days
Priority pollutant metals				
Metals, except mercury	100	P, G	HNO_3 to pH<2	6 mo
Mercury	100	P, G	HNO_3 to pH<2	28 days

TABLE E-11. (Continued)

Measurement	Minimum Sample Size[a] (mL)	Container[b]	Preservative[c]	Maximum Holding Time
Priority pollutant organic compounds				
Extractable compounds (includes phthalates, nitrosamines, organochlorine pesticides, PCBs, nitroaromatics, isophorone, polycyclic aromatic hydrocarbons, haloether, chlorinated hydrocarbons, phenols, and TCDD)	4,000	G only, TFE-lined cap	Cool, 4 °C 0.008% $Na_2S_2O_3$[f] Store in dark	7 days until extraction 40 days after extraction
Purgeable compounds	40	G only, TFE-lined septum	Cool, 4 °C 0.008% $Na_2S_2O_3$[f]	7 days[g]
Total and fecal coliform bacteria	250-500	P, G	Cool, 4 °C 0.008% $Na_2S_2O_3$[f]	6 h
Enterococcus bacteria	250-500	P, G	Cool, 4 °C 0.008% $Na_2S_2O_3$[f]	6 h

Source: Adapted from U.S. EPA (1979b), 40 CFR Part 136.

[a]Recommended field sample sizes for one laboratory analysis. If additional laboratory analyses are required (e.g., replicates), the field sample size should be adjusted accordingly.

[b]P = Polyethylene; G = Glass.

[c]Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, the samples should be maintained at 4 °C until compositing.

[d]Immediately means as soon as possible after the sample is collected, usually within 15 min (U.S. EPA 1984b).

[e]No recommended holding time is given by EPA for floating particulates. Analysis should therefore be made as soon as possible.

[f]Should be used only in the presence of chlorine residual.

[g]Holding time and preservation technique for purgeable compounds are based on the use of EPA Method 624 for screening all priority pollutant volatiles organic compounds, including acrolein and acrylonitrile. If analysis of acrolein and acrylonitrile is found to be of concern, a separate subsample should be preserved by adjusting the pH to 4-5 and the sample should then be analyzed by EPA Method 603.

QUALITY ASSURANCE/QUALITY CONTROL

QA/QC procedures should be detailed in the quality assurance project plan (U.S. EPA 1979c, 1987d). The following items should be discussed in the quality assurance project plan:

- Statement and prioritization of study objectives;
- Responsibilities of personnel associated with sample collection and analysis;

- Sampling locations, frequency, and procedures;
- Variables to be measured, sample sizes, sample containers, preservatives, and sample holding times;
- Equipment checklist;
- Sample splits or performance samples to be submitted with the samples;
- Sample handling, packaging, labeling, and shipping requirements; and
- Laboratories to which samples will be shipped.

U.S. EPA (1987d) provides QA/QC guidance for the following activities:

- Preparation for sampling program;
- Sample collection;
- Sample processing;
- Sample size;
- Sample containers;
- Sample preservation;
- Sample holding times;
- Sample shipping;
- Record keeping;
- Labeling;
- Custody procedures;

- Analytical methods;
- Calibration and preventive maintenance;
- Quality control checks;
- Corrective action; and
- Data reporting requirements.

Field Sampling Procedures

For the field sampling effort, the following procedures are recommended:

- Establish and implement chain-of-custody protocols to track samples from the point of collection to final disposition.
- Establish and implement protocols to prepare sample containers.
- Prepare field "blank" samples to assess potential sample contamination by the sampling devices.
- Prepare "trip blanks" to assess potential contamination by volatile organic analytes en route to the laboratory (one trip blank per sample shipment).
- Collect replicate samples to assess sample precision and the homogeneity of samples collected.
- Use appropriate sample collection procedures (see Table E-11).

Volatile organic samples and split composite samples should be collected carefully. Grab samples for volatile organic analyses should be collected in duplicate. Residual chlorine should be eliminated, and the volatile sample containers should be filled with a minimum of mixing and to capacity, leaving no headspace. When splitting composite samples into discrete aliquots for analyses, the composite sample should be mixed to provide a homogeneous mixture. A representative portion of any solids in the container should be suspended in the composite

sample. Composite samples may be homogenized by hand stirring with clean glass rods or by mechanical stirring with Teflon-coated paddles. Metal mixing devices should not be used.

Laboratory Procedures

Laboratory analytical results must be accurate and reliable. Laboratory QA/QC procedures are generally specified for each different analytical method, and the level of QA/QC and associated deliverables vary among methods (Tables E-9 to E-11). The following documentation is required by the analytical laboratory for QA review of data on organic substances (see Tables E-10 and E-11):

- Initial multipoint calibration;
- Demonstration of method proficiency;
- Determination of method detection limit [usually 5-10 ppb for base, neutral, and acid organic compounds (U.S. EPA Method 625); 0.005-0.10 ppb for pesticide/PCB analysis (U.S. EPA Method 608); and 1-10 ppb for volatiles (U.S. EPA Method 624)];
- Daily checks of calibration and instrument tuning;
- Daily analysis of method blanks (1 blank/20 samples); and
- Analysis of duplicate samples (minimum of 5 percent of samples analyzed) and use of matrix spikes to determine organic recoveries.

The following documentation is required by the analytical laboratory for QA review of data on inorganic substances (see Table E-8):

- Multipoint calibration;
- Analysis of reagent blanks;
- Use of matrix spikes of 0.5-5 times the sample concentration;
- Determination of method detection limits;

- Analysis of full method blanks at a minimum frequency of every 20 samples, rather than reagent water blanks;

- Verification of calibration by analysis of standards (daily or with every 10 sample batches);

- Performance of duplicate analyses for a minimum of 5 percent of the total number of samples analyzed; and

- Use of the method of standard additions for samples demonstrating interferences.

Data Evaluation

Data generated from the monitoring program should be evaluated using the stepwise approach discussed below.

1. Assemble the original raw data reports and the associated QA/QC data. The analytes and analytical methods used will determine the types of QA/QC data generated and may include the following:

   - Sample results;

   - Blank sample results;

   - Instrument calibrations (initial and continuing);

   - Matrix spike/matrix spike duplicate results;

   - Surrogate recovery data;

   - Instrument tuning data;

   - Chain-of-custody records;

   - Analytical request forms;

- Gas chromatograms;
- Mass spectra;
- Instrument detection limit determinations;
- Serial dilution results;
- Clean-water precision and accuracy studies;
- Furnace atomic absorption quality control data;
- Interference check data;
- Laboratory control sample results; and
- Holding time documentation.

2. Because the resulting data will be used to determine regulatory compliance of the discharge, the following sequence is recommended to conduct a QA review of the data:

   - Confirm the sample identifier, container, and preservation with chain-of-custody records.
   - Confirm the analytical procedure (e.g., extraction or digestion) used with the procedure requested.
   - Confirm that an acceptable instrument detection limit was achieved.
   - Confirm that the analysis proceeded in the manner specified.
   - Confirm that all quality control data deliverables specified by the analytical protocol have been submitted.
   - Confirm that the analysis was performed within the specified sample holding time.

- Confirm that the instrumentation used was properly calibrated initially and that the method was validated.

- Confirm detection limits, precision, and accuracy for each substance and review duplicate analysis results.

- Confirm that blank samples were analyzed and that the field sampling and analytical procedures did not contaminate the data.

- Evaluate the presence of matrix interferences through the use of surrogate recoveries and matrix spikes.

- Annotate the data with appropriate qualifiers, and note deviations from prescribed methods.

- Detail problems associated with the analyses.

UPGRADING TO A FULL-SCALE SECONDARY TREATMENT FACILITY

Data obtained from the monitoring program described above will be used to determine the mean and peak concentrations and site-specific toxic pollutant removal capabilities for secondary treatment. The performance of the secondary treatment pilot plant will be closely related to the attention and expertise of the operator controlling the plant. If the pilot plant is not properly operated, the data will not approximate the removals that could be achieved with a full-scale facility. Conventional pollutant data (e.g., suspended solids, BOD) can be used to determine when the pilot plant is operating within the expected design removal efficiencies. The most important factor in performing site-specific toxic pollutant removal investigations is to ensure that an acclimated biological seed exists before initiating sample collection for pollutant analyses.

Plant operators should be aware that activated sludge microorganisms are susceptible to biological and chemical effects that may kill the organisms or severely inhibit their effectiveness. Accumulations of toxic waste components (via gradual concentration from continuous discharges, or sudden slugs) could limit the ability of the activated sludge system to achieve design effluent quality (see Tables E-12 and E-13). Disruptions or changes could be found by reviewing operating records (e.g., settling characteristics of secondary sludge, species populations in the MLSS). If inhibition or upset conditions are found, the concentration and source of each pollutant of concern should be determined. Concentrations shown in Tables E-12 and E-13 are not absolute and should be used only for comparison purposes and preliminary investigations.

Toxic pollutant removal efficiencies at the secondary treatment pilot plant may differ from than those expected in a full-scale secondary treatment facility. For example, the pilot plant will be operated at a constant flow rate and will not be subject to the diurnal and seasonal flow fluctuations normally experienced at treatment facilities or to the slug loadings and batch discharges that POTWs can experience in daily operation. Also, at the relatively higher aeration rates of the pilot plant system, higher degrees of volatile organics stripping may occur, thereby implying higher levels of removal of biodegradable material than might actually happen under full-scale conditions.

TABLE E-12. REPORTED VALUES FOR ACTIVATED SLUDGE BIOLOGICAL PROCESS TOLERANCE LIMITS OF ORGANIC PRIORITY POLLUTANTS

Pollutant	Threshold of Inhibitory Effect (mg/L)[a]
Acenaphthene	NI[b] at 10
Acrolein	NI at 62
Acrylonitrile	NI at 152
Benzene	125
Benzidine	5
Carbon tetrachloride	NI at 10
Chlorobenzene	NI at 1
1,2,4-Trichlorobenzene	NI at 6
Hexachlorobenzene	5
1,2-Dichloroethane	NI at 258
1,1,1-Trichloroethane	NI at 10
Hexachloroethane	NI at 10
1,1-Dichloroethane	NI at 10
1,1,2-Trichloroethane	NI at 5
1,1,2,2-Tetrachloroethane	NI at 201
bis(2-Chloroethyl)ether	NI at 10
2-Chloroethyl vinyl ether	NI at 10
2-Chloronaphthalene	NI at 10
2,4,6-Trichlorophenol	50
4-Chloro-3-methyl phenol	NI at 10
Chloroform	NI at 10
2-Chlorophenol	NI at 10
1,2-Dichlorobenzene	5
1,3-Dichlorobenzene	5
1,4-Dichlorobenzene	5
1,1-Dichloroethylene	NI at 10
trans-1,2-Dichloroethylene	NI at 10
2,4-Dichlorophenol	NI at 75
1,2-Dichloropropane	NI at 182
1,3-Dichloropropylene	NI at 10
2,4-Dimethylphenol	NI at 10
2,4-Dinitrotoluene	5
2,6-Dinitrotoluene	5
1,2-Diphenylhydrazine	5
Ethylbenzene	NI at 10
Fluoranthene	NI at 5
bis(2-Chloroisopropyl)ether	NI[b] at 10
Chloromethane	NI at 180
Bromoform	NI at 10
Dichlorobromomethane	NI at 10
Trichlorofluoromethane	NI at 10
Chlorodibromomethane	NI at 10
Hexachlorobutadiene	NI at 10
Hexachlorocyclopentadiene	NI at 10
Isophorone	NI at 15.4
Naphthalene	500
Nitrobenzene	500

TABLE E-12. (Continued)

Pollutant	Threshold of Inhibitory Effect (mg/L)[a]
2-Nitrophenol	NI at 10
4-Nitrophenol	NI at 10
2,4-Dinitrophenol	1
N-Nitrosodiphenylamine	NI at 10
N-Nitrosodi-n-propylamine	NI at 10
Pentachlorophenol	0.95
Phenol	200
bis(2-Ethylhexyl)phthalate	NI at 10
Butyl benzyl phthalate	NI at 10
Di-n-butyl phthalate	NI at 10
Di-n-octyl phthalate	NI at 16.3
Diethyl phthalate	NI at 10
Dimethyl phthalate	NI at 10
Chrysene	NI at 5
Acenaphthylene	NI at 10
Anthracene	500
Fluorene	NI at 10
Phenanthrene	500
Pyrene	NI at 5
Tetrachloroethylene	NI at 10
Toluene	NI at 35
Trichloroethylene	NI at 10
Aroclor-1242	NI at 1
Aroclor-1254	NI at 1
Aroclor-1221	NI at 1
Aroclor-1232	NI at 10
Aroclor-1016	NI at 1

Source: U.S. EPA (1986c).
[a]Unless otherwise indicated.
[b]NI = no inhibition at tested concentrations. No concentration is listed if reference lacked concentration data.

TABLE E-13. REPORTED VALUES FOR ACTIVATED SLUDGE BIOLOGICAL PROCESS TOLERANCE LIMITS OF INORGANIC PRIORITY POLLUTANTS

Pollutant	Threshold of Inhibitory Effect (mg/L)
Arsenic	0.1
Cadmium	1
Chromium (VI)	1
Chromium (III)	10
Copper	1
Cyanide	0.1
Lead	0.1
Mercury	0.1
Nickel	1
Silver	5
Zinc	0.03

Source: U.S. EPA (1986c).

DEMONSTRATING COMPLIANCE USING PILOT PLANT DATA

The purpose of operating a secondary treatment pilot plant is to determine the concentrations of toxic pollutants in the effluent that would be realized if the applicant were providing secondary treatment rather than less-than-secondary treatment, as requested in the 301(h) application. Effluent from the secondary treatment pilot plant is then analyzed to determine the concentration of each toxic pollutant in the effluent. If these concentrations are more stringent than effluent limits based on state water quality standards or 304(a)(1) water quality criteria, if applicable, or are otherwise required to ensure that all environmental protection criteria are met, then these concentrations define the maximum allowable concentrations in the discharge of less-than-secondary treated effluent.

To demonstrate secondary equivalency, the applicant must demonstrate that the concentration of each toxic pollutant in the effluent of the section 301(h) modified discharge is equal to, or less than, the concentration achieved using the secondary treatment pilot plant. For toxic pollutants whose concentration in the section 301(h) modified discharge is greater than the concentration in the secondary treated effluent, the applicant must lower the concentration using either or both of two approaches. The first approach is to establish local limits for such pollutants, in accordance with the guidance given earlier. These would be in the form of numeric local limits, allocated according to one of the approaches outlined previously in this appendix. As discussed in this section of the appendix, local limits allocations can be based on concentration limits or on flow-corrected mass loading limits, depending on the type of toxic pollutant (conservative vs. nonconservative) and the type and mix of industrial sources of that toxic pollutant. The second approach is to upgrade the treatment process within the POTW. Having implemented either or both of these approaches, the applicant must then provide results of additional effluent analyses to demonstrate that the maximum allowable concentrations of toxic substances are not being exceeded after the proposed controls have been implemented.

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ATTACHMENT 1 TO APPENDIX E
U.S. EPA GUIDANCE MANUAL ON THE DEVELOPMENT AND IMPLEMENTATION OF LOCAL DISCHARGE LIMITATIONS UNDER THE PRETREATMENT PROGRAM
(DECEMBER 1987)

CHAPTER 5 - INDUSTRIAL USERS MANAGEMENT PRACTICES

5. INDUSTRIAL USER MANAGEMENT PRACTICES

5.1 INTRODUCTION

The development and implementation of numeric local limits is not always the only appropriate or practical method for preventing pollutant pass through and interference, or for protecting POTW worker health and safety. Control of chemical spills and slug discharges to the POTW through formal chemical or waste management plans can go a long way toward preventing problems. A local requirement for an IU to develop and submit such a plan can be considered as a type of narrative local limit and can be a useful supplement to numeric limits.

The basic philosophy of instituting management practices is to minimize the discharge of toxic or hazardous pollutants to the sewer, or at least to reduce the impact of toxic/hazardous pollutant discharges by avoiding short-term, high concentration discharges. Management practice plans generally are developed to prevent or control the discharge of hazardous or toxic materials, such as acids, solvents, paints, oils, fuels and explosives by means of appropriate handling procedures, possibly in addition to pretreatment. Slug discharges of process wastewater (including high BOD/COD wastes) can also be effectively controlled through the use of management practices.

In the NPDES permitting program for direct dischargers, industries can be required under 40 CFR Part 125, Subpart K to implement best management practices (BMPs) to minimize the discharge of toxicants to surface waters. These plans are meant to address:

- Toxic and hazardous chemical spills and leaks
- Plant site run-off
- Sludge and waste disposal
- Drainage from material storage areas
- Other "good housekeeping" practices.

While direct discharger BMPs address only activities which are ancillary to manufacturing or treatment processes, IU management practices under a local pretreatment program can also include:

- Solvent management plans
- Batch discharge policies
- Waste recycling
- Waste minimization.

The first step a POTW must take in implementing its program is to be certain that the POTW has the requisite legal authority. This involves ensuring that proper language regarding IU management practices are contained in the sewer use ordinance (at a minimum) and in IU permits. The sewer use ordinances or regulations of most POTWs may already include provisions for requiring IUs to develop management practice plans.

When evaluating the need for IU management plans, POTWs may follow the following steps:

- Evaluation of the potential for toxic and hazardous chemicals onsite to reach the sewer system
- Assessing the adequacy of any industry management plans and practices already in place, and requiring revisions to these as necessary.

1. Evaluation of the Potential for Toxic and Hazardous Chemicals Onsite to Reach the Sewer System. The primary concern on the part of the POTW when evaluating the adequacy of IU management practices is the likelihood of slugs/spills of chemicals reaching the sewer system. Inspectors need to focus on: (1) the types of and quantities of chemicals that are handled (e.g., transferred), stored, or disposed onsite; and (2) the location(s) of all chemical handling, storage and disposal activities with respect to sewer access. The chemicals managed in areas of highest risk of being discharged to the sewers (through spills, slug loading, or accidents) should be of the highest priority to be addressed in management plans.

2. Assessing the Adequacy of Existing Management Plans and Practices. POTW officials should carefully evaluate any existing industry management plans. Receiving particular scrutiny should be:

- The practices that are proposed (and whether they are currently being followed)

- Whether the plan is reflective of current operations at the industry
- Whether the plan was designed to prevent discharges to the sewers
- Whether plant personnel are required to follow the plan
- The familiarity of personnel with the plan
- Any conditions that must be met before a response/corrective action can be taken
- Whether all toxic chemicals managed in areas with access to sewers are addressed.

If deficiencies are found in the existing plans, the IU should be required to correct them before submitting a revised plan to the POTW for approval. Further details of recommended plan specifics are discussed later in this section.

The following sections of this chapter outline the elements of three types of industry management practice plans; chemical management plans, spill contingency, and best management practices plans. POTWs should be aware that hybrids of the plans presented may be appropriate for a particular situation and that some overlap of management practice requirements exists. Key to each of these plans is the continued training of staff and proper implementation.

5.2 CHEMICAL MANAGEMENT PLANS

Chemical management plans differ from the other two types of management plans introduced above because they target specific chemicals or groups of chemicals that are considered to be of concern. One example of a chemical management plan that is widespread is the solvent management plan required of metal finishers by federal categorical standards.

POTWs may wish to pay special attention to certain groups of chemicals that have historically caused management problems. Examples of such chemical groups are:

Strong acids (e.g., hydrochloric acid, sulfuric acid, nitric acid, and chromic acid)

Strong bases (e.g., caustic soda, lye, ammonia, lime, etc.)

Noxious/fuming chemicals (e.g., phosphorus pentachloride, hydrofluoric acid, benzene, chloroform)

Flammable chemicals (e.g., acetone, naptha, hexane, cyclohexane)

Explosive chemicals (e.g., nitroglycerine, metallic sodium, picric acid, and lead azide)

Oxidants (e.g., chlorine dioxide, phosphorus pentoxide, potassium permanganate, sodium chlorate)

Reductants (e.g., sodium borohydride, phosphine, methyl hydrazine)

Oils and fuels (e.g., diesel oil, gasoline, bunker fuel oil)

Toxic wastes (e.g., pesticides)

Solvents

Radioactive materials

Foaming Materials (e.g., surfactants).

It is impossible to present an all encompassing list of chemicals that might suitably be addressed under chemical management plans as the needs and concerns of any specific POTW and its industries will be different. However, much attention has recently been paid to one particular group of chemicals, the frequently used solvents. Table 5-1 presents a list of frequently used solvents and their regulatory status. In presenting this table, it is not the intention to suggest that the solvents on this list will always be a problem. Rather, this list is a recognition of the fact that solvents are ubiquitous to sewer systems and can make up a large portion of the usually uncontrolled organic loadings to treatment plants. Concerns regarding these chemicals may be less familiar to POTW personnel than concerns regarding other chemicals such as acids and bases.

As part of the assessment of an industry's chemical management plan, the POTW must first determine the following: the nature of chemical usage at the IU, chemical handling practices, specific process streams containing the chemical, and locations where the chemicals might (intentionally or unintentionally) enter the sewers. An analysis of the chemical's concentration at potential as well as known release points should be obtained as part of this

data gathering effort. These data should be gathered through onsite inspections whenever possible. Once this basic information is compiled, its accuracy should be verified with the IU and should subsequently provide the basis for assessing the need for, and adequacy of, chemical management plans submitted by the industry. Elements of the industry's chemical management plan should address each of the potential release points. Whenever possible, the industry should be provided with specific language indicating the acceptable levels of the chemical in the sewer so that a clear yardstick is established against which the success or failure of the management plan can be measured. An example of this is again provided by the metal finishing industry's solvent management plans which attempt to achieve a total toxic organic (TTO) pollutant limit of 2.13 mg/l.

Examples of plan components that would target specific release points are: prevent access through floor drains to sewers in areas of possible chemical spillage; the installation of sumps in floor drains providing a capacity that exceeds the largest projected potential spill volume by a safety margin of perhaps 10 percent; and the education of plant workers handling the chemicals of concern in areas with access to sewers.

POTW staff could also discuss the feasibility of possible chemical substitution, process modifications, and/or waste segregation as means of source control.

- Chemical substitution may be possible if there are other compounds that will fulfill the same function demanded of the chemical of concern; assuming that the substitute itself does not exhibit any properties with the potential to cause problems for the POTW. Key factors in the feasibility of this option will be the cost and availability of the substitute chemical; the chemical and physical properties of the substitute and whether these properties will have a substantive effect on the manufacturing process or subsequent wastes handling operations/liabilities.

- Process modifications that would reduce or eliminate the presence of the chemicals of concern would be an attractive option if feasible. It is likely that industry officials will have a better understanding of the limitations to such modifications than POTW personnel, but this should not inhibit inspectors from raising this option as a possibility. Examples of process modification are the use of different, more effective polymers during wastewater treatment, resulting in an improved removal efficiency for the target pollutant; and changing the

degreasing procedures utilized in cleaning product components, possibly from immersion in solvent baths and subsequent rinsing with water, to the wiping of the components manually with the solvent, and air drying under a vacuum hood.

- Waste segregation may be an effective means for improving wastewater treatment efficiency. If the presence of more than one wastewater component acts to limit the efficiency of a treatment process, it may be possible to undertake some form of waste segregation (possibly by distillation) that would separate the components sufficiently to allow for efficient subsequent treatment.

In some instances the institution of formal procedures for the handling, transfer, and storage of chemicals will be useful. For example, if a specific chemical is only used in the manufacturing process in small quantities, the dispensing of the chemical in bulk quantities could be discouraged. This action would reduce the quantities potentially spilled during transfer and also reduce the quantity of "left-over" chemicals that might be carelessly discarded. In some instances the centralized storage of chemicals could improve the logistics of chemical use supervision and provide a principle point of focus for chemical management efforts.

The chemical management plan for each facility should be endorsed by a responsible official at the facility and include a written commitment that the practices described will be followed as a matter of company policy. In instances where industries appear reluctant to implement the procedures delineated in the management plans, POTWs may wish to withhold formal approval of the management plan until a trial period illustrates that the procedures are indeed being implemented.

5.3 SPILL CONTINGENCY PLANS

Many industries with large storage tanks onsite may already have spill contingency plans in place, sometimes as a matter of company policy. This kind of familiarity with planning and response procedures is a definite plus from the POTW's point of view. However, existing spill plans may address only a portion of the potential pollutant sources of concern to the POTW and may not be as sensitive to protection of the sewer system as needed. Also, the quantity and types of materials spilled that would initiate a spill response under existing contingency plans may be inconsistent with pretreatment

concerns and needs. With this in mind, POTW inspectors should carefully review any existing plans for their adequacy as opposed to accepting them at face value. The items which should be focused upon in revieving a spill contingency plan are the same as those considered in the design of a new plan and include:

- Identification of high risk chemicals
- Identification of high risk handling and storage procedures and plant locations
- Identification and mapping of potential release points relative to sewer access points
- Identification of and preparation for possible spill containment and/or countermeasures
- Identification of individuals responsible for implementation of the spill plan, individuals with the authority to commit additional resources to a response action, if necessary; and designation of a predetermined chain of command for coordinating spill response activities--depending on the type of spill
- Documentation of the entire spill contingency plan, including:
  - Maps of key area
  - Equipment lists, and equipment storage and in-plant staging locations
  - Names and functions of all plant officials with a role in spill contingency planning and implementation
  - Names and phone numbers of POTW officials who should be contacted in the event of a spill (the industry may choose to also include local fire department, police, and emergency rescue information)
  - A commitment to provide the POTW with a written notification or report within a short period (3 days) following an incident, explaining the cause of the spill, and steps that are being taken to prevent recurrence
  - An endorsement of the spill plan by responsible industry officials, including a commitment to implement the plan as per the facility's permit requirement
  - An indication as to the date when the plan was last updated, and a commitment to update the plan periodically, or following a spill incident.

Inspectors should carefully review all the details of the plan and be satisfied that it is adequate from the POTW's perspective before recommending formal approval. Additional information on spill contingency plans may be found in "EPA Region X Guidance Manual for the Development of Accidental Spill Prevention Programs," U.S. EPA Region X, Seattle, WA, February 1986. An example is also provided in Appendix K. In addition, EPA is currently developing a guidance manual to help identify the need and methods for developing slug control plans.

5.4 BEST MANAGEMENT PRACTICES PLANS

The concept of best management practices plans (BMPs) is well accepted in the NPDES program, and many of the same principles apply equally well to indirect dischargers. In this section, the types of requirements that could be required of an IU under the provisions of a BMP are discussed. As in the case of the other types of management plans, the actual requirement imposed on any particular industry will vary depending on site-specific needs.

Much of the focus of BMPs is on good housekeeping and proper operation and maintenance measures. While these items may at first seem obvious or trivial, experience has shown that the documentation of proper procedures and a requirement that the procedures be followed are very effective in reducing the number of (preventable) breakdowns in equipment, and miscommunication that can lead to unwanted discharges to the sewers. In considering the need for BMPs and in reviewing the design of BMPs proposed by industry, the following should be considered:

- Equipment O & M. While most facilities will make every effort to take care of the equipment that they have purchased and installed for waste management purposes, this cannot be assumed to always be the case. Where equipment is at a level of sophistication that is beyond the comprehension of its operators, or when the equipment is simply old, attention paid to operation and maintenance practices becomes all the more important. In such cases, BMP requirements should be directed at ensuring that necessary routine maintenance is performed and that equipment failures are not due to neglect. Where sophisticated electronics are a part of a treatment system the manufacturers of such equipment frequently provide either technical training or the option of equipment maintenance contracts. These services should be encouraged by POTW staff wherever appropriate.

- Reduction of contaminated runoff. The potential exists for contaminated runoff from any process operation, chemical transfer area, or raw materials, product, or waste storage area that is exposed to

rainfall. Walk through inspections of a facility may reveal telltale stains on the ground in problem areas. Depending on the nature of the contamination, this type of runoff may be of concern. If the contaminated runoff is readily treated by the IU's pretreatment processes and does not contribute to hydraulic overloading of the system, then it may be of little consequence. However, if pollutants (or the flow) resulting from runoff appear to be a problem, then some form of mitigation should be considered by the IU. After discussing the problems and possible solutions with industry staff, the POTW inspectors should leave the selection of remedial measures to industry management. Mitigative measures might include the construction of berms and/or diversion structures, the shifting of operations to covered areas, recontouring of surfaces, or even the modification of pretreatment systems onsite. The ongoing maintenance and implementation of runoff control measures are appropriately contained in the facility's BMP.

- Segregation of wastes for reclamation. In some instances, opportunities will exist to segregate wastes within a facility for the purpose of reclamation. This practice also reduces the quantities of possibly hazardous waste that must be disposed and may even reduce pollutant loadings in the wastewater. Contaminated oils and spent solvents are examples of wastes for which a substantial reclamation market exists.

- Routine cleaning operations. Many industries will schedule routine cleaning of plant areas and equipment. This may come at the end of every few shifts, on specified days of the week, or possibly at the end of seasonal operations. While these cleaning activities are necessary for the continued efficient (and perhaps sanitary) nature of plant operations, the use of large quantities of detergents and solvents, and the pollutants carried by these chemicals, can be of concern. In some instances, it is possible for industries to reduce the loadings to the sewers through the substitution of dry methods of cleaning or modification of cleaning procedures. For instance, it is often possible to achieve highly efficient cleaning of surfaces while reducing chemical usage by using high pressure application wands. This type of chemical application also allows for more direct application and more efficient chemical usage. When reviewing routine cleaning operations, POTWs should also endeavor to ensure that required cleaning of grease traps are indeed conducted with necessary frequency. Once again, the use of formal procedures, and perhaps even operations log books could be of help.

- Chemical storage practices. A walk through of a facility's process operations may reveal that chemicals and fuels are being stored adjacent to, and perhaps directly over floor drains (so that leaks and drips do not make a mess). This kind of practice should be discouraged and is perhaps the simplest type of preventive measure. Also, if a facility acknowledges routine amounts of chemical spillage and leaks (perhaps during dispensing chemicals) with the use of drip pans, it is probably worth inquiring as to the frequency with which these pans are emptied, whose responsibility it is, and where and how the spilled substances are disposed.

5.5 LEGAL AUTHORITY CONSIDERATIONS

All POTWs must have the minimum legal authority required by 40 CFR 403.8(f)(i), to deny or condition discharges of pollutants that could violate local or Federal pretreatment standards and requirements. The goals of management practice requirements are the same as those of numerical local limits -- to prevent pass through, interference, and violations of the specific prohibitions. However, the imposition of the management plans described in this chapter may or may not be within the scope and authority of some local ordinances. Therefore, it is suggested that each POTW specifically evaluate its legal ability to impose these requirements. Once verified or obtained, specific requirements for industrial users to submit a management plan should be included in the user's control mechanism (i.e., industrial user permit).

5.6 APPROVAL OF INDUSTRIAL USER MANAGEMENT PLANS

Once the need for a chemical management plan, spill prevention plan or BMP is determined, the POTW may require the plan(s) to be submitted in conjunction with the industrial user's permit application and approved in conjunction with issuance of the permit. The industrial user permit should be reissued to include the requirements of the management plan if necessary. Satisfactory implementation of the plans should then be verified during the periodic industrial inspections by the POTW.

TABLE 5-1. LIST OF COMMONLY USED SOLVENTS

Solvent	RCRA Ignitability	RCRA Toxicity	Proposed TCLP	CWA Priority Pollutant
Acetone	Yes	No	No	No
Benzene	Yes	Yes	Yes	Yes
n-Butyl alcohol	Yes	No	No	No
Carbon disulfide	Yes	Yes	Yes	No
Carbon tetrachloride	No	Yes	Yes	Yes
Chlorobenzene	No	Yes	Yes	Yes
Cresols (o-m-p isomers)	No	Yes	Yes	No
Cyclohexanone	Yes	No	No	No
1,2-Dichlorobenzene	No	Yes	Yes	Yes
Dichlorodifluoromethane	No	Yes	No	No
2-Ethoxyethanol	Yes	Yes	No	No
Ethyl acetate	Yes	No	No	No
Ethyl benzene	Yes	No	No	Yes
Ethyl ether	Yes	No	No	No
Isobutanol	Yes	Yes	Yes	No
Methanol	Yes	No	No	No
Methylene chloride	No	Yes	Yes	Yes
Methyl ethyl ketone	Yes	Yes	Yes	No
Methyl isobutyl ketone	Yes	No	No	No
Nitrobenzene	No	Yes	Yes	Yes
2-Nitropropane	Yes	Yes	No	No
Pyridine	Yes	Yes	Yes	No
Tetrachloroethylene	No	Yes	Yes	Yes
Toluene	Yes	Yes	Yes	Yes
1,1,1-Trichloroethane	No	Yes	Yes	Yes
1,1,2-Trichloroethane	No	Yes	Yes	Yes
Trichloroethylene	No	Yes	Yes	Yes
Trichlorofluoromethane	No	Yes	No	No
1,1,2-Trichloro-1,2,2-trifluoroethane	No	Yes	No	No
Xylene (o-m-p isomers)	Yes	No	No	No

ATTACHMENT 2 TO APPENDIX E
U.S. EPA GUIDANCE MANUAL ON THE DEVELOPMENT AND IMPLEMENTATION OF LOCAL DISCHARGE LIMITATIONS UNDER THE PRETREATMENT PROGRAM
(DECEMBER 1987)

APPENDIX I - LOCAL LIMITS DERIVATION EXAMPLE

APPENDIX I

LOCAL LIMITS DERIVATION EXAMPLE

In this appendix, local limits for a hypothetical POTW are derived. This POTW is a conventional activated sludge plant, with anaerobic sludge digestion. POTW characteristics are as follows:

- POTW influent flow = 3.35 MGD
- POTW sludge flow to disposal = 0.01 MGD
- POTW sludge flow to digester = 0.015 MGD
- Percent solids of sludge to disposal = 7.5%
- Receiving stream flow = 47 MGD (7Q10)
  26 MGD (1Q10)

In the first section of this appendix, local limits will be derived for four metals. The second section of this appendix discusses the identification of organic pollutants of concern, and details the calculation of local limits for these organic pollutants.

DERIVATION OF LOCAL LIMITS FOR METALS

The derivation of local limits for metals (cadmium, chromium, copper and lead have been selected as representative) is demonstrated in this section. The methodology for deriving local limits for these metals entails:

- Acquisition of representative removal efficiency data
- Identification of applicable treatment plant/environmental criteria and conversion of criteria into allowable headworks loadings
- Allocation of maximum allowable headworks loadings to domestic and industrial sources, thereby setting local limits

Representative Removal Efficiency Data

Representative removal efficiency data are crucial to the development of allowable headworks loadings. In this section, the acquisition of

representative metal pollutant removal efficiencies for the hypothetical POTW is discussed.

The POTW has monitored its effluent and sludge for the metals cadmium and copper on a monthly basis over the past year. Tables I-1 and I-2 present these monthly effluent and sludge monitoring data, respectively. Corresponding monthly removal efficiency data can be derived from the monthly effluent and sludge monitoring data shown in Tables I-1 and I-2. In order to derive removal efficiencies from the Table I-1 and I-2 data, the following equation can be used:

$$R_{EFF} = \frac{(C_{SLDG})\ (PS/100)\ (Q_{SLDG})\ (100)}{(C_{SLDG})\ (PS/100)\ (Q_{SLDG}) + (C_{EFF})\ (Q_{POTW})}$$

where: R_{EFF} = POTW removal efficiency, percent
C_{SLDG} = Sludge level, mg/kg dry sludge
PS = Percent solids of sludge to disposal
Q_{SLDG} = Sludge flow to disposal, MGD
C_{EFF} = POTW effluent level, mg/l
Q_{POTW} = POTW flow, MGD

This removal efficiency expression was derived from the removal efficiency equation for metals presented in Section 3.2.4. The above equation is based upon the assumption for metals that the POTW influent pollutant loading is equal to the sum of the POTW's effluent and sludge pollutant loadings.

Table I-3 presents site-specific removal efficiencies derived from the above removal efficiency equation, the Table I-1 and I-2 data, and the following POTW operational data:

- POTW flow = 3.35 MGD
- Sludge flow to disposal = 0.01 MGD
- Percent solids of sludge to disposal = 7.5%

TABLE I-1. MONTHLY POTW EFFLUENT MONITORING DATA FOR METALS (MG/L)

Pollutant	Detection Limit*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cd	0.001	ND**	ND	ND	ND	0.03	ND	ND	0.02	ND	ND	0.27	ND
Cu	0.001	0.10	0.06	0.09	0.02	0.14	0.02	0.05	0.06	0.03	0.06	0.13	0.07

*From "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," USEPA Environmental Monitoring and Support Laboratory, Cincinnati, OH, July 1982 (EPA 600/4-82-057).

**ND = Not detected.

TABLE I-2. MONTHLY DIGESTED SLUDGE MONITORING DATA FOR METALS (MG/KG DRY SLUDGE)

Pollutant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cd	55.	50.	35.	44.	60.	65.	26.	30.	30.	11.	42.	26.
Cu	205.	185.	200.	340.	325.	340.	150.	120.	410.	80.	240.	16.

TABLE I-3. MONTHLY REMOVAL EFFICIENCY DATA FOR METALS (PERCENT)

Pollutant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cd	96	96	94	95	31	97	92	25	93	83	3	92
Cu	31	41	33	79	34	79	40	31	75	23	29	5

Notes: Calculated using data in Tables I-1 and I-2. Pollutant levels indicated in Table I-1 as below detection were set equal to one-half the detection limit.

As surrogates for Table I-1 pollutant levels designated as below detection, pollutant levels corresponding to one-half the analytical detection limit (i.e., Cd = 0.0005 mg/l) were used in the removal efficiency calculations.

Section 3.2.4.2 of the manual suggests the use of removal efficiency deciles in deriving allowable headworks loadings. Following these procedures, the second and eighth removal efficiency deciles for cadmium and copper can be obtained from the Table I-3 removal efficiency data. Table I-4 presents second and eighth decile removal efficiency data for these two pollutants, as well as literature decile removal efficiency data for the additional metals chromium and lead. The removal efficiencies shown in this table will be used in deriving allowable headworks loadings for the four metals.

Removal efficiencies for the four metals across primary treatment will also be needed, to derive allowable headworks loadings based on activated sludge inhibition threshold data. The POTW conducted an additional monitoring effort to obtain representative primary removal efficiencies for the four metals. The result of this effort is the median primary removal efficiency data shown in Table I-5. Primary removals varied only slightly from month to month; as a consequence, the POTW elected to use median primary removals and did not consider the use of the removal efficiency decile approach to be necessary.

Derivation of Allowable Headworks Loadings

Having obtained removal efficiency data, allowable headworks loadings are now derived, based on the following treatment plant/environmental criteria:

- NPDES permit limits
- Water quality standards
- Activated sludge inhibition data
- Anaerobic digester inhibition data
- Sludge disposal criteria

TABLE I-4. REPRESENTATIVE REMOVAL EFFICIENCIES FOR THE HYPOTHETICAL POTW

Pollutant	Second Decile Removal	Eighth Decile Removal
Cd	29%	96%
Cr	68%*	91%*
Cu	27%	77%
Pb	39%*	76%*

*Literature value from Table 3-9.

TABLE I-5. REPRESENTATIVE PRIMARY TREATMENT REMOVAL EFFICIENCES FOR THE HYPOTHETICAL POTW

Pollutant	Median Removal Across Primary Treatment
Cd	21%
Cr	31%
Cu	23%
Pb	12%

The derivation of allowable headworks loadings on each of the above-listed bases are discussed in this section.

NPDES Permit Limits

The following equation is used to derive allowable headworks loadings based on NPDES permit limits (from Section 3.2.1.1 of the manual):

$$L_{IN} = \frac{(8.34)(C_{CRIT})(Q_{POTW})}{(1-R_{POTW})}$$

where:

L_{IN} = Allowable headworks loading, lbs/d

C_{CRIT} = NPDES permit limit, mg/l

Q_{POTW} = POTW flow, MGD

R_{POTW} = Removal efficiency across POTW based on second decile

The hypothetical POTW has only one metal pollutant NPDES permit limit, a 0.5 mg/l limit for cadmium. To calculate the corresponding allowable headworks loading of cadmium for the hypothetical POTW, the following values have been established: C_{CRIT} = 0.5 mg/l, Q_{POTW} = 3.35 MGD, and R_{POTW} = 0.29 (from Table I-4). Thus, the allowable headworks loading for cadmium, based on the NPDES permit limit, is:

$$L_{IN} = \frac{(8.34)(0.5)(3.35)}{(1-0.29)} = 19.7 \text{ lbs/d}$$

Water Quality Standards

The following equations are used to derive allowable headworks loadings based on water quality standards (from Section 3.2.1.2 of the manual):

$$L_{IN/C} = \frac{(8.34)[C_{CWQ}(Q_{7Q10} + Q_{POTW})-(C_{STR}Q_{7Q10})]}{(1-R_{POTW})}$$

$$L_{IN/A} = \frac{(8.34)[C_{AWQ}(Q_{1Q10} + Q_{POTW})-(C_{STR}Q_{1Q10})]}{(1-R_{POTW})}$$

where:

$L_{IN/C}$ = Allowable headworks loading based on chronic toxicity standard, lbs/d

$L_{IN/A}$ = Allowable headworks loading based on acute toxicity standard, lbs/d

C_{CWQ} = Chronic toxicity standard, mg/l

C_{AWQ} = Acute toxicity standard, mg/l

Q_{7Q10} = Lowest 7-day average receiving stream flow over the past 10 years, MGD

Q_{1Q10} = Lowest single day receiving stream flow over the past 10 years, MGD

Q_{POTW} = POTW flow, MGD

C_{STR} = Background (upstream) pollutant level in receiving stream, mg/l

R_{POTW} = Removal efficiency across POTW based on second decile

The POTW contacted the State environmental agency and obtained the following receiving stream flow data for deriving allowable headworks loadings based on water quality standards:

Q_{7Q10} = 47 MGD

Q_{1Q10} = 26 MGD

The POTW also obtained from the State agency the applicable water quality standards and receiving stream background level data presented in Table I-6. The Table I-6 water quality standards are converted into corresponding allowable headworks loadings, by means of the above equations. These calculations are illustrated below for cadmium:

$$L_{IN/C} = \frac{(8.34)[(0.001)(47 + 3.35)-(0)(47)]}{(1-0.29)} = 0.59 \text{ lbs/d}$$

$$L_{IN/A} = \frac{(8.34)[(0.005)(26 + 3.35)-(0)(26)]}{(1-0.29)} = 1.72 \text{ lbs/d}$$

TABLE I-6. WATER QUALITY STANDARDS AND RECEIVING STREAM BACKGROUND LEVELS FOR THE HYPOTHETICAL POTW

Pollutant	Chronic Water Quality Standard, mg/l	Acute Water Quality Standard, mg/l	Receiving Stream Background Level, mg/l
Cd	0.001	0.005	0.0*
Cr	0.012	0.025	0.002
Cu	0.015	0.05	0.003
Pb	0.005	0.008	0.001

*Assumed. No data available.

The chronic toxicity-based allowable headworks loading (0.59 lbs/d) is more stringent and is selected as the POTW's overall water quality standard-based allowable headworks loading for cadmium.

The water quality standard-based allowable headworks loadings for the remaining three metals are calculated in an identical fashion. The water quality standard-based allowable headworks loadings for all four metals are listed in Table I-8.

Biological Treatment Process Inhibition

The following equations are used to derive allowable headworks loadings based on biological treatment process inhibition (from Section 3.2.2.1 of the manual):

$$L_{IN/AS} = \frac{(8.34)(C_{IN/AS})(Q_{POTW})}{(1-R_{PRIM})}$$

$$L_{IN/AD} = \frac{(8.34)(C_{IN/AD})(Q_{DIG})}{R_{POTW}}$$

where:

$L_{IN/AS}$ = Allowable headworks loading based on activated sludge process inhibition, lbs/d

$C_{IN/AS}$ = Activated sludge inhibition threshold level, mg/l

Q_{POTW} = POTW flow, MGD

R_{PRIM} = Median primary removal efficiency (Table I-5)

and:

$L_{IN/AD}$ = Allowable headworks loading based on anaerobic digester inhibition, lbs/d

$C_{IN/AD}$ = Anaerobic digester inhibition threshold level, mg/l

Q_{DIG} = Sludge flow to digester, MGD

R_{POTW} = Removal efficiency across POTW based on eighth decile (Table I-4)

The inhibition threshold levels provided in Tables 3-4 and 3-6 of the text are used in these calculations. The sludge flow to the digester (Q_{DIG}) is 0.015 MGD.

Demonstrating the use of the above equations in calculating allowable headworks loadings for cadmium:

- From Table 3-3, $C_{IN/AS}$ = 1 mg/l
- From Table 3-6, $C_{IN/AD}$ = 20 mg/l
- Q_{POTW} = 3.35 MGD
- Q_{DIG} = 0.015 MGD
- R_{PRIM} = 0.21 (Table I-5)
- R_{POTW} = 0.96 (Table I-4)

$$L_{IN/AS} = \frac{(8.34(1)(3.35)}{(1-0.21)} = 35.4 \text{ lbs/d}$$

$$L_{IN/AD} = \frac{(8.34)(20)(0.015)}{(0.96)} = 2.6 \text{ lbs/d}$$

The activated sludge and anaerobic digester inhibition-based allowable headworks loadings for all four metals are presented in Table I-8.

Sludge Disposal Criteria

The POTW land-applies 0.01 MGD of sludge (7.5% consistency) to 500 acres of cropland (soil pH = 7.0, cation exchange capacity = 12 meq/100g). The site life is estimated at 20 years. The POTW contacted the State environmental agency, which advised the POTW that the sludge disposal criteria presented in Table I-7 apply to the POTW's current sludge disposal practices.

Two sludge disposal criteria must be compared for each pollutant: 1) the sludge disposal limit taken directly from Table I-7, and 2) the corresponding sludge disposal limit based on the cumulative application limit from Table I-7. The latter sludge disposal limit is calculated from the following equation (from Section 3.2.2.2 of the manual):

$$C_{LIM(C)} = \frac{(CAR)(SA)}{(SL)(Q_{SLDG})(PS/100)(3046)}$$

where:

$C_{LIM(C)}$ = Sludge disposal limit based on cumulative application rate limit, mg/kg dry sludge

CAR = Cumulative application rate limit, lbs/acre over the site life

TABLE I-7. SLUDGE DISPOSAL CRITERIA FOR LAND APPLICATION OF SLUDGE BY THE HYPOTHETICAL POTW

Pollutant	Sludge Limit, mg/kg dry weight	Cumulative Application Limit, lbs/acre
Cd	25	8.92
Cu	1000	223.1
Pb	1000	892.2

SA = Site area, acres

SL = Site life, years

Q_{SLDG} = Sludge flow to disposal, MGD

PS = Percent solids of sludge to disposal

Demonstrating the use of this equation for cadmium:

- From Table I-7, CAR = 8.92 lbs/acre
- SA = 500 acres
- SL = 20 years
- Q_{SLDG} = 0.01 MGD
- PS = 7.5%

$$C_{LIM(C)} = \frac{(8.92)(500)}{(20)(0.01)(7.5/100)(3046)} = 97.6 \text{ mg/kg dry sludge}$$

Since the sludge disposal limit listed in Table I-7 (25 mg/kg) is more stringent than the above-calculated limitation, the 25 mg/kg limit should be used in deriving the sludge disposal-based allowable headworks loading for cadmium. Similar calculations show that the sludge disposal limits listed in Table I-7 are more stringent for the other two metals as well.

In order to convert a sludge disposal criterion into an allowable headworks loading, the following equation is used (from Section 3.2.2.2 of the manual):

$$L_{IN} = \frac{(8.34)(C_{SLCRIT})(PS/100)(Q_{SLDG})}{R_{POTW}}$$

where:

L_{IN} = Allowable headworks loading, lbs/d

C_{SLCRIT} = Sludge disposal criterion, mg/kg dry sludge

PS = Percent solids of sludge to disposal

Q_{SLDG} = Sludge flow to disposal, MGD

R_{POTW} = Removal efficiency across the POTW, based on eighth decile

For cadmium:

- From above, C_{SLCRIT} = 25 mg/kg
- PS = 7.5%
- Q_{SLDG} = 0.01 MGD
- From Table I-4, R_{POTW} = 0.70

$$L_{IN} = \frac{(8.34)(25)(7.5/100)(0.01)}{(0.70)} = 0.16 \text{ lbs/d}$$

Allowable headworks loadings based on sludge disposal criteria are listed in Table I-8 for the three metals.

Table I-8 presents a comparison of allowable headworks loadings for the four metals, derived on all five bases. As can be seen from Table I-8, the smallest loading for each pollutant is selected as the pollutant's maximum allowable headworks loading. Local limits are to be derived from these maximum allowable headworks loadings.

Allocating Maximum Allowable Headworks Loadings

The allocation of maximum allowable headworks loadings entails:

- Incorporation of a safety factor and subtraction of domestic/ background wastewater loadings
- Allocation of resulting maximum allowable industrial loadings to individual industrial users

Four methods for allocating allowable industrial loadings are demonstrated in this section:

- Uniform concentration method
- Industrial contributory flow method
- Mass proportion method
- Selected industrial reduction method

TABLE I-8. COMPARISON OF ALLOWABLE HEADWORKS LOADINGS FOR METALS

Pollutant	Allowable Headworks Loading (lbs/d) Based on: NPDES Limit	Water Quality Standard	Activated Sludge Inhibition	Anaerobic Digester Inhibition	Sludge Disposal Criterion	Maximum Allowable Headworks Loading, lbs/d
Cd	19.7	0.59	35.4	2.6	0.16	0.16
Cr	-	13.3	40.5	15.1	-	13.3
Cu	-	7.0	36.3	6.5	8.1	6.5
Pb	-	2.8	3.2	56.0	8.2	2.8

The uniform concentration method derives limits which apply to all industrial users, whereas the other three methods are IU-specific, in that derived limits only apply to those industrial users known to be discharging a given pollutant at greater than the domestic/background level.

Incorporation of a Safety Factor/Subtraction of Domestic Loadings

The following equation is used to convert maximum allowable headworks loadings into maximum allowable industrial loadings, through 1) the incorporation of a safety factor, and 2) the subtraction of the total pollutant loading from domestic/background sources:

$$L_{ALL} = (1-SF)L_{MAHL} - L_{DOM}$$

where:

L_{ALL} = Maximum allowable industrial loading, lbs/d

L_{MAHL} = Maximum allowable headworks loading, lbs/d

SF = Safety factor, decimal

L_{DOM} = Domestic/background wastewater pollutant loading, lbs/d (uniform concentration method)

or,

L_{DOM} = Domestic/unregulated wastewater pollutant loading, lbs/d (IU-specific methods)

It can be seen from the above equation that the domestic/background loading (L_{DOM}) for each pollutant depends on the allocation method selected. For the IU-specific allocation methods, IUs which do not discharge the particular pollutant are considered as background sources, discharging at normal domestic/background pollutant levels. Therefore for the IU-specific allocation methods, L_{DOM} for each pollutant includes background pollutant loadings from these IUs. As a result, L_{DOM} for the IU-specific allocation methods is greater than L_{DOM} for the uniform concentration allocation method.

Table I-9 presents a summary of industrial user and domestic/background wastewater flow, concentration, and pollutant loading data for the hypothetical POTW. The distinction between the two types of domestic/background

TABLE I-9. INDUSTRIAL USER MONITORING DATA FOR METALS

Industrial Uses	Flow, MGD	Cd mg/l	Cd lbs/d	Cr mg/l	Cr lbs/d	Cu mg/l	Cu lbs/d	Pb mg/l	Pb lbs/d
Chemical Manufacturer	0.5	0.0018*	-	0.023*	-	0.40	1.67	0.011*	-
Equipment Rebuilder	0.085	0.010	0.007	2.24	1.59	0.20	0.14	3.75	2.66
Ceramic Manufacturer	0.155	0.0015*	-	0.85	1.10	0.05*	-	1.25	1.62
Total Industrial	0.74		0.007		2.69		1.81		4.28
Domestic Wastewater	2.61	0.002	0.044	0.075	1.63	0.080	1.74	0.015	0.33
Domestic Plus Unregulated Wastewater			0.054		1.95		1.84		0.39

*Pollutant level less than domestic wastewater level. IU discharge flow is considered part of the unregulated wastewater flow for the pollutant.

wastewater loadings is evident from the Table I-9 data; the domestic/background loadings for the IU-specific method are increased to account for industrial user background loadings. The amount of this increase equals the flow from those industries not discharging the pollutant times the domestic wastewater background concentration.

The calculation of maximum allowable industrial loadings, using domestic/background pollutant loading data from Table I-9, is demonstrated below for cadmium:

- From Table I-8, L_{MAHL} = 0.16 lbs/d
- From Table I-9, L_{DOM} = 0.044 lbs/d (Uniform Concentration Method)
- From Table I-9, L_{DOM} = 0.054 lbs/d (IU-specific methods)
- SF = 0.10 (ten percent safety factor assumed)

L_{ALL} = (1-0.10)(0.16) - 0.044 = 0.10 lbs/d (Uniform Concentration Method)

L_{ALL} = (1-0.10)(0.16) - 0.054 = 0.09 lbs/d (IU-specific methods)

Table I-10 presents maximum allowable industrial loadings for the four metals. These loadings were derived from the above equation, incorporating a ten percent safety factor and using the domestic/background pollutant loading data presented in Table I-9.

Allocation of Maximum Allowable Industrial Loadings

Table I-11 to I-13 present local limits for each of the hypothetical POTW's industrial users, derived by application of the four industrial loading allocation methods discussed in Chapter 3 of the manual. The equations and calculations pertinent to the derivation of these local limits are discussed in the following sections.

Uniform Concentration Allocation Method

The uniform allocation method derives local limits which apply to all three of the hypothetical POTW's industrial users. The equation for this method is (from Figure 3-2 of the manual):

$$C_{LIM} = \frac{L_{ALL}}{(8.34)(Q_{IND})}$$

TABLE I-10. MAXIMUM ALLOWABLE INDUSTRIAL LOADINGS, LBS/D

Pollutant	Uniform Concentration Method	IU-Specific Allocation Methods
Cd	0.10	0.09
Cr	10.34	10.02
Cu	4.11	4.01
Pb	2.19	2.13

TABLE I-11. LOCAL LIMITS FOR THE HYPOTHETICAL CHEMICAL MANUFACTURER

Pollutant	Local Limit, mg/l: Uniform Concentration	Industrial Contributory*	Mass Proportion*	Selected Industrial Reduction**
Cd	0.02	-	-	-
Cr	1.68	-	-	-
Cu	0.67	0.82	0.89	-
Pb	0.35	-	-	-

*Local limits not derived for pollutants discharged by the IU at levels below the domestic sewage background concentration. The IU would be notified that it is not allowed to increase its discharge above the domestic sewage background level.

**Calculation of limits by the selected industrial reduction method is illustrated for lead only.

TABLE I-12. LOCAL LIMITS FOR HYPOTHETICAL EQUIPMENT REBUILDER

Pollutant	Local Limit, mg/l: Uniform Concentration	Industrial Contributory*	Mass Proportion*	Selected Industrial Reduction**
Cd	0.02	0.13	0.13	-
Cr	1.68	5.01	8.35	-
Cu	0.67	0.82	0.44	-
Pb	0.35	1.06	1.87	1.0

*Local limits not derived for pollutants discharged by the IU at levels below the domestic sewage background concentration. The IU would be notified that it is not allowed to increase its discharge above the domestic sewage background level.

**Calculation of limits by the selected industrial reduction method is illustrated for lead only.

TABLE I-13. LOCAL LIMITS FOR HYPOTHETICAL CERAMIC MANUFACTURER

Industrial User:

Pollutant	Local Limit, mg/l			
	Uniform Concentration	Industrial Contributory*	Mass Proportion*	Selected Industrial Reduction**
Cd	0.02	-	-	-
Cr	1.68	5.01	3.17	-
Cu	0.67	-	-	-
Pb	0.35	1.06	0.62	1.0

*Local limits not derived for pollutants discharged by the IU at levels below the domestic sewage background concentration. The IU would be notified that it is not allowed to increase its discharge above the domestic sewage background level.

**Calculation of limits by the selected industrial reduction method is illustrated for lead only.

where: C_{LIM} = Uniform concentration limit, mg/l

L_{ALL} = Maximum allowable industrial loading, lbs/d

Q_{IND} = Total industrial flow, MGD

As an example, for chromium:

L_{ALL} = 10.34 lbs/d (See Table I-10)

Q_{IND} = 0.74 MGD (Table I-9)

$$C_{LIM} = \frac{(10.34)}{(8.34)(0.74)} = 1.68 \text{ mg/l}$$

This limit applies to all three industrial users of the hypothetical POTW (See Tables I-11 to I-13).

Industrial Contributory Flow Method

The industrial contributory flow method derives local limits which apply only to those industrial users discharging the particular pollutant at greater than the normal background concentration in domestic sewage. The equation for this method is (from Figure 3-2 of the manual):

$$C_{LIM} = \frac{L_{ALL}}{(8.34)(Q_{CONT})}$$

where:

C_{LIM} = Industrial contributory flow-based limit, mg/l

L_{ALL} = Maximum allowable industrial loading, lbs/d

Q_{CONT} = Industrial contributory flow, MGD

As an example, for chromium:

L_{ALL} = 10.02 lbs/d (See Table I-10)

Q_{CONT} = flow from chromium dischargers = 0.085 + 0.155 = 0.24 MGD (See Table I-9)

$$C_{LIM} = \frac{10.02}{(8.34)(0.24)} = 5.01 \text{ mg/l}$$

This limit applies only to the hypothetical equipment rebuilding and ceramic manufacturing industrial users. (See Tables I-11 to I-13).

Mass Proportion Method

The mass proportion method allocates allowable industrial loadings to individual IUs in direct proportion to each IU's current pollutant loading. This allocation method is also IU-specific. The equation for this method is (from Figure 3-2 of the manual):

$$C_{LIM(x)} = \frac{(L_{CURR(x)}/L_{CURR(t)})}{(8.34)(Q_{(x)})} \times L_{ALL}$$

where:

$C_{LIM(x)}$ = Local limit for industrial user (x), mg/l

L_{ALL} = Maximum allowable industrial loading, lbs/d

$L_{CURR(x)}$ = Current loading from industrial user (x), lbs/d

$L_{CURR(t)}$ = Total industrial loading, lbs/d

$Q_{(x)}$ = Industrial user (x) discharge flow, MGD

As an example, for chromium:

L_{ALL} = 10.02 lbs/d (Table I-10)

$L_{CURR(t)}$ = 2.69 lbs/d (Table I-9)

Equipment Rebuilder:

$L_{CURR(x)}$ = 1.59 lbs/d

$Q_{(x)}$ = 0.085 MGD

$$C_{LIM(x)} = \frac{(1.59/2.69)}{(8.34)(0.085)} \times (10.02) = 8.35 \text{ mg/l}$$

Ceramic Manufacturer:

$L_{CURR(x)}$ = 1.10 lbs/d

$Q_{(x)}$ = 0.155 MGD

$$C_{LIM(x)} = \frac{(1.10/2.69)}{(8.34)(0.155)} \times (10.02) = 3.17 \text{ mg/l}$$

The above limits apply only to the industrial users indicated (See Tables I-11 to I-13).

Selected Industrial Reduction Method

The selected industrial reduction method is based upon the reduction of current industrial user discharge loadings by the installation of treatment technologies. As an example of the application of this method, selected industrial reduction limits for lead will be derived in this section.

From Table I-9, the current total industrial loading of lead is 4.28 lbs/d. The maximum allowable industrial loading, from Table I-10, is 2.13 lbs/d. The required industrial loading reduction is:

4.28 lbs/d - 2.13 lbs/d = 2.15 lbs/d

Appendix L (Table L-1) and Table 6-1 in Chapter 6 document that a reduction of lead to less than 1.0 mg/l can be achieved through the installation of precipitation technologies. This concentration limit may be imposed upon the POTW's current lead dischargers as long as it results in the minimum required industrial loading reduction of 2.15 lbs/d. That this loading reduction can be achieved with a 1.0 mg/l limit is demonstrated as follows:

- For the equipment rebuilder, current lead loading = 2.66 lbs/d (from Table I-9)

  At 1.0 mg/l, the IU's lead loading is reduced to:

  (8.34)(1.0 mg/l)(0.085 MGD) = 0.71 lbs/d

  The lead loading reduction effected by the equipment rebuilder equals:

  2.66 lbs/d - 0.71 lbs/d = 1.95 lbs/d

- For the ceramic manufacturer, current lead loading = 1.62 lbs/d (from Table I-9)

  At 1.0 mg/l, the IU's lead loading is reduced to:

  (8.34)(1.0 mg/l)(0.155 MGD) = 1.29 lbs/d

The lead loading reduction effected by the ceramic manufacturer equals:

1.62 lbs/d - 1.29 lbs/d = 0.33 lbs/d

- The combined lead loading reduction brought about by the two industrial users equals:

1.95 lbs/d + 0.33 lbs/d = 2.28 lbs/d

Since this lead loading reduction of 2.28 lbs/d exceeds the required loading reduction of 2.15 lbs/d, the 1.0 mg/ lead limit may be imposed upon the equipment rebuilder and the ceramic manufacturer (see Tables I-11 to I-13).

DERIVATION OF LOCAL LIMITS FOR ORGANICS

The derivation of organic pollutant local limits for the hypothetical POTW entails:

- Identification of organic pollutants of concern for which local limits may be needed
- Derivation of maximum allowable headworks loadings
- Allocation of maximum allowable headworks loadings
- Establishing local limits to address pollutant flammability/ explosivity and fume toxicity concerns

Each of the above tasks are discussed in the following sections.

Identification of Organic Pollutants of Concern

The first step in deriving organic pollutant local limits for the hypothetical POTW will be to identify organic pollutants of concern for which local limits may be needed. As discussed in Chapter 2 of this manual, the first step involves completion of a thorough industrial user survey which identifies chemicals used, produced, stored, or disposed by the IUs. Then, sampling of IU discharges and at the POTW is performed to screen for the presence of those pollutants reasonably expected to be present in significant quantities. Based on the results of this preliminary sampling, some quick rules of thumb may be used to determine whether more extensive coordinated

influent/effluent/sludge sampling for particular pollutants is needed to provide data necessary for calculation of local limits. For example, the following conservative rules of thumb could be used to decide which pollutants would warrant further consideration:

- Water quality-based local limits - Does the result of a receiving stream dilutional analysis based on maximum POTW effluent concentration exceed State water quality standards?

- Inhibition-based local limits - Does the maximum POTW influent grab sample concentration exceed one-half, or the maximum POTW influent 24-hour composite sample concentration exceed one-fourth, of the activated sludge inhibition threshold level?

  Does the maximum POTW influent concentration exceed one five-hundredth of the anaerobic digester inhibition threshold level?

- Sludge disposal criteria-based local limits - Does the maximum concentration of the pollutant in POTW sludge exceed one-half of the State sludge disposal criterion?

- Flammability/explosivity and fume toxicity-based local limits - Are IU discharge levels in excess of flammability/explosivity - and/or fume toxicity-based discharge screening levels?

The above pollutant evaluation scheme is based on the chemical-specific approach to identifying pollutant of concern, discussed in Section 2.3.3.1 and Figure 2-2 of the manual, and the flammable/explosive and fume toxic pollutant screening techniques discussed in Sections 4.1.1.5 and 4.2.3 of the manual. This evaluation scheme focuses on POTW influent and IU discharge data, but also incorporates the use of effluent and sludge data. As discussed in Section 2.3.3.1 of the manual, the POTW should perform at least a limited amount of effluent and sludge monitoring as part of its preliminary sampling program, in order to screen for pollutants which have concentrated to detectable levels in effluent or sludge even though not detectable in the influent.

Table I-14 and I-15 summarize organic pollutant monitoring data for the hypothetical POTW's influent and effluent, respectively, and Table I-16 summarizes organic pollutant monitoring data for the POTW's principal industrial user, an organic chemical manufacturing facility. The monitoring data presented in these tables will be used in demonstrating the above-described pollutant evaluation scheme. The application of each step of the pollutant evaluation scheme is demonstrated in the following sections.

TABLE I-14. POTW INFLUENT MONITORING DATA FOR ORGANIC POLLUTANTS

Pollutant	Number of Detections in Grab Samples	Concentration Range, mg/l	Number of Detections in Composite Samples	Concentration Range, mg/l
Priority Pollutant Organics:				
Chlorobenzene	2	0.24 - 1.16	6	0.04 - 0.74
Chloroform	1	0.06	6	0.002 - 0.38
Ethylbenzene	1	0.003	4	0.001 - 0.005
Methyl Chloride	1	3.48	7	0.001 - 0.69
Methylene Chloride	2	0.001 - 0.03	3	0.006 - 0.11
Nitrobenzene	0		2	0.087 - 0.28
Phenol	1	0.0002	1	0.036
Toluene	1	0.008	8	0.001 - 0.043
Non-priority Pollutant Organics:				
Acetone	1	0.1	1	2.62
Aniline	1	0.76	3	0.6 - 2.0
Benzoic Acid	0		2	0.27 - 0.7
3-(Dimethylamino) phenol	1	1.56	0	
N,N-Dimethylaniline	1	0.67	1	0.2
N,N-Dimethyl Formamide	1	1.4	0	
Quinaldine	1	2.7	2	0.4 - 1
Resourcinol Dimethyl Ether	0		3	0.1 - 0.47
Hydroquinone Monomethyl Ether	0		1	0.41
Methyl Isobutyl Ketone	1	0.018	1	0.12

TABLE I-15. POTW EFFLUENT MONITORING DATA FOR ORGANIC POLLUTANTS

Pollutant	Number of Detections in Grab Samples	Concentration Range, mg/l	Number of Detections in Composite Samples	Concentration Range, mg/l
Priority Pollutant Organics:				
Chlorobenzene	6	0.39 - 23.0	5	0.05 - 1.36
Chloroform	4	0.04 - 0.83	5	0.01 - 0.09
Ethylbenzene	2	0.002 - 4.6	5	0.001 - 0.008
Methyl Chloride	1	1.58	5	0.002 - 1.16
Methylene Chloride	2	0.007 - 0.014	1	0.021
Nitrobenzene	0		1	0.028
Phenol	0		2	0.001 - 0.037
Toluene	5	0.005 - 0.048	7	0.004 - 0.01
Non-priority Pollutant Organics:				
Acetone	1	0.1	1	9.73
Aniline	1	0.4	2	0.1 - 0.82
Benzoic Acid	0		1	0.55
3-(Dimethylamino) phenol	1	0.56	0	
N,N-Dimethylaniline	0		1	0.3
N,N-Dimethyl Formamide	1	0.15	0	
Quinaldine	1	0.53	1	0.4
Resourcinol Dimethyl Ether	0		1	0.2
Resourcinol Monomethyl Ether	0		1	0.1
Hydroquinone Monomethyl Ether	0		1	0.41

TABLE I-16. IU DISCHARGE MONITORING DATA FOR ORGANIC POLLUTANTS

Pollutant	Number of Detections in Grab Samples	Concentration Range, mg/l	Number of Detections in Composite Samples	Concentration Range, mg/l
Priority Pollutant Organics:				
Chlorobenzene	1	10.99	26	0.18 - 13.8
Chloroform	1	0.69	17	0.04 - 0.9
2,4-Xylenol	0		1	6.1
Ethylbenzene	0		1	12.2
Methyl Chloride	1	39.27	6	0.09 - 13.9
Methylene Chloride	1	0.73	4	0.016 - 2.4
Nitrobenzene	1	1.49	23	0.11 - 34.0
Phenol	0		10	0.01 - 17.0
Toluene	1	0.014	6	0.06 - 0.62
Non-priority Pollutant Organics:				
Aniline	0		22	0.18 - 108.0
Benzoic Acid	0		1	3.8
3-(Dimethylamino) phenol	0		4	0.088 - 6.0
4-(Dimethylamino)benzaldehyde	1	1.99	4	0.045 - 3.6
N,N-Dimethylaniline	1	1.89	4	0.2 - 4.0
N,N-Dimethyl Formamide	0		1	9.6
Hydroquinone Monomethyl Ether	0		1	2.2

TABLE I-16. IU DISCHARGE MONITORING DATA FOR ORGANIC POLLUTANTS (CONTINUED)

Pollutant	Number of Detections in Grab Samples	Concentration Range, mg/l	Number of Detections in Composite Samples	Concentration Range, mg/l
Non-Priority Pollutant Organics:				
3-(Hydroxyphenyl) Ethanol	1	0.78	0	
Methyl Acetate	0		3	0.01 - 1.7
Methyl Benzoate	0		2	0.085 - 0.64
Quinaldine	1	10.53	3	0.75 - 6.3
Resourcinol Dimethyl Ether	1	5.56	3	0.27 - 2.3
Resourcinol Monomethyl Ether	0		3	0.1 - 0.89
Tridecanol	1	2.72	0	
Methyl Ethyl Ketone	1	0.9	0	
Methyl Isobutyl Ketone	1	0.15	1	1.44

Screening of Organic Pollutants on the Basis of Water Quality Standards

The first step of the evaluation scheme consists of a receiving stream dilutional analysis to identify pollutants of potential water quality concern. The equation for conducting this dilutional analysis is as follows:

$$C_{PROJ} = C_{EFF} \times \left(\frac{Q_{POTW}}{Q_{STR} + Q_{POTW}}\right)$$

where:

C_{PROJ} = Projected downstream level, mg/l

C_{EFF} = Maximum POTW effluent level, from Table I-15, mg/l

Q_{POTW} = POTW flow, MGD

Q_{STR} = Receiving stream flow, MGD

- 7Q10 flow for comparison to chronic criteria
- 1Q10 flow for comparison to acute criteria

Projected downstream levels calculated from the above equation are compared with State water quality standards. Table I-17 presents organic pollutant State water quality standards for the POTW.

The screening technique is demonstrated below for chlorobenzene:

Q_{POTW} = 3.35 MGD

Q_{STR} = 47 MGD (7Q10)
26 MGD (1Q10)

C_{EFF} = 23 mg/l (Table I-15)

Chronic: $C_{PROJ} = 23 \times \left(\frac{3.35}{3.35 + 47}\right) = 1.5$ mg/l

Acute: $C_{PROJ} = 23 \times \left(\frac{3.35}{3.35 + 26}\right) = 2.6$ mg/l

Table I-17 indicates that the chronic water quality standard for chlorobenzene is 0.026 mg/l and the acute standard is 0.59 mg/l. Since the above-derived projected in-stream levels exceed these water quality standards, the development of water quality-based local limits for chlorobenzene is warranted.

TABLE I-17. ORGANIC POLLUTANT WATER QUALITY STANDARDS FOR THE POTW

Pollutant	Acute Water Quality Standard, mg/l	Chronic Water Quality Standard, mg/l
Acetone	550	78
Chlorobenzene	0.59	0.026
Chloroform	1.8	0.079
Ethylbenzene	1.4	0.062
Methylene Chloride	9.7	0.43
Phenol	5.3	0.37
Toluene	2.4	1.7
Nitrobenzene	27.0	- *

*No standard available.

Based on this screening technique, the POTW determined that water quality-based local limits should be developed for the following organic pollutants:

- Chlorobenzene
- Ethylbenzene

Screening of Organic Pollutants on the Basis of Biological Process Inhibition

The second step of the pollutant evaluation scheme entails the comparison of POTW influent levels of organic pollutants with activated sludge and anaerobic digester inhibition threshold data, as follows:

- Maximum level in grab sample of POTW influent compared with one-half of the activated sludge inhibition threshold
- Maximum level in composite sample compared with one-fourth of the activated sludge inhibition threshold
- Maximum POTW influent level compared with one-five hundredth of the anaerobic digester inhibition threshold

Activated sludge inhibition data are provided in Table 3-2 of the manual. Comparing POTW influent data from Table I-14 with inhibition threshold cutoffs derived from the Table 3-2 data:

Pollutant	Maximum Grab Sample Level, mg/l	One-half of Inhibition Threshold, mg/l	Maximum Composite Sample Level, mg/l	One-fourth of the Inhibition Threshold, mg/l
Ethylbenzene	0.003	100	0.005	50
Nitrobenzene	Not detected	15	0.28	7.5
Phenol	0.002	25	0.036	12.5
Toluene	0.008	100	0.043	50

The above-listed organics are present in the POTW influent at levels well below their corresponding cutoffs. Local limits for these organics need not be developed from activated sludge process inhibition data.

Table 3-5 of the manual presents anaerobic digester threshold inhibition data. Comparing maximum POTW influent levels with anaerobic digester inhibition cutoffs derived from Table 3-5 data:

Pollutant	Maximum Influent Level, mg/l	One-five hundredth of the Digester Inhibition Level, mg/l
Chlorobenzene	1.16	0.002
Chloroform	0.38	0.002
Methyl Chloride	3.48	0.007

All three pollutants are present in the POTW influent at levels in excess of their cutoffs. Based on this screening analysis, local limits based on anaerobic digester inhibition may be needed for all three pollutants. The POTW should therefore perform the additional sampling necessary to perform a headworks loading analysis. It would also be wise for the POTW to sample for pollutants in the digester to determine whether inhibition threshold levels are currently exceeded.

Screening of Organic Pollutants on the Basis of Sludge Disposal Criteria

The hypothetical POTW contacted the State environmental agency to determine if any State sludge disposal guidelines had been established for organic pollutants in land-applied sludge. The POTW was informed that State sludge disposal guidelines for organic pollutants had not been established. The hypothetical POTW concluded that without sludge disposal criteria, no basis existed for a sludge disposal criteria analysis.

Screening of Organic Pollutants Based on Flammability/Explosivity and Fume Toxicity

The final step of the pollutant evaluation scheme is to compare industrial user discharge levels with IU discharge screening levels based on pollutant flammability/explosivity and fume toxicity. These screening levels are developed as per the methodologies presented in Sections 4.1.1.5 and 4.2.3 of the manual.

Table I-18 presents a comparison of IU discharge levels (from Table I-16) with discharge screening levels developed in accordance with the Section 4.1.1.5 and Section 4.2.3 methodologies. The comparison suggests that fume toxicity-based local limits may be needed for the following pollutants:

- o Chlorobenzene
- o Chloroform
- o Ethylbenzene
- o Methyl chloride
- o Nitrobenzene

The comparison also suggests that flammability/explosivity-based local limits may be needed for methyl chloride.

Derivation of Maximum Allowable Headworks Loadings

The pollutant evaluation scheme identified the following pollutants for which allowable headworks loadings should be developed:

Water Quality-based Headworks Loadings

- o Chlorobenzene
- o Ethylbenzene

Anaerobic Digester Inhibition-based Headworks Loadings

- o Chlorobenzene
- o Chloroform
- o Methyl chloride

Earlier in this appendix, allowable headworks loadings for metals were derived from State water quality standards. The same procedures can be followed here to derive water quality-based allowable headworks loadings for chlorobenzene and ethylbenzene. Based on the following data:

- o Receiving stream flow, 7Q10 = 47 MGD
- o Receiving stream flow, 1Q10 = 26 MGD
- o POTW flow = 3.35 MGD

TABLE I-18. COMPARISON OF IU DISCHARGE LEVELS WITH IU DISCHARGE SCREENING LEVELS

Pollutant	Maximum IU Discharge Level, mg/l	Flammability/ Explosivity-Based Screening Level, mg/l	Fume Toxicity-Based Screening Level, mg/l
Chlorobenzene	13.8	403.	2.35
Chloroform	0.9	- *	0.42
Ethylbenzene	12.2	158.	1.59
Methyl Chloride	39.27	11.	0.007
Methylene Chloride	2.4	5760.	4.15
Nitrobenzene	34.0	98035.	5.41
Phenol	17.0	- *	688.4
Toluene	0.62	173.	1.35
Aniline	108.0	712086.	143.9
N,N-Dimethylaniline	4.0	- *	71.4
Methyl Acetate	1.7	21531.	140.0
Methyl Ethyl Ketone	0.9	24848.	249.0
Methyl Isobutyl Ketone	0.15	24601.	88.0

*Screening level not developed (LEL data not available)

- Receiving stream background levels = 0 (i.e., not available)
- Chlorobenzene chronic standard = 0.026 mg/l
- Chlorobenzene acute standard = 0.59 mg/l
- Ethylbenzene chronic standard = 0.062 mg/l
- Ethylbenzene acute standard = 1.4 mg/l
- Chlorobenzene removal efficiency = 90%*
- Ethylbenzene removal efficiency = 67% (Table 3-10)

Allowable headworks loadings of 109.2 lbs/d chlorobenzene and 78.9 lbs/d ethylbenzene are derived.

The following equation is used to derive allowable headworks loadings for organic pollutants based on anaerobic digester inhibition data (from Section 3.2.2.1 of the manual):

$$L_{IN} = L_{INF} \times \left(\frac{C_{CRIT}}{C_{DIG}}\right) = \frac{(8.34)(Q_{POTW})(C_{INF})}{(C_{DIG})} \times C_{CRIT}$$

where: L_{IN} = Allowable headworks loading, lbs/d

L_{INF} = POW influent pollutant loading, lbs/d

C_{CRIT} = Anaerobic digester inhibition threshold level, mg/l

C_{DIG} = Pollutant level in sludge to digester, mg/l

Q_{POTW} = POTW flow, MGD

C_{INF} = POTW influent level, mg/l

Table 3-11 presents anaerobic digester inhibition levels (C_{CRIT}) for incorporation into the above expression; however, C_{INF}/C_{DIG} data must be obtained through site-specific monitoring. C_{DIG} data are not currently available for the hypothetical POTW. For the three pollutants of concern (chlorobenzene, chloroform, methyl chloride), the hypothetical POTW should perform coordinated monitoring of the POTW influent and the sludge to the digester, in order to obtain C_{INF}/C_{DIG} data for incorporation into the above expression.

*From Reference [19].

Allocation of Maximum Allowable Headworks Loadings

Requisite pollutant loading reductions for nonconservative pollutants can be calculated from the following equation:

$$R = \frac{L_{INF} - L_{IN}}{L_{INF}} (100)$$

where:

R = Requisite pollutant loading reduction, percent

L_{INF} = Current POTW influent loading of the pollutant, lbs/d

L_{IN} = Maximum allowable headworks loading, lbs/d

Use of the above equation requires that the current POTW influent loading of the particular pollutant exceeds the maximum allowed ($L_{INF} > L_{IN}$).

The application of the above equation is demonstrated below for chlorobenzene:

- Recent composite sampling of the hypothetical POTW quantified the current POTW influent level of chlorobenzene at 4.50 mg/l. Therefore:

  $L_{INF} = (8.34)(Q_{POTW})(C_{INF}) =$

  $(8.34)(3.35)(4.50) = 125.7$ lbs/d

- Uncontrollable sources of chlorobenzene have been assessed to be negligible

- The allowable headworks loading for chlorobenzene (water quality-based) is 109.2 lbs/d

- Required removal is:

  $$R = \frac{125.7 - 109.2}{125.7} (100) = 13.1\%$$

- The hypothetical POTW's chemical manufacturing IU is the only known discharger of chlorobenzene to the POTW. For this IU:

  - Discharge flow = $Q_{(X)} = 0.5$ MGD
  - Discharge level = $L_{CURR(X)} = 13.8$ mg/l (Table I-16)

  $L_{CURR(T)} = (8.34)(Q_{(X)})(L_{CURR(X)})$

  $= (8.34)(0.5)(13.8) = 57.5$ lbs/d

- The IU's chlorobenzene discharge limit is derived as follows:

$$C_{LIM(X)} = \frac{L_{CURR(X)} - (1 - R)}{(8.34)(Q_{(X)})}$$

$$C_{LIM(X)} = \frac{57.5 - (1 - 0.131)}{(8.34)(0.5)} = 12.0 \text{ mg/l}$$

The above minimum discharge limit should be incorporated into the industrial user's permit.

This minimum industrial reduction may need to be increased further to account for domestic/background sources if the assumption that these sources are negligible is not accurate. These limits should be reassessed during routine evaluation of local limit effectiveness. If subsequent evaluation of the actual influent loading indicates insufficient reduction has been achieved, the POTW should consider whether the industrial reduction needs to be increased.

Local Limits to Address Pollutant Flammability/Explosivity and Fume Toxicity Concerns

The pollutant evaluation scheme determined that the hypothetical POTW's chemical manufacturing IU is discharging potentially fume toxic levels of the following five pollutants:

- Chlorobenzene
- Chloroform
- Ethylbenzene
- Methyl chloride
- Nitrobenzene

The POTW decided to adopt the Cincinnati MSD volatile organic pollutant local limit procedure (See Sections 4.1.1.2 and 4.2.1, and Appendix J) and impose a volatile organic pollutant local limit on the chemical manufacturer's discharge. The MSD volatile organic pollutant local limit consist of a 300 ppm hexane equivalent limit on volatile organics in headspace gases collected over an equilibrated wastewater sample.

In addition to imposing the volatile organic pollutant local limit, the POTW has planned a comprehensive inspection of the chemical manufacturer's industrial processes. This inspection is to identify IU chemical management practice deficiencies which might account for the presence of the above-listed volatile organics in the IU's discharge. The POTW plans to impose chemical management practice requirements on the IU to correct these deficiencies and prevent the IU from discharging flammable/explosive and fume toxic levels of the five organics.

APPENDIX F
WATER QUALITY-BASED TOXICS CONTROL

WATER QUALITY-BASED TOXICS CONTROL

In addition to compliance with section 301(h) of the Clean Water Act and its implementing regulations, permits issued to facilities with 301(h) waivers must also ensure compliance with other appropriate sections of the CWA. Among these is section 301(b)(1)(C), which requires, in part, the imposition of any conditions necessary to meet water quality standards. Regulations that implement section 301(b)(1)(C) are found at 40 CFR 122.44(d), and the following discussion highlights some of the requirements of those regulations. This appendix is not intended as a comprehensive statement of NPDES permitting requirements. Rather, the information is presented as an overview to advise the 301(h) applicant of some of the additional CWA requirements and to guide the applicant to requirements similar or complementary to the 301(h) requirements.

Under 40 CFR 122.44(d), NPDES permits must contain limitations to control all pollutants or pollutant parameters that *are or may be discharged at a level which will cause, have reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality.* The regulations require these evaluations to be made using procedures that account for existing controls on point and nonpoint sources of pollution, the variability of the pollutant in the effluent, species sensitivity (for toxicity), and, where appropriate, dilution in the receiving water. The limits must be stringent enough to ensure that water quality standards are met and must be consistent with any available wasteload allocation.

The regulations also specifically address when toxicity and chemical-specific limits are required. A toxicity limit is required whenever toxicity has the reasonable potential to cause or contribute to an excursion above either a numeric or narrative standard for toxicity. The only exception is where chemical-specific limits will achieve the narrative standard. A chemical-specific limit is required whenever an individual pollutant is at a level of concern [as defined at 40 CFR 122.44(d)(1)] relative to the numeric standard for that pollutant.

40 CFR 122.44(d)(1)(vi) outlines the options to be used to interpret a state narrative criterion in the absence of a numeric criterion for a pollutant. Under the first option, the permitting authority [in the case of 301(h) modified NPDES permits, EPA] may use a criterion that is derived based on a proposed state criterion or an explicit state policy or regulation interpreting its narrative criterion, supplemented with other relevant information. The second option is to establish effluent limitations based on EPA's water quality criteria. Finally, the

permitting authority may establish limits on an indicator pollutant, provided that certain conditions are met.

EPA's *Technical Support Document for Water Quality-based Toxics Control* (U.S. EPA 1991a) provides guidance for evaluating "reasonable potential" and establishing water quality-based effluent limits for specific chemicals, as well as whole effluent toxicity. Although the whole-effluent toxicity discussions focus primarily on fresh water, the approach outlined in U.S. EPA (1991a) is appropriate for marine waters as well.

In addition to the *Technical Support Document for Water Quality-based Toxics Control*, EPA has published several manuals that provide guidance for conducting whole-effluent toxicity testing and for addressing any toxicity that is found. *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, 4th ed. (U.S. EPA 1991b) addresses acute (e.g., rapid response) toxicity. EPA's *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (U.S. EPA 1988a) provides protocols for conducting chronic (e.g., long-term) testing.

If toxicity is found in an effluent, the permittee will be required to conduct a toxicity identification evaluation (TIE) and, if appropriate, a toxicity reduction evaluation (TRE) to control toxicity. Two EPA manuals, *Toxicity Identification Evaluations: Characterization of Chronically Toxic Effluents, Phase 1* (U.S. EPA 1991c) and *Toxicity Reductions Evaluation Protocols for Municipal Wastewater Treatment Plants* (U.S. EPA 1988b), address TIE/TRE procedures for POTWs.

REFERENCES

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