National Management Measures to Control Nonpoint Source Pollution from Marinas and Recreational Boating

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SECTION 1: INTRODUCTION

Section 1 Contents

The Purpose and Scope of This Guidance

This national management measures guidance for marinas and recreational boating provides guidance to states, territories, authorized tribes, and the public regarding management measures that may be used to reduce nonpoint source pollution from marinas and recreational boating activities.

The guidance is intended to provide technical assistance to state program managers and others on the best practicable means of reducing nonpoint source pollution of surface waters from marinas and recreational boating. The guidance provides background information about nonpoint source pollution from marinas and recreational boating—including where it comes from and how it enters the nation's waters—and technical information about how to reduce nonpoint source pollution from marinas and recreational boating. It also discusses the relationship of marinas to the watersheds in which they are located.

The guidance can assist marina managers in identifying possible sources of nonpoint source pollution and offers potential solutions. Finding a solution to nonpoint source pollution problems at a marina requires taking into account the site-specific factors that together compose the setting of a marina. The best management practices (BMPs) presented in Section 4 of this guidance are recommended based on their successful application at many marinas nationwide. Their applicability to any particular marina or situation, however, must be determined based on site-specific factors. The applicability of the individual BMPs and combinations of BMPs should be considered within the overall context of the location, environment, design, and needs of the marina. Marina managers should make informed decisions, based on the circumstances at their particular marina, as to whether the BMPs in this guidance or others would be most effective for controlling nonpoint source pollution. Which BMP or combination of BMPs is used is not the critical point. Preventing water pollution is.

This guidance refers to statutory and regulatory provisions that contain legally binding requirements. It does not take the place of those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on the U.S. Environmental Protection Agency (EPA), states, territories, authorized tribes, or the public and might not apply to a particular situation. The decision makers of EPA, states, territories, and authorized tribes retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. EPA may change this guidance in the future.

The guidance is organized in six parts:

- Section 1 introduces the guidance.
- Section 2 discusses the sources of nonpoint source pollution and the specific pollutants of concern associated with marinas and recreational boating.
- Section 3 discusses management measures and site-specific BMPs generally, the use of combinations of BMPs (BMP systems), and the characteristics of surface waters where marinas are located.
- Section 4 introduces the 15 management measures for marinas and recreational boating and describes BMPs that can be used to achieve the management measures.
- Section 5 describes some models used to estimate pollutant loads and discusses water quality monitoring.
- Appendices provide additional relevant information.

The *management measures* in this guidance are the best available, economically achievable practices or combinations of practices that can be used to address nonpoint sources of pollution related to marinas and recreational boating. EPA originally identified 15 management measures for implementation within the state coastal management areas (see *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* [USEPA, 1993]). The titles of the management measures are listed in the box to the above right. From discussions with marina owners and operators at facilities on fresh waters nationwide, these 15 management measures and associated practices have been found generally to be just as applicable to fresh water marinas as they are to coastal water marinas. They form the basic measures recommended in this guidance.

Management Measures for Marinas and Recreational Boating

Flushing
Water quality assessment
Habitat assessment
Shoreline stabilization
Storm water runoff
Fueling station design
Petroleum control
Liquid material management
Solid waste management
Fish waste management
Sewage facilities
Maintenance of sewage facilities
Boat cleaning
Boat operation
Public education

Best management practices are individual activities or structures that can be used alone or in combination to achieve the management measures. Refer to Section 4 for a thorough discussion of the 15 management measures for marinas and recreational boating and the known BMPs that can be used to achieve them.

The scope of this national management measures guidance is broad, covering diverse nonpoint source pollutants from marinas and recreational boating. Because it reflects all types of waterbodies, it cannot provide all practices and techniques suitable to all regional or local marina or waterbody conditions. Also, BMPs are continuously being modified and developed as a result of experience gained from BMP implementation and the innovation of marina managers across the country.

Management measures are steps that can be taken to control of the addition of pollutants from nonpoint sources. Management measures are achievable through the application of BMPs, technologies, processes, siting criteria, operating methods, or other alternatives.

Relationship to CZARA Guidance

Readers should note that this guidance is consistent with the *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (USEPA, 1993) published under section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). This guidance does not supplant or replace the 1993 coastal management measures guidance for the purpose of implementing programs under section 6217.

Under CZARA, states that participate in the Coastal Zone Management Program under the Coastal Zone Management Act are required to develop Coastal Nonpoint Pollution Control Programs that ensure the implementation of EPA's management measures in their coastal management areas. The 1993 guidance continues to apply to that program.

This national management measures guidance modifies and expands upon the supplementary technical information contained in the coastal management measures guidance both to reflect circumstances relevant to differing inland conditions and to provide current technical information. It does not set new or additional standards for state Nonpoint Source Management Programs under section 319 of the Clean Water Act (CWA) or section 6217 of CZARA. It does, however, provide information that government agencies, private sector groups, and individuals can use to understand and apply measures and practices to address nonpoint source pollution from marinas and recreational boating.

National Water Quality Inventory

The nation's aquatic resources are among its most valuable assets. Although environmental protection programs in the United States like those implemented under the CWA have brought great improvements to water quality during the past 30 years, many challenges remain. Significant progress has been made in reducing pollution to the nation's waters from industrial and municipal wastewater treatment systems. Nevertheless, EPA reported in its 1998 *National Water Quality Inventory*, published in June 2000, that more than 35 percent of the inland waters and estuaries assessed are still too polluted to support their designated uses (based on survey information submitted by states, territories, and tribes). The health of these waters is primarily degraded by nonpoint source pollution, which is described more fully on page 1-4.

Every 2 years, EPA reports to Congress on the quality of the nation's waters in the *National Water Quality Inventory*. States, territories, and tribes survey the water quality in a sample of the rivers and streams; lakes, ponds, and reservoirs; estuaries; ocean shorelines; and/or Great Lakes shorelines in their jurisdictions and report the findings to EPA for the Inventory. Because each state, territory, and tribe surveys its jurisdictional waters according to individual priorities, the survey results cannot be generalized as the quality of the nation's waters overall, but the results do provide a snapshot of nationwide water quality and water quality trends.

The 1998 *National Water Quality Inventory* summarizes the water quality assessment reports submitted by states, territories, and tribes. Table 1-1 lists the overall percentages of each waterbody type surveyed and the water quality of those waters in terms of *designated use* support.

States, territories, and tribes designate waters as suitable for particular uses, depending on location, surrounding land use, and other factors. For instance, a river passing near an urban area might be designated to be used for noncontact recreation (such as fishing or boating), while a stream in a state park might be designated for aquatic life support. Water quality criteria are set for each waterbody according to its designated use(s).

The types of pollutants that degrade these waters are

> ***Designated uses*** are set by states as water quality goals for individual waterbodies. Designated use goals include drinking water supply, primary contact recreation (such as swimming), and aquatic life support. Each designated use has a unique set of water quality requirements or criteria that must be met for the use to be attained.

Table 1-1. Percentages of surveyed waters supporting designated uses.

Waterbody Type	Percent Surveyed	Fully Supporting All Uses[a]	Threatened for One or More Uses[a]	Impaired for One or More Uses[a]	Quantity of Waterbody Type in US
Rivers & Streams (miles)	23	65	10	35	3.7 million miles
Lakes, Ponds, & Reservoirs (acres)	42	55	9	45	41.6 million acres
Estuaries (square miles)	32	56	9	44	90,465 square miles
Ocean Shoreline (miles)	5	88	8	12	66,645 miles
Great Lakes Shoreline (miles)	90	4	2	96	5,521 miles

[a] Percent of units of waterbody type *surveyed* in this category. For example, 9 percent of the 32 percent of estuaries surveyed were threatened for one or more uses at the time of the survey.
Source: USEPA, 2000 (1998 Report to Congress)

- Nutrients (excess nitrogen and phosphorus).
- Sediment (from soil and shoreline erosion).
- Disease-causing bacteria (from animal waste washed into surface waters and inadequately treated sewage).
- Toxic metals (from mining runoff, storm-water runoff from urban and industrial areas, and industrial processes).
- Toxic organic chemicals (such as dioxins and polychlorinated biphenyls, or PCBs).
- Oxygen-depleting materials (organic materials like leaf litter that consume oxygen as they break down in the water).
- Pesticides (including insecticides and herbicides).
- Petroleum compounds (such as fuel, oil, and grease).
- Noxious or invasive aquatic plants (such as Eurasian water milfoil and water hyacinth).

The leading sources of these pollutants are agriculture, municipal point sources, industrial discharges, nonpoint sources (in general), urban runoff/storm sewers, atmospheric deposition, hydrologic modification (dams and shoreline modification), habitat modification, and mining.

Although marinas are not one of the major sources of pollution to our nation's rivers, lakes, or estuaries, they are centers of recreation, and poor or inadequate pollution prevention practices in them can result in human health problems and local water quality degradation. Examples of potential nonpoint source pollution problems at marinas include poor water circulation and flushing within the marina, petroleum spills from storage tanks and boat fueling, bilge oil discharges, and runoff from boat hull maintenance and engine repair areas. Nonpoint source pollution at marinas can also result from poor housekeeping practices (such as in-water boat washing with polluting detergents), a lack of containers for recycling solid and liquid waste materials, and inadequate sanitary facilities.

What Is Nonpoint Source Pollution?

Nonpoint source pollution results from rainwater and snow (or snowmelt) carrying pollutants picked up from the atmosphere or the ground to *surface water* and *ground water*. It is also associated with land runoff from irrigation or lawn watering, ground water drainage from mines and landfills, seepage from broken or leaking pipes, and hydrologic modification. Hydrologic modification is anything that alters natural water currents, such as dams and levees or changes to natural shorelines with hard structures or excavation, such as riprap or cement. These are considered nonpoint sources of pollution because of the harm that can occur to the biological and physical integrity of surface and ground waters as a result of them. The nonpoint source pollutants that cause the greatest harm to surface waters are nutrients, sediments, organic matter, pathogens,

> ***Surface waters*** include ponds, lakes, streams, rivers, estuaries, bays, and oceans. ***Ground water*** is the water in soils and aquifers.

and toxic compounds (including petroleum compounds and toxic metals).

Technically, the term *nonpoint source* is defined to mean any source of water pollution that does not meet the legal definition of *point source* in section 502(14) of the CWA of 1987:

> *The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.*

Although diffuse runoff is usually treated as nonpoint source pollution, runoff that enters and is discharged from conveyances like those described above is treated as a point source discharge. Point sources typically enter receiving water bodies at some identifiable site, such as the end of a pipe, and they are usually the result of a discharge from some industrial process or construction activity, not rain or snowfall. The distinction between point and nonpoint sources of pollution is an important one because point source discharges such as municipal and industrial wastewaters and storm sewer outfalls from urbanized areas are regulated and issued permits under the CWA, whereas nonpoint sources are not subject to federal permit requirements.

Watershed Approach to Nonpoint Source Pollution Control

Marinas, by nature of their business, are positioned in a *watershed*, where the activities of others in the watershed affect water quality in the marina basin. Water quality at any specific point along a river is influenced by all upstream and upgradient locations in the river's watershed. Marinas located on rivers and reservoirs are potential recipients of the runoff from sources located upstream and along upstream tributaries, and from all upgradient land-based activities in the watershed. Lakes are the natural sinks for runoff from activities in their basins, and the water quality in marinas on lakes is potentially influenced by all of the activities in the watershed and activities that occur on the lake. The water quality of marinas in estuaries and coastal areas is similarly influenced by the numerous activities that contribute runoff and pollutants to the water flowing into the marina basin. The runoff from marinas in urban settings is often mixed with runoff from nearby areas because runoff is directed toward the surface waters where marinas are located. Similarly, marinas in watersheds where agriculture is abundant may receive a lot of runoff from upland agricultural sources.

Marinas can benefit from cooperative environmental protection efforts that involve and educate those who potentially contribute pollutants to the surface waters in the watershed where the marina is located and seek responsible, shared solutions to water quality problems.

Since 1991 EPA has promoted the watershed protection approach as a comprehensive framework for addressing complex pollution problems, such as those from nonpoint sources within a defined geographic area. The watershed protection approach is not a new centralized government program. It is a flexible framework for focusing and integrating current environ-

> ***Watersheds*** are areas of land that drain to a single stream, lake, or other water resource. Watersheds are defined solely by drainage areas and not by land ownership or political boundaries.

mental protection efforts and for exploring innovative methods to achieve maximum efficiency in using resources and obtaining positive environmental effects.

The watershed protection approach is a comprehensive planning process that considers all natural resources in a watershed, as well as social, cultural, and economic factors (Figure 1-1). The process tailors workable solutions to ecosystem needs through the participation and leadership of stakeholders.

Although watershed approaches might vary in terms of specific objectives, priorities, elements, timing, and resources, all should be based on the following guiding principles:

- *Partnerships*: People affected by management decisions are involved throughout and help shape key decisions. Cooperative partnerships among federal, state, and local agencies; Indian tribes; and nongovernmental organizations with interests in the watershed are formed. This approach ensures that environmental objectives are well integrated with those for economic stability and other social/cultural goals of the area. The approach also builds support for action among the people who are economically dependent on the natural resources of the area.

  Watershed projects typically involve state environmental, public health, agricultural, and natural resources agencies; local and/or regional boards, commissions, and agencies; EPA waterand air programs; other federal agencies; private wildlife and conservation organizations; industry sector representatives; and the academic community.

- *Geographic focus*: Resource management activities are coordinated and directed within specific geographic areas, usually defined by watershed boundaries, areas overlying or recharging ground water, or a combination of both. Watershed projects encompass all or most of the landscape in a well-defined watershed or other ecological, physiographic, or hydrologic unit, such as an embayment, an aquifer, or a lake and its drainage area.

- *Sound management techniques based on strong science and data*: Collectively, watershed stakeholders employ sound scientific data, tools, and techniques in an

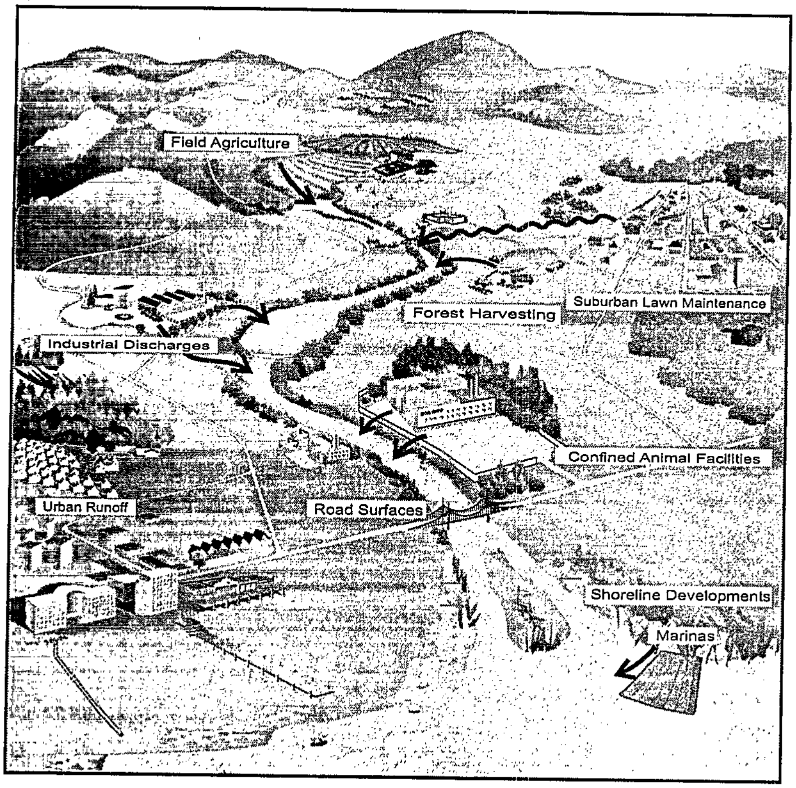

Figure 1-1. Schematic of a watershed. Sources of pollutants from throughout the watershed are carried downstream in surface water runoff and ground water flow. The watershed approach involves examining all pollution problems in the watershed, setting priorities, and taking an integrated approach to addressing the problems.

iterative decision-making process. Typically, this process includes:

– Assessment and characterization of the natural resources in the watershed and the people who depend on them.

– Goal setting and identification of environmental objectives based on the condition or vulnerability of resources and the needs of the aquatic ecosystem and the people. Well-defined goals and objectives are established for the watershed, including objectives for chemical water quality (e.g., reduced toxicity), physical water quality (e.g., temperature, flow, circulation), habitat quality (e.g., channel morphology, health of biotic communities), and biodiversity (e.g., species number, range, replacement of exotic species with native species).

– Identification of priority problems. Watershed projects identify the most significant threats to water quality, based on a comparative risk analysis of the potential human health, ecological, and economic impacts. The resources of the participants in a watershed project are then targeted in a coordinated fashion toward the high-risk problems.

– Development of specific management options and action plans. Based on the priorities that have been set, integrated action plans that will achieve the goals and objectives of the watershed protection project are devised.

– Implementation, evaluation, and revision of plans as needed. All appropriate authorities and techniques are employed to achieve the goals and objectives set forth in the action plans. Normally, existing programs of local, state, and federal agencies; private environmental and civic groups; and industries and corporations form the basis of the framework for implementation of the action plans. These separate efforts are merely coordinated and redirected to work together more efficiently to achieve common goals. Cost savings due to this coordination of efforts are often realized by the participants.

- *Getting Organized*: Working as a task force, stakeholders reach consensus on goals and approaches for addressing a watershed's problems, the specific actions to be taken, and how those actions will be coordinated and evaluated. Coordinated action can be taken in areas such as voluntary pollution prevention (BMP installation) and source reduction (waste minimization).

Programs to Control Nonpoint Source Pollution

Several federal laws and programs that address nonpoint source pollution in one form or another are in effect. The most important ones are discussed below.

National Nonpoint Source Pollution Control Program

During the first 15 years of the federal water pollution control program to abate and control water pollution (1972–1987), EPA and the states focused most of their water pollution control activities on industrial and municipal wastewater point source discharges. They regulated point sources through the National Pollutant Discharge Elimination System (NPDES) permit program established by section 402 of the 1972 Federal Water Pollution Control Act (Clean Water Act). Discharges of dredged and fill materials into wetlands were also regulated by EPA and the U.S. Army Corps of Engineers under section 404 of the CWA.

As a result of these activities, by the mid-1980s pollutant loads from point source discharges had been greatly reduced and considerable progress had been made in restoring and maintaining water quality. However, the gains made in controlling point sources had not achieved the desired level of water quality improvement. Recent studies and surveys by EPA and by state water quality agencies indicate that most of the remaining water quality improvement impairments in rivers, streams, lakes, estuaries, coastal waters, and wetlands result from nonpoint source pollution and other nontraditional sources, such as urban storm water discharges and combined sewer overflows.

In view of the growing national awareness of the now-dominant influence of nonpoint source pollution on water quality, Congress amended the CWA in 1987 to focus pollution control efforts on nonpoint sources. The amended CWA added a fundamental principle to section 101, "Declaration of Goals and Policy":

> *It is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution.*

Supporting the section 101 Declaration, Congress enacted section 319 in the 1987 act, which established a national program to control nonpoint sources of water pollution. Under section 319, states, territories, and Indian tribes address nonpoint source pollution by assessing the problems and causes of nonpoint source pollution and implementing management programs to control them. Section 319 authorizes EPA to issue grants to states and tribes to assist them in implementing management programs or the portions of management programs that have been approved by EPA. In 1990–2001, EPA awarded more than $1.3 billion in section 319 grants to help states, territories, and tribes implement their nonpoint source programs.

Further information about nonpoint source pollution control is available at EPA's web site, http://www.epa.gov/owow/nps.

Storm Water Permit Program

The CWA prohibits the discharge of any pollutant to waters of the United States from a point source unless the discharge is allowed under a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permitting program is designed to track classes of point source discharges, monitor the discharge of pollutants from specific sources to surface waters, and require the implementation of the controls necessary to minimize the discharge of pollutants.

As pollution control measures for industrial and municipal wastewater sources were implemented and refined, studies showed that storm water runoff draining large surface areas, such as agricultural and urban land, was also a significant cause of water quality impairment.

In 1987 Congress amended the CWA to require implementation of a comprehensive national program for addressing problematic nonagricultural sources of storm water discharges. As required by the amended CWA, the NPDES Storm Water Program is implemented in two phases:

- Phase I requires permits for separate storm water systems serving large- and medium-sized communities (those with more than 100,000 inhabitants) and for storm water discharges associated with industrial and construction activity involving at least 5 acres (see Title 40 of the Code of Federal Regulations [CFR], Part 122).
- Phase II addresses urban areas with populations of less than 100,000; construction sites of 1 to 5 acres; and retail, commercial, and residential activities.

Further information is available on EPA's NPDES Storm Water Program web page, http://www.epa.gov/owm/npdes.htm.

Information on the applicability of the Storm Water Permit Program to marinas is provided in Section 4.5.

Coastal Nonpoint Pollution Control Program

In November 1990 Congress enacted CZARA. The amendments were intended to address the impacts of nonpoint source pollution on coastal water quality. Section 6217, "Protecting Coastal Waters" (codified as 16 U.S.C. section 1455b), provides that each state with an approved Coastal Zone Management Program must develop and submit a Coastal Nonpoint Pollution Control Program to EPA and the National Oceanic and Atmospheric Administration (NOAA) for approval. Section 6217 required NOAA to recommend and states to determine the geographic area in each coastal state within which land and water uses have a significant effect on coastal water quality, and states are to implement control measures within this 6217 management area, or coastal management area.

Coastal Nonpoint Pollution Control Programs are not intended to supplant existing Coastal Zone Management Programs and Nonpoint Source Management Programs. Rather, they are to serve as an update and expansion of existing nonpoint source management programs in the 6217 management area and are to be coordinated closely with the Coastal Zone Management Programs that states and territories are already implementing. The legislative history indicates that the central purpose of section 6217 is to strengthen the links between federal and state coastal zone management and water quality programs and to enhance state and local efforts to manage land use activities that degrade coastal waters and habitats.

Section 6217(g) of CZARA required EPA to publish, in consultation with NOAA, the U.S. Fish and Wildlife Service, and other federal agencies, "guidance for specifying management measures for sources of nonpoint pollution in coastal waters." EPA published *Guidance Specifying Management Measures for Sources of Nonpoint Source Pollution in Coastal Waters* in 1993. In that document, CZARA management measures and BMPs were defined and described for marinas and recreational boating, as well as for urban development, agriculture, hydromodification and wetlands, and forestry.

Further information on CZARA and coastal nonpoint source pollution control can be found at the EPA web site for CZARA and section 6217: http://www.epa.gov/owow/czmact.html.

Clean Vessel Act Pumpout Grant Program

The Clean Vessel Act (CVA) Pumpout Grant Program makes matching grants available, through a competitive process, to all states and territories for construction and education efforts and to coastal states (excluding Alaska) to conduct surveys and develop plans for the installation of pumpouts for onboard sewage holding tanks. States match grant funds at a 3:1 (federal-to-state) ratio. The program benefits boaters, who will have more numerous and convenient pumpout facilities to use as a result of the program, and the public and environment as a whole through reductions of disease-carrying microorganisms contained in sewage discharges and improvements in dissolved oxygen concentrations. Further information is available at http://fa.r9.fws.gov/cva/cva.html.

International Convention for the Prevention of Pollution from Ships (MARPOL)

The International Convention for the Prevention of Pollution from Ships, known as MARPOL 73/78 (for Marine Pollution) is an internationally accepted treaty that, together with U.S. laws and regulations, sets out operational waste discharge requirements for ships. MARPOL 73/78 contains five annexes designed to reduce marine pollution by controlling or prohibiting discharges of harmful substances from ships (see box). It covers intentional and accidental discharges of wastes of all kinds from vessels and applies to ports, terminals, and marinas as well. The United States is signatory to MARPOL 73/78 and Annexes I, II, III, and V; Annex IV is not currently in force internationally.

MARPOL 73/78 ANNEXES

Annex I:	Oil
Annex II:	Noxious liquid substances in bulk
Annex III:	Harmful substances carried in package form
Annex IV:	Sewage
Annex V:	Garbage and all other ordinary ship-generated solid and liquid waste not covered by Annexes I, II, III, and IV

In the United States, MARPOL 73/78 is implemented through the Act to Prevent Pollution from Ships of 1980, as amended. The U.S. Coast Guard is responsible for promulgating regulations and enforcing the treaty. Regulations for ships are included in 33 CFR Part 151; those for port reception facilities are included in 33 CFR Part 158.

MARPOL 73/78 Annex V is implemented in the United States by the Marine Plastic Pollution Research and Control Act (MPPRCA) of 1987, Title II of Public Law 100-220. Annex V prohibits disposal of plastics at sea and restricts at-sea disposal of other vessel-generated trash. It also requires shore reception facilities for the plastics and other trash brought to shore for disposal. Recreational boating facilities, along with other ports and terminals, are required to have a trash reception facility that is capable of receiving trash from those vessels that do business with them (33 CFR Part 158). Vessels 26 feet or longer must display a placard that explains MARPOL 73/78 Annex V ocean disposal regulations (Figure 1-2).

Oil Pollution Act (OPA) and Regulations

The Oil Pollution Act (OPA) is a comprehensive prevention, response, liability, and compensation regime for dealing with vessel- and facility-generated discharges of oil or hazardous substances. Under the OPA, any hazardous waste spill from a vessel must be reported by the owner of the vessel and vessel owners are responsible for any costs of a resulting environmental cleanup and any damage claims that might result from the spill. Marinas are responsible for any oil contamination resulting from their facilities, including dumping or spilling of oil or oil-based paint and the use of chemically treated agents.

The OPA also requires Area Committees to prepare an Area Contingency Plan for approval by EPA and the Coast Guard. An Area Contingency Plan provides details of how to respond to a spill within a specific geographic area. Marinas are subject to a broader range of claims and liability than vessel owners, and marina owners should consult their Area Contingency Plan for proper remedial actions.

There are other laws that relate directly and indirectly to marinas and recreational boating. The major tenets of those laws are presented in Appendix D and on EPA's web site at http://www.epa.gov/oilspill.

Sources of Further Information

Other information about nonpoint source pollution and its control can be accessed at the Office of Wetlands, Oceans, and Watersheds page of the EPA web site, http://www.epa.gov/owow.

USCG. 1994. *Managing Waste at Recreational Boating Facilities.* U.S. Coast Guard, Marine

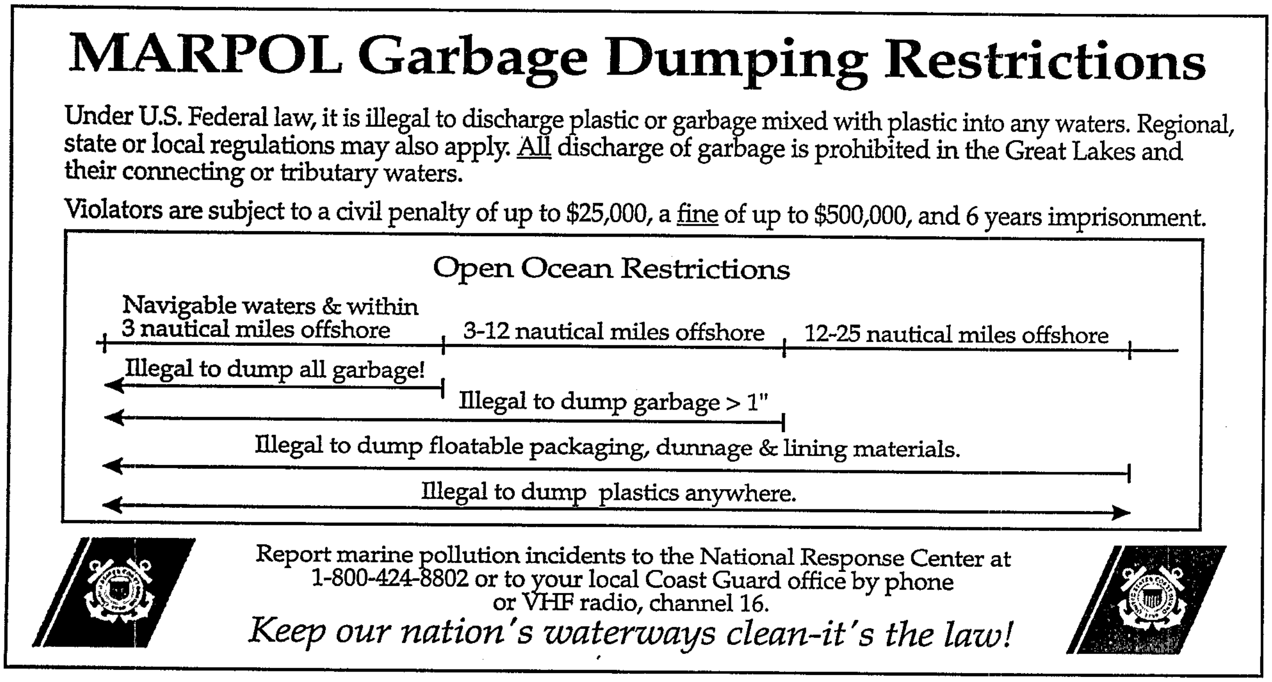

Figure 1-2. MARPOL placard

Environmental Protection Division, Environmental Coordination Branch, Washington, DC. April.

USEPA. 1993. *Guidance specifying management measures for sources of nonpoint pollution in coastal waters*. EPA 840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. January.

USEPA. 1996. *Clean Marinas—Clear Value: Environmental and Business Success Stories*. EPA 841-R-96-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC. August.

USEPA and USDOC. 1993. *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance*. U.S. Environmental Protection Agency, Office of Water, Washington, DC, and National Oceanic and Atmospheric Administration, Washington, DC. January.

Watershed Resources

EPA's Surf Your Watershed web site offers a Web-based source of information about watersheds throughout the United States. The site contains information about watershed size, pollutants, stressors, and condition. Access information for any watershed in the nation by clicking on maps at http://www.epa.gov/surf.

USEPA. 1991. *The Watershed Protection Approach*. EPA/503/9-92/002. U.S. Environmental Protection Agency, Office of Water, Washington, DC. December.

USEPA. 1995. *Watershed Protection: A Project Focus*. EPA841-R-95-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC. August.

USEPA. 1997. *Top 10 Watershed Lessons Learned*. EPA840-F-97-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. October. [This document discusses some very important lessons in ensuring the success of watershed protection projects, gained from experience with the watershed approach for addressing environmental problems. The document contains case studies of watershed projects that have been implemented throughout the country and lists of contacts for further information and technical assistance. It is available at http://www.epa.gov/owow/lessons.]

Other references and information on organizations related to pollution prevention in marinas can be found in the bibliography and Appendix E. Other information about nonpoint source pollution and its control can be found at the EPA Office of Wetlands, Oceans, and Watersheds web page: http://www.epa.gov/owow.

SECTION 2: SOURCES OF WATER POLLUTION FROM MARINAS AND RECREATIONAL BOATING

Section 2 Contents

Marinas are not reported by states, territories, or tribes to be a major source of nonpoint pollutants that contribute to poor water quality, as are sources such as agriculture and urban areas, though the location of marinas at the water's edge can lead to their being affected by other pollutant sources. Pollutants from upstream point and nonpoint sources in a watershed might flow to a marina's waters, adding to any nonpoint pollutants released at the marina itself. Water quality in a marina, therefore, is often a reflection of not only nonpoint source pollutants generated at the marina but also a cumulative load of pollutants from several watershed sources. Awareness of the potential for the generation of nonpoint source pollution at a marina and of how to use management measures and site-specific BMPs to reduce nonpoint source pollution is important to ensuring the best possible water quality in a marina basin. This section of the guidance describes the pollutants that can be generated at a marina and their potential effects on water quality and aquatic life.

The construction of a marina can create a condition of reduced water circulation. Installing structures such as bulkheads and jetties, which are necessary to ensure the safety of vessels, docks, and shoreside structures, can cause water circulation in the basin to be below what it was before the marina's construction. In an area already protected from wave action, such as a cove or inlet, marinas can potentially introduce pollutants to an area with limited natural circulation or water exchange. Over time, reduced circulation and increased pollutant generation can increase pollutant concentrations in the water column, sediments, and aquatic organisms.

The pollutants that might be generated at a marina and enter a marina basin include nutrients and pathogens (from pet waste and overboard sewage discharge), sediments (from parking lot runoff and shoreline erosion), fish waste (from dockside fish cleaning), petroleum hydrocarbons (from fuel and oil drippings and spills and from solvents), toxic metals (from antifoulants and hull and boat maintenance debris), and liquid and solid wastes (from engine and hull maintenance and general marina activities). The effects of these pollutants on waterways and aquatic plants and animals are discussed in this section. Marina construction and reconstruction, in-water modifications at marinas, and propeller wash and boat wakes can also disturb aquatic habitats, plants, and animals.

Although nonpoint source pollution is a serious problem nationally, more is always being learned about effective ways to prevent and reduce it. The purpose of this section is to describe the general causes of nonpoint source pollution, the specific pollutants and problems of concern, and the general approaches to reducing the impact of pollutants and other problems on aquatic resources as these relate to marinas and recreational boating. Figure 2-1 illustrates the general types of problems that various pollutants can cause in aquatic systems.

Pollutant Types and Impacts

Marina construction can alter habitats at a site. Shoreline vegetation may be reduced at some locations. Bottom sediments may be stirred up more frequently with boating activity and dredging to maintain channel and basin depth. These kinds of alterations can have both negative and positive effects. For example, installation of marina pilings and bulkheads introduces a hard-surfaced habitat into a marina that previously might have been dominated by a soft-bottomed habitat of mud and silt. Organisms that prefer rocks and other hard surfaces (fouling organisms) will colonize this new habitat and in turn may attract other invertebrates and juvenile fish to the area.

The fact that a marina is present does not mean that water quality is poor. Many marinas have good to excellent water quality. Despite this, their aquatic habitats might not be healthy enough to support a natural diversity of aquatic organisms, and they might still have sediments contaminated by pollutants from storm water runoff or by antifoulants that have leached from ship hulls or piers.

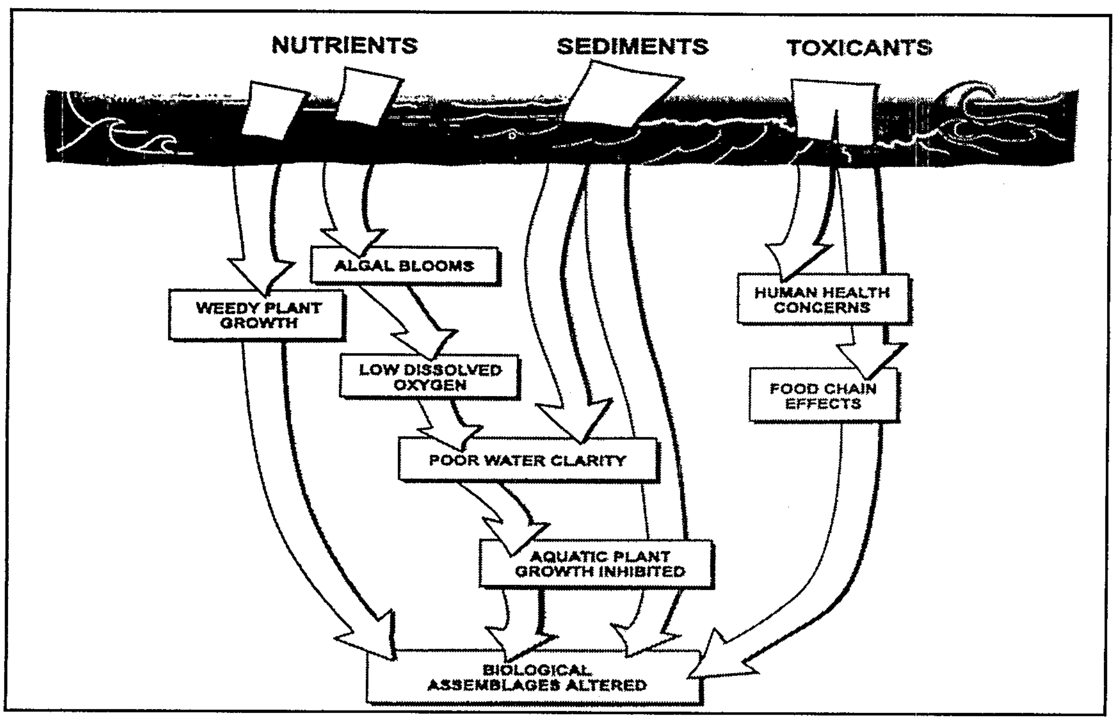

Figure 2-1. Effects of pollutants in aquatic systems.

Pollutants in the Water Column

Pollutants from marinas can cause pollution problems in the water column. These problems usually take the form of decreased levels of dissolved oxygen and increased levels of metals and petroleum hydrocarbons. Pollutants that cause these problems get into the water through storm water runoff, discharges from boats, and spills of fuel or bilge water.

Low Dissolved Oxygen

The organic matter in materials such as sewage discharged from recreational boats, trash tossed into surface waters or on the ground, pet waste carried to waterbodies in storm water runoff, and fish waste disposed of into surface waters consumes dissolved oxygen as it decomposes. The amount of dissolved oxygen required to decompose sewage and other organic matter is measured as the "biological oxygen demand" (BOD) of a waterbody. Consumption of oxygen by decomposing organic matter leaves less oxygen for fish, crabs, clams, and other aquatic organisms. Very low levels of dissolved oxygen can result when water temperatures are high (because hotter water holds less oxygen), which is often the case during the peak summer boating season. Decreases in dissolved oxygen in several northwestern marinas have been noted in the late summer and early fall, the peak times of marina use. An intensive study in several North Carolina marinas showed large differences in dissolved oxygen concentrations in the marinas compared to the concentrations in the adjacent waterbodies, with concentrations in the marinas being much lower.[1] These low concentrations of dissolved oxygen were thought to be due to high biological oxygen demand in the marina basins (due to unknown causes) and poor flushing.

Metals

Metals and metal-containing compounds have many functions in boat operation, maintenance, and repair. Arsenic is used in paint pigments, pesticides, and wood preservatives. Zinc anodes are used to deter corrosion of metal hulls and engine parts, and zinc is often a constituent of motor oil and tires. Copper is used as a biocide in antifoulant paints. Chromated copper arsenate (CCA) is used in wood as a preservative. Mercury is contained in many float switches for bilge pumps and shower water storage tank pumps and in air conditioning/heating thermostats. These switches can contain as much mercury as 100 fluorescent lamps. Nickel is a component of brake linings and pavement material; and cadmium is present in batteries and brake linings. These and other metals (aluminum, iron, and chromium) are used in various components used at marinas or by recreational boaters and can wash from parking lots, service roads, and launch ramps into surface waters with rainfall. High levels of zinc, chromium, and lead have been detected in the waters of some marinas.

Many of the antifoulants used for barnacle control in marine waters are used in fresh waters as well. Copper is the most common metal found at toxic concentrations in marina waters.[2] Dissolved copper has been detected at toxic concentrations at several marinas within the Chesapeake Bay.[3] Copper is leached to surface waters and sediments from bottom paints and scrapings. Tin in the form of butyltin, an extremely potent and non-specific biocide, has been detected at toxic levels in marina waters nationwide.[4] The use of butyltins in bottom paint is now restricted to paints with release rates of 4.0 micrograms per square centimeter or less and on vessels larger than 25 meters (82 feet) in length and on aluminum-hulled vessels regardless of size. Although butyltins are no longer used on most boats, the years of their use in antifoulants has left areas of low to high concentrations of these compounds in sediments. Disturbance of the sediments can reintroduce the toxic compounds into the water column, where they can be ingested by fish or other aquatic organisms and in turn by people.

1 NCDEM, 1990.

2 NCDEM, 1990, 1991; METRO, 1992.

3 Hall et al., 1987.

4 Grovhoug et al., 1986; Maguire, 1986; Stephenson et al., 1986; Stallard et al., 1987.

Petroleum Hydrocarbons

Sources of hydrocarbons at a marina include fueling stations; operation, maintenance, and repair of boat engines; and storm water runoff from the marina property and off-site upland areas. Petroleum hydrocarbons are contained in fuel, oil, grease, lubricants, finishes, and cleansers. Petroleum can be spilled directly into surface waters when fuel drips from fueling nozzles or a fuel tank is overfilled at a dock. Older 2-stroke marine engines discharge unburnt fuel and oil directly to the atmosphere and surface waters while they are operating. Oil, fuel, paint, antifreeze, or other liquids dripped from engines or paint brushes or spilled while draining oil or fuel from engines enter surface waters indirectly with storm water runoff or in flows of ground water after the substances have seeped into the ground. Rainwater washes anything dripped, spilled, deposited, or disposed of from building roofs, parking areas, boat ramps, and maintenance areas on the marina property and nearby properties to the nearest downstream surface water, which is often the marina basin.

Solvents

Solvents like methylene chloride, tetrachloroethane, trichloroethene, and trichlorethylene are contained in degreasing agents, varnishes, paint removers, and lacquers. They are used at marinas for engine maintenance and repair activities and vessel painting and cleaning. If not properly contained, solvents can potentially enter marina waters through surface water runoff or through ground water transport from hull maintenance areas. Solvents are stable compounds that are insoluble in water, which makes them very mobile in ground water. They are usually heavy, long-chain organic compounds, so they sink to an impermeable bottom layer in the ground (like bedrock) and accumulate. Many solvents are known cancer-causing compounds (carcinogens).

Antifreeze

Antifreeze is used at marinas in dry storage of boats and engine maintenance. It contains either ethylene glycol or propylene glycol. Propylene glycol antifreeze is reported to be much less toxic to aquatic organisms than ethylene glycol and is therefore preferred for use in boats. Both types of antifreeze, however, are considered toxic and should be poured, stored, and drained carefully to avoid spillage. Used antifreeze should be taken to a hazardous waste collection center and recycled if possible.

Acids

Batteries contain battery acid, which is very corrosive and toxic and often contains high levels of toxic metals like lead. Cleaning compounds and detergents often contain strong acids or lye. These materials can be washed into the marina basin with the next rain along with the petroleum hydrocarbons, solvents, paint chips, and other material spilled on the ground. Many hazardous waste collection stations accept used batteries.

Surfactants

Surfactants are compounds used in detergents and other cleaning agents to reduce surface tension. Some are known to be very deadly to aquatic organisms. Surfactants can also accumulate at the water surface and create a barrier against the transfer of dissolved oxygen across the air-water interface, resulting in lowered dissolved oxygen concentrations in the water. For these reasons, surfactants are best not used on boats that are in the water or on upland areas where runoff washes into surface waters.

Pollutants in Aquatic Organisms

Many aquatic organisms feed by sifting through sediments or eating organisms that filter food particles out of the water. The aquatic organisms thus ingest any pollutants attached to or mixed in with the sediments or suspended particles. The pollutants they ingest accumulate in their tissues rather than being excreted. When many smaller organisms, each of which has accumulated some pollutants in its tissues, are eaten by an organism higher in the food chain (for instance, a fish), that organism then accumulates in its tissues all of the pollutants accumulated by the lower organisms. This process, called bioaccumulation, is the reason that very small quantities of pollutants in the water column can result in dangerous concentrations of pollutants in fish, oysters, and other aquatic organisms. Numerous studies conducted from the late 1970s through early 1990s have demonstrated this effect and, in particular, the effect on marinas when proper pollution prevention is not practiced.[5] Copper and zinc have been found at higher concentrations in oysters from marinas than in oysters from sites outside marinas; higher-than-normal concentrations of copper, cadmium, chromium, lead, tin, zinc, and PCBs have been found in mussels from marina waters; after 3 months, concentrations of lead, zinc, and copper were two to three times higher in oysters transplanted to marinas than in oysters left outside marinas; and concentrations of copper in green algae and fouling organisms (barnacles, etc.) were much higher in a marina area than in adjacent areas.

Pollutants in Sediments

Many contaminants generated from boat maintenance and general marina use (e.g., oil and grease drippings from cars) do not dissolve well in water and accumulate to higher concentrations in sediments than in the overlying water. Contaminated sediments may, in turn, act as a source from which these contaminants can be released into overlying waters. Benthic organisms—those organisms that live on the bottom or in the sediment—are exposed to pollutants that accumulate in sediments. Pollutants ingested by these organisms become increasingly concentrated in animal tissue as the pollutants are passed up the food chain, and thus can reach levels dangerous for human consumption. Many fish advisories are issued for this reason.

Metals

Copper is the major contaminant of concern in sediments because many common antifouling paint preparations contain cuprous oxide as the active biocide component.[6] In most cases metals tend to sink and accumulate in sediments and not stay in the water column, though they do attach to small suspended particles and can be distributed in the water column with these particles. When attached to suspended particles, metals are often associated with small particles, so they settle out of the water column slowly and are mixed upward easily. In marinas, higher levels of some metals (such as copper and lead) have been found near maintenance area drains and fuel docks than at other locations, suggesting that maintenance areas and fueling stations are sources of metals to the water and good targets for pollution prevention practices.[7]

Petroleum Hydrocarbons

Petroleum hydrocarbons, particularly polynuclear aromatic hydrocarbons (PAHs), tend to attach to suspended particles and sediments. Because they can stay in sediments for years, they can be ingested by mussels, oysters, or other bottom-dwelling organisms long after they are spilled or washed into the water. Studies have found high concentrations of petroleum hydrocarbons in marinas, though the studies have also found that concentrations of these compounds are much lower in the sediments of well-flushed marinas.[8] Such findings support the supposition that sufficient flushing in a marina basin is important to prevent a buildup of pollutants in marina sediments.

Pathogens

Studies that have attempted to determine whether there is a correlation between boating density and pathogen (fecal coliform) concentrations in lakes and reservoirs are divided in their conclusions. Pathogens are added to surface waters by wildlife, dogs and cats, seeping septic tanks, and combined sewer outfall overflows, and these sources could have a larger impact than boaters on pathogen concentrations. Some violations of health standards for fecal coliform bacteria (the bacteria found in human and animal wastes) have been related to periods of high-intensity recreational use, such as holiday weekends. These violations could be due to either boater discharges

[5] CARWQCB, 1989; Marcus and Stokes, 1985; McMahon, 1989; NCDEM, 1991; Nixon et al., 1973; SCDHEC, 1987; Wendt et al., 1973; SCDHEC, 1987; Wendt et al., 1990; Young et al., 1979.

[6] METRO, 1992.

[7] McMahon, 1989; NCDEM, 1991; Soule et al., 1991.

[8] Marcus et al., 1988; McMahon, 1989; NCDEM, 1990: Voudrias and Smith, 1986.

or sediments where pathogens are concentrated being stirred up, or both.

Studies conducted in Puget Sound, Long Island Sound, Narragansett Bay, North Carolina, and Chesapeake Bay have shown that boats can be a source of fecal coliform bacteria in areas with high boat densities and poor flushing.[9] Human health problems can result, especially if nearby waters are used for swimming, surfing, wind surfing, water skiing, or other recreational activities that involve significant water contact.

Bacterial and viral contamination of waters can result from improper use of marine sanitation devices (MSDs). If a vessel has an installed toilet, the law requires that it be equipped with an MSD. Incorrect configuration of the toilet and MSD can lead to direct discharge of waste to surface waters. Discharge of the contents of portable toilets to surface waters also results in contamination. Boats with portable toilets are not required to have MSDs, and their contents should be disposed of at a sanitation facility.

Currently a number of states have designated all or nearly all of their surface waters as no discharge zones (NDZs). These states include Michigan, Missouri, New Hampshire, New Mexico, Rhode Island, and Wisconsin. Boats on fresh waters in New Hampshire, Missouri, and New Mexico must be configured such that wastes cannot be discharged directly into the water (i.e., Y-valves must be disabled), and boats may be inspected to see that this requirement is met. In addition, other states have segments of their surface waters designated as NDZs. These states include California, Florida, Georgia, Massachusetts, Minnesota, New Jersey, Nevada, New York, South Carolina, Texas, and Vermont. NDZs are approximately evenly divided (in number of areas designated) between fresh waters and marine or estuarine waters. A no-discharge policy is also in effect on all Army Corps of Engineers reservoirs.

[9] Fisher et al., 1987; Gaines and Solow, 1990; Milliken and Lee, 1990; NCDEM, 1990; Sawyer and Golding, 1990; Seabloom et al., 1989.

Debris and Litter

The numerous activities that occur at marinas—vessel and engine repair and maintenance, recreation on and off boats, fueling, dock maintenance, and building and grounds maintenance—are sources of a variety of debris and litter. Paper towels and cups, plastic bags, plastic and glass bottles, fish netting, fishing line, discarded oil filters and engine parts, discarded rags, debris from sanding or pressure washing, pet droppings, aluminum cans, and other forms of trash all find their way into surface waters if not disposed of properly. Coastal cleanups result in the collection of millions of pounds of trash and debris from U.S. coasts annually. The most common items found along the nation's coasts are cigarette butts, plastic pieces, foamed plastic pieces, plastic food bags/wrappers, plastic caps/lids, paper pieces, glass pieces, plastic straws, metal beverage cans, glass beverage bottles, plastic beverage bottles, and foamed plastic cups. These wastes are dangers to marine animals, which can die from becoming entangled in items like fishing nets and lines and from ingesting small pieces of debris that are mistaken for food. The trash and debris are dangerous to people visiting the coasts, who might accidentally step on discarded items, injure themselves, and risk infection. They are also unnatural, unsightly additions to the coastal landscape.

Sediment and Habitat Alterations

Dredging can disturb aquatic habitats; resuspend bottom sediments (and recirculate toxic metals, hydrocarbons, pathogens, and nutrients that are found in sediments into the water column); and increase turbidity, which reduces sunlight available to algae and aquatic vegetation. Increased turbidity lowers the rate of photosynthesis and decreases the rate at which dissolved oxygen is added to the water. Because dredging usually occurs over a short time period and then ceases, impacts that result from it, such as turbidity and dissolved oxygen reductions, are usually temporary and do not have long-term negative effects. Other consequences of dredging, such as habitat disruption and deterioration, can have lasting impacts.

Boat operation can cause these same problems in the water column and for aquatic organisms by disrupting shallow habitats and communities and mixing nearshore sediments into the water column.[10] Propeller-driven boats operated too fast near the shoreline can cause bank erosion.[11] Shallow waterways can be affected by propellers cutting off or uprooting aquatic plants from the bottom and propwash mixing sediments into the water.[12] The latter not only reduces photosynthesis, but also can interfere with fish and other sight-feeding animals, clog fish gills, and smother plants and animals.

The effect that boat traffic and motor operation can have on water quality and biological communities in lakes, reservoirs, rivers, and estuaries varies and depends on the characteristics of the waterbody and the type of watercraft being operated on it.[13] The effects are most acute in soft-bottomed lakes and reservoirs, quiet side channels of rivers and streams where fine sediment accumulates because of the lack of strong currents, and waterbodies that have sediments rich in nitrogen and phosphorus.

The impact of boats on rooted plants depends on the depth of the plants below the surface. Where submerged aquatic vegetation (SAV) occurs in shallow areas, boats passing through the area can create troughs where the vegetation is eliminated or severely reduced. Most direct effects of motorboats on submerged aquatic vegetation take place in water less than 5 feet deep, and motorboats can effectively remove all rooted vegetation in water less than 3 feet deep, especially in areas with sandy sediments. Recovery of submerged aquatic vegetation beds can take years, and loss of vegetation can lead to increased erosion and invasion by other species. Submerged aquatic vegetation protects shorelines from erosion and is an important resource for many aquatic organisms because it provides food and shelter.

Larval and juvenile fish can be killed directly by boat propellers and propeller wash. Spawning or nesting fish can be disturbed, and propeller wash can be powerful enough to destroy fish eggs. Fish populations can be lowered if survival of young-of-the-year fish is diminished and reproductive success is lowered. Manatees and other aquatic animals that swim near the water surface also suffer from propeller strikes. Many manatees in Florida bear the scars of propeller cuts.

Shoaling and Shoreline Alterations

Shoaling and shoreline erosion result from the physical transport of sediment caused by waves and currents. These waves and currents can be natural (wind-induced, rainfall runoff, etc.) or human-induced by boat wakes or in-water structures that change currents or reflect waves.

When waves caused by passing vessels or reflected from breakwaters reach the shallow margins of a waterway, they can erode banks and nearby bottom sediments. This effect tends to wash away plants loosely rooted in sediments near the shore and the associated animal life. A substantial volume of the sediment that causes shoaling is eroded from banks, and removing this material by dredging is a costly recurrent expense. Frequent dredging can be necessary where boat traffic causes extensive bank erosion. No wake zones and travel lanes located away from shorelines can reduce and help prevent bank erosion and shoaling. There is a direct relationship between factors such as the distance of a boat from shore, boat speed, slopes of the sides of a bank, type of sediment, and depth of the waterway and the amount of erosion and subsequent shoaling that results. The location of travel lanes should be determined for each specific case with these factors in mind.

The amount of shoreline erosion caused by boat wakes in lakes and reservoirs depends on the same factors as in coastal environments—design features of the boat (size, hull shape, and draft), distance of the boat from the shoreline, water depth, channel width (if the boat is passing through a channel), shoreline soil condition, slope of the shoreline bank, and amount of shoreline vegetative cover. In contrast to coastal environments, in lakes and reservoirs vegetation often grows up to the shoreline, currents are minimal, and there are no tides. Therefore, although boat

10 Chmura and Ross, 1978.
11 British Waterways Board, 1983.
12 USEPA, 1974.
13 USFWS, 1982.

wakes may be a primary source of erosive energy in lakes with a large amount of boating activity, vegetated shorelines reduce the potential for erosion in lakes. Boat wakes are most likely to cause lake shoreline erosion where the shoreline has been altered and not stabilized and is therefore already susceptible to erosion.

SECTION 3: NONPOINT SOURCE POLLUTION CONTROL AND WATERBODY CHARACTERISTICS

Section 3 Contents

Understanding Management Measures and Practices

Management measures and practices are implemented at marinas primarily to control nonpoint source pollution, which in turn protects water resources and terrestrial and aquatic habitat, enhances the aesthetic appeal of the marina, and protects the marina and the people using it from toxic and harmful substances. The focus of this guidance is on management measures and practices that mitigate the generation of pollutants (using pollution prevention practices) and the delivery of runoff or nonpoint source pollutants (using source reduction practices) to our nation's coastal and fresh waters.

Management measures are defined as

> *economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint source control practices, technologies, processes, siting criteria, operating methods, and other alternatives.*

Marinas and recreational boating management measures contain general management guidelines to prevent or minimize nonpoint source pollution. Individual management practices are not included as part of the statement of the management measures, and states have considerable flexibility in determining *how* they will achieve the management measures.

Best management practices, or BMPs, are used to fulfill management measures. There are two basic types of management practices—*pollution prevention and source reduction.* Pollution prevention practices are practices implemented to prevent the creation or release of pollution into the environment. An example is a vacuum sander that gathers sanding dust before it even has a chance to fall to the ground. Using a nontoxic cleanser in place of a toxic one is another example of pollution prevention. Source reduction controls are practices implemented to gather pollutants that have been released before they can reach the water. They include practices that filter, screen, trap, contain, absorb, chemically neutralize, or divert pollutants before they reach a waterbody or ground water. An oil/water separator in a storm drain is an example. A tarp under a boat during hull maintenance, with follow-up disposal of all collected debris in a trash receptacle, is another example of source reduction.

Management measures and practices can also be either *structural* (e.g., used oil collection containers, multiple openings to a marina basin) or *managerial* (e.g., pollution control agreements in slip leases, marina policies regarding where boat hull maintenance can be done on the marina property and who is allowed to do it). Individual management practices are not usually sufficient for solving water quality problems but are used in combination to control the diverse potential sources of pollution at marinas. For example, placement of absorbent pads in bilges is a good means to control the release of petroleum-based pollutants, but without storm water runoff controls in parking lots and air/fuel separators to control spillage during refueling, petroleum hydrocarbon pollution in the marina basin is likely.

Management practices are best selected, designed, implemented, and maintained in accordance with site-specific considerations to ensure that the practices function together properly to achieve overall pollution management goals. For example, a grassed drainage swale designed to handle only the quantity of water expected to fall on a parking lot during a design storm will not effectively control pollution if the grassed drainage swale receives runoff from non-marina upland areas as well. When more than one management practice is used to control a type of pollutant from individual or multiple sources, the individual practices will work as a system more effectively if the design standards and specifications of the individual practices are compatible. Additional effectiveness might be achieved if BMPs for a site are selected within the context of an overall watershed protection program. Further information can be found at EPA's watershed protection web site, http://www.epa.gov/owow/watershed.

EPA's management measures for marinas and recreational boating are described in Section 4.

How Management Measures and Practices Work to Prevent Nonpoint Source Pollution

Nonpoint source pollution control management measures and practices are devised to prevent and reduce the introduction of pollutants generated by marina-related activities to the marina basin. Controlling the entry of pollutants into the marina basin helps protect water quality, control aquatic weeds, reduce odors that result from decaying matter, ensure a more attractive and healthy shoreline, maintain water clarity, and allow for the natural ecological processes of the marina basin and surrounding waters to maintain the basin without the need for expensive chemical or mechanical treatments.

Management measures are recommended to control the delivery of nonpoint source pollutants to receiving waters by

- Minimizing pollutants released to the environment during an activity (pollution prevention).
- Preventing the transport and delivery of pollutants by reducing runoff and thus the amount of pollutant transported (source reduction).
- Treating runoff pollution before it is released into surface or ground waters (source reduction).

Management practices are used to control pollutants generated by specific activities. For example, pumpouts, dump stations, and/or restrooms are installed to discourage dumping sewage into waterways and thus to reduce the release of organic materials and pathogens into the water.

Implementing management measures and practices also provides secondary benefits. For example, use of a vacuum-based (often referred to as "dustless") sanding system prevents paint, wood, and fiberglass dust from being blown about and potentially ending up in marina basin waters. It also improves working conditions, protects the health of employees, and reduces post-sanding clean-up work so workers can be more productive. Another example of a management practice that provides environmental benefits beyond those linked to water quality is a grassed drainage swale surrounding a marina basin. As a runoff pollution control practice, it reduces nutrient and sediment delivery to the basin. It also provides an aesthetic buffer along the water's edge and natural habitat for aquatic plants and animals.

Nitrogen and phosphorus, in both dissolved organic and inorganic forms, are the two principal nutrients that promote plant and algal growth. In general, nitrogen is the limiting nutrient for plant growth (the nutrient whose abundance determines rates of plant growth) in marine ecosystems, and phosphorus is the limiting nutrient in freshwater ecosystems. Both nitrogen and phosphorus can limit plant growth in some estuarine systems, where freshwater and marine ecosystems converge, and both are necessary for the production of phytoplankton, free-floating microscopic algae, and macrophytes (larger floating and rooted plants). When the limiting nutrient is overabundant, phytoplankton, algae, and macrophytes can grow excessively, causing a decrease in water clarity, production of unsightly surface scum, and clogged waterways. All of these conditions are detrimental to marina operations for aesthetic reasons. They are also detrimental for operational reasons: excessive macrophytes can hinder boat passage and entangle propellers and pipelines. As these plants die, their decomposition in the marina basin consumes dissolved oxygen and degrades water quality. In extreme cases, anaerobic, foul-smelling water might result.

For these reasons, controlling the entry of nutrients into the marina basin makes good managerial sense. The marina will be aesthetically more appealing and operationally more functional, and maintenance costs will be kept down by not having to harvest overgrowths of aquatic plants.

Sources of nitrogen and phosphorus at a marina include detergents that contain phosphorus, sewage from boat heads or on-site septic systems, fertilizers used on marina grounds, pet and wildlife waste, and waste from fish cleaning.

The introduction of pathogens into a marina basin due to inadequate sanitation practices is a legitimate cause for concern by marina managers. If the water in a marina basin has elevated levels of fecal coliform bacteria or is contaminated with viruses, marina patrons could be in danger of contracting illness. Insistence that marina patrons use pumpout stations or have a properly operating Type I or II marine sanitation device (MSD) on their vessel can protect the patrons from the dangers of poor sanitation and the marina owner from lawsuits that could result from such incidents. The types of MSDs are described in Table 3-1.

Untreated sewage, pet waste, discarded fish parts, and all forms of litter can add polluting organic matter and debris to a marina basin's water, creating an aesthetically and biologically undesirable environment. Excessive organic matter in a marina basin leads to lowered dissolved oxygen levels. It also makes water murky. Water clarity is reduced further from other activities that stir sediment and particles of decomposing organic debris up from the bottom. Litter like paper and styrofoam cups, plastic bags and soda can holders, fishing lines or nets, and discarded materials from boat maintenance activities creates an unsightly marina basin. It is also a threat to fish, waterfowl, and shorebirds, which can become entangled in plastics or might eat debris mistaken for food and die as a result. Harmful or toxic compounds in a marina basin create conditions that not only are dangerous to the health of people and animals but also can be aesthetically unpleasant and expensive to correct. Petroleum compounds can be toxic to aquatic habitat and a nuisance for marina patrons. Oil, gasoline, and materials that contain these compounds (such as discarded oily rags, bilge pads, and dirty bilge water) are pollutants that detract from the beauty of the marina setting by leaving an unsightly surface sheen. In addition, the discharge of any petroleum product in a sufficient quantity to cause a surface sheen is a violation of federal law and is punishable by the imposition of substantial fines and penalties. These compounds foul boats, docks, and anything else that comes into contact with them. Fish gills and the feathers of waterfowl are fouled by these substances, jeopardizing the animals' health, and plant leaves can become coated, preventing or reducing the plants' ability to photosynthesize.

All of these potential sources of pollution to marina basins and the undesirable conditions they cause for marina patrons and owners point out the importance of establishing controls on how wastes

Table 3-1. Marine sanitation device descriptions

MSD TYPES	
Type I (Vessel size = <65 ft)	A flow-through MSD in which sewage is filtered though an on-board treatment system and then directly discharged. Required to produce an effluent with a fecal coliform bacteria count ≤ 1,000/100 mL and no visible floating solids (40 CFR 140.3). Rely on maceration and disinfection for treatment of sanitary waste.
Type II (Vessel size = >65 ft)	A flow-through device larger than a Type I MSD. Required to produce an effluent with a fecal coliform bacteria count ≤ 200/100 mL and suspended solids ≤ 150 mg/L (40 CFR 140.3). A Type II MSD provides more advanced treatment than a Type I MSD.
Type III (All vessel sizes)	Device designed to prevent overboard discharge of treated or untreated sewage. Commonly a called holding tank because the sewage flushed from the marine head is deposited into a tank containing deodorizers and other non-treatment chemicals. Contents of the holding tank are stored until properly disposed of at a shoreside pumpout facility. Can be equipped with a discharge option, called a Y-valve, that allows the boater to direct the discharge from the head either into the holding tank or directly overboard. Overboard discharge is illegal in U.S. navigable waters.

are disposed of, the use of pumpouts, where storm water drains, and where boat maintenance is allowed to occur. Good pollution control can leave marina basin waters as healthy an environment for people, fish, aquatic plants, and other aquatic organisms as any other part of a waterbody.

Management Practice Systems

Water quality problems can't usually be solved with one management practice because single practices cannot provide the full range and extent of control needed to limit the entry of pollutants from numerous sources. Multiple management measures or practices can be combined to build *management practice systems* that address the pollutant control needs associated with pollutant generation from more than one source. For example, controlling petroleum hydrocarbon pollution is an objective of four marina management measures (storm water runoff, fueling station design, liquid material, and petroleum control). A single management practice cannot adequately control petroleum hydrocarbon pollution because one management practice can usually address pollution from only a single source. Separate management practices are necessary to control pollution from other sources. For instance, a grassed drainage swale can control petroleum hydrocarbon pollution from surface runoff, air/fuel separators can control it from boat fuel tanks, berms are helpful (and might be required) at liquid material storage areas, and bilge pads are effective in boat bilges. If any one of these sources is overlooked or inadequately addressed, the overall goal of controlling petroleum hydrocarbon pollution in the marina basin might not be attained.

Site-Specific Design of Management Practices

There is no single, ideal management practice for controlling a pollutant or class of pollutants in all situations. Rather, management practices should be chosen and designed based on the types of pollutants causing problems, sources of the pollutants, causes of pollution at the marina, climate, type of waterbody, existing water quality, habitats in and around the marina basin, pollution reduction goals, experience of the system designers, and willingness and ability of the marina owner to implement and maintain the practices. The relative importance of these and other factors varies depending on other considerations such as whether the implementation is voluntary or mandatory (e.g., required under a storm water permit).

Important Characteristics of Marina Environments from a Pollution Perspective

Marinas are located on nearly every type of surface water—lakes, rivers, inland waterways, reservoirs, embayments, bays, coastal channels, and others. Each of these waterbody types has different characteristics that affect how pollutants behave in them; that is, whether they are diluted quickly or not, accumulate in sediments or remain in the water column, or concentrate in specific areas or disperse. Although marina operators cannot affect the qualities of or processes that occur in waterbodies, knowledge of the qualities and processes particular to the type of waterbody where a marina is located is useful when devising a pollution control strategy and in general for helping to understand the larger watershed context within which every marina is located.

General Factors Common to All Waterbodies

Sediment has the potential to be a concern at any marina because of the turbid waters it can create, the dredging that might become necessary if too much sediment accumulates in the marina basin, and the pollutants it can carry with it. Sediment can enter a marina from upland flow (storm water runoff) and from surrounding waters. The amount of sediment contained in either of these sources is very site-specific and needs to be assessed individually at each marina.

Along with the sediment are nutrients and toxic substances attached to sediment particles. The types and quantities of these pollutants are other factors that are best assessed on a site-specific basis. Many chemicals (including nutrients and chemical pollutants) have different forms with different tendencies to attach to particles, biodegrade, and volatilize. Each chemical form might have a different toxicity to aquatic life. The chemical form can change when the compound moves from one environment to another—for instance, from ground water to surface water or from fresh water to salt water. Heavy metals naturally react to particles and sorb onto suspended particulates. This process is particularly accentuated in estuaries, where the mixing of fresh and salt water creates turbulent and turbid conditions. Most metals transported down rivers to estuaries are removed to bottom sediments in the estuary.

Pollutant resuspension is another potential concern in marinas, and it is affected by currents, boat traffic, and dredging. Toxic metals and hydrocarbons are often mentioned in the context of pollutant resuspension, but bacteria and viruses, nutrients, organic matter, and any other pollutants concentrated in sediments are also resuspended by water turbulence and can cause water quality problems.

The type of waterbody on which a marina is located plays a role in processes in the marina basin, like sedimentation; pollutant delivery, settling, and resuspension; and circulation. The subsections that follow discuss the general types of environments where marinas are located and factors of concern in each of them.

Lakes and Reservoirs

Lakes and reservoirs are strongly affected by the characteristics of the watersheds in which they are located, more so than coastal waters because lakes and reservoirs are not flushed and mixed with a larger body of water. Water that enters lakes and reservoirs carries with it nutrients, sediment, oxygen, decomposing organic matter, fertilizers and pesticides used on farms and lawns, and weathered minerals. In addition, pollutants from on-site waste disposal systems (septic tanks) that leak into ground water, industrial and municipal point sources that discharge into rivers and streams that then feed into the lake or reservoir, street runoff, and pollutants from the atmosphere all enter lakes and reservoirs and affect their ecology.

The water quality and biological effects of pollutants discharged into the waters of lakes and reservoirs depend on a combination of lake and reservoir characteristics. Depth is one of the characteristics that determines the effect of marinas and recreational boating in a lake or reservoir. Lakes and deeper reservoirs are usually thermally divided during the summer into distinct upper (*epilimnion*) and lower (*hypolimnion*)

> ***Watersheds*** are areas of land that drain to a single stream, lake, or other water resource. Watersheds are defined solely by drainage areas and not by land ownership or political boundaries.

portions. Because the density of water depends on its temperature, the temperature difference between the upper and lower portions creates a difference in density as well. Wind circulation alone is not enough to overcome the density difference between the upper and lower portions, so there is little exchange of dissolved oxygen between the upper portion and the lower portion while a lake or reservoir is divided in this manner.

The epilimnion usually has a depth of from about 10 feet in shallow lakes to 40 feet in deep lakes. A narrow region where water temperature changes rapidly with depth (usually about 1.5 °F per 3 feet of depth), the *thermocline*, rests between the epilimnion and the hypolimnion. The hypolimnion is more or less uniform in temperature and extends from the base of the thermocline to the bottom of the lake or reservoir.

Stratified lakes and reservoirs have two periods of overturn or mixing each year, one in the autumn and another in the spring. The change of season from a warm summer to a cold winter destratifies lakes and reservoirs and induces mixing; the reverse process of warming with the change from winter to summer induces another mixing period. Because there is limited exchange of dissolved oxygen between the epilimnion and the hypolimnion while a lake or reservoir is stratified, the oxygen depleted in the hypolimnion during the summer is not replenished until the autumn overturn. During the overturn, when a lake or reservoir is unstratified, dissolved oxygen is usually uniformly distributed from the surface to the bottom.

Stratification and mixing of lakes and reservoirs influence the effect of pollutants on them. When a lake or reservoir is stratified, the upper (*epilimnetic*) volume of the lake or reservoir determines the volume of water available for dilution of fuel, oil, and other wastes that are not mixed into or do not sink into the hypolimnion while the waterbody is stratified. The total volume of the lake or reservoir determines the volume of water available to dilute pollutants over time.

Another important characteristic of lakes and reservoirs is the hydraulic residence time (HRT). The HRT of a lake or reservoir is the time it would theoretically take for all of the water in the lake or reservoir to be replaced by new water entering it naturally. For example, if a lake has a volume of 5 million gallons and natural flow into the lake from streams averages 10,000 gallons per day, the HRT of the lake would be 500 days (5,000,000/10,000). In a lake with an HRT of 10 years, therefore, even if pollution input were completely stopped, existing lake water would predominate for many years while new water slowly replaced the polluted water. There would be a long lag time (perhaps 2 to 3 years) before improvements in lake water quality would be seen.

Rivers

Water quality at any point along a river is strongly influenced by upstream water and land uses. If the conditions that affect upstream water quality change, downstream water quality is affected. Examples of upstream changes in conditions include clearing land near the river for construction or forest harvesting, which might increase sediment loading, or changing land use change from forest to agriculture, which could increase sediment, nutrient, and chemical pollution. Water quality changes at downstream locations can occur in pulses if inputs of pollutants from upstream dredging or pesticide and fertilizer applications, for instance, are short-lived. The duration of changes in water quality depends on the type of upstream change. A change in land use from forest to agriculture over a large area, for instance, could cause long-term changes in water quality, whereas an increase in suspended sediment from dredging might last no longer than the duration of the dredging work.

Estuaries

Estuaries are similar to coastal embayments with the special characteristic of receiving fresh water from upland areas via rivers and streams. This characteristic creates special circumstances and properties. Where fresh water meets salt water, there is a change in salinity and alkalinity, a change in water density (because salt water is more dense than fresh water), a loss of water velocity, and turbulence due to the meeting of fast-moving river water and quiescent estuarine water. These factors affect the behavior of sediment and the pollutants attached to it.

Sedimentation is greater in the upper portions of estuaries where rivers enter because of the water's loss of velocity. Sedimentation also occurs where the fresh water and salt water meet because the change in salinity causes suspended particles to join together into larger particles and settle. The changes in salinity and pH affect many pollutants, such as nutrients and toxic metals, in the incoming fresh water as well. The form of a pollutant might change because of these changes in the water, making it less or more toxic or causing it to attach to or detach from sediment particles. As in coastal embayments, the force of tides influences estuarine environments as well.

Coastal Environments

Coastal environments are areas of high energy, with tides moving in and out, coastal storms, waves constantly washing against the shore, and currents moving along the coast. Marinas cannot afford to be subject to all of this energy because of the need to offer protection for boats and on-land structures; therefore, they are usually located on quieter embayments along the coast or are protected from coastal energies by artificial means like breakwaters. However, the energetic processes of the coast still exert a strong effect on the water quality and aquatic environment of marinas.

Coastal embayments have quieter waters than open coastal areas, and sediments tend to accumulate in quiet-water areas because the lack of water movement permits the sediment to settle. Countering this tendency are tides and coastal storms that mix sediments from the bottom and transport them to open waters. So, in marinas located in coastal embayments, pollutants can build up if tidal action is not strong or the embayment is well protected from storm action. As noted above, metals transported down rivers to estuaries sorb onto particulates and settle to sediments. In general, more than 90 percent of particulate matter transported by rivers settles in estuarine and coastal marine areas and does not escape to offshore waters.

Modification of coastal areas—for example, by excavating coastal land to create a marina or by adding breakwaters—can alter coastal currents near marina entrances. The effect in any particular area depends on local conditions relating to currents and the sizes and types of sediments transported by them. Coastal currents carry sediments with them, and these sediments tend to be transported into channels that lie perpendicular to the current. Artificial structures and channels can also alter erosion patterns due to alterations of wave patterns in the immediate vicinity. Thus, marinas in altered coastal environments might have to contend with problems of sedimentation and erosion that were not present before the coastal alterations.

Boating on Inland Waters

A picture of a marina on a large inland reservoir, lake, or river would look very similar to a picture of a coastal marina. Lakes and reservoirs range in size from small (an acre or less) to very large. Reservoirs operated by the Tennessee Valley Authority range in surface area size from relatively small (10 to 12 miles long by ½ mile wide) to large (180 miles long by 1 mile wide), and their depths typically range from 100 to 300 feet. The size of a lake or reservoir dictates the types of boats that can be used on it, and the boats used on large inland lakes and reservoirs are usually of the same types (keeled sailboats, large motorboats, and yachts) as those used along the coast. Marinas on large lakes and reservoirs are also very similar to coastal marinas. They can have as many as 200 slips (some marinas on Lake Winnipesaukee in New Hampshire have 150 to 200 slips); they often have fueling stations, pumpout services, and hull maintenance areas; boat use is concentrated on the weekends, with holiday weekends being especially busy. Inland marinas can also be smaller, especially those located on smaller lakes and rivers. A directory of marinas in Louisiana lists 51 marinas on freshwater lakes, rivers, and bayous with capacities of as few as 10 boats in slips or moorings.

Because reservoirs are dendritic (that is, they have a branching configuration; see Figure 3-1), the surface area in their main channels is limited. Marinas or docks extending into the main channel of a reservoir would impede navigation, and therefore they are typically located to the side of the main channel. Some typical features of lakes and reservoirs are summarized in Figure 3-1.

Boating Access

In 1984 Congress created the Aquatic Resources Trust Fund, which made two sources of funding available for the acquisition, design, and construction of recreational boating facilities. The Boating Safety Account is administered by the U.S. Coast Guard and primarily provides grants to states to help finance boating safety programs, one element of which is access. The Sport Fish Restoration Account is administered by the U.S. Fish and Wildlife Service. Ten percent of revenues to the account from recreational user taxes and a marine fuel tax must be expended by states for boating access. States may also use funds from the account to operate and maintain recreational boating facilities.

The States Organization for Boating Access (SOBA) was created in 1987 to promote the acquisition, development, and administration of recreational boating facilities. The organization maintains close ties with the Coast Guard and Fish and Wildlife Service both to ensure that the boating access aspects of the grant programs administered by these agencies receive the funds and attention that Congress intended and to provide input from states on program requirements.

Construction of boat ramps is an aspect of boating access that can affect shorelines and water quality in inland waters. Where appropriate, measures that can help protect the environment and ensure attractive and safe boating access points are highlighted throughout this document and are based on the concepts developed by SOBA. A thorough treatment of the topic can be found in SOBA's book *Design Handbook for Recreational Boating and Fishing Facilities* (1996), available from SOBA at 919-781-0239.

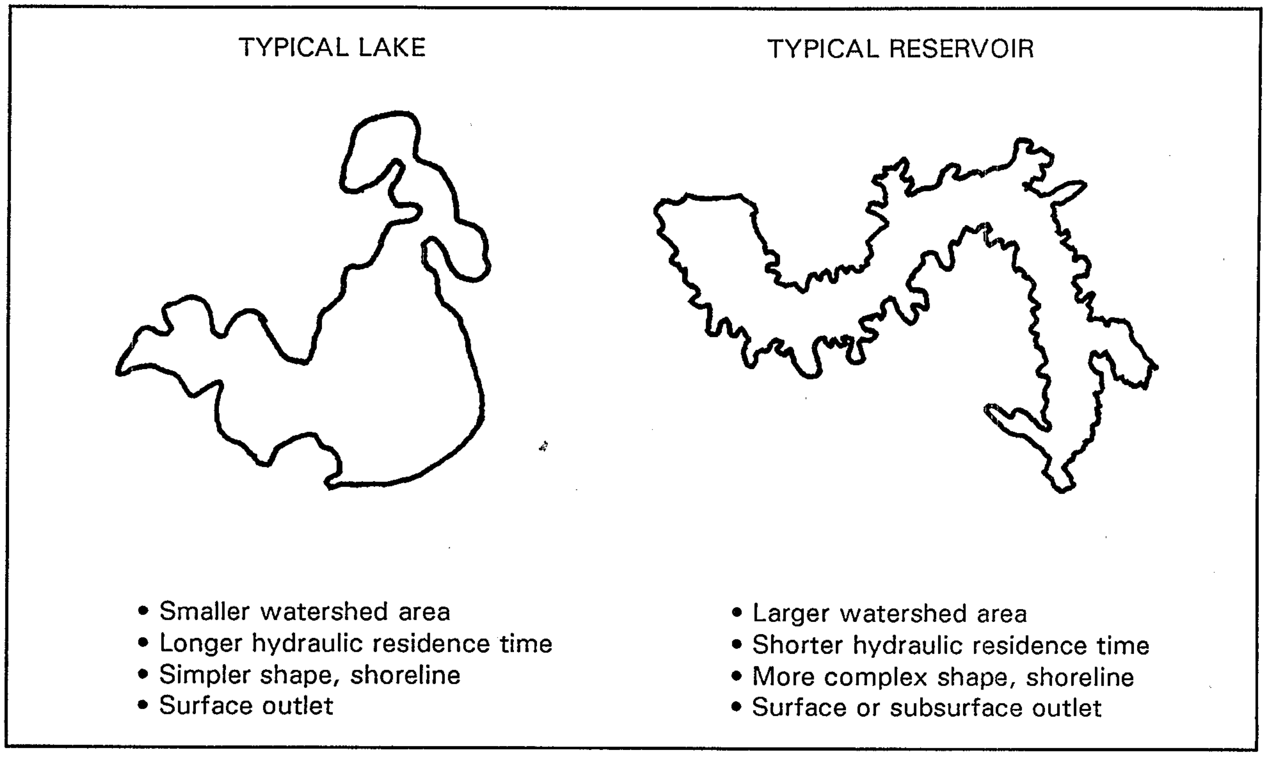

Figure 3-1. Typical features of and differences between lakes and reservoirs.

SECTION 4: MANAGEMENT MEASURES

Section 4 Contents

Introduction

Management measures are the best available, economically achievable practices or combinations of practices that can be used to address nonpoint source pollution from marinas and recreational boating. *Best management practices* (BMPs) are individual activities or structures that can be used alone or in combination to achieve the management measures.

EPA identified 15 measures for implementation within state coastal management areas. From discussions with marina owners and operators at facilities on fresh waters nationwide, these 15 management measures and associated practices have been found generally to be just as applicable to freshwater marinas as to coastal water marinas. They form the basic measures recommended in this guidance. This section discusses the 15 management measures for marinas and recreational boating and BMPs that can be used to achieve them.

The scope of this guidance is broad, covering diverse nonpoint source pollutants from marinas and recreational boating. Because it applies to all types of waterbodies, it cannot provide all practices and techniques suitable to all regional or local marina or waterbody conditions. Also, BMPs are continually being modified and developed as a result of experience gained from their implementation and the innovation of marina owners and operators across the country.

The guidance can help marina managers identify potential sources of nonpoint source pollution and offer potential solutions. Finding the best solution to a nonpoint source pollution problem at a marina requires taking into account the many site-specific factors that together compose the setting of a marina and identifying the most applicable BMPs.

Considering management measures and BMPs during marina design will help to ensure that the site has good flushing and water circulation characteristics, avoid encroachment on vital aquatic habitats, improve habitat quality in and around the marina basin, and reduce the potential for water quality problems in the marina basin. Considering pollution prevention possibilities when planning a marina can help ensure that the design of the marina and activities at the marina do not lead to degraded water quality in the basin once the marina is operational. Incorporating pollution prevention and source reduction measures into an existing marina can help improve and protect water quality at the marina. Good water quality can help any marina keep operational costs low and improve customer satisfaction.

Marina siting and design play important roles in determining how good water quality in a marina basin will be. Marina location (*open*—sited directly on a river, lake, bay, or barrier island, or *semi-enclosed*—sited on an embayment, cove, or other protected area) affects circulation in a marina basin and, therefore, how well it flushes. The depth of a marina basin affects circulation of deep water in the basin and how often it needs maintenance dredging, if at all. Dredging stirs contaminants from the bottom and can disturb bottom habitats. Marina design, especially the configuration of the basin and its orientation to prevailing winds, waves, tides, and currents, affects the retention of pollutants in a marina basin and the movement of pollutants out of a basin. Some marinas may be affected by storm water runoff from upland areas in the watershed.

Existing marinas can improve water and habitat quality in the marina basin through application of these management measures. Circulation and flushing may be improved in a marina basin by creating an additional opening in a breakwater. Shoreline stabilization may reduce the sedimentation rate and sediment levels in a marina basin, provide an area for patron activities, and make shoreline habitats more suitable for a variety of aquatic and terrestrial plants and animals. Improvements to storm water runoff patterns, fueling stations, sewage facilities, hull maintenance areas, or other areas or aspects of a marina where pollutants are generated can reduce pollutant inputs to the marina basin from these sources and improve water quality.

A marina designed with the important points of the management measures in mind—including physical location, flushing and circulation, aquatic habitat, shoreline stability, and pollution prevention—will probably have better water quality and fewer water-pollution-related problems during its life of operation, and economic benefits may result from making such improvements.[1] This applies whether the management measures are applied while the marina is being designed or incorporated into the marina after it is operational.

Subsections 4.1 through 4.15 of this section discuss each of the management measures. It is best to plan to apply management measures comprehensively by first evaluating pollution problems throughout the marina and incorporating those elements of different management measures that will most efficiently and effectively address the specific pollution issues at the marina. With a comprehensive approach to management measure application, any marina can achieve or maintain good water quality and maintain healthy shorelines and aquatic habitats.

In addition to the management measures, BMPs are also described. EPA has found the BMPs described in this guidance to be representative of the types of BMPs that can be applied successfully to achieve the management measures. Site-specific or regional circumstances, however, should be considered in the selection of BMPs for a particular marina. Circumstances such as type of adjacent waterbody, climate, and type of work performed at the marina affect the design constraints and pollution control effectiveness of BMPs. The list of practices for each management measure is not all-inclusive, and marina operators are encouraged to use other BMPs where they would be as effective as or more effective than those discussed in this guidance.

The management measures for marinas and recreational boating are applicable to the facilities and their associated shore-based services that support recreational boats and boats for hire. Generally, the following types of operations and facilities would be expected to benefit by use of

1 See USEPA, 1996: *Clean marinas—Clear Value: Environmental and Business Success Stories.*

the management measures and BMPs in this guidance:

- Any facility that contains 10 or more slips, piers where 10 or more boats may tie up, or any facility where a boat for hire is docked.
- Boat maintenance or repair yards that are adjacent to the water.
- Any federal, state, or local facility where recreational boat maintenance or repair is done on or near the water.
- Public or commercial boat ramps.
- Any residential or planned community marina with 10 or more slips.
- Any mooring field where 10 or more boats are moored.

Facilities with fewer than 10 slips, where fewer than 10 boats are moored, or where piers have a capacity of fewer than 10 boats might also benefit from the management measures and BMPs described in this guidance, and operators of such facilities are encouraged to review the information presented here and consider its possible application to their situations.

Some of the management measures (e.g., marina flushing) are more applicable to the siting and design phase of marina construction or expansion, while others (e.g., maintenance of sewage facilities) concern marina operation and maintenance and are more applicable to operational marinas. Still others (e.g., storm water runoff) are applicable to all marinas, whether in the design phase, already operational, or in the process of expanding.

Following the discussion of each management measure and its associated BMPs is a table that restates the management measure and summarizes the environmental concerns that the management measure addresses, the BMPs applicable to the management measure, and information pertinent to the implementation of each BMP. The table that follows here, *Key to BMP Tables*, describes the type of content in each column in the tables. The tables (beginning with *BMP Summary Table 1*, p. 4-11) are organized as follows:

- The first column, *Best Management Practice Examples,* lists the BMPs mentioned in this guidance that can be used to achieve the management measure. Where appropriate, BMPs are divided by category, either pollution prevention or source reduction, as described in the *Key to BMP Tables.*
- The second column, *Marina Location & Usage*, identifies where in the marina the BMP would usually be located and the purpose for its use. The applicability of each BMP is categorized as universal, general, or recommended, as described in the *Key to BMP Tables.*
- The third column, *Benefits to Marina,* describes the benefits that marina owners and operators and boat owners at the marina could expect from using the BMP. The magnitude of the benefits is categorized as high, moderate, or low, as described in the *Key to BMP Tables.*
- The fourth column, *Projected Environmental Benefits*, describes the environmental benefits that can be expected from using the BMP. These are also categorized as high, moderate, or low, as described in the *Key to BMP Tables.*
- The fifth column, *Initial Cost Estimate*, is an estimate of the cost of initially installing the BMP (e.g., a structural BMP) or establishing the practice (e.g., a recycling program) at the marina. A cost range, as described in the *Key to BMP Tables*, is provided for each BMP.
- The sixth column, *Annual Operation & Maintenance Cost Estimate*, is an estimate of the ongoing cost, if any, of using or maintaining the BMP at a marina. The cost of annual operation and maintenance is estimated as for the initial cost estimate. See the *Key to BMP Tables.*
- The last column, *Notes,* provides descriptions of additional benefits or other information pertinent to the BMP.

KEY TO BMP TABLES: Title of Management Measure

MANAGEMENT MEASURE: The statement of the U.S. Environmental Protection Agency management measure.

APPLICABILITY: A statement of the general applicability of the management measure.

ENVIRONMENTAL CONCERNS: A descriptive statement of the potential environmental problems, what the pollutants could be, reason for concern, and how they could get into the water.

MANAGEMENT MEASURE PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Each best management practice (BMP) listed is a recommended example used successfully by marinas or boaters. Many of these practices are simple common sense. Not all practices are appropriate for each marina since each facility has site-specific needs. Managers can alter a practice to meet their site-specific situation as appropriate to achieve comparable benefits. In some marinas a single practice might be sufficient to achieve a result, and in others a combination of practices might be necessary. This list should not limit anyone from trying something new or different if it is cost-effective and practical and will help maintain or improve water quality.	This is a general description of where in the marina the practice is likely to be used. For example, a pumpout is where it is easiest for most boats to get service, such as on the fuel dock. A vacuum sander is used in the boat maintenance area. No-wake zones are present in the channels leading to or near the marina basin.	Use of this practice should provide clear benefits to the marina or boat owner for adoption to happen. Benefits may be economic, simple to use, available off the shelf, easily taught/learned, and effective. The benefits listed are typical and will help in determining which practice to select for the site-specific need.	A good practice has environmental benefits and improvements to clean boating. Each recommended practice has one or more environmental benefits for consideration. Although it is impossible to predict exact benefits everywhere, the most common found here will aid in selecting the most cost-effective practice. Use of any practice must predictably result in clear and measurable environmental protection or improvement in water quality.	Estimated cost ranges for the purchase, construction, and installation of each practice. Actual costs vary from site to site. The initial cost does not include the cost of applying for construction permits and legal services.	Estimated annual cost ranges for operating each practice and maintaining it in running condition for a reasonable use life. Actual costs vary from operation to operation.	Each practice has descriptions of additional benefits, effects, information, tips, advice, cautions, or comments to help select and use the technique for cleaner boating and marina facilities.

KEY TO BMP TABLES. (cont.) Title of Management Measure

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Some BMPs are applied where products are used to prevent pollutants from being released into the water. They are often the first, best, least costly, and most effective practices to prevent contaminants from entering the water. BMPs of this type include not using a toxic solvent, diluting a product so it is less toxic, switching to a less or non-harmful product, or doing something differently so no pollution results. Education can teach people to change their behavior so they do things in a less polluting manner or to use methods that reduce the type or amount of contamination created.	Some BMPs may be appropriate for use in all or most marinas and boats, whereas others have limited usage. Select practices that are appropriate and cost-effective for each site-specific need. Every BMP will not work everywhere. Some could be broadly effective in many sites; others are less adaptable for wide or effective use.	HIGH = Considerable value to user; best cost/benefits when used. MODERATE = Of value to user; good cost/benefits from use. LOW = Some value; fewer cost/benefits to the user.	HIGH = Considerable environmental protection; clear and obvious water quality improvement can be expected. MODERATE = Protects the environment; improvement to water quality could be expected. LOW = Some protection to the environment; limited water quality improvement expected.	NONE = $0 LOW = under $2,000 MODERATE = $2,000 to 9,999 HIGH = $10,000 to 24,999 EXPENSIVE = $25,000+ When a range is given, e.g., High to Moderate, expect cost to lean toward higher end	NONE = $0 LOW = under $1,000 MODERATE = $1,000 to 4,999 HIGH = $5,000 to 9,999 EXPENSIVE = $10,000+ When a range is given, e.g., Low to Moderate, expect cost to lean toward lower end	

KEY TO BMP TABLES. (cont.) Title of Management Measure

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Other BMPs are used to remove pollutants from the environment, and are applied between the place where pollutants are released and the water. These practices can capture, filter, screen, trap, contain, absorb, or chemically neutralize pollutants or divert them to municipal sewer lines. Recycling and use of a filter in a storm drain are examples. These BMPs often are more expensive to use and less effective than BMPs that reduce pollutant releases.	UNIVERSALLY RECOMMENDED Very effective practice for wide use; best choice; greatest cost/benefits; can be used in any marina (or on any boat) where applicable. GENERALLY RECOMMENDED Good practice for common use; effective choice; good cost/benefits; can be used in most marinas (or on most boats) where applicable. RECOMMENDED Practice for selected use, workable choice; reasonable cost/benefits; may be used in some marinas (or some boats) where better practices are not available or practical.					

4.1. Marina Flushing

Management Measure for Marina Flushing:

Site and design marinas such that tides and/or currents will aid in flushing of the site or renew its water regularly.

Management Measure Description

Water quality in a marina basin depends largely on how well the basin is flushed, which depends in turn on how well water circulates within the marina. Studies have shown that adequate flushing improves water quality in marina basins, reduces or eliminates water stagnation, and helps maintain biological productivity and aesthetic appeal. Flushing can reduce pollutant concentrations in a marina basin by anywhere from 70 percent to almost 90 percent over a 24-hour period.[1]

When a single number (e.g., 10 days) is given as the *flushing time* or *residence time* of a body of water (e.g., marina basin, harbor, or estuary), this number represents an average and doesn't accurately reflect what is happening inside the marina basin. Actually, flushing time in a marina basin can range from zero days at the boundary with the adjacent waterbody (at points of entry into the marina basin) to as much as several weeks within the marina basin at secluded locations or where in-water structures prevent water from circulating.

In a poorly flushed marina, pollutants tend to concentrate in the water and/or sediments. Pollutants and debris can collect in poorly flushed corners or secluded or protected spots in the same way that leaves collect in depressions in the ground where they are protected from wind. Stagnant, polluted water—with little biological activity, lifeless shorelines, and offensive odors—can be the consequence.

1 Cardwell and Koons, 1981; Tetra Tech, 1988.

In tidal waters, flushing is driven primarily by the ebb and flow of the tide. A large tidal volume relative to the total volume of a marina basin provides excellent flushing because each tidal exchange replaces a large amount of the marina basin water with "new" water from outside the marina basin. This condition is common on coastal waters in northern New England, the Pacific Northwest, and Alaska, where tidal circulation should adequately flush marinas.

In nontidal coastal waters, such as the Great Lakes, wind drives circulation in the water adjacent to a marina. The circulating water outside a marina basin can have a flushing effect on water within the marina if the speed, persistence, and direction of the wind create a strong enough current. In many situations wind-driven currents can provide adequate flushing of marina basins.

In river waters, with current flow, water usually moves into and out of the marina basin continuously unless the basin is built into the land or has only one small entrance channel.

The BMPs mentioned below are particularly applicable for incorporation into a marina's design at new and expanding marinas. Marinas with poor water quality that could be attributed to poor flushing might also benefit from using one or more of the following BMPS, as appropriate. Entrance channel design and wave protection structures must be designed with other factors in mind as well. Adequate protection from wave energies, episodic storm currents, and ice floes and shoreline erosion protection must be considered in the overall design strategy.

Applicability

This management measures primarily applies to new and expanding marinas.

Best Management Practices

♦ *Ensure that the bottom of the marina and the entrance channels are not deeper than adjacent navigable channels*

Flushing rates in marinas can be improved and maximized by proper design of entrance channels and the basin. Areas with minimal or no tides or poor circulation should have basin and channel depths designed to gradually increase toward open water to promote flushing.

Even where good flushing does occur, this alone does not guarantee that a marina's deepest waters will be renewed on a regular basis. As mentioned previously, deep canals and depressions much deeper than adjacent waters might not be adequately flushed by tidal action or wind-generated forces. Fine sediment and organic debris will collect in them, and low dissolved oxygen concentrations can result. In the warmer months when dissolved oxygen concentrations are normally low because of higher water temperatures, the even lower dissolved oxygen concentrations in these depressions can deteriorate water quality and hinder biological activity in the water.

♦ *Consider design alternatives in poorly flushed waterbodies to enhance flushing. For example, consider*

- An open design where a semienclosed design is not functional.

> There are situations where it may be necessary to have areas deeper than the rest of the marina basin. For example, Cove Haven Marina (Rhode Island) services large 12-meter America's Cup sailboats with deep keels and needs sufficiently deep water in and adjacent to the boat haul-out facility to do so. In this case, the state allows the marina to maintain this site dredged deeper than the rest of the marina (USEPA, 1996: *Clean Marinas—Clear Value*).

- Floating wave attenuators where fixed breakwaters are not functional.

When selecting a marina site and developing a design or when reconfiguring an existing marina, the need for efficient flushing of marina waters should be a prime consideration.

Where a poorly flushed location is the only one available or where a marina is already operational in such a location, special arrangements may be necessary to ensure adequate flushing. Selection of an open marina design may be considered. Open marina designs have no natural barriers to restrict the exchange of water between the larger waterbody and the marina basin. To accommodate both improved flushing and protection from wave energy, floating wave attenuators can be useful. Floating wave attenuators do not impede flushing because water exchange is not restricted by an underwater structure, yet the marina is protected from limited wave action. Floating wave attenuators can provide effective protection where waves do not usually exceed 3 feet, and open area designs can be a viable alternative where they do not leave a marina exposed to excessive wave action that could damage property and cause shoreline erosion.

♦ *Design new marinas with as few enclosed water sections or separated basins as possible to promote circulation within the entire basin.*

Overall flushing in a marina is a function of the number of separate basins in the marina. A marina in open water generally flushes better than a one-basin marina; a one-section marina, instead of square corners, can eliminate stagnant corner water and can help produce strong circulation in a marina basin. A marina in open water flushes better than a one-segment marina, a one-segment marina generally flushes better than a two-section marina, and so forth (Figure 4-1). Curved corners, instead of square corners, can eliminate stagnant corner water and can help produce strong circulation within a marina basin.

♦ *Consider the value of entrance channels in promoting flushing when designing or reconfiguring a marina.*

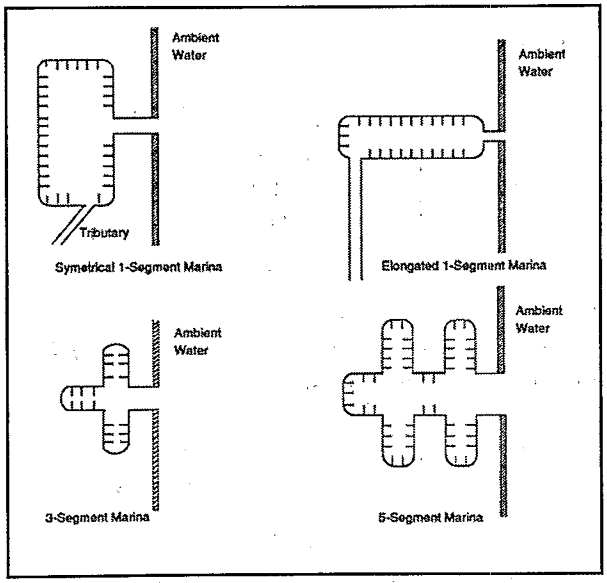

Figure 4-1. Example marina designs.

The alignment and number of entrance channels may affect flushing, along with many other site-specific factors. The following points generally hold true and should be considered when designing or reconfiguring a marina:

- Entrance channels that follow the natural channel alignment and have only gradual bends promote flushing.
- Where the tidal range is small, a wider entrance may promote flushing.
- Where the tidal range is large, a single narrow entrance channel may improve flushing.
- In tidal and nontidal waters, entrance channels aligned parallel to the direction of prevailing winds or water flow might enhance flushing.

The orientation and location of a solitary entrance might affect marina flushing rates and should be considered along with other factors that affect flushing. Consider the following points:

- In a square or rectangular marina basin, a single entrance at the center of a marina may promote flushing better than a single corner-located asymmetric entrance.
- In a circular marina basin, an off-center entrance channel might promote better circulation.

♦ *Establish two openings at the most appropriate locations within the marina to promote flow-through currents.*

Where water-level fluctuations are small (e.g., nontidal waters), alternatives in addition to the ones previously discussed can be considered to ensure adequate water exchange and to increase flushing rates. An elongated marina situated parallel to a tidal river may be adequately flushed by using two entrances to promote a flow-through current. A small outlet onto an adjacent waterbody can be opened solely to enhance flushing (Figure 4-2). Buried pipelines have been similarly used to promote flushing.

♦ *Consider mechanical aerators to improve flushing and water quality where basin and entrance channel configuration cannot provide adequate flushing.*

Where poor water quality throughout a marina basin or in secluded spots is a problem because of poor flushing, limited circulation, or other circumstances, mechanical aerators (such as those used for ice protection) might be helpful.

These devices can raise the level of dissolved oxygen in the water and circulate floating debris out of corners into the rest of the basin, where it can be flushed out naturally. Underwater air bubblers or submerged impeller-type motors can be effective during short-term episodes that might occur during the summer. In certain circumstances, such as in shallow and enclosed waters, water clarity improvement is often noted if artificial aeration is used.

> Both compressed air and agitator systems work in fresh water, salt water, and brackish water. They do not work well in ice-covered rivers because river currents destroy bubble or flow patterns and because of the lack of heat. Thermal mixing of river water is a natural process, and a river that has formed an ice cover has already dissipated nearly all available heat.

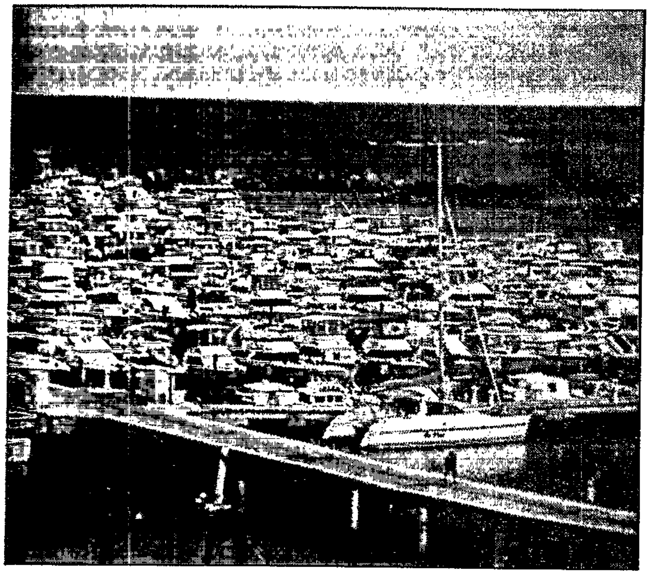

Figure 4-2. Puerto Del Ray Marina (Puerto Rico) has an offshore rubble mound breakwater that protects the southeastern and eastern exposures of the marina. Two hundred feet of the southern breakwater was removed, creating a new south side breachway exit/enterance that is still well protected but now allows for greater circualtion in the basin. Water clarity improved after the alteration, and as a result new customers (a 3 percent increase for the marina) relocated to Puerto Del Rey Marina (USEPA, 1996: *Clean Marinas—Clear Value*).

Ice suppression systems available for marinas hinder ice formation by using compressed air bubblers or in-water agitators. Bubbler systems force air to entrain warmer bottom water into a rising plume, which reacts with and melts the underside of the ice sheet. Water agitators work on the basis of thermal reserves of basin waters and surface currents to prevent freezing.

BMP Summary Table 1 summarizes the BMPs for Marina Flushing mentioned in this guidance.

BMP Summary Table 1. MARINA FLUSHING MANAGEMENT

MANAGEMENT MEASURE: Site and design marinas such that tides and/or currents will aid in flushing of the site or renew its water regularly

APPLICABILITY: This management measure primarily applies to the design of new and expanding marinas.

ENVIRONMENTAL CONCERNS: Good marina water quality depends on water circulation within the boat basin and the level of pollutants existing and new amounts entering the water. In a poorly flushed marina, pollutants tend to concentrate in the water and/or sediments. In a basin with poorly flushed corners or secluded or protected spots, pollutants and debris can tend to collect in these locations. Stagnant, polluted water—with little biological activity, lifeless shorelines, and offensive odors—can be the consequence. The flushing rate is the time required to replace the water within a basin. In tidal waters, flushing is primarily driven by the ebb and flow of the tide, while inland lake and river flushing depends on wind-driven circulation and current speed. Pollutants tend to concentrate in water or sediments in poorly flushed coves and marinas. Fine sediment and organic debris can collect in uncirculated water, which can deplete the amount of oxygen in the water. Reduced dissolved oxygen in stagnant water hinders biological activity and can result in lifeless shores and offensive odors. Adequate marina flushing greatly reduces or eliminates the potential for water stagnation in a marina and helps maintain the biological productivity and aesthetic value of a marina basin. Good flushing can reduce pollutant concentrations in a marina basin from 70% to almost 90% over a 24-hour period.

MARINA FLUSHING PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Ensure that the bottom of the marina and the entrance channel are not deeper than adjacent navigable channels	Marina basin; generally recommended	MODERATE; sloping toward marina exit(s) improves flushing	HIGH; ensures that even the marina's deepest waters will be renewed on a regular basis	EXPENSIVE to HIGH	EXPENSIVE; depending on frequency of maintenance dredging	Marina basins deeper than entrance channels can be stagnant at depth, with poor water quality
Consider design alternatives in poorly flushed waterbodies to enhance flushing	Marina basin; universally recommended	MODERATE to HIGH; helpful where a poorly flushed location is the only one available or where conditions permit its use	MODERATE to HIGH; practice promotes circulation more than designs that enclose the basin	EXPENSIVE	HIGH to EXPENSIVE; depending on degree of wave attenuation	May leave the marina more exposed to wave energies and episodic storms. Fixed breakwaters may be necessary where additional protection is needed.
Design new marinas with as few enclosed water sections or separated basins as possible to promote circulation within the entire basin	Marina basin; universally recommended	HIGH; enclosed sections can create stagnant water	HIGH; flushing improves overall as the number of separate basins within a marina decreases	HIGH	MODERATE to HIGH	Curved corners, rather than square, eliminate stagnant corner water and can help produce strong circulation within a marina basin. The existing land configuration might preclude use of such designs
Consider the value of entrance channels in promoting flushing when designing or reconfiguring a marina	Entrance channels; universally recommended	MODERATE to HIGH	MODERATE to HIGH; properly designed entrance channels can increase flushing efficiency	HIGH	MODERATE	Takes advantage of natural circulation patterns in the waterbody.

BMP Summary Table 1. (cont.) MANAGEMENT MEASURE FOR MARINA FLUSHING

Best Management Practice Example	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Establish two openings at the most appropriate locations within the marina to promote flow-through currents	Entrance channels; recommended only where feasible	MODERATE to HIGH; flow-through circulation promotes good water	MODERATE to HIGH; entrance channels aligned with natural flow can increase flushing	EXPENSIVE	HIGH to EXPENSIVE; depending on degree of wave attenuation	More than one entrance channel may leave the marina too exposed
Consider mechanical aerators to improve flushing and water quality where basin and entrance channel configuration cannot provide adequate flushing	Marina basin; generally recommended for marinas with poor circulation	HIGH; useful to keep floating debris from collecting in corners; also can be used as ice control system in winter	HIGH; can quickly improve circulation and raise the dissolved oxygen concentration; improves water clarity	LOW - per unit; MODERATE to HIGH - bubbler system	LOW to MODERATE; depending on number of units and days used	Air bubblers or impeller motors are effective during short periods of low dissolved oxygen concentration, e.g., during a very hot period.

4.2. Water Quality Assessment

Management Measure for Water Quality Assessment:

Assess water quality as part of marina siting and design.

Management Measure Description

Water quality can be assessed as a part of new marina development or expansion. This management measure is useful for determining the suitability of a location for marina development, the best marina design for ensuring good water quality, and the causes and sources of water quality problems.

When planning for a new or expanded marina site, state water quality management agencies can be contacted for available information. A water quality assessment consists of taking samples of water from a waterbody; testing them for one or more criteria, usually chemical and physical characteristics and the presence of pathogenic organisms; and comparing the results to accepted standards of water quality. Historically, state water quality assessments have focused on testing the dissolved oxygen concentration of water and the presence of pathogen indicators, such as fecal coliform bacteria (*Escherichia coli*) and enterococci. Other tests, such as measurement of water temperature or Secchi disk depth (Figure 4-3), are used as well.

The dissolved oxygen concentration in water is used as an indicator of the general health of an aquatic ecosystem. A good concentration of dissolved oxygen (typically about 6 milligrams/liter [mg/L], but "good" can vary from waterbody to waterbody) can indicate that there's enough oxygen for fish to breathe and aquatic plants to photosynthesize, and there's a good exchange of gases between the waterbody and the atmosphere. A low dissolved oxygen concen-tration, or a level below what is normal for the waterbody, might indicate that there is too much decaying organic matter in the water or that a film of oil or other substance is on the surface preventing an exchange of gases with the atmosphere, either of which could be due to nonpoint source pollution.

Pathogenic organisms in the water indicate the potential for public health problems. Pathogens are contained in human and animal fecal waste, and they can cause illness. Tests for these water quality criteria can be used to determine the condition of a site where a marina is proposed to be developed.

Federal, state, and municipal agencies routinely test the water of coastal and estuarine waters, lakes, and reservoirs, especially if there is a lot of recreational use of the waterbody and protection of public health is important. Results of the tests can be obtained by calling the agency that does the testing (e.g., state department of natural resources or environmental protection).

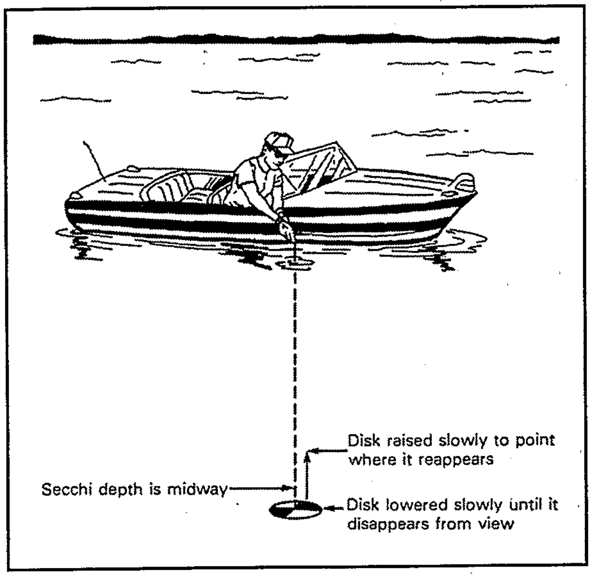

Figure 4-3. The Secchi disk is a simple and useful tool for monitoring long-term trends in water quality.

Applicability

This management measure primarily applies to the design of new and expanding marinas.

Best Management Practices

Monitoring can serve many purposes, such as determining the ambient quality of water, determining the extent or causes and sources of a water quality problem, analyzing trends in water quality, and measuring the effectiveness of management practices used in the marina. *Modeling* is appropriate for comparing the effects of different options, such as predicting the water quality that would result from different marina designs before actual construction or the effects of various marina designs on water circulation in a marina basin before a planned expansion. In areas of known good water quality, monitoring might not be needed for small marina developments. The BMPs described here are useful for major developments or expansions so that sufficient water quality measurements are made at a site to ensure that existing conditions are not significantly altered.

When considering monitoring water quality at a marina, consider that results indicating a water quality problem exists at a marina do not necessarily mean that the marina is the source of the problem. Marinas often are located where their water quality reflects other activities in a watershed, lake, or river. Determining of the source of water quality problems often involves a watershed-wide monitoring effort. See page 1-5 for more information about EPA's Watershed Approach.

♦ *Use water quality sampling and/or monitoring to measure water quality conditions.*

Water quality data for the waterbody on which a marina is located might be available. Many states or local agencies collect this information. A state agency of environmental protection, a local or regional water quality authority, a parks and recreation department, USEPA, the U.S. Geological Survey, the U.S. Army Corps of Engineers, or a local university (such as a Sea Grant college) is potential source of water quality data.

It will be useful to contact the state agency responsible for water quality data at the outset of a project to establish water quality objectives and to determine whether water quality data are available for the site. Comparing water quality data from the marina to water quality data collected by a state agency, for instance, would be best accomplished by using the same sampling strategy and analytical methods used by the state agency so that a comparison of the two sets of data will be meaningful (Figure 4-4).

♦ *Use a water quality modeling methodology to predict postconstruction water quality conditions.*

Not all proposals for new or expanding marinas will require the use of modeling techniques to predict water quality characteristics. Numerical modeling can be useful, however, for studying the effects of different design alternatives and for selecting the design that best avoids or minimizes impacts on water quality.

Modeling techniques can be useful for predicting flushing time and pollutant concentrations in the absence of site-specific data. A distinct advantage of numerical models over monitoring studies is the ability to perform sensitivity analyses. For instance, dissolved oxygen concentrations and flushing times can be predicted for a number of design options once data for the marina project have been entered into the model. Modeling can be an expensive undertaking, and the costs should be weighed against any anticipated benefits.

A professional marina designer would be the best person to consult regarding the feasibility and cost

> EPA Region 4 completed an in-depth report on marina water quality. The primary focus of the study was to provide guidance for selecting and applying computer models for analyzing the potential water quality impacts (both dissolved oxygen and pathogen indicators) of a marina. EPA reviewed a number of available methods and classified them into three categories—simple methods, mid-range models, and complex models. See Section 5.

Figure 4-4. Cedar Island Marina (Connecticut) scallop monitoring. After the state of Connecticut declined a permit for expansion on the grounds that it would result in "destroying valuable marina life and habitat," the marina began a program of water quality monitoring to prove the state wrong. The marina monitors temperature, salinity, dissolved oxygen, habitat, coastal birds, finfish, and scallop growth. The photo shows marina personnel checking scallop cages suspended below the docks. The marina has found better dissolved oxygen levels and lower fecal coliform bacteria counts than those reported for the town beach, and heavy metals do not accumulate in scallops grown at the marina (USEPA, 1996: *Clean Marinas—Clear Value*).

of using models. Some models applicable to marinas are reviewed in Section 5.

♦ *Monitor water quality using indicators.*

Water sampling, water quality monitoring, and numerical modeling are not necessary in many cases to gather information about the health of a marina's waters. Simple yet effective forms of monitoring that provide valuable information about the conditions in the water can be done by someone knowledgeable of the marina and the surrounding waterbody. Visual inspections of the abundance and appearance of aquatic plants in and around the marina, use of the marina and surroundings by ducks and geese, the appearance of bottom sediments, the general clarity of the water near docks, and the abundance of fish can provide all the information necessary to judge the health of the water (Figure 4-5). All of these characteristics are indicators of the health of the waters. These types of inspections can be done during the course of daily operations by any member of the marina staff at minimal cost to the marina. (See volunteer monitoring BMP below.) Done every year, these visual inspections lead to a good knowledge of the "normal" conditions in the marina and surrounding waterbody, and any changes will be apparent to the keen observer. When changes are noted, some limited water sampling can be done to determine what might account for them if a local or state environmental management authority hasn't already done this.

♦ *Use rapid bioassessment techniques to monitor water quality.*

Rapid bioassessment techniques can provide a cost-effective means to assess potential sites for marina development and to assess water quality in an existing marina basin. This technique is discussed further under the Habitat Assessment management measure.

♦ *Establish a volunteer monitoring program.*

Marinas can help involve their clientele and local community in water quality issues and environmental protection at the marina by beginning a volunteer monitoring program. Across the country, private citizens are learning about water quality issues and helping protect the Nation's water resources by becoming volunteer monitors. Volunteers analyze water samples for dissolved oxygen, nutrients, pH, temperature, and a host of other water constituents; evaluate the health of stream habitats and aquatic biological communities; inventory streamside conditions and land uses in a watershed that might affect water quality; catalog and collect beach debris; and restore degraded habitats.

EPA's Office of Water encourages citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that might otherwise be unassessed, and increase the amount of water quality information available. Among the uses of volunteer data are delineating and characterizing watersheds, screening for water quality problems, and measuring baseline conditions and trends.

For more information, contact EPA's Office of Wetlands, Oceans, and Watersheds, Monitoring Branch, or the monitoring branch of a regional EPA or state environmental protection office. EPA's volunteer monitoring Web site is located at <www.epa.gov/owow/monitoring/vol.html>.

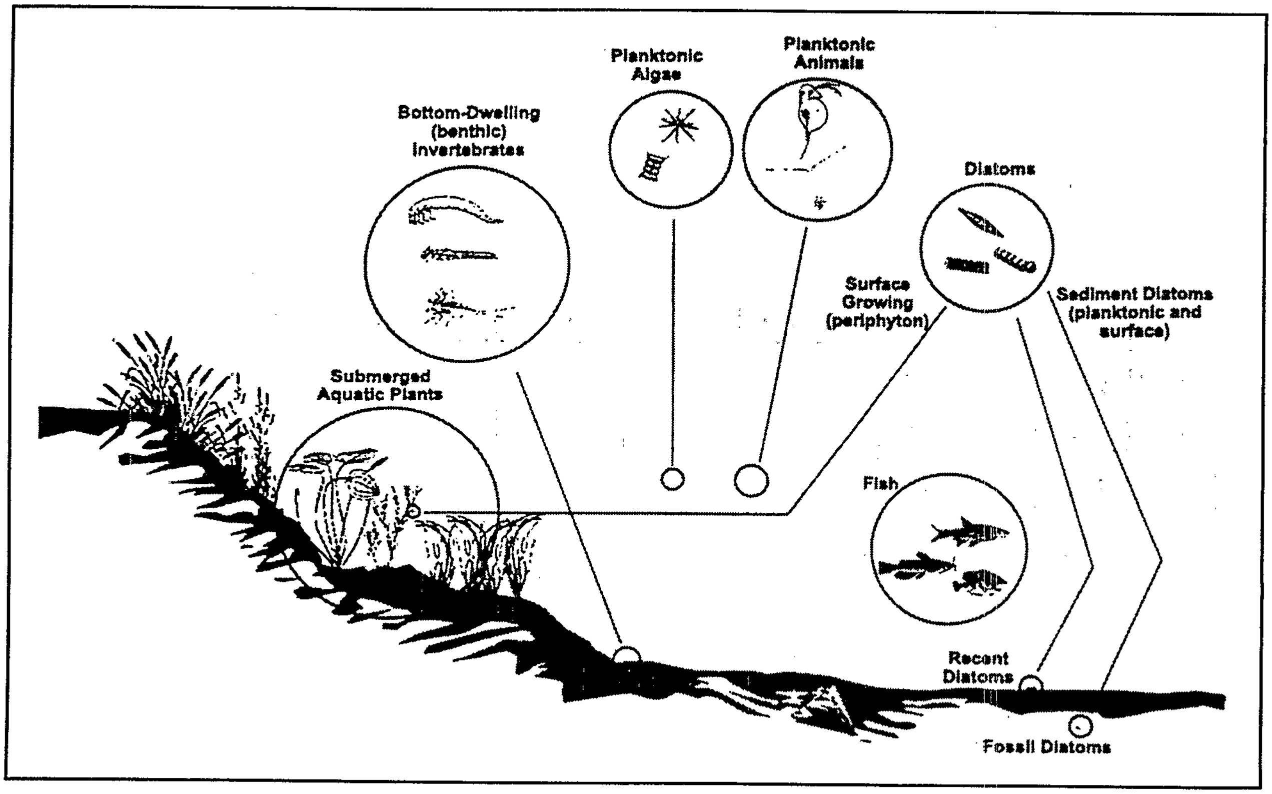

Figure 4-5. Biological assemblages used for lake monitoring.

BMP Summary Table 2 summarizes the BMPs for Water Quality Assessment mentioned in this guidance.

BMP Summary Table 2. WATER QUALITY ASSESSMENT MANAGEMENT

MANAGEMENT MEASURE: Assess water quality as part of marina siting and design.

APPLICABILITY: Primarily applies to the design of new and expanding marinas.

ENVIRONMENTAL CONCERNS: Water quality is assessed during the marina design phase to predict the effect of marina development on the chemical and physical health of the water and aquatic environment. Marina development can cause changes in flushing and circulation; and boat maintenance, boat operation, and the human activities in and around boats can be sources of solid and liquid wastes, pathogenic organisms, and petroleum compounds. The results of water quality predictions or sampling are compared to state or federal water quality standards. Water quality assessments for dissolved oxygen concentration and pathogenic organisms can be used as indicators of the general health of an aquatic environment. Water quality assessments can be useful in determining the suitability of a location for marina development, the best marina design for ensuring good water quality, and the causes and sources of water quality problems.

WATER QUALITY ASSESSMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use water quality sampling and/or monitoring to measure water quality conditions	Proposed marina basin/expansion site; generally recommended	MODERATE; can help determine whether a proposed marina will negatively affect water quality and suggest design alternatives; might be required	MODERATE to HIGH; can help determine if an area can sustain good water quality with a marina	HIGH, depends on type of tests and number or samples	NONE	Monitoring an area larger than just the marina is necessary to determine the source of water quality problems; gather existing data first; check with state and county agencies, U.S. Geological Survey (USGS).
Use a water quality modeling methodology to predict post-construction water quality conditions	Proposed marina basin; recommended for large new projects	MODERATE to HIGH; can cost less than sampling; can assist in choosing the best design; suitable for predicting circulation and wave damage exposure	MODERATE to HIGH; models can predict flushing and pollutant loads for many different marina designs	MODERATE to HIGH	NONE	Some models applicable to marinas are reviewed in Section 5.
Monitor water quality using indicators	Marina grounds and basin; universally recommended	HIGH to MODERATE; quickly provides information about the health of the water and aquatic habitat	HIGH; regular visual inspections help track changes, help identify potential problems before they become large	NONE	LOW to NONE	Appearance, clarity, and smell of water, abundance and appearance of aquatic plants, and appearance of sediments are all good indicators; very cost-effective; simple; requires little training.
Use rapid bioassessment techniques to monitor water quality	Marina basin; recommended where bioassessment protocols have been established	HIGH to MODERATE; provides information about the biological quality of marina waters.	MODERATE; can indicate water quality problems that might not be tested for in a water quality sampling program.	LOW; might have to train someone in aquatic invertebrate identification.	LOW	Cost-effective; not available for many waters

BMP Summary Table 2. (cont.) MANAGEMENT MEASURE FOR WATER QUALITY ASSESSMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Establish a volunteer monitoring program	Marina grounds and basin; universally recommended	HIGH to MODERATE; provides information about all aspects of the marina; actively involves marina patrons	MODERATE to HIGH; volunteers focus on different environmental issues and develop keen environmental awareness and concern	LOW; some basic equipment and training for volunteers will be necessary	LOW	Can help build public involvement; consult with state for guidelines; check EPA's web site, <www.epa.gov/owow/monitoring/vol.html>

4.3. Habitat Assessment

> Management Measure for Habitat Assessment:
>
> ***Site and design marinas to protect against adverse effects on shellfish resources, wetlands, submerged aquatic vegetation, or other important riparian and aquatic habitat areas as designed by local, state, or federal governments.***

Management Measure Description

The construction of a marina in any waterbody can disrupt aquatic habitats. This management measure is important because of the value of protecting natural habitats so they continue to provide food and recreational opportunities for people, as well as food and shelter for plants and animals, and so their roles in the ecological health of waterbodies are protected. Past waterfront development has adversely affected many waterbodies, but our knowledge of ecology has increased. We now realize the importance of healthy aquatic habitats to both our health and the overall health of our waterbodies. Efforts to decrease the introduction of invasive and exotic species have increased, and minimizing pollution in waterbodies is widely accepted as a sound ecological and economic practice. In many cases, federal and state laws require analyses of the potential impacts on the natural environment before projects begin. This management measure focuses on marina siting and design and extends to assessments of how marinas can incorporate natural habitats into their siting and design.

When well designed and cared for, marinas can be a valuable habitat for plants and animals that are adapted to quiet, sheltered waters. Regardless of the type of waterbody on which a marina is to be constructed, siting it where its development or operation will diminish the biological or economic value of the surrounding habitats should be very carefully considered, especially if the potential site is near locations that have been given special designations by local, state, or federal governments. Such habitats might be fish spawning areas, shellfish harvesting areas, designated wetlands, beds of submerged aquatic vegetation (SAV), or areas where threatened or endangered species are known to occur. If a marina is properly designed and located, aquatic plants and animals should be able to continue to use the marina waters for the same activities (e.g., reproduction or feeding) that occurred in the waters before the marina's presence.

Marinas that have been operating for a while can provide sheltered, quiet waters for plants and animals that prefer this type of environment or for animals that need this type of environment during specific life stages, such as spawning. Where the surrounding environment has been developed and offers little in the way of natural habitat, such as in an urbanized waterfront district, a marina might provide a refuge for many species. A pollution prevention and control program, based on the management measures presented in this guidance, can help maintain or improve water and habitat quality for aquatic species.

The locations of all important aquatic and riparian habitats in a locality or waterbody might not be known. A visual survey by a biologist may be appropriate before any marina construction or expansion begins, and a specialist in aquatic habitat restoration can be contacted if marina management is considering modifying the marina to create good aquatic habitat in the marina basin. Geographic information systems (GIS) are being used increasingly to map biological resources in many states and show promise as a method of conveying important habitat and other siting information to marina developers and environmental protection agencies. The state department of environmental protection or natural resources can be contacted for this type of information.

Applicability

This management measure is applicable to new and expanding marinas where site changes might affect wetlands, shellfish beds, aquatic vegetation, or other important aquatic resources or habitats.

Best Management Practices

- *Conduct habitat surveys and characterize the marina site, including identifying any exotic or invasive species.*

The first step in constructing a marina that will be compatible with the surrounding natural environment or expanding or modifying an existing marina to create a more natural environment is to characterize the environment of the proposed site or operational marina. Before marina development or expansion, critical or unique habitats, such as beds of submerged vegetation and shellfish beds, should be identified. The importance of the area that will be affected by development to aquatic organisms for spawning, feeding, or their overall survival should be assessed within the context of the entire waterbody (Figure 4-6). Equally as important, exotic plants and animals that could be problematic for marina operation should be identified. Table 4-1 lists some common exotic and invasive aquatic species in the United States. Once the site has been characterized, marina development or expansion can proceed in a way that minimizes adverse effects on aquatic life and habitats.

- *Assess habitat function (e.g., spawning area, nursery area, feeding area) to minimize indirect effects.*

An area proposed for marina development or expansion could be used seasonally by fish or other animals. Animals use special areas of many coves, shorelines, beds of submerged vegetation, rivers, streams, and estuaries for short periods of time—from a few nights to weeks—for particular life functions such as migration, spawning, and rearing young. Marinas can accommodate these special, short-term

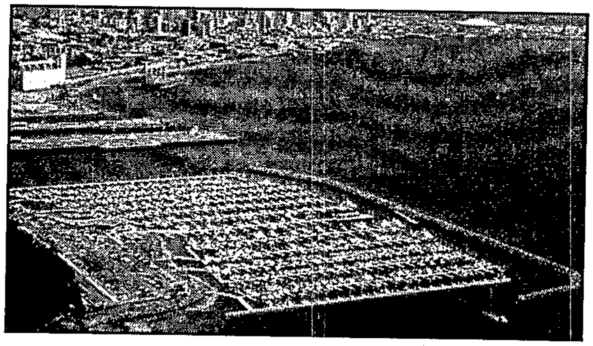

Figure 4-6. Habitat assessment was used at Elliot Bay Marina (Washington) to design the marina to work with natural habitat function. Wide openings between rock groin-type breakwaters, docks, and beach give easy access to migrating juvenile salmon leaving Puget Sound, while providing good water circulation and tidal changes inside the marina basin. A man-made 1,500-foot-long sandy beach has replaced lost habitat, providing a feeding ground for young salmon. Schools of young salmon and herring move throughout the marina basin (USEPA, 1996: *Clean Marinas—Clear Value*).

uses if marina designers and managers are aware of the need for the areas and the marina is built with the needs in mind.

- *Use rapid bioassessment techniques to assess effects on biological resources.*

Rapid bioassessment techniques, where they have been developed, provide cost-effective biological assessments of potential marina development sites. Rapid bioassessment uses biological criteria (usually invertebrate and fish populations) as indicators of the condition of a habitat. To apply rapid bioassessment to a marina development site or an operating marina, select biological communities at the proposed site or the operational marina are compared to the same biological communities at an undisturbed site in the same waterbody or a similar one. The biological health of the proposed site or marina basin is rated based on how favorably the invertebrate or fish communities there compare with those of the undisturbed site. Scores from rapid bioassessments are useful for determining whether a site is stressed by pollution or other factors, such as habitat alteration. Rapid bioassessment protocols for macroinvertebrates and fish in freshwater streams and rivers are being developed by many states, and a document on them is available from EPA at the web address

Table 4-1. Common Invasive and Exotic Species of the United States

Species	Distribution	Problems caused	Control Methods	Additional Information
Crustaceans				
Spiny water flea *Bythotrephes cederstroemi*	Throughout the Great Lakes and in some inland lakes	May compete directly with young perch and other small fish for food, such as *Daphnia* zooplankton; may wind up unseen in bilgewater, bait buckets, and livewells; fishing lines and downriggers are often coated with both eggs and adults	The spread of all exotic and invasive species can be controlled by: 1. Removing aquatic plants and animals from boats and trailers, including the anchor, trailer rollers and axle, propeller, and boat hull. 2. Draining all lake, bay, ocean, or river water from the boat before transporting it to another waterbody. 3. Disposing of any unwanted live bait on land. 4. Rinsing the boat and all equipment with high-pressure, hot water, especially if moored for more than a day. **OR** Drying everything for at least 5 days before putting the boat into another waterbody.	http://www.sg.ohio-state.edu/publications/nuisances/bythotrephes/fs-049.html http://www.sg.ohio-state.edu/publications/nuisances/bythotrephes/fs-049.html
Mollusks				
Zebra mussel (*Dreissena polymorpha*)	All of the Great Lakes and waterways in many states, as well as Ontario and Quebec; Map: http://nas.er.usgs.gov/images/currzm00.gif	Fouls underwater structures and intake pipes; can spread from one waterbody to another on trailered or transported boats; microscopic larvae may be carried in livewells or bilgewater; adults can attach to boats or boating equipment that is in the water		http://www..seagrant.unm.edu/exotics/fieldguide.html
Asian clam (*Corbicula fluminea*)	Found in 38 states. Map included on: http://nas.er.usgs.gov/mollusks/docs/co_flumi.html	Cause biofouling; cause problems in irrigation canals and pipes and drinking water supplies; alter benthic substrate and compete with native species for limited resources; currently introduced through bait buckets, passive movement via water currents, intentional introduction as a food item in markets		http://nas.er.usgs.gov/mollusks/docs/co_flumi.html http:/lionfish.ims.usm.edu/%7Ēmusweb/nis/Corbicula fluminea.html
Plants				
Eurasian Watermilfoil (*Myriophyllum spicatum*)	Map included on: http://nas.er.usgs.gov/plants/docs/my_spica.html	Form thick underwater mats of stems and vegetation, crowding out native water plants; may be spread by becoming entangled in boat propellers (a single segment of stem and leaves can take root and form a new colony)		http://nas.er.usgs.gov/plants/docs/hy_spica.html
Hydrilla (*Hydrilla verticullata*)	Map included on: http://nas.er.usgs.gov/plants/docs/hy_verti.html	Grows aggressively and forms thick mats in surface waters, blocking sunlight to native plants; alters physical and chemical characteristics of lakes; reduces foraging efficiency; affects water flow and water use; mainly introduced to new waters as castaway fragments on recreational boat motors and trailers and in livewells		http://nas.er.usgs.gov/plants/docs/hy_verti.html
Purple loosestrife (*Lythrum salicaria*)	All contiguous U.S. states except Florida; Map included on: http://www.dnr.cornell.edu/bcontrol/purple.htm	Rapidly degrade wetlands by crowding out native species; spread rapidly across North America because of absence of its natural predators (beetles native to Europe); seeds may be dispersed by water, wind, and in mud attached to animals, or root or stem segments can form new flowering stems		http://www.inhs.uiuc.edu/edu/VMG/ploosestrife.html
Water hyacinth (*Eichhornia crassipes*)	Map: http://nas.er.usgs.gov/plants/maps/ei_crass.gif	Dense mats reduce spawning areas for fishes and shade out benthic communities; can nearly block the diffusion of oxygen through the water-atmosphere interface and kill fish		

<http://www.epa.gov/owowwtr1/monitoring/rbp/index.html>.

♦ *Redevelop waterfront sites that have been previously disturbed and expand existing marinas.*

Waterfront areas that have been previously used for industrial or military purposes might make good locations for new marinas because they have been developed before, usually have all the necessary infrastructure, and minimize disturbances to aquatic habitats. Many sites suitable for recreational boating facilities may be located in existing urban harbors where shorelines have been modified by bulkheading and filling. The adverse environmental consequences of redevelopment are usually minimal, and redevelopment can improve water quality, expand upland habitats, beautify and expand shorelines, and provide additional public access.

Waterfronts that are converted from water-dependent uses, such as marinas and recreational boating, to non-water-dependent uses, such as residences, office space, and shopping areas, reduce the availability of sites for marina development. To protect against such conversion in areas that contain important habitat, a state may purchase the property or the development rights from existing water-dependent uses. To preserve an existing marina, for example, a state government could pay the difference between the market value for other non-water-dependent development, such as for condominiums, and the water-dependent value of the marina to the marina owner, and receive in return a guarantee that the site would not be converted to a non-water-dependent use. States can use this method to retain sites suitable for marinas, maintain access for boating uses of the waterways, prevent conversion to other uses, and reduce the base value for property taxes.

The Hammond Marina (Indiana) was built on a derelict brownfield industrial site with a steel mill slag shoreline. The area is now a pleasant and protected boating facility with an attractive public access area, and it is popular as a sportfishing site. The local economy has benefitted from the redevelopment, and shorelines, upland habitats, and aquatic habitat at the site have been tremendously improved (USEPA, 1996: *Clean Marinas —Clear Value*).

♦ *Consider alternative sites where adverse environmental effects will be minimized or positive effects will be maximized.*

An analysis of alternative sites (sites other than the one proposed) can be used to demonstrate which site is the most economically and environmentally suitable. Analysis of alternative sites and designs has been effectively used to reduce the effects of development (including effects on tidelands, stream courses, shorelines, wetlands, and submerged aquatic vegetation) at many proposed marinas, and to find sites with flushing characteristics better than those at the sites initially proposed.

Many marinas built on freshwater lakes and rivers over the past two decades are located on what are known as brownfields, or shoreland that had been modified and seriously abused by previous industrial facilities. Usually, these areas support little to no natural vegetation or habitats when they are first converted to marinas. The marinas have turned these areas into recreational sites and public access points and have provided sheltered areas with protected shorelines, where natural vegetation has been able to reestablish itself.

♦ *Create new habitats or expand habitats in the marina basin.*

Almost any surface placed in coastal or inland waters, and especially rough surfaces—including rocks, piles, piers, and floats—quickly becomes home to a host of plants, animals, and bacteria. The submerged parts of breakwaters, piers, and floating docks are excellent examples of this kind of "created" habitat. The plants that colonize these surfaces provide refuge for a variety of invertebrates and are a good source of food for juvenile fish, which in turn can attract sport fish (Figure 4-7).

♦ *Minimize disturbance of riparian areas.*

Riparian areas are the narrow areas along the banks of rivers, streams, lakes, ponds, reservoirs,

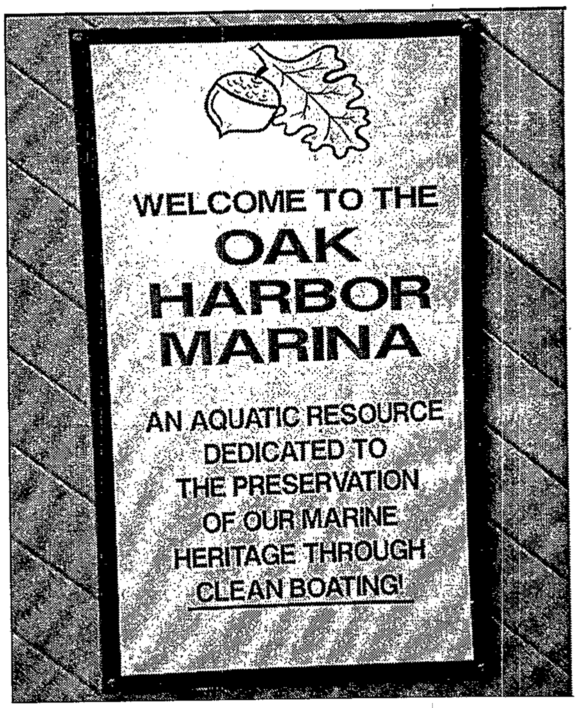

Figure 4-7. Oak Harbor Marina sign. Oak Harbor Marina (Washington) has used its marina waters to raise salmon for release. Volunteers built salmon pens, and more than 420,000 salmon have been released as a result of the program. Deep River Marina (Connecticut) was the site for a 3-year federal/state stocking program for Atlantic salmon. The Puerto Rico Department of Natural Resources' Fisheries Office is located in Puerto del Rey Marina (Puerto Rico) and uses part of the facility's clean waters for an injured sea turtle rescue and recovery program (USEPA, 1996; *Clean Marinas–Clear Value).*

and wetlands. They may be vegetated, or may be beaches or rocky areas. Vegetated riparian areas extract nutrients from runoff from the land as it moves toward the waterbody and from the water that constantly circulates along the banks of the waterbody. The nutrients make them very productive habitats, with biodiversity and biomass typically higher than those of adjacent uplands. Many processes important to the health of waterbodies occur in vegetated riparian areas, including the following:

- Large quantities of nutrients are absorbed as waters pass through riparian areas.
- Eroded soils and other pollutants are filtered out of the water and absorbed by riparian vegetation.
- Nutrients are modified from forms that can't be used by aquatic organisms to forms they can readily use.
- The vegetation in riparian areas serves as a refuge for species for nesting, hiding from predators, and foraging.

Beaches and rocky shorelines also provide habitat variety and are important to many aquatic organisms. Because of the importance of all types of riparian areas to the general health of waterbodies, minimizing disturbances to them during marina development can be beneficial. Creating favorable conditions for the presence of riparian or wetland areas within a marina basin might be an effective, low-cost way to improve water quality in the basin or increase habitat diversity in the basin, depending on site conditions and space limitations.

♦ *Use dry stack storage.*

An alternative to building new docks for expanding boating access and marina capacity is to build dry stack storage facilities, in which many boats are stored on vertical stands on very little land. Boats stored in dry stack storage do not leak antifoulants to the water and can be more easily maintained on land in protected hull maintenance areas, providing less opportunity for spillage directly to surface waters. Dry stack storage has minimal environmental effects, and where zoning restrictions permit it, it is an appropriate means to increase public access to waterways.

BMP Summary Table 3 summarizes the BMPs for Habitat Assessment mentioned in this guidance.

BMP Summary Table 3. HABITAT ASSESSMENT MANAGEMENT

MANAGEMENT MEASURE: Site and design marinas to protect against adverse effects on shellfish resources, wetlands, submerged aquatic vegetation, or other important riparian and aquatic habitat areas as designated by local, state, or federal governments.

APPLICABILITY: New and expanding marinas where site changes might affect wetlands, shellfish beds, aquatic vegetation, or other aquatic resources or habitats.

ENVIRONMENTAL CONCERNS: The construction of a new marina in any waterbody type has the potential to disrupt aquatic habitats; these habitats include fish spawning areas, shellfish harvesting areas, designated wetlands, beds of submerged aquatic vegetation (SAV), or the habitats of threatened or endangered species. Design and locate marinas to help support aquatic plants and animals occurring in the waters before the marina's construction; operate marinas as a valuable habitat for plants and animals that do well in quiet, sheltered waters.

HABITAT ASSESSMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Conduct habitat surveys and characterize the marina site, including identifying any exotic or invasive species	Marina basin and shores; recommended for new marinas or major expansions	MODERATE to LOW; might be required by federal or state laws	MODERATE to HIGH; minimizes adverse effects on aquatic life and habitats during construction and expansion	MODERATE to HIGH	NONE	State and/or federal agencies might have site-specific information; they might be willing to assist with site characterization; see EPA's web site, http://www.epa.gov/owow/monitoring/bioassess.html, for further information
Assess habitat function (e.g., spawning area, nursery area, feeding area) to minimize indirect effects	Marina basin and shores; recommended for new marinas or major expansions	MODERATE to LOW; might be required by federal or state laws	MODERATE; ensures that aquatic organisms can continue to use marina waters for special or seasonal habitat uses	HIGH to EXPENSIVE	NONE	
Use rapid bioassessment techniques to assess effects on biological resources	Marina basin and shores; recommended where bioassessment protocols have been established	HIGH to MODERATE; provides information about the biological health of waters	MODERATE; helps to determine whether a site is stressed by pollution or other factors, such as habitat alteration	LOW; requires training in aquatic invertebrate identification	LOW	
Redevelop waterfront sites that have been previously disturbed and expand existing marinas	Marina basin and shores; universally recommended for new marinas in urban areas	HIGH; previously developed sites usually have all necessary infrastructure for marina usage; redevelopment may expedite the permitting process and have lower land purchase/lease costs	HIGH; reduces pressure to use undeveloped shore; aids in cleanup of previous pollution; might improve water quality and shore and upland habitats	HIGH to EXPENSIVE	MODERATE to HIGH	Local zoning and planning changes might be required
Consider alternative sites where adverse environmental effects will be minimized or positive effects will be maximized	Marina basin and shores; generally recommended for new marinas	MODERATE to HIGH; analysis can help find more appropriate and economically suitable locations; potential long-term savings on environmental protection	HIGH; alternative sites are usually those with less sensitive environments, aquatic or shoreline flora and fauna, or better flushing characteristics	MODERATE to HIGH	MODERATE to HIGH	All reasonable potential sites should be considered before marina development

BMP Summary Table 3. (cont.) HABITAT ASSESSMENT MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Create new habitat or expand habitat in the marina basin	Marina basin; generally recommended	MODERATE to HIGH; "created" habitat can attract sportfish and improve fishing from shoreline or dock; improves marina appearance	HIGH; new habitats increase habitat diversity for more animals and plants and may cleanse runoff	MODERATE to EXPENSIVE	MODERATE to LOW	Riprap, new beaches in basin corners, and vegetated shorelines are examples of this kind of "created" habitat
Minimize disturbance of riparian areas	Marina basin and shores; universally recommended for new marinas or major expansions	MODERATE; retaining riparian or wetland areas within a marina basin can be an effective, low-cost means to improve water quality and reduce construction costs	HIGH; riparian areas cleanse runoff and basin water; improves and diversifies habitat for plants and animals	MODERATE to HIGH	MODERATE to HIGH	Riparian areas are the narrow vegetated areas along the banks of rivers, streams, lakes, ponds, and reservoirs. They are very productive and are important habitats for many land and aquatic animals. They are critical landscape elements.
Use dry stack storage	Marina land and docks; recommended wherever space and local ordinances allow	HIGH; can reduce all types of marina-related pollution in the marina basin	HIGH; reduces habitat disturbance in the marina basin	HIGH	MODERATE	Dry rack storage is applicable to shallow draft and low-height powerboats of less than approximately 40 feet LOA; use may require zoning changes; may conflict with scenic vista issues; increases upland impervious surface area

4.4. Shoreline and Streambank Stabilization

Management Measure for Shoreline and Streambank Stabilization:

Where shoreline or streambank erosion is a nonpoint source pollution problem, shorelines and streambanks should be stabilized. Vegetative methods are strongly preferred unless structural methods are more cost-effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines, streambanks, and offshore areas.

Protect shorelines and streambanks from erosion due to uses of either the shorelands ar adjacent surface waters.

Management Measure Description

Streambank erosion is used in this guidance to refer to erosion along nontidal streams and rivers.

Shoreline erosion is used here to refer to erosion in tidal portions of coastal bays and estuaries.

Erosion is a natural process that results from water acting on streambanks and shorelines. Erosion along a river or stream removes material from one area and deposits it elsewhere, and beaches are constantly and naturally eroded and resupplied with sediment from other areas. Streambank and shoreline stabilization may be needed where natural erosion is occurring to protect shoreline structures.

Induced erosion often occurs where soil, streambanks, or shorelines have been disturbed. Removing vegetation from any streambank or shoreline exposes soil to the erosive energy of waves and currents. Altering a watercourse (for instance, by installing a breakwater or a dam) or artificially affecting the course of water (perhaps by channelizing a river) can cause erosion because the manner in which energy is transmitted through a waterbody can be affected. In the latter case, erosion sometimes occurs far from the location of the channelization. Properly designed erosion control measures and structures can reduce natural as well as induced erosion.

In a marina, structural elements are often necessary to protect boats and the marina perimeter from waves or water current energy. Hence, the marina basin is often a fairly calm, nonerosive environment. Erosion can still occur along the perimeter, however, and wave energy reflected off a structure, such as an improperly designed breakwater, or from boat wakes may be a contributing factor. Bank erosion may result where it is desirable to hold a given slope. Scour along the bottom of a structure such as a breakwater or at the abrupt junction of two unlike materials, such as river bottom sediments and a cement boat ramp, can also be a problem. Bank erosion and scour can result in sediment filling in a marina basin (and the need for maintenance dredging) or erosion at the edges of a boat ramp. Minimizing shoreline erosion can protect marina shorelines and can reduce the need for or frequency of maintenance dredging. Less frequent dredging also reduces the need for proper and potentially costly disposal of dredged material.

A vegetated shoreline can minimize the transmission of wave energy to other locations. Vegetation is also a relatively low-cost means to stabilize a shoreline, and it can add a natural, attractive element to an otherwise engineered environment. Used by itself, vegetation is most effective where waves or currents are low in energy and the soil is stable enough for plant growth. Another site factor conducive to vegetative stabilization is shallow sloped banks. Where wave or current energy is too strong for vegetation to gain a foothold, temporary structures can be used to protect vegetation until it can establish itself, or permanent structures might be necessary.

Permanent streambank or shoreline protection structures could be needed where wave or current energy is too great for establishing and maintaining vegetation. Some structural methods to stabilize shorelines and navigation channels are gabions, riprap, sloping revetments, bulkheads, jetties, and breakwaters. The first three dissipate incoming wave energy more effectively than the rest and usually result in less scouring than the last three. Bulkheads are appropriate in some circumstances where other preferred alternatives are not feasible. Vegetation can often be added at the edges of these structural elements to control erosion from storm water runoff and to serve as a landscaping element.

The type of perimeter stabilization might be dictated in both inland and coastal marinas by local variations in water level due to dam drawdown in a reservoir, natural fluctuation in a lake, or tides along the coast. In some of these instances, shoreline stabilization might not be practical. Because rivers are hydrographically complex and many factors need to be taken into account when determining how to correct erosive problems, shoreline stabilization might not be sufficient to eliminate an erosion problem. Streambank and river restoration projects, of which erosion is usually only a small part, can encompass anywhere from a small section of a river or stream to the entire watershed.

Herrington Harbour Marina South (Maryland) retained and enhanced much of the natural shoreline during a recent rebuilding, modernization, and expansion program. An old, failing bulkhead was removed, and rock riprap and filter cloth were placed on the regraded shoreline. Native shore species were planted along the shore, and nearby wetlands were cleaned and restored to native marsh grasses. Over a few years, the shoreline vegetation filled in and created a very attractive and effective buffer that helps control erosion and storm water runoff. Wildlife diversity also increased in the surrounding shoreline area, including several blue herons that have taken up year-round residence.

Some specialized locations along the banks of rivers, reservoirs, and lakes, however, may be ideal candidates for shoreline stabilization. Such locations may be severely eroded soils around a storm sewer discharge point, disturbed soils where a boat ramp has been installed or is in need of maintenance, or overused shoreline areas in or next to established recreational areas.

Examples of vegetative and structural methods are presented below. Before selecting any of them for a particular erosion problem, it is important to identify the cause of the erosion, which, especially in rivers and coastal environments, could be extremely complex. Selecting the appropriate technique to remedy an erosion problem might require analysis by a professional.

Applicability

This management measure is applicable to new and expanding marinas where site changes might result in shoreline erosion.

Best Management Practices

♦ *Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows.*

Vegetative plantings, wetland enhancements, beaches, and preservation of natural shorelines, where feasible, can be the most effective means of shoreline stabilization. Plantings can be in the form of a grassed buffer strip that serves the triple purpose of shoreline stabilization, establishing a visually aesthetic area, and controlling polluted runoff. If natural wetlands are found or were present within the boundaries of a marina before its development, their preservation or re-creation can protect shorelines, dissipate low wave energy, provide wildlife habitat, and filter pollutants out of the water and storm water runoff. A sloping beach is the best surface for attenuating wave action, though such beaches can occupy more space than other perimeter stabilization methods.

Establishing a "no wake zone" in nearshore, shallow aquatic areas can also be effective to reduce impacts from boat wave energy.

♦ *Where shorelines need structural stabilization and where space and use allow, riprap revetment is preferable to a solid vertical bulkhead.*

In some cases, primarily because of space limitations or elevation differences between the land and water surface, steep slopes are necessary within marinas. Riprap is a common and economical revetment that can withstand substantial wave energy. Its irregular surface also reduces wave energy transmission better than a solid vertical bulkhead does. Natural rock is the best material. Concrete rubble can be used, but its many flat surfaces transmit more wave energy than do irregular natural rocks. Gabions (rock in heavy-duty wire mesh baskets) can be used where a slope steeper than that which can be obtained with riprap is needed. Gabions function best where waves do not exceed 12 inches. The irregular surface of riprap revetment can provide habitat for shore and nearshore plants and animals.

♦ *Where reflected waves will not endanger shorelines or habitats and where space is limited, protect shorelines with structural features such as vertical bulkheads.*

Vertical bulkheads reflect waves and are not a good choice for shoreline stabilization where waves or surges occur in the marina basin and are not mitigated in the stabilization design. They are usually more costly to install than other forms of shoreline protection but might be necessary where boats are hauled and launched, where the marina cannot be moved farther into the water, and where valuable real estate needs protection. They can be constructed of concrete, treated timbers, steel, aluminum, or vinyl. Vertical bulkheads can be combined with riprap by placing the former at the upper portion of a bank and riprap along the lower edge. Scour protection at the toe of the bulkhead should be incorporated into the structural design.

♦ *At boat ramps, retain natural shoreline features to the extent feasible and protect disturbed areas from erosion.*

Near boat ramps, shorelines can be damaged during ramp construction. Shorelines are also susceptible to erosion from runoff that is channeled alongside the ramp (especially if the site has been sloped for the ramp), boat wakes, waves, and currents after initial installation. During boat ramp construction, therefore, retention of natural shoreline features to the extent possible generally saves maintenance or corrective costs later. Natural-appearing shorelines are also aesthetically appealing, and they can minimize the likelihood of invasion by unwanted or exotic plant species later.

BMP Summary Table 4 summarizes the BMPs for Shoreline Stabilization mentioned in this guidance.

BMP Summary Table 4. SHORELINE AND STREAMBANK STABILIZATION MANAGEMENT

MANAGEMENT MEASURE: Where shoreline or streambank erosion is a nonpoint source pollution problem, shorelines and streambanks should be stabilized. Vegetative methods are strongly preferred unless structural methods are more cost-effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines, streambanks, and offshore areas.

APPLICABILITY: New and expanding marinas where site changes may result in shoreline erosion.

ENVIRONMENTAL CONCERNS: Erosion in any waterbody is a natural process that results when moving water and waves undermine, collapse, and wash out banks and shorelines. Banks erode along nontidal lakes, rivers, and streams; shorelines erode along intertidal portions of coastal bays and estuaries. Eroding streambanks and shorelines do not protect the land and structures during storm events. Such erosion contributes to nonpoint source pollution problems, turbidity, and shoaling increases the need for maintenance dredging in marina basins and channels. Vegetation and structural methods have been shown to be effective for mitigating shoreline erosion and for filtering pollutants from overland and storm water runoff.

SHORELINE AND STREAMBANK STABILIZATION PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows	Marina shores and banks; generally recommended	MODERATE to HIGH; reduce frequency of maintenance dredging; provide recreational areas for customers; attractive; eliminate wave refraction	HIGH; effective shoreline stabilization that also filters pollutants from runoff and provides wildlife habitat	LOW to MODERATE	LOW to MODERATE	Includes vegetative plantings, wetland enhancements, beaches, and preservation of natural shorelines; suitable for low-energy waves and currents, low sloping shores. No-wake zones are also effective
Where shorelines need structural stabilization and where space and use allow, riprap revetment is preferable to a solid vertical bulkhead	Marina shores and banks; generally recommended	HIGH; revetments withstand substantial wave energy and reduce wave energy transmission; lowered erosion rate reduces need for maintenance dredging	HIGH; the irregular surface provides excellent habitat for aquatic plants and animals through reduced sedimentation and dissipated wave action	EXPENSIVE	LOW to MODERATE vertical bulkheads require ongoing maintenance; gabion baskets are subject to failure	Natural rock set over filtercloth is commonly used; concrete rubble transmits more wave energy; gabions permit steeper slopes
Where reflected waves will not endanger shorelines or habitats and where space is limited, protect shorelines with structural features such as vertical bulkheads	Marina shoreline, particularly in areas of deep water and boat lift/haulout wells; generally recommended	HIGH to MODERATE; easy to install; occupy little horizontal space	LOW; vertical surfaces reflect waves; can increase bottom scour along wall base; limit aquatic habitat	EXPENSIVE	NONE to LOW	Allows marinas to locate closer to shore; can help reduce dredging frequency
At boat ramps, retain natural shoreline features to the extent possible and protect disturbed areas from erosion	Boat ramp shores and banks; generally recommended	MODERATE to HIGH; can save on maintenance or corrective costs; retain the natural appearance of the shoreline	MODERATE to HIGH; reduce damage from boat wakes and waves, and currents; stabilize shoreline; retain habitat for plants and animals	MODERATE to HIGH	LOW to MODERATE	Refer to the boat launch ramp design booklet published by the States Organization for Boating Access (SOBA); blend shoreline features with functionality of the ramp and access ways

4.5. Storm Water Runoff Management

Management Measure for Storm Water Runoff:

Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas.

Reduce the average annual loadings of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For the purposes of this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

Management Measure Description

Any debris that is on the ground and light enough to be swept away by flowing rainwater or snow-melt can end up in lakes, reservoirs, ponds, rivers, streams, canals, bays, estuaries, or oceans. Sanding dust, paint dust and chips, copper and other heavy metals, and other such solids that are carelessly or inadvertently allowed to drop to the ground while maintaining or repairing a boat by sanding, pressure washing, or other abrasive methods can be swept up by the runoff of the next rainstorm. Oils, grease, solvents, paint drippings, and fuel spilled or dripped onto the ground can also be carried away in the runoff. Unless the runoff is controlled or treated in some manner, all of these pollutants end up in the marina basin, where they create unsightly surface films or float until they adhere to surfaces like boat hulls or docks. Some of these pollutants flow dissolved in runoff or attached to soil carried by the runoff. When they reach the marina basin, they sink with the soil to the bottom, are eaten by bottom-feeding fish or by filter-feeding shellfish, or settle onto the leaves of aquatic vegetation and clog their pores. Storm water that is treated in some way to remove these pollutants before they can reach the marina basin does not result in these problems.

The National Pollutant Discharge Elimination System (NPDES) was established to control pollutant discharges to the nation's waters, including those from storm water runoff. The 1987 amendments to the Clean Water Act mandated EPA to develop a tiered implementation strategy for the NPDES Storm Water Program. In response to the 1987 Amendments, EPA developed Phase I of the NPDES Storm Water Program in 1990. Phase I requires NPDES permits for storm water discharges from

- "Medium" and "large" municipal separate storm sewer systems (MS4s) that serve or are located in incorporated places or counties with populations of 100,000 or more people.
- Eleven categories of industrial activity, one of which is construction activity that disturbs 5 acres or more of land.

The 11 categories of industrial activities for which storm water discharge permits are required are defined at 40 CFR 122.26(b)(14). A permit is required for Standard Industrial Classification (SIC) codes 4493 (marinas) and 3732 (boatyards and boat builders that repair, clean, and/or fuel boats). Note that the North American Industry Classification System (NAICS) is replacing the U.S. SIC system and is scheduled to be completed by 2002. NAICS was developed jointly by the United States, Canada, and Mexico to provide new comparability in statistics about business activity across North America. NAICS numbers corresponding to the previous SIC numbers are provided in Table 4-2.

Table 4-2. Conversion of SIC to NAICS.

SIC		NAICS	
3732	Boat Building and Repairing		
	Boat Repair	81149	Other Personal and Household Goods Repair and Maintenance (part)
	Boat Building	336612	Boat Building
4493	Marinas	71394	Marinas

The second phase, known as Storm Water Phase II, was signed by EPA in October 1999 and published in the *Federal Register* on December 8, 1999. The Phase II Rule will bring many municipal separate storm sewer systems serving fewer than 100,000 people, census districts in counties with population densities greater than 1,000 per square mile, and small construction sites of between 1 and 5 acres into the NPDES permitting program by March 2003. Construction sites where more than 1 acre is disturbed will need to obtain a permit and implement BMPs to minimize erosion and pollutant runoff. The rule exempts from regulation facilities that have industrial materials or activities that are not exposed to rain or snow. The Storm Water Rule and further information on Phases I and II of the Storm Water Program can be obtained from EPA's web site for the point source permitting program: http://cfpub1.epa.gov/npdes.

Removal of TSS at the 80 percent level is practicable, and the management practices mentioned here, or combinations of them, can achieve this degree of pollutant removal if they are designed properly and the site is suitable for their installation and use. The 80 percent level also provides a high degree of protection for surface waters. Used properly, pollutant removal management practices can also reduce final TSS concentrations in runoff very effectively. Table 4-3 reviews the pollutant removal efficiencies of many storm water control practices. Tables in Appendix F compare the advantages and disadvantages of many storm water control practices and their costs.

The 80 percent removal of TSS is recommended for hull and engine maintenance areas, the runoff from which often contains higher levels of toxic pollutants than runoff from other parts of a marina property. Pollutants in runoff from the remaining marina property should be considered when designing an effective runoff pollution prevention system. If sufficient land area is not available on-site to install runoff systems, management practices that increase vegetative cover, reduce impervious surfaces, and include infiltration devices are practical solutions.

The principal pollutants in runoff from marina parking areas and hull maintenance areas are suspended solids (paint chips, sanding dust, and the like.) and organics (predominately oil and grease). Toxic metals (in antifoulant paints) from boat hull scraping and sanding tend to attach themselves to suspended soil particles and are carried to the marina basin with the particles.

Designing and operating a hull maintenance work area with a focus on pollution prevention is an excellent way to prevent dangerous pollutants from reaching the marina basin. Particularly effective practices are designating a specified area that has an impervious surface (cement, for example) for hull maintenance work; doing all hull maintenance work under a roof to prevent the area from getting wet; and channeling and draining runoff from other areas of the marina property away from hull maintenance areas so it won't pick up the pollutants associated with hull maintenance. Devices with controls that collect pollutants as they are produced, such as vacuum-based (or dustless) sanders, are also effective for preventing pollutants from entering runoff.

Pollutants can also be trapped, collected, or filtered after they are on the ground but before it rains. This can be accomplished by using street

Table 4-3. Effectiveness of management practices for runoff control (adapted from Caraco and Winer, 2000).

Runoff Treatment or Control Practice Category or Type	**Median Pollutant Removal (Percent)**							
	No. of Studies	**TSS**	**TP**	**OP**	**TN**	**NOx**	**Cu**	**Zn**
Quality Control Pond	3	3	19	N/A	5	9	10	5
Dry Extended Detention Pond	6	61	20	N/A	31	-2	29	29
Dry Ponds	9	47	19	N/A	25	3.5	26	26
Wet Extended Detention Pond	14	80	55	69	35	63	44	69
Multiple Pond System	1	91	76	N/A	N/A	87	N/A	N/A
Wet Pond	28	79	49	39	32	36	58	65
Wet Ponds	43	80	51	65	33	43	57	66
Shallow Marsh	20	83	43	66	26	73	33	42
Extended Detention Wetland	4	69	39	59	56	35	N/A	-74
Pond/Wetland System	10	71	56	37	19	40	58	56
Submerged Gravel Wetland	2	83	64	14	19	81	21	55
Wetlands	36	76	49	48	30	67	40	44
Organic Filter	7	88	61	30	41	-15	66	89
Perimeter Sand Filter	3	79	41	68	47	-53	25	69
Surface Sand Filter	7	87	59	N/A	31.5	-13	49	80
Vertical Sand Filter	2	58	45	21	15	-87	32	56
Bioretention	1	N/A	65	N/A	49	16	97	95
Filtering Practices[a]	18	86	59	*57*	38	-14	49	88
Infiltration Trench	3	100	42	100	42	82	N/A	N/A
Porous Pavement	3	95	65	10	83	N/A	N/A	99
Ditches[b]	9	31	-16	N/A	-9	24	14	0
Grass Channel	3	68	29	32	N/A	-25	42	45
Dry Swale	4	93	83	70	92	90	70	86
Wet Swale	2	74	28	-31	40	31	11	33
Open Channel Practices	9	81	34	*10*	*84*	31	51	71
Oil-Grit Separator	1	-8	-41	40	N/A	47	-11	17

Shaded rows show data for groups of practices (e.g., dry ponds includes quality control ponds and dry extended detention ponds).
Numbers in italics are based on fewer than five data points.
[a] Excludes vertical sand filters
[b] Refers to open channel practices not designed for water quality.
TSS = total suspended solids, TP = total phosphorus, OP = ortho-phosphorus, TN = total nitrogen, NOx = nitrate and nitrite nitrogen, Cu = copper, Zn = zinc.

sweepers and vacuums that collect debris from the ground, placing tarps under boats while they are being sanded or painted, and planting grass buffers around hull maintenance areas, parking lots, sidewalks, and other impervious surfaces where pollutants tend to accumulate. Grass buffers effectively filter runoff water before it reaches surface waters, and they are attractive landscape elements.

Covering areas that are not used for boat maintenance with a porous surface allows rainwater to filter into the ground and reduces the amount of runoff created on the marina property. Crushed gravel or concrete and low grassy areas interspersed around and within otherwise impervious areas (parking lots, for example) are surfaces that allow rainwater to infiltrate into the ground. Directing storm water to a grassed area instead of to drains, pipes, or cement channels is an effective way to prevent the pollutants in runoff from reaching the marina basin, regardless of whether the runoff originates from parking lots, hull maintenance areas, rooftops, or any other impervious surface.

Some marinas might need to pretreat storm water runoff before it is discharged to a local sewer system. Pretreating wastewater from hull cleaning (pressure washing) might also be needed. The state or local environmental agency should be contacted to determine any specific legal requirements for treatment before discharge.

The goal of 80 percent reduction in the load of total suspended solids (TSS) in storm water runoff recommended in this management measure is achieved by eliminating (by pollution prevention or source reduction) 80 percent of the total annual load of suspended materials produced in an average year of work. Most marinas use some management practices and are already collecting some or all of this 80 percent. Note that 80 percent of the TSS load cannot usually be eliminated during each storm because the efficiency of any means chosen to remove pollutants from storm water fluctuates above and below 80 percent for individual storms. The goal of the management measure is to control an average of 80 percent of the amount of TSS produced at a marina during any given year. Because no two marinas are the same, the storm water control management practices used to achieve this goal have to be chosen site-specifically for each marina.

The annual TSS load baseline can be calculated as follows:

- Assume that marina operations are being conducted as usual, except that no management practices are used to collect pollutants from hull maintenance areas. All of the sanding dust, paint chips, and so forth produced fall to the ground.
- Given this scenario, add together the total amount of solid pollutants, such as paint chips and sanding dust, that would be swept away in runoff during storms that occur over a 1-year period and that are less than or equal to the 2-year/24-hour storm for the area. Solids carried away in snowmelt runoff should also be included.
- Multiply this quantity by 80 percent (0.80) to obtain the target minimum quantity of solid pollutants to be removed from storm water runoff and prevented from reaching the marina basin or storm drain.

This calculation can be complicated, primarily because of the difficulty in measuring the quantity of pollutants produced at a marina. The state or local environmental agency can be contacted for additional storm water guidance and for information pertaining to storm water regulations.

Applicability

This management measure is applicable to new and expanding marinas and to existing marinas at a minimum at hull maintenance areas.

Best Management Practices

♦ *Perform as much boat repair and maintenance work as possible inside work buildings.*

Sandblasting is best performed in a place where the debris produced is prevented from drifting to surrounding areas and being swept away in storm water runoff. One of the simplest and most effective ways to prevent pollutants from boat repairs from entering storm water runoff is to perform as much work as possible under roofs or in enclosures. Performing maintenance work in a fully enclosed building protects the work area from wind and contains the dust and debris produced during the work so it is much easier to clean up afterward.

♦ *Where an inside work space is not available, perform abrasive blasting and sanding within spray booths or tarp enclosures.*

The inside of a building provides the most protected space, but if a large enough interior space is not available, a suitably sized area can be protected with tarps or temporary plastic buildings can be used. Tarps help prevent residue from drifting to nonwork areas of the marina and into surface waters. Scheduling work on calm days helps ensure that wind won't carry debris and pollutants to other areas of the marina property and the marina basin.

♦ *Where buildings or enclosed areas are not available, provide clearly designated land areas for boat repair and maintenance.*

If a facility is large enough, one or more sections of the yard, ideally located well away from the shore, can be designated for boat repairs and maintenance (Figure 4-8). Mark the area well with signs, post a list of boat owner responsibilities, indicate the rules for use of the work area, and do not permit work outside the designated areas. Areas where abrasive work will be performed should be protected from wind and enclosed if possible. This practice should help the marina property stay relatively clean. Where possible, inland areas, away from surface waters, should be used for boat repair work.

♦ *Design hull maintenance areas to minimize contaminated runoff.*

Hull maintenance areas can be located indoors or outdoors, and activities that produce a large amount of polluting debris can be conducted over a dry, impervious surface like a cement pad. Other portable, temporary ground covers like tarps can also be effective. Such a surface makes it easy to collect and properly dispose of debris, residues, solvents, and spills before they enter storm water runoff.

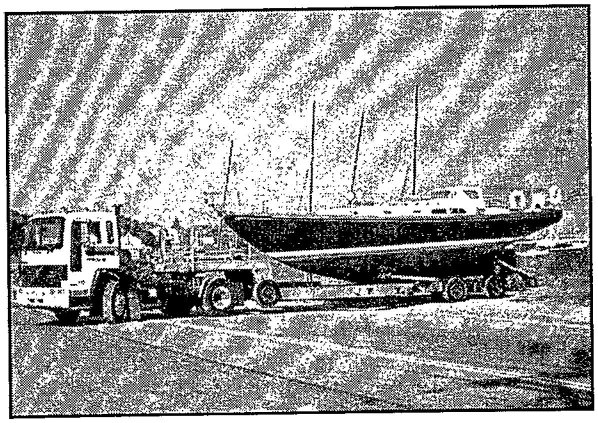

Figure 4-8. Conanicut Marine Service (Rhode Island) found that purchasing land almost a mile from the shore and using a hydraulic boat trailer was significantly less expensive than purchasing waterfront property, and doing so allowed expansion of its service work to an inland boatyard. No coastal permits were needed for the inland yard, and the risk of water pollution from runoff from the yard was significantly reduced (USEPA, 1996: *Clean Marinas—Clear Value*).

♦ *Use vacuum sanders both to remove paint from hulls and to collect paint dust and chips.*

Vacuum sanders have proven very effective at capturing paint dust and chips during boat hull and bottom sanding. Immediate capture prevents paint dust and chips from entering the marina basin, makes cleaning up the work area easier. It also increases the speed at which a boat bottom can be completely sanded.

Such sanders capture up to 98 percent of the dust generated. Workers do not have to wear full suits with respirators. They use fewer disk pads and have less cleanup to perform in surrounding areas. Vacuum-based sanders are increasingly being used in boatyards and marinas, and they might be available for rental by boat owners who want to sand their own hulls. Many marinas have converted to dustless sanders and require that they be used by customers and outside contractors. In addition to preventing pollution, using vacuum sanders can dramatically increase the efficiency of sanding operations.

The results of a BMP demonstration project at five Rhode Island marinas showed that several techniques can make the use of vacuum sanders more effective. First, the availability of the machinery needs to be publicized with flyers or signs in hull maintenance areas. Second, staff should be well trained and ready to inform customers that a professional vacuum sander is available for use and how to use it properly. Users need to be given complete operating instructions and must clearly understand them before using the machine.

♦ *Restrict the types and/or amount of do-it-yourself work done at the marina.*

Largely for environmental liability reasons, an increasing number of marina owners are restricting do-it-yourself boat repair work of the "dirty" kind, such as exterior sanding and painting. A small but increasing percent of marinas are prohibiting such repairs on-site unless done by a professional who is trained in, understands, and follows state-approved environmental management practices.

♦ *Clean hull maintenance areas immediately after any maintenance to remove debris, and dispose of collected material properly.*

Cleaning hull maintenance areas immediately after maintenance or repair work is done removes trash, visible paint chips, and other debris before they can be blown or washed into the marina basin. Spent sandblasting grit, boat repair debris, and solid waste should be stored under cover and in a manner that minimizes contact with process or storm water. Vacuuming or sweeping is an excellent method of collecting these wastes, especially over paved surfaces. Hosing a maintenance area for cleanup can result in the same pollution that storm water would cause.

♦ *Capture and filter pollutants out of runoff water with permeable tarps, screens, and filter cloths.*

Tarpaulins can be placed on the ground, before a boat is placed in a cradle or stand for sanding and painting. The common plastic tarpaulins collect paint chips, sanding dust, and paint drippings, which then can be collected and disposed of into dumpsters with other solid trash, as permitted by local or state ordinances. Impermeable plastic tarps, however, have their drawbacks. Wind easily blows dust and chips off the tarps, and rainwater washes debris from the tarps. Semipermeable filter cloths can be more effective than solid cloth or plastic tarps for collecting debris where wind is a problem, where tarps are not always cleaned each day after work is completed, or where work is continued during light rains. The filter cloths hold onto debris better and allow water to pass through while retaining debris for later disposal.

♦ *Sweep or vacuum around hull maintenance areas, roads, and driveways frequently.*

Frequent vacuuming of impervious areas can effectively prevent pollutants from reaching the marina basin and nonmaintenance areas of the marina property. Scheduling vacuuming (e.g., once a day or every other day during the boating season) and adhering to the schedule helps make this a particularly effective management practice. The practice is most effective in hull maintenance areas if the surface under any boat being worked on is swept at the end of each workday.

♦ *Sweep parking lots regularly.*

Cars, trucks, commercial vehicles, and foot traffic carry a lot of sand, grit, and dirt to parking lots. Gum wrappers, paper and styrofoam cups, cigarette butts, and cellophane wrappings tend to end up on parking lot pavement as well. Storm water carries these pollutants to the marina basin or to drain inlets, catch basins, and oil/grit separators. Regular parking lot sweeping helps reduce the amount of sand, grit, and trash that reaches the marina basin and storm water controls. Because catch basins and oil/grit separators require periodic cleaning for efficient operation, sweeping the parking lot extends the time between sweepings.

♦ *Plant grass between impervious areas and the marina basin.*

Grass retains and filters pollutants from runoff. A well-maintained lawn that is located between impervious surfaces (e.g., parking lots) and the marina basin and to which runoff from the impervious surface is directed increases rainwater infiltration and creates an attractive marina environment (Figure 4-9).

The technical term for a channel or ditch planted with grass and used for storm water treatment is *grassed swale*. Grassed swales are low-gradient

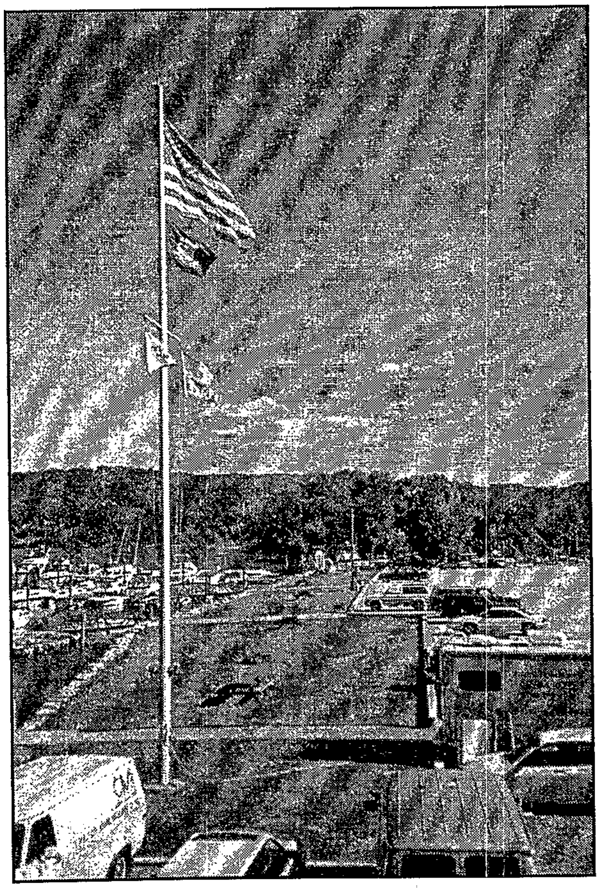

Figure 4-9. Storm water runoff is controlled at Deep River Marina (Connecticut) by 50-foot-wide grass buffers and a parking lot that is covered with crushed rock and has sediment traps in the storm drains. Picnic tables and flowers in the lawn areas make the marina visually attractive and useful to families. Summerfield Boat Works (Florida) added an unpaved parking lot across the street from the main marina property and basin and landscaped its perimeter to blend in with the neighborhood. Harbour Towne Marina (Florida) reduced runoff contamination by planting a grass buffer around the perimeter of the facility. The facility's parking is largely paved and drains to the buffer strip, and the grass adds a cooling and visually pleasing element to the marina property (USEPA, 1996: *Clean Marinas—Clear Value*).

channels that can be used in place of buried storm drain pipes (Figure 4.10). To effectively remove pollutants, grassed swales need to have only a slight slope and should be long enough to allow all of the pollutants in storm water to be filtered out. Because storm water is directed to them and storms are occasionally very strong, erosion-resistant vegetation such as deep-rooted grasses works best. The vegetation filters out pollutants and absorbs nutrients from the storm water, and runoff infiltrates into the ground as it is slowed by the grass in the swale. Grassed swales are best used in conjunction with other practices listed under this management measure.

♦ *Construct new or restore former wetlands where feasible and practical.*

If space and economy permit, consider restoring wetland vegetation that might have formerly existed at the edge of the marina basin or altering a portion of the basin perimeter to support wetland vegetation. Wetlands are extremely efficient at removing pollutants from water.

♦ *Use porous pavement where feasible.*

Pervious pavement has strength characteristics approximately equal to those of traditional pavement but allows rainfall and runoff to percolate through it. The key is the elimination of most of the fine aggregate found in conventional pavements. There are two types of pervious pavement, porous asphalt and pervious concrete. Porous asphalt has coarse aggregate held together in the asphalt with sufficient interconnected voids to yield high permeability. Pervious concrete, in contrast, is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that also yields interconnected voids for the passage of air and water. Underlying the pervious pavement are a filter layer, a stone reservoir, and a filter fabric. Stored runoff gradually drains out of the stone reservoir into the subsoil.

A porous surface can also consist of a coarse, permeable top layer covering an additional layer of gravel (Figure 4-11). Runoff infiltrates through the porous layer and into the ground. As storm water passes through the pavement, the gravel, and perhaps a perforated underground pipe system and then into the underlying soil, pollutants are naturally filtered out. Porous pavement helps recharge ground water and provides excellent pollutant removal (up to 80 percent of sediment, trace metals, and organic matter).

Other types of porous pavements might be suitable for walkways and areas that will not be subjected to heavy loads.

♦ *Install oil/grit separators and/or vertical media filters to capture pollutants in runoff.*

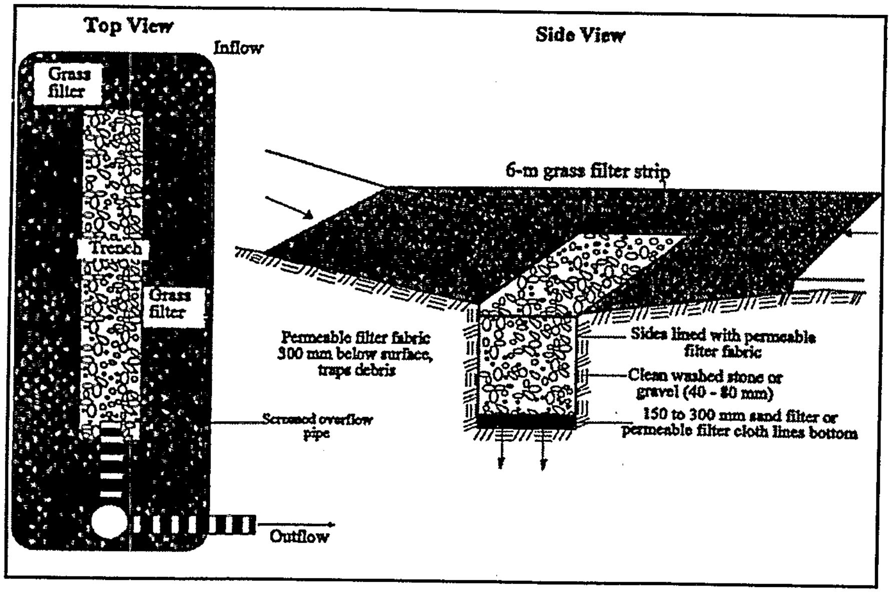

Figure 4-10. Grassed filter strip surrounding an infiltration trence (adapted from Schueler, 1987).

Oil/grit separators are useful where petroleum is spilled or could be spilled (Figure 4-12). Oil/grit separators can be used to treat water from small areas where other measures are infeasible. They are particularly applicable where the work performed contributes large loads of grease, oil, mud, or sand to runoff. Inspection and maintenance should occur at least twice per year or per the manufacturer's recommendations. With proper maintenance, oil/grit separators can last 50 years.

Vertical media filters use passive filtration to remove many pollutants from storm water. The pollutants removed include sediment, nutrients, soluble metals, hydrocarbons, trash, and debris. The filters are typically installed in high-use parking lots, industrial parking lots, roads, bridge decks, and multiple-use areas. A variety of filter media can be installed to capture different pollutants, and the number of filter media used can be adjusted, permitting the user to adapt the installation to the requirements of the specific location.

♦ *Use catch basins where storm water flows to the marina basin in large pulses.*

Catch basins with flow restrictions are used to prevent large pulses of storm water from entering the marina basin at one time. Particulates and soil settle to the bottom of a catch basin, in which the bottom of the basin is typically 2 to 4 feet below the outlet pipe (the pipe through which the trapped water is allowed to escape). The traps in a catch basin require periodic cleaning and maintenance, but if properly maintained, a catch basin should have a life span similar to that of oil/grit separators (50 years).

Catch basins can have a separate chamber filled with sand. With this design, runoff first enters an open chamber where coarse particles that could clog the sand are filtered out. The runoff then flows into a second chamber where other pollutants are filtered out by infiltrating through the sand. Catch basins with sand filters are effective in highly impervious areas, where other practices have limited usefulness. They need to be inspected at least annually, and the top layer of sand should be removed periodically and replaced with fresh, clean sand.

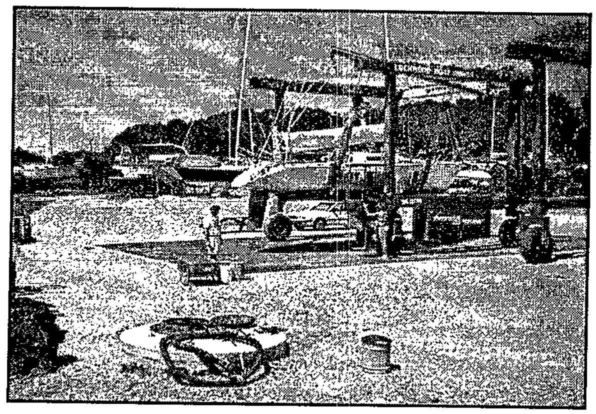

Figure 4-11. Lockwood Boat Works (New Jersey) regraded its combined parking and boat maintenance yard and surfaced it with 6 inches of crushed concrete to successfully control runoff. Using recycled concrete crushed into stone-sized pieces, the cost was $18,000 per acre installed, whereas crushed rock would have cost $27,000 per acre and asphalt paving would have cost $54,000 per acre (USEPA, 1996: *Clean Marinas—Clear Value*).

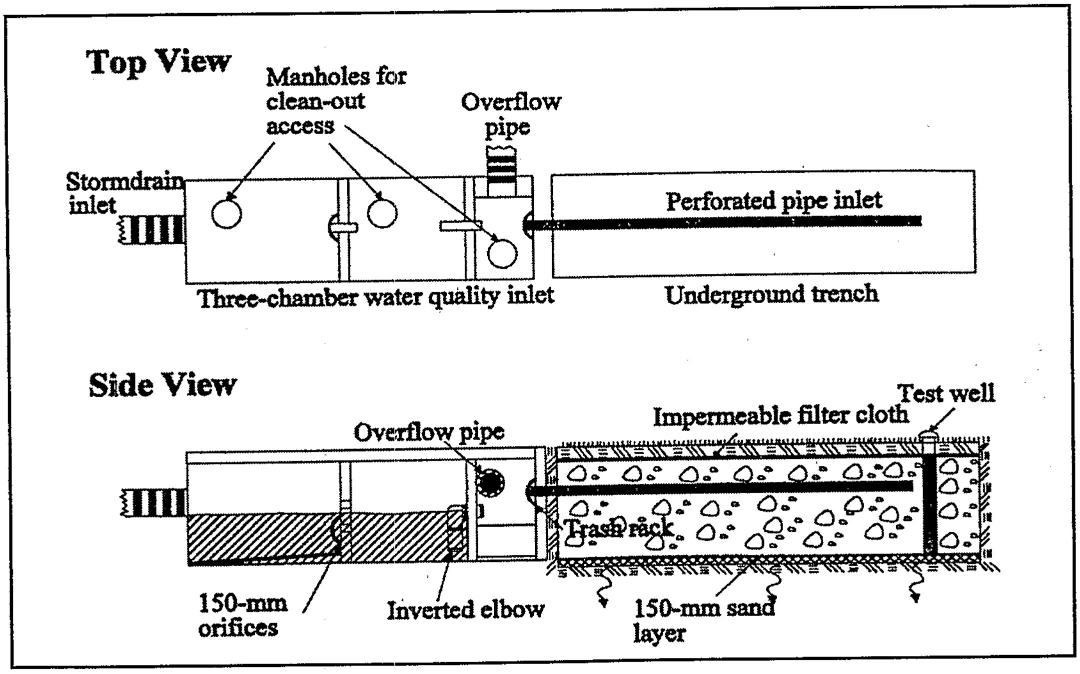

Figure 4-12. Underground trench with oil/grit chamber (adapted from Schueler, 1987).

♦ *Add filters to storm drains that are located near work areas.*

Some storm drain designs permit insertion of a filter to screen solid materials out of runoff. If oil is typically contained in runoff, an oil absorption pad can be inserted into the water pool or trap beneath the filter as well. Filters and absorption pads placed in storm drains must be cleaned or replaced regularly to function properly.

♦ *Place absorbents in drain inlets.*

Oil and grease are not ordinarily captured by catch basins. An absorbent material placed in a drain where it will intercept storm water can remove much of the oil and grease contained in runoff. Absorbent material products can remove 10 to 25 times their weight in oil. Absorption pads placed in drain inlets must be cleaned or replaced regularly to function properly.

♦ *Use chemical and filtration treatment systems only where necessary.*

Wastewater can be treated by the addition of certain chemicals that cause small solid particles to adhere together to form larger particles, which are then filtered from the water. This type of treatment system can remove more than 90 percent of the suspended solids and 80 percent of most toxic metals associated with hull pressure-washing wastewater. The degree of treatment is determined by how much of the chemical is added and the porosity of the filter used, and it can be altered to meet municipal standards. Because the chemicals used for this type of treatment require disposal themselves, this method of pollutant removal is suggested for use only where other methods prove ineffective. This type of treatment system might be regulated by the state or local environmental authority, and any regulatory restrictions for its use should be determined before choosing to use it.

BMP Summary Table 5 summarizes the BMPs for Storm Water Runoff control mentioned in this guidance.

BMP Summary Table 5. STORM WATER RUNOFF MANAGEMENT

MANAGEMENT MEASURE: Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas. Reduce the average annual loadings of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For the purposes of this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

APPLICABILITY: New and expanding marinas, and existing marinas at a minimum at hull maintenance areas.

ENVIRONMENTAL CONCERNS: Sanding dust, paint dust and chips, copper and other heavy metals, and other such solids that drop on the ground during boat repair and maintenance can all be swept into the water by the next rainstorm's runoff. Oils, grease, solvents, paint drippings, and fuel spilled or dripped onto the ground are also be carried away in runoff. Unless runoff is treated in some manner, all of these pollutants will end up in the marina basin, where they will create unsightly surface films or float until they adhere to a surface like a boat hull. Some of these pollutants can sink to the bottom soil, where they can be eaten by bottom-feeding fish or filter-feeding shellfish, or settle onto the leaves of aquatic vegetation and clog their pores.

STORM WATER RUNOFF MANAGEMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Perform as much boat repair and maintenance work as possible inside work buildings	Boat maintenance area; universally recommended	MODERATE to HIGH; protects the work area from wind and rain; contains dust and debris for easier cleanup	MODERATE to HIGH; simple and effective way to prevent pollutants from entering storm water runoff	LOW if building exists to EXPENSIVE for new building	MODERATE	Temporary plastic buildings can be used
Where an inside work space is not available, perform abrasive blasting and sanding within spray booths or tarp enclosures	Boat maintenance area; universally recommended	MODERATE to HIGH; protects the work area from wind and rain; contains dust and debris for easier cleanup	MODERATE to HIGH	MODERATE	MODERATE	Schedule work on calm days to help ensure that debris and pollutants are not carried to other areas of the marina property and the marina basin
Where buildings or enclosed areas are not available, provide clearly designated land areas for boat repair and maintenance	Hull maintenance in designated upland areas; generally recommended	MODERATE; keeping all work in one area helps control pollutants	HIGH; keeping the work away from the water is an effective way to protect water quality	LOW to MODERATE	LOW to MODERATE	Protect from wind and capture debris using one of the BMPs mentioned (tarp, filter cloth, etc.)
Design hull maintenance areas to minimize contaminated runoff	Boat maintenance area; universally recommended	MODERATE to HIGH; debris collection and cleanup are easier when appropriate controls are in place	HIGH; decreases possibility that maintenance debris will enter waterbody with runoff	MODERATE to HIGH	MODERATE	Construct hull mainten-ance areas with an impervious surface like cement; mark the boundaries of maintenance areas with clear visible signs.

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use vacuum sanders both to remove paint from hulls and to collect paint dust and chips	Hull maintenance areas; universally recommended	HIGH; perhaps the most efficient and effective practice; easy to use; saves cost of cleanup, improves quality and speed of hull work	HIGH; 98% effective at keeping sanding dust out of environment	LOW to MODERATE per unit	LOW per unit	Rental fee income can defray capital cost; vacuum sanders are desirable but not effective for some tasks
Restrict the types and/or amount of do-it-yourself work done at the marina	Hull maintenance areas; generally recommended	MODERATE; reduces debris production, non-compliance with marina rules, and staff time spent cleaning up	MODERATE; reduces debris produced at hull maintenance areas and surface water pollution	LOW	LOW	Do-it-yourself work can be appropriate where users first are thoroughly educated in pollutant reduction and privileges can be revoked for non-compliance. Restrict the types and/or amount of do-it-yourself work done at the marina
Clean hull maintenance areas immediately after any maintenance to remove debris, and dispose of collected material properly	Hull maintenance areas; universally recommended	MODERATE; daily cleaning of work areas reduces accidents, improves work quality, and increases customer satisfaction	MODERATE; reduces amount of maintenance debris and litter blowing around marina and into the water; sweeping keeps litter and sand out of storm drains	LOW	MODERATE	Minimize use of hose water for cleaning grounds because pollutants can be carried in the runoff
Capture and filter pollutants out of runoff water with permeable tarps, screens, and filter cloths	Upland and indoor maintenance areas; generally recommended	MODERATE; debris is more easily collected and disposed of into dumpsters with other solid trash, as permitted by local or state ordinances; inexpensive, reusable materials	MODERATE to HIGH for semipermeable filter cloths; LOW for impermeable plastic tarps	LOW	LOW	Where heavily used, tarps need daily cleaning and are subject to wind blowing and rain runoff; semipermeable filter cloth tarps are better
Sweep and/or vacuum around hull maintenance areas, roads, and driveways frequently	Marina upland areas; universally recommended	HIGH to MODERATE; sweeping reduces the need to clean the basin; keeps marina attractive	MODERATE to HIGH; regular sweeping keeps sand, grit, and debris out of surface waters	LOW; HIGH if mobile sweeper purchased	MODERATE	Clean grounds encourage boaters to keep the marina and waters clean
Sweep parking lots regularly	Marina parking lots and roads; universally recommended	HIGH to MODERATE; sweeping the parking lot will extend the time between cleanings of catch basins and oil/grit separators; keeps marina attractive	MODERATE to HIGH; regular sweeping keeps litter and sand out of storm drains and the water	LOW; HIGH if mobile sweeper purchased	MODERATE	Particularly important for porous pavement

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Plant grass between impervious areas and the marina basin	Between marina work and parking areas and shoreline; generally recommended	HIGH; creates an attractive buffer, which add good appearance; if wide enough, can serve as recreation area for boaters	HIGH; lawn grass is a very effective buffer; retains and filters pollutants from runoff; absorbs nutrients from storm water; stabilizes the shore	MODERATE	MODERATE	A shallow ditch planted with grass and used for storm water treatment is a "grassed swale" regular maintenance is required
Construct new or restore former wetlands where feasible and practical	Shore and water edge; recommended where space allows	MODERATE to HIGH; wetlands are attractive shoreline habitat; attract customers	MODERATE to HIGH; wetlands are extremely efficient at removing pollutants from the water; act as natural buffers; reduce erosion	HIGH to EXPENSIVE	LOW to HIGH	Not suitable where land is limited; plantings can be hard to establish; but once established, require little or no maintenance
Use porous pavement where feasible	Marina parking lots and maintenance areas; generally recommended	HIGH to MODERATE; porous pavement can be cheaper than asphalt paving; reduced need for other elaborate/costly runoff control measures	HIGH; recharges ground water and provides excellent pollutant filtration through the ground	HIGH to EXPENSIVE	LOW to MODERATE	Suitable under certain conditions; requires frequent cleaning; not suitable for passage of heavy loads and equipment
Install oil/grit separators to capture petroleum spills and coarse sediment	Boat maintenance areas; generally recommended	MODERATE to HIGH; oil/grit separators should last 50 years with proper maintenance; minimal labor cost once installed	MODERATE to HIGH; efficient practice where the work performed contributes large loads of grease, oil, mud, sand, or trash to runoff	MODERATE per unit	LOW	Must be cleaned regularly; see manufacturer's specifications
Use catch basins where storm water flows to the marina basin in large pulses	Marina storm drains; recommended	MODERATE to HIGH; with proper maintenance, catch basins should last 50 years	HIGH; catch basins with sand filters are effective in highly impervious areas, where other practices have limited usefulness	HIGH	LOW	Traps of catch basins require periodic cleaning and maintenance
Add filters to storm drains that are located near work areas	Marina storm drains in work areas; generally recommended	MODERATE to HIGH; very low-cost; easy to get and replace; effectively filter out most large materials from runoff; simple and reliable	MODERATE to HIGH; screen larger solid materials out of water; not as effective for very small particles	LOW	LOW	Require periodic maintenance; held in place just below the drain cover

BMP Summary Table 5. (cont.) STORM WATER RUNOFF MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Place absorbents in drain inlets	Marina storm drains and catch basins; generally recommended	MODERATE; oil pads and pillows absorb most petroleum products effectively; low cost and readily available; easy inspection and replacement	HIGH; remove much of the oil and grease from runoff; can remove 10 to 25 times their weight in oil from water	LOW	LOW	Absorbent materials need to be inspected regularly and changed periodically
Use chemical and filtration treatment systems only where necessary	Boatyard work and hull cleaning areas; recommended	LOW; very effective but very expensive practice	HIGH; these systems can remove in excess of 90% of suspended solids and 80% of most toxic metals from hull pressure-washing wastewater	HIGH to EXPENSIVE	HIGH to EXPENSIVE	Check with local or state environmental authority before installation because permits might be required

4.6. Fueling Station Design

Management Measure for Fueling Station Design:

Design fueling stations to allow for ease in cleanup of spills.

Management Measure Description

The possibility of spills during fueling operations always exists, and spills of gasoline and diesel fuel during boat fueling are a common source of pollution in marina waters. Most fuel dock spills are small and result from overfilling boat fuel tanks so that fuel splashes back at the nozzle onto the deck, squirts out of the boat's air vent line, or drips from the nozzle as it is removed from the boat and returned to the fuel dock. Therefore, installation of equipment that can minimize the occurrence of spills and taking precautions to contain, absorb, and minimize the spread of petroleum products spilled during fueling operations in navigable waters are prudent environmental practices at all marinas.

Congress passed the Occupational Safety and Health Act (OSHA) to ensure worker and workplace safety. Their goal was to make sure employers provide workers a place of employment free from recognized hazards to safety and health, such as exposure to toxic chemicals, excessive noise levels, mechanical dangers, heat or cold stress, or unsanitary conditions. OSHA has various regulations governing employee involvement in spill cleanups, including requiring training for such activities. Facilities are encouraged to have employees attend hazardous materials handling training or other appropriate training.

A form of fuel loss that occurs rarely but is particularly damaging is when fuel leaks from fuel pipes and hoses between the fuel storage tank and the pump. This leakage can result from dock damage caused by a major storm or a collision involving a large boat. Because boat fuels are lighter than water, they float on the water's surface and are easy to capture if spill containment and absorption equipment is readily available and used quickly.

The most effective way to minimize fuel spills and petroleum hydrocarbon pollution at a marina is to locate, design, build, and operate a boat fuel dock or station so that most spills are prevented and those that do occur are quickly contained and cleaned up. An essential step in spill prevention for both new and existing fuel docks is to identify and locate possible sources of leaks or spills, such as at joints in piping systems or between pipes and storage tanks, and to address each one in the facility's Spill Prevention, Control, and Countermeasures (or SPCC) Plan. An SPCC plan is a federal requirement (40 CFR Part 112) for any marina that has more than 660 gallons of petroleum in a single aboveground container, an aggregate of 1,320 gallons above ground, or more than 42,000 gallons under ground. The regulation requires that SPCC plans be certified by a professional engineer. Not all marinas are required to prepare and submit an SPCC plan, but if fuel is stored or transferred at a marina, even if only from a portable gasoline container filled at a distant gas station, being prepared to handle a spill is good environmental practice.

Oil is defined in federal regulations to include gasoline, diesel fuel, crude and refined oils, and petroleum-derived products like turpentine. Among the marine transportation-related facilities considered to have the potential to cause "substantial harm" to the environment are "onshore facilities capable of transferring oil to or from a vessel with a capacity of 250 barrels or more and deepwater ports." A barrel of petroleum contains 42 gallons, so 250 barrels translates to 10,500 gallons.

Rules for underground storage tanks (USTs) and UST systems (40 CFR Part 280) apply to all owners and operators of UST systems, except as noted in the regulations. Marinas with one or more stationary fuel storage tanks, above or below ground, with a combined storage capacity of 1,100 gallons or more of petroleum products are subject to federal and state bulk storage regulations for registration, testing, monitoring, replacement, reconditioning, closure, and/or removal. Fuel storage is also subject to other regulations, such as for occupational safety and fire. To ensure compliance with all applicable regulations, the state and local authorities should be contacted. Underground tanks with a capacity of 110 gallons or more are subject to federal underground storage tank (UST) regulations. UST regulations can be viewed on the EPA web site at <www.epa.gov/swerust1/fedlaws/index.htm>.

The location and design of fueling facilities also must meet applicable local, state, and federal regulations.

Applicability

This management measure is applicable to new and expanding marinas where fueling stations are to be added or moved.

Best Management Practices

♦ *Use automatic shutoffs on fuel lines and at hose nozzles to reduce fuel loss.*

A commercial fuel line shutoff can be located between the fuel storage tank and the dockside fuel pump. The shutoff automatically stops fuel movement when the system senses passage of a high volume of fuel through the line. The shutoff can also be manually closed when the fuel dock is not in operation or during emergencies. State and local codes might require shutoffs in specific locations.

Similarly, automatic shutoff fuel nozzles guard against overfilling boat fuel tanks by automatically stopping the flow of fuel from the pump. They are an excellent way to guard against spillage where marina patrons fill their own tanks. Fume return lines can also be used on automatic shutoff nozzles.

♦ *Remove old-style fuel nozzle triggers that are used to hold the nozzle open without being held.*

Old fuel nozzle triggers that hold the line open are illegal in some states because they can result in overfilling of fuel tanks and fuel loss out of air vents. Most new fuel nozzles automatically shut off when the tank fills. Check to see if the state you are in requires their use.

♦ *Install personal watercraft (PWC) floats at fuel docks to help drivers refuel without spilling.*

Special docking facilities for PWCs can be installed to stabilize them while they are at a fuel dock (Figure 4-13). Docking PWCs while fueling reduces fuel loss caused by the craft rocking on the water while fueling. These docks have proven popular with PWC operators and do reduce spillage.

♦ *Regularly inspect, maintain, and replace fuel hoses, pipes, and tanks.*

Regularly scheduled preventive maintenance is the best source control for fuel loss from the fuel storage and delivery system, and it is often less costly than cleanup costs and fines levied for spills. Many marinas are changing from underground storage tanks (UST) to aboveground, lined tanks. For EPA publications about USTs, call EPA's RCRA/Superfund Hotline at 1-800-424-9346 or visit the EPA web site at <http://www.epa.gov/swerrims/> (*InformationServices* link).

♦ *Install a spill monitoring system*

The U.S. Navy has designed a real-time monitoring system that can detect spilled crude and petroleum-based products 24 hours a day in any weather condition. The floating instrument detects sheen as well as emulsion layers below the surface, and it also determines the type of spill. Either the instrument is hardwired or the data from the instrument is telemetered to a base station, where associated software distinguishes between background levels and spills. The software can be set for continuous or discrete event logging data storage, and if a spill is detected, the base station automatically contacts authorities until a response is made.

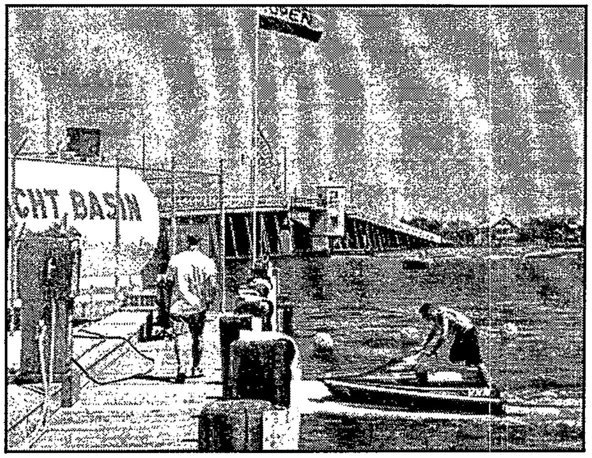

Figure 4-13. Two PWC floating docks were installed at Winter Yacht Basin, Inc. (New Jersey). The floats are 4 feet by 10.5 feet and are connected to PVC pipes to allow them to ride up and down with the tide. Operators of PWCs can drive up onto the platform, step off, and fill the tank from the dock. The platform is stable enough to limit spilling during fueling. This practice has also decreased conflict between PWCs and larger boats at the fuel dock and has increased fuel sales at the marina (USEPA, 1996: *Clean Marinas—Clear Value*).

♦ *Train fuel dock staff in spill prevention, containment, and cleanup procedures.*

Marinas should have at least one key staff member fully trained and certified in spill management, and this person should be designated to be responsible for inspection, training, and control of any spill. Hazardous materials response training, such as 40-hour HAZWOPER training, is recommended. Contact the local agency responsible for hazardous waste response or a fire department for information. All staff members should know the location of absorbent materials and how to use them to remove the fuel immediately from the water or ground. Regular practice drills ensure that staff are familiar with the proper use of these materials.

♦ *Install easy-to-read signs on the fuel dock that explain proper fueling, spill prevention, and spill reporting procedures.*

Most states and some federal agencies have specific signage guidance. Signs with easy-to-follow instructions, perhaps using pictures, located on or near fuel pumps and fuel delivery locations can help expedite a cleanup if a spill occurs. It is helpful to have signs that state the following information:

- Step-by-step way to fuel a boat
- Requirements of the law and spill reporting phone numbers
- Procedures to follow in the event of a spill
- Locations of absorbent materials
- Proper use and disposal of fuel-absorbent materials
- Warnings against the use of detergents or emulsifiers.

Spills should be immediately reported to either the U.S. Coast Guard or EPA. The U.S. Coast Guard is the lead response agency for spills in coastal waters and deepwater ports, and EPA is the lead response agency for spills that occur in inland waters. Oil spills can be reported 24 hours a day at 1-800-424-8802. On navigable waters, any oily slick or sheen must be reported. More information on laws and regulations related to spills can be obtained at the U.S. Coast Guard web site: <http://www.uscg.mil/>. EPA's web site for oil spill information is www.epa.gov/oilspill.

♦ *Locate and design boat fueling stations so that spills can be contained, such as with a floating boom, and cleaned up easily.*

A well-positioned and well-designed fueling station allows for spill containment equipment, such as booms, to be easily deployed to surround a spill and any boats that may be tied to the fuel dock if a spill occurs. Fuel storage tanks, the fuel truck delivery area, and pipelines that deliver fuel to the pump are also sites of potential spills. Facilities that can be set back from the water should be so placed, and spill prevention equipment located at all likely places where spills could occur (such as at pipe junctions). Many marinas are switching from underground fuel storage tanks to aboveground tanks because the latter make spill detection and control easier and the capital costs are lower.

When a spill occurs at the boat fueling station, there are three basic steps to take, which need to be considered when planning or rebuilding a fuel dock:

- Report the spill to the proper authorities (U.S. Coast Guard, EPA, and the appropriate state agency). Any spill can be reported by calling the U.S. Coast Guard's National Spill Response Hotline, 1-800-424-8802. Any petroleum spill onto the navigable waters of the United States sufficient to cause a slick or sheen on the water is a violation of section 311 of the Clean Water Act and must be reported to the hotline.
- Contain the petroleum spill to prevent it from spreading. Put a boom around and confine diesel and other nonvolatile oils. The U.S. Coast Guard recognizes that gasoline spills pose an extreme explosion and fire threat and recommends that small gasoline spills be allowed to evaporate as quickly as possible without a boom placed around them.
- Place materials on the water within the contained spill area to absorb the petroleum. If the spill is large, a commercial spill clean-up contractor may be needed.
- Remove and dispose of the material at the appropriate time. Contact the local spill control authority, a fire department, or the local U.S. Coast Guard for specific removal and disposal guidance.

> Cap Sante Boat Haven (Washington) uses oil absorption booms anchored cross-current to capture floating oil. The booms are changed twice a year. The marina also uses about 800 oil absorption pads a year at a cost of $200. Battery Park Marina (Ohio) also uses an oil boom where the fuel line joins the floating dock, in case the connection leaks. These booms are replaced every 6 months at a cost of $25 each. Cedar Island Marina (Connecticut) keeps a pole with a small floating absorption boom attached at one end on its fuel dock to be used quickly and effectively by staff to sweep and mop the water surface if any small spills occur during boat fueling (USEPA, 1996: *Clean Marinas— Clear Value*).

♦ *Write and implement a fuel spill recovery plan.*

An SPCC plan is a first line of defense against petroleum pollution and should be developed by all marinas, whether required by regulations or not. An example plan is appended to the Petroleum Control Management Measure. An SPCC plan should be written to apply to all locations in the marina where fuel or oil is stored or transferred, and it should clearly explain spill emergency procedures, including health and safety, notification, and spill containment and control measures. Marina personnel should be trained in spill containment and control practices. The plan should address the following:

- *Who:* Clearly identify who is responsible for taking what action. Action items will include deploying the equipment and contacting the emergency agencies and additional cleanup services. The plan should contain a list, updated periodically, of emergency phone numbers to be used if a spill occurs. One person on the marina staff should be designated the official spokesperson for the facility.
- *What:* Define what actions should be taken if a fuel spill occurs and, based on likely threats, what equipment should be deployed. Include information on the type of spill equipment available on-site and its characteristics and capabilities. List emergency phone numbers to be called, including the U.S. Coast Guard and local fire department, when a spill is discovered. Make sure dispersants are *not* used on any spill.
- *When:* Clearly state when additional resources, such as spill control services, should be called for assistance. Plan when the marina's spill control equipment will be inspected and replaced, if necessary. A maintenance schedule for the equipment and a training schedule for staff should be established.
- *Where:* Show where the spill control material is located in the facility. Make sure storage lockers are clearly marked and easy to access. Identify sources where additional spill

response equipment can be obtained quickly if necessary. Potential sources include commercial spill response companies, fire departments, or neighboring marinas that have fuel spill response equipment. If a commercial fuel spill response firm is to be used, establish a prearranged agreement and cost estimates with the firm.

- *How:* Explain how the spill control equipment should be used and disposed of. To be sure that marina personnel understand the response plan, regularly conduct drills that simulate a fuel spill. Evaluate the drill and share observa-tions with all employees.

State and local regulations might have broader applicability than federal regulations and might even require an SPCC plan of any facility where fuel is stored or transferred. Contact the appropriate state and local authorities to determine if the facility needs to have a plan and for assistance in preparing one.

An example of an oil spill response plan is contained in Appendix B. In order that it is clear what type of information is to be entered for the plan, the example is filled out with explanations of the information to be filled in or as if it were for an actual marina. Information specific to this fictitious marina is printed in Arial font. Where this font occurs, the entries should be replaced with information specific to the actual marina for which the plan is being written, and the plan should be updated as changes in procedure, regulations, or the marina occur. Oil spill information is updated quarterly in EPA's "Oil Spill Program Update" on the Oil Program web site at <www.epa.gov/oilspill>.

♦ *Have spill containment equipment storage, such as a locker attached or adjacent to the fuel dock, easily accessible and clearly marked.*

Store the appropriate type and quantity of fuel spill containment and control materials in a clearly marked cabinet or locker that is easily and quickly accessible at the fuel dock. The type and quantity depend on the type of spill likely to occur and the potential quantity of a spill. Place absorbent pads and booms, a copy of the SPCC plan, and other important petroleum spill equipment in the locker. Effective fuel spill containment equipment is readily available from commercial suppliers. Booms can absorb up to 25 times their weight in petroleum products and float even when they are saturated. It's best to have enough length of boom to encircle the dock and the largest boat serviced, or a length of boom about three times as long as the longest boat serviced.

The following are examples of fuel/oil spill control products currently available:

- *Booms:* Usually 10-foot floating sections that interconnect to encircle the spill.
- *Pads:* Flat absorbent sheets that float; also called diapers.
- *Pillows:* Short booms often used in bilge of larger boats.
- *Bilge sock:* Small pillow for most boat bilges.
- *Filter:* Separates fuel from water.
- *Bilge switch:* Replaces float switch and shuts off when floating fuel layer is reached.

BMP Summary Table 6 summarizes the BMPs for Fueling Station Design mentioned in this guidance.

BMP Summary Table 6. FUELING STATION DESIGN MANAGEMENT

MANAGEMENT MEASURE: Design fueling stations to allow for ease in cleanup of spills.

APPLICABILITY: New and expanding marinas where fueling stations are to be added or moved.

ENVIRONMENTAL CONCERNS: Spills of gasoline and diesel oil during boat fueling are a common source of pollution in marina waters. Usually these are very small spills that occur from overfilling boat fuel tanks. These small spills may accumulate to create a larger pollution problem. The hydrocarbons in oil are harmful to juvenile fish, and to fish reproduction and genetics, and they interfere with the growth and reproduction of bottom-dwelling organisms. The oil and gas ingested by one animal can be passed to the next animal that eats it. In a marina, petroleum also deteriorates the white Styrofoam in floats and docks and discolors boat hulls, woodwork, and paint. Gasoline spills are also a safety problem because of the flammability of this product. The most effective way to minimize fuel spills and petroleum hydrocarbon pollution at a marina is to locate, design, build, and operate a boat fuel dock or station in such a manner that most spills are prevented and those that do occur are quickly contained and cleaned up.

FUELING STATION DESIGN PRACTICES

Best Management Practice Examples	Marina Location& Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use automatic shutoffs on fuel lines and at hose nozzles to reduce fuel loss	Fuel hose nozzles; universally recommended	HIGH; automatic shutoffs prevent most back-splashing as tank fills; keeps fuel dock neater; reduces fire hazard	HIGH; greatly reduces volume of fuel spills from overfilling fuel tanks	LOW	NONE to LOW	A commercial fuel line shutoff can be located between the fuel storage tank and the dockside fuel pump; fume return lines can also be used on automatic shut-off nozzles
Remove old-style fuel nozzle triggers that are used to hold the nozzle open without being held	Fuel hose nozzles; universally recommended	HIGH; old-style nozzle triggers are illegal in some states	HIGH; greatly reduces possibility of fuel spills during filling; most fuel is spilled during tank filling, so this practice nearly eliminates this environmental impact	LOW	LOW	Replacing old nozzles is recommended
Install personal watercraft (PWC) floats on fuel docks to help drivers refuel without spilling	Fuel dock; generally recommended	HIGH; drive-on floats lift PWCs out of the water, stop vessel tipping, reduce spills, and increase fuel sales to PWC users; popular with PWC operators	HIGH; reduces fuel loss caused by rocking on the water, so less risk to the environment from fuel spills	MODERATE	LOW	Usually placed off to side where larger boats can't tie up; floating docks are available for PWC storage on the water
Regularly inspect, maintain, and replace fuel hoses, pipes, and tanks	Fuel storage area and fuel dock; universally recommended	HIGH; regularly scheduled preventive maintenance is the best way to prevent leaks from the fuel storage and delivery system; usually less costly than cleanup costs and resulting fines	MODERATE; reduces chance that persistent small leaks become a large pollution problem	MODERATE to HIGH	LOW to MODERATE	Biannually or more often, as necessary and prudent

BMP Summary Table 6. (cont.) FUELING STATION DESIGN MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Install a spill monitoring system	Fuel storage system and pipes; recommended	HIGH; automatic detection of leaks	HIGH; reduces chance of unnoticed spills, increases chance of early detection	MODERATE to HIGH	LOW	Easy to install; software is Windows 95/98-compatible
Train fuel dock staff in spill prevention, containment, and cleanup procedures	Marina wide for staff at fuel dock; universally recommended	HIGH; done annually or more often, can reduce fire and environmental hazards; response staff must be fully trained and certified in spill management	MODERATE to HIGH	LOW	LOW	HAZWOPER training is recommended; regular practice drills ensure familiarity with proper response protocol
Install easy-to-read signs on the fuel dock that explain proper fueling, spill prevention, and spill reporting procedures	Fuel dock on or at pumps; universally recommended	HIGH; inexpensive and effective way to educate customers and remind staff; customers want and look for guidance on how to fuel boats	MODERATE; signs increase chance of proper spill response and can ensure spills of different types (e.g., oil and fuel) are responded to properly	LOW	NONE to LOW	Check with local, state, and federal guidelines; USCG might have recommendations
Locate and design boat fueling stations so that spills can be contained, such as with a floating boom, and cleaned up easily	Boat fueling dock; universally recommended	HIGH; makes spill containment easier and faster; reduces liability and cleanup costs and fines	MODERATE; fast cleanup reduces environmental harm	MODERATE to EXPENSIVE	LOW to MODERATE	Location considera-tions: ease of spill response, convenience for customers, proximity to pumpout
Write and implement a fuel spill recovery plan	All marina locations where fuel or oil is stored or transferred; universally recommended	HIGH; required by state regulations; helps reduce liability in case of a fuel spill when coupled with annual staff training and good records	MODERATE; increases chance that a spill will be quickly and efficiently contained, reducing environmental impact	LOW to MODERATE	LOW to MODERATE if annual staff training is included	Staff training required; provide clearly written instructions for customers if self-serve fueling
Have spill containment equipment storage, such as a locker attached or adjacent to the fuel dock, easily accessible and clearly marked	Fuel dock; universally recommended	HIGH; keeping all necessary cleanup material in a locker ensures that the equipment is easily reached and used quickly after a spill	MODERATE; ensures quick response to spills; reduces potential of harm to environment	MODERATE	LOW to MODERATE, depending on frequency of spills	Check with local authorities for appropriate types and quantities

4.7. Petroleum Control

> Management Measure for Petroleum Control:
>
> ***Reduce the amount of fuel and oil from boat bilges and fuel tank air vents entering marina and surface waters.***

Management Measure Description

Fuel is easily spilled into surface waters from the fuel tank air vent while fueling a boat (if overfilling), and oil is easily discharged during bilge pumping. A small fuel sheen on the water surface near docked boats is not an uncommon sight and can be caused by a spill of only a few drops or a slow leak from a gas tank. Because of the properties of oil, a cup of oil can spread as a very thin oil sheen over more than an acre of calm water. Small amounts of oil spilled from numerous boats can accumulate to create large oil sheens. Gasoline spills are also a safety problem because of gasoline's flammability.

Hydrocarbons are dangerous to aquatic plants and animals both at and below the water surface. Less than half of spilled oil stays in the water; the rest evaporates. Spread over the surface, oil creates a barrier to oxygen movement across the water surface and to animals (for instance, insect larvae) that must breathe at the surface. At and below the surface, oil attaches to plant leaves, decreasing their respiration, and bottom sediments. It can also be ingested by animals directly, or indirectly by feeding on other organisms such as filter feeders (mussels, sponges) that have ingested the oil. The hydrocarbons in oil harm juvenile fish, upset fish reproduction, and interfere with the growth and reproduction of bottom-dwelling organisms. Some oil remains as sediment contamination.

Petroleum spills can also cause structural damage at marinas, such as discoloration on boat hulls, woodwork, and paint, and deterioration of white Styrofoam in floats and docks (because petroleum dissolves this material).

The practices discussed here are used in many marinas, and their use can minimize the entry of petroleum from fueling and bilge pumping into surface waters. Technologies such as air/fuel separators, oil-absorbing pads, and bioremedial pads and socks have been developed in response to a growing recognition of the ecological and cumulative damage that can be done by even small spills of petroleum products into surface waters. These small spills escape the attention of many people, and marina owners and operators can play an important role in bringing the importance of controlling this form of pollution to the attention of their patrons.

Applicability

This management measure is applicable to marina managers and boat owners. Although marina managers have no control over the implementation of many of the BMPs mentioned in this section, particularly those applicable to privately owned and operated watercraft, aware-ness of the issues associated with boat engines and their maintenance is important because engines are potential sources of nonpoint source pollution and their operation and maintenance have the potential to affect marina waters.

Best Management Practices

- ♦ *Promote the installation and use of fuel/air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into surface waters during fueling.*

Often during fueling operations fuel overflows from the air vent from the built-in fuel tank on a boat. Attachments for vent lines on fuel tanks, which act as fuel/air separators, are available commercially and are easily installed on most boats. These devices release air and vapor but contain fuel before it can overflow. Marinas can make these units available in their retail stores and post notices describing their spill prevention benefits and availability.

♦ *Avoid overfilling fuel tanks.*

Fuel expands as it warms and the temperature in a boat's fuel tank usually is much higher than that in the storage tank, especially an underground tank. While fueling, a distinctive change in sound occurs when a tank is almost full. Filling can be stopped at this time, leaving a small amount of space in the tank to allow for expansion of the fuel with temperature changes. Without this space, fuel in a completely filled tank can spill out when the fuel expands. Automatic shutoff nozzles might not stop fuel flow before some fuel spillage occurs through the air vent, and listening for the sound of the almost-full tank is the best way to know when to stop filling. Having an oil absorbent pad ready to wipe up any drops is also a good fueling practice.

♦ *Provide "doughnuts" or small petroleum absorption pads to patrons to use while fueling to catch splashback and the last drops when the nozzle is transferred back from the boat to the fuel dock.*

Although few of us may be concerned about drops of fuel spilled onto the ground while we fill our car at the gas station, at the marina those drops can go directly into surface waters. There is no oil/water separator or catch basin to prevent drops at the marina fuel dock from entering the water, so using a little extra caution and taking precautions to prevent spills is good practice at the fueling dock. A doughnut placed over the fuel nozzle or a small absorbent pad in hand to catch any backsplash when the fuel tank is full and any drops that fall while the handle is replaced at the pump is an effective and easy way to prevent the small spills that can add up to big problems.

A small absorbent pad temporarily attached to the hull below the fuel tank air vent during fueling provides an added precaution against fuel spilling directly into surface waters. Pads that attach to vertical or horizontal surfaces with suction cups are commercially available. Properly dispose of all petroleum-containing materials as hazardous waste, or according to your local hazardous waste authority's recommendation.

> At Battery Park Marina on Lake Erie, staff cut absorption pads into squares, then cut an X-shaped hole in the center for the fuel nozzle to pass through. Any splashes while fueling are absorbed by the pad (USEPA, 1996: *Clean Marinas—Clear Value*).

♦ *Keep engines properly maintained for efficient fuel consumption, clean exhaust, and fuel economy. Follow the manufacturer's specifications.*

Well-tuned and maintained engines burn fuel more efficiently, improve mileage, and lower exhaust emissions. Mixing fuel for 2-cycle outboard engines according to the manufacturer's specifications (usually 50:1 fuel to oil) can help prevent inefficient burning.

♦ *Routinely check for engine fuel leaks and use a drip pan under engines.*

The best way to keep fuel and oil out of bilge water is to check for and fix small leaks, including making sure fuel lines are secure and inspecting them for wear.

♦ *Avoid pumping any bilge water that is oily or has a sheen. Promote the use of materials that capture or digest oil in bilges. Examine these materials frequently and replace as necessary.*

Marina operators can advertise the availability of oil-absorbing materials or can include the cost of installation of such material in yearly dock fees. A clause can be inserted in leasing agreements that requires boaters to use oil-absorbing materials in their bilges.

One oil spill response agent uses microbes to assist in cleaning up petroleum pollutants. Because it uses natural organisms, it is completely nonhazardous, nontoxic, and biodegradable. In independent tests by the National Environmental Technology Applications Corporation (NETAC), oil pollutants treated with the agent were reduced by up to 98 percent within 8 weeks.

The agent can be sprayed as a loose powder onto an oil spill, where it bonds with the oil and keeps it from sinking and harming aquatic life. Special socks containing the agent can be placed directly in boat bilges to absorb oil there. The socks can immediately absorb twice their weight in oil, and they continue to degrade oil so that one sock can be used for an entire boating season. Once the oil has been degraded, the agent degrades itself and the empty sock can be thrown away. Consumers should make sure that they are using an oil spill response agent that actually "eats" the oil rather than seemingly similar products that are pills made of biodegradable detergents. These are actually emulsifiers that only break oil down into smaller particles to be discharged into the water.

♦ *Extract used oil from absorption pads if possible, or dispose of it in accordance with petroleum disposal guidelines.*

If a container for recycling oil is available, boaters should place extracted oil into it. Recycled oil should be handled by a commercial waste oil hauler. If recycling is not an option, boat owners can place used pads in a sealed plastic bag and dispose of them with other oily wastes. All fuel- or oil-soaked materials should be stored together and removed by a certified waste hauler. Some booms can be cleaned and reused. Some materials can be recycled or burned as a heat source. If a marina doesn't have a used oil collection receptacle or program, a local department of environmental protection can be contacted for the location of the nearest used oil recycling station or collection point.

♦ *Prohibit the use of detergents and emulsifiers on fuel spills.*

Soaps, detergents, and emulsifying products should not be used on oil or petroleum spills because they only hide spills and seemingly make them disappear. They actually cause petroleum products to sink into the water, where the combination of fuel and detergent can harm aquatic life and make the pollutants difficult to collect. Use of detergent bilge cleaners is illegal and subject to a high fine imposed by the U.S. Coast Guard. Many bilge cleaners are actually detergents and their use should be discouraged as well because environmentally friendly alternatives exist.

BMP Summary Table 7 summarizes the BMPs for Petroleum Control mentioned in this guidance.

BMP Summary Table 7. PETROLEUM CONTROL MANAGEMENT

MANAGEMENT MEASURE: Reduce the amount of fuel and oil from boat bilges and fuel tank air vents entering marina and surface waters.

APPLICABILITY: Marina managers and boat owners.

ENVIRONMENTAL CONCERNS: Although more than half of the oil that spills into the water evaporates, less than a cup of oil can create a very thin sheen over more than an acre of calm water. Small amounts of oil spilled from numerous boats can accumulate to create a large oil sheen, that blocks oxygen from moving through the surface of the water and can be harmful to animals and larvae that must break the surface to breathe. The hydrocarbons in oil harm juvenile fish, upset fish reproduction, and interfere with the growth and reproduction of bottom-dwelling organisms. Oil and gas ingested by one animal can be passed to the next animal that eats it. In a marina, petroleum spills also dissolve the white Styrofoam in floats and docks and discolor boat hulls, woodwork, and paint. Gasoline spills, which evaporate quickly, are also a safety problem because of the flammability of gasoline.

PETROLEUM CONTROL PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Promote the installation and use of fuel/air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into surface waters during fueling	Boat; generally recommended	MODERATE benefit to boater; saves fuel and keeps hull cleaner	MODERATE; eliminates small but common spills from air vents	LOW	LOW	
Avoid overfilling fuel tanks	Fuel dock; universally recommended	HIGH; marina policy for staff and fuel dock customers will reduce small spills, saving cleanup costs and reducing visible oil slicks	HIGH; reduces small spills from air vent when boats return to slips as fuel warms up and expands	NONE	NONE to LOW	Fuel expands as it warms, and the temperature in a boat fuel tank might be higher than that in the fuel storage tank, especially an underground tank; very effective when coupled with installation of fuel/air separator in fuel vent line
Provide "doughnuts" or small petroleum absorption pads to patrons to use while fueling to catch splashback and the last drops when the nozzle is transferred back from the boat to the fuel dock	Fuel dock; universally recommended	HIGH; absorption pads are inexpensive and easily cut into smaller sizes for use by boaters; low technology and easy to use	HIGH; significantly reduces amount of small fuel spills in marina and visible petroleum sheens	LOW	LOW	If fuel absorbed is gasoline, do not store pad in an enclosed space until fumes have dispersed
Keep engines properly maintained for efficient fuel consumption, clean exhaust, and fuel economy. Follow the manufacturer's specifications	Marina area; universally recommended	LOW for marina; HIGH for boater; well-tuned and maintained engines burn fuel more efficiently; fewer exhaust fumes	HIGH; well-tuned and maintained engines produce fewer emissions and leak less to the water	LOW	LOW	

BMP Summary Table 7. (cont.) PETROLEUM CONTROL MANAGEMENT MEASURE

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Routinely check for engine fuel leaks and use a drip pan under engines	Boat storage area; recommended	MODERATE	MODERATE	LOW	LOW	Unattended boats with slow leaks can contaminate groundwater.
Avoid pumping any bilge water that is oily or has a sheen. Promote the use of materials that capture or digest oil in bilges. Examine these materials frequently and replace as necessary	Boats with inboard engines; universally recommended	MODERATE to HIGH; can sell oil-absorbing materials to customers; require that customers use oil-absorbing/ digesting materials in their bilges at all times while in marina	MODERATE to HIGH; an economical and effective approach to preventing release of oil in bilge water into surface waters	LOW	LOW	Prior to turning on the bilge pump, inspect the bilge to ensure that no oil or fuel is in the bilge water
Extract used oil from absorption pads if possible, or dispose of them in accordance with petroleum disposal guidelines	Marina; recommended	MODERATE; recycling and reusing (where possible) makes good economic sense	MODERATE to HIGH; recycling and reusing reduces raw material use	LOW	LOW	If recycling is not an option, boat owners should dispose of used pads in a sealed plastic bag for landfill disposal.
Prohibit the use of detergents and emulsifiers on fuel spills	Marina basin; universally recommended	MODERATE; using detergents is illegal and can result in fine by the U.S. Coast Guard	HIGH; soaps, detergents, and emulsifiers cause petroleum products to sink into water, making them impossible to remove	NONE	NONE	Because better alternatives exist, discourage use of detergent bilge cleaners

4.8. Liquid Material Management

Management Measure for Liquid Material Management:

Provide and maintain appropriate storage, transfer, containment, and disposal facilities for liquid material, such as oil, harmful solvents, antifreeze, and paints, and encourage recycling of these materials.

Management Measure Description

Marinas store a variety of liquid materials for boat and facility operation and generate various liquid wastes through the activities that occur on marina property. Adequate storage and disposal facilities are important if these materials are to be kept out of the environment. Proper storage is also important to ensure that liquid materials do not become contaminated while in storage and have to be disposed of prematurely. Marina patrons and employees are more likely to properly dispose of liquid wastes if adequate and safe disposal facilities are provided. Many states have mandatory or voluntary programs that address this management measure.

Proper storage and disposal of potentially harmful liquid materials can eliminate their entering marina waters and harming the aquatic environment, aquatic organisms, and marina or customer property. Liquid materials for sale or use at the marina, such as fuels, oils, solvents, and paints, should be stored in a manner that minimizes the chance of a spill and contains a spill if one occurs. Liquid wastes, such as waste fuel, used oil, spent solvents, and spent antifreeze, should be similarly stored until they can be recycled or disposed of properly.

Small quantities of many liquid wastes, including antifreeze, waste oil, pesticides, cleaners, solvents, and paints, can be harmful or deadly to people, wildlife, pets, fish, and other aquatic organisms. Discharge of these materials into marina waters not only is environmentally damaging but also destroys the overall clean, healthy environment that a marina can provide to its patrons. Dirty marinas affect boater satisfaction and present a poor image to prospective patrons. A clean marina reinforces the public image that boating is clean and that marinas are beneficial for the environment.

Regulations also play a role in proper liquid material and waste management. Approved spill protection materials and methods might be required by the local fire department and are necessary for marine environmental and liability insurance coverage. Regardless of whether a liquid waste material is eventually recycled or disposed of, careful documentation of how much material is collected, how it is removed from the facility, and where it is ultimately going is extremely important. These records are invaluable if there is ever any question from state or federal authorities about the marina's hazardous waste collection and disposal practices.

Marina staff and boaters should be informed about safe storage and disposal of liquid wastes. If a marina collects waste oil for recycling or disposal, precautions need to be taken to prevent contamination of one waste type with an incompatible type. Contaminated or mixed liquid wastes are very expensive to dispose of because commercial removal companies charge their highest rates for unknown mixtures. Some marinas have received costly fines by not controlling what is dumped into waste oil containers or who dumps materials into them. Holding tanks for liquid wastes should be kept locked, and a staff person should be responsible for moving waste from a collection site to the storage facility.

Applicability

This management measure is applicable to marinas where liquid materials used in the maintenance, repair, or operation of boats are stored.

Best Management Practices

With respect to all BMPs mentioned in this section, please consult with your state and local regulatory authorities for specific requirements and make sure your facility is in compliance. Where state and local regulations contradict the recommendations provided in this guidance, the facility must follow regulatory requirements.

♦ *Build curbs, berms, or other barriers around areas used for liquid material storage to contain spills.*

To contain spills, curbs or berms should be installed around areas where liquid material is stored. A general guide is to build berms or curbs to be capable of containing 10 percent of the total volume of liquid material stored or 110 percent of the volume of the largest container in storage, whichever is greater. Drains in the floor would defeat the purpose of the curbs or berms, so any drains present should be permanently closed.

♦ *Store liquid materials under cover on a surface that is impervious to the type of material stored.*

Containers of hazardous liquid materials are best stored in a protected place where rain will not lead to the containers' rusting and rupturing. It is equally important that the surface on which the containers are stored and of which the berms or curbs are made be impervious to the contents of the containers. If they aren't, a spill could quickly destroy the spill containment material and spread.

♦ *Storage and disposal areas for liquid materials should be located in or near repair and maintenance areas, undercover, protected from runoff, with berms or secondary containment, and away from flood areas and fire hazards.*

> Elliot Bay Marina (Washington) has its staff pick up almost any hazardous waste directly from the boat owner. This saves the potential high cost for disposing of hazardous materials that have been accidentally mixed by customers, thrown into dumpsters, or left on the dock where they could fall or leak into the water. This practice has worked well and has resulted in lower disposal costs, a spill-free marina, and happier customers who do not have to handle the waste product (USEPA, 1996: *Clean Marinas—Clear Value*).

♦ *Store minimal quantities of hazardous materials.*

A good idea is to conduct a regular review of the facility's hazardous materials inventory to identify any materials that can be stored in smaller amounts, or that are no longer needed or that have expired on the shelf. Buying only as much material as will be used within a year, or on a project basis, can save money and reduce waste.

♦ *Provide clearly labeled, separate containers for the disposal of waste oils, fuels, and other liquid wastes.*

Waste oils include waste engine oil, transmission fluid, hydraulic fluid, and gear oil. Waste fuels include gasoline, diesel, gasolines/oil blends, and water contaminated by these fuels. Other liquid materials of concern include used antifreeze/coolant, solvents, acetone, paints, and, if a restaurant is present, edible cooking oils and fats. Each of these liquids needs a separate container that is clearly marked to prevent mixing with other liquids and to assist in its identification for proper disposal. The containers should be covered in a

> Deep River Marina (Connecticut), Conanicut Marine Services (Rhode Island) and many other marinas use portable oil-changing units that use a vacuum tank to suction oil out of an engine through the dip-stick tube. The unit is rented to boaters for do-it-yourself oil changing (USEPA, 1996: *Clean Marinas—Clear Value*).

manner that prevents rainwater from entering them. Used oil filters are best drained before disposal by placing the filter in a funnel over the appropriate waste collection container. Waste should be removed from the marina site by someone permitted to handle such waste, such as a hazardous material contractor, and receipts and records of all materials disposed of and hauled away should be retained for inspection.

Paint cans with unused paint should be opened in well ventilated areas and left to dry until solid, then disposed of with normal trash. For information on how to handle particular types of hazardous wastes and which wastes are hazardous and which are not, contact a local extension service, waste hauler, or fire department.

♦ *Recycle liquid materials where possible.*

The decision to recycle is usually based on the type of waste and the availability of recycling facilities. Where a recycling program is available, consider participating and encouraging the participation of all marina patrons. Liquids that are often acceptable for recycling include waste or used oil and used antifreeze. Drop-off at a hazardous waste collection point may be necessary.

♦ *Change engine oil using nonspill vacuum-type systems to perform spill-proof oil changes or to suction oily water from bilges.*

♦ *Use antifreeze and coolants that are less toxic to the environment.*

Care should be taken to avoid combining different types of antifreeze/coolants. Propylene-glycol-based antifreeze (with a pink color) should be used because it is less toxic to the environment. Ethylene-glycol-based antifreeze (identifiable by its blue-green color) is very toxic to animals and should be recycled when it is used.

♦ *Use alternative liquid materials where practical.*

When possible, use low-toxicity or nontoxic materials, such as water-based paints and solvents and propylene-glycol antifreeze, in place of more toxic products. The use of nontoxic, high-bonding, easily cleaned coatings can be encouraged among marina patrons. Solvents with low volatility and coatings with low volatile organic compound (VOC) content are available, as are long-lasting and nontoxic antifouling paints.

♦ *Follow manufacturer's directions and use nontoxic or low-toxicity pesticides.*

At both marinas and boat launch sites, all pesticides (herbicide or insecticide) should be applied according to the directions provided on the container and should be applied by someone trained in pesticide application. All precautions should be taken to avoid allowing any pesticide to enter surface waters. Herbicides that are not toxic to aquatic life are safest to use. A local extension service is a good source of information on the relative safety of pesticides and where and when they can be safely applied. Using mulches in gardens and under shrubs can be as effective a method for controlling weeds and is more environmentally friendly than using herbicides.

♦ *Burn used oil used as a heating fuel.*

EPA permits burning used oil as a heating fuel (though some states might not permit it) if special high-temperature furnaces are used. This eliminates disposing of the used oil as a hazardous waste (Figure 4-14). Normally, the only oil that can be used as a fuel for high-temperature furnaces is that collected as part of normal maintenance and boat service work, but check with the furnace manufacturer. Also, verify that use of this system is permissible with the local environmental authority.

♦ *Prepare a hazardous materials spill recovery plan and update it as necessary.*

If large amounts of hazardous materials and/or wastes are stored even for short periods of time on marina property, a spill prevention and recovery plan should be adopted. The plan should list the types and volumes of materials that could potentially be spilled. This information is important because spill response action depends on the type of material spilled. A spill response plan for hazardous material can be integrated into an oil spill response plan and should include the same components:

- *Who*: Clearly identify who is responsible for taking what action.

Figure 4-14. West Access Marina (Illinois) installed a high-temperature furnace in 1993, which extended the marina's boat maintenance activities into and through the winter. The marina's engine maintenance service collects between 1,000 and 2,000 gallons of waste oil a year. It is collected in small containers and stored in a 1,000-gallon drum. The furnace burns very cleanly at 3,000 EF. The furnace saves the marina thousands of dollars each year in waste oil removal costs (USEPA, 1996: *Clean Marinas—Clear Value*).

- *What*: Explain what action should be taken during a spill event and, based on multiple scenarios, what equipment should be deployed.
- *When*: Specify when additional resources should be called for assistance.
- *Where*: Tell where the material is located in the facility.
- *How*: Explain how the equipment should be used and disposed of.

♦ *Keep adequate spill response equipment where liquid materials are stored.*

Equipment that is suitable for the variety of materials stored and can contain spilled material and prevent it from entering surface waters should be readily available near where spills are likely. Many hazardous materials do not remain on the water surface if they do enter surface waters, so absorbent materials should be used as soon as possible after a spill to contain them. These materials should then be disposed of properly.

BMP Summary Table 8 summarizes the BMPs for Liquid Material management mentioned in this guidance.

BMP Summary Table 8. LIQUID MATERIAL MANAGEMENT

MANAGEMENT MEASURE: Provide and maintain appropriate storage, transfer, containment, and disposal facilities for liquid material, such as oil, harmful solvents, antifreeze, and paints, and encourage recycling of these materials.

APPLICABILITY: Marinas where liquid materials used in the maintenance, repair, or operation of boats are stored.

ENVIRONMENTAL CONCERNS: Liquid material such as fuels, oils, solvents, paints, pesticides, acetone, cleaners, and antifreeze are potentially harmful or deadly to wildlife, pets, and humans and are toxic to fish and other aquatic organisms when they enter a waterbody. This is true for other types of liquid wastes such as waste fuel, used oil, spent solvents, battery acid, and used antifreeze. Waste oils include waste engine oil, transmission fluid, hydraulic fluid, and gear oil. Waste fuels include gasoline, diesel, gasoline/oil blends, and water contaminated by these fuels.

LIQUID MATERIAL MANAGEMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Build curbs, berms, or other barriers around areas used for liquid materials storage to contain spills	Designated work area; universally recommended	MODERATE; reduces loss of spilled liquids; containment makes for easy, less expensive cleanup	HIGH; provides extra protection by ensuring that if spills or leaks do occur, the hazardous liquids will be contained and not enter the water	MODERATE to EXPENSIVE	LOW	Check with local and state authorities before implementing any of these BMPs because regulations vary from location to location
Store liquid materials under cover on a surface that is impervious to the type of material stored	Designated work area; universally recommended	HIGH; properly protected containers should not rust or rupture; saves on cleanup costs	HIGH; impervious surface protects against the spreading of harmful liquids into the ground ifa spill does occur	LOW to MODERATE	LOW	
Storage and disposal areas for liquid materials should be located in or near repair and maintenance areas, undercover, protected from runoff, with berms or secondary contain-ment, and away from flood areas and fire hazards	Designated work area; universally recommended	MODERATE; more convenient to have the liquids storage area located near repair and maintenance	MODERATE; keeping storage area away from flood zones and fire hazards reduces risk of spills, leaching, or explosion	MODERATE to HIGH	LOW to MODERATE	

BMP Summary Table 8. (cont.) LIQUID MATERIAL MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Store minimal quantities of hazardous materials	Designated work area; universally recommended	MODERATE; reduces inventory and spill potential	MODERATE; reduces potential for environmental damage due to leaks, spills, or explosions	LOW	LOW	Check Occupational Safety and Health Administration (OSHA) and Resource Conservation and Recovery Act (RCRA) regulations for applicability; check with local and state regulatory authorities before using these BMPs
Provide clearly labeled, separate containers for the disposal of waste oils, fuels, and other liquid wastes	Designated work area; universally recommended	HIGH; expensive for waste haulers to remove an unknown mixture of substances, cheaper if substances are known	HIGH; ensures that each type of waste will be properly handled and disposed of	MODERATE	LOW to MODERATE	
Recycle liquid materials where possible	Designated work area; universally recommended	MODERATE to HIGH; in some locations recycling is cheaper than disposal	MODERATE; benefits beyond the marina	LOW	LOW to MODERATE	
Change engine oil using nonspill vacuum-type systems to make spill-proof oil changes or to suction oily water from bilges	Marina docks and dry work areas; generally recommended	MODERATE; can be a profit source for marinas; easy to use off-the-shelf equipment	HIGH; spill-proof container keeps oil out of water; easy to carry to recycling container	LOW	LOW	
Use antifreeze and coolants that are less toxic to the environment	Designated work areas; universally recommended	MODERATE; lower toxicity products protect the marina property and customer health	MODERATE; less toxic propylene-glycol based antifreeze (with PINK color) is much less toxic to animals	None	LOW	
Use alternative liquid materials where practical	Designated work areas - universally recommended	MODERATE; less toxicity to environment and human health, generally work just as well as more toxic products	MODERATE; reduces use of toxic substances and possibility that toxins will enter the water	LOW	LOW	Liquids such as water-based paints, propylene-glycol antifreeze, solvents with low volatility, coatings with low volatile organic compounds, and longer-lasting or non-toxic antifouling paints can be used and promoted
Follow manufacturer's directions and use non-toxic or low-toxicity pesticides	Designated work areas; universally recommended	MODERATE; reduces risk to human health, pets, chilcren	MODERATE; reduces toxicity to aquatic life	LOW	LOW	Cooperative Extension Service can provide information on pesticide safety and use

BMP Summary Table 8. (cont.) LIQUID MATERIAL MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Burn used oil as a heating fuel	Designated work areas; universally recommended	HIGH; cost-saving measure because it eliminates cost of waste oil removal and extends maintenance activities through the winter	HIGH; any reuse of oil reduces the use of fossil fuels	MODERATE	LOW	Allowed only in special high-temperature furnaces; check with local and state authorities before using
Prepare a hazardous materials spill recovery plan and update it as necessary	Designated work areas; universally recommended	MODERATE; ensures more efficient cleanup in the event of a spill; helps reduce liability exposure	MODERATE; planning and training reduce chance and volumes of spills	LOW	LOW	May be integrated into an oil spill response plan
Keep adequate spill response equipment where liquid materials are stored	Designated work areas; universally recommended	MODERATE; having equipment available will control spills faster; helps reduce liability exposure	MODERATE; equipment must be suitable for the variety of materials stored	LOW to MODERATE	LOW to MODERATE	Many hazardous materials do not remain on the water, so absorbent materials should be used to contain them

4.9. SOLID WASTE MANAGEMENT

Management Measure for Solid Waste:

Properly dispose of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of solid wastes to surface waters.

Management Measure Description

This management measure is focused on controlling the solid waste that can collect at marinas and boat ramp sites if waste receptacles are not provided and conveniently located or if sufficient attention is not given to controlling waste produced during boat cleaning, maintenance, and repair activities. Many of the management practices that are useful for reducing solid waste production during boat maintenance activities are discussed under the Storm Water Runoff management measure because much of the solid waste produced during boat maintenance activities could potentially be carried to surface waters in storm water runoff. Please refer to the discussions of those management practices under the Storm Water Runoff management measure.

The purpose of this management measure is to prevent solid waste from polluting surface waters. Solid waste from boat cleaning, maintenance, and repair might contain harmful substances such as antifoulant paint chips or solvents used to clean or polish metal or wood parts. Solid waste from general activities and marina use, such as plastic bags, cups, cigarette butts, and food containers, also pollutes surface waters and degrades the habitats of aquatic animals and plants. The simple act of picking up and properly disposing of trash goes a long way toward preventing this form of nonpoint source pollution.

Marinas that appear clean because litter is not a visual problem are also more attractive to customers when they are shopping for a place to dock their boats or when the time comes to sign a new slip rental lease. Cleanliness at a marina can also lead to public recognition and to fewer complaints about flat tires or floating trash in slips. Substantial cleanup costs can be replaced by small initial investments in trash collection and preventive practices (Figure 4-15). The investment in some clean marina practices can be recovered by renting equipment such as dustless sanders or selling items such as filter cloth to boat owners.

Providing sufficient waste receptacles, separating wastes into classes of recyclables, and preventing litter are all accepted practices today and are part of customer service and environmentally friendly management at any public establishment. Marinas generate solid waste through boat maintenance, parties and small social gatherings on boats, restaurants, commercial activity at the marina, and the day-to-day operation of the facility

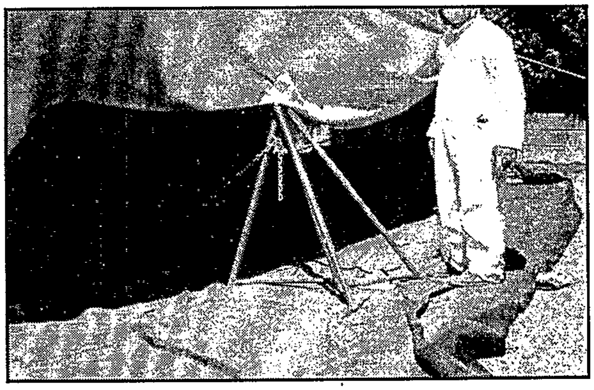

Figure 4-15. Filter cloths to capture debris. Port Annapolis Marina (Maryland) uses geotextile screening cloths to capture the normal sanding and scraping debris, as well as screws, nails, and other solid materials. This reduces cleanup time and improves appearance (USEPA, 1996: *Clean Marinas—Clear Value*).

(Figure 4-16). If adequate trash and solid waste disposal facilities are not available, solid waste is more likely to end up in surface waters or scattered on the marina grounds, from which it might be blown or washed into surface waters. Marina patrons and employees are more likely to properly dispose of solid waste if given adequate opportunity and disposal facilities. In fact, under federal law, marinas and port facilities must supply adequate and convenient waste disposal facilities for their customers.

Applicability

This management measure is applicable to all marinas. Many of the BMPs mentioned here are directed at boat owners and users, and the information is provided here so that marina managers are aware of the potential nonpoint source pollution problems.

Best Management Practices

♦ *Encourage marina patrons to avoid doing any hull maintenance while their boats are in the water.*

The quantity of debris discarded into the marina basin from boat maintenance activities can be minimized by limiting in-the-water boat maintenance to tasks (such as propeller work and hull inspection) that do not remove paint and other solid materials. Dustless sanders can be used for topside work in slips, and tarps can be laid out between a boat and the dock to catch any debris.

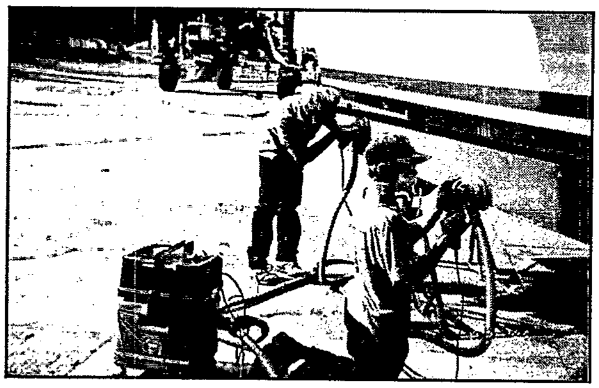

Figure 4-16. Vacuum sanders. Employees at The Lodge of Four Seasons Marina (Missouri) use vacuum or "dustless" sanders to prepare hulls for painting, reducing waste in the environment and cleanup time (USEPA, 1996: *Clean Marinas— Clear Value*).

It can be very difficult to do any hull maintenance while the boat is in the water without some debris falling into the water, and some marina managers require that all work be done on land. If feasible, limit in-the-water hull maintenance to cleaning, preferably without the use of cleansers. (See the Boat Cleaning management measure).

♦ *Place trash receptacles in convenient locations for marina patrons. Covered dumpsters and trash cans are ideal.*

Many people don't want to put their trash anywhere but in a trash receptacle. For these people, and to encourage those who might otherwise consider dropping trash on the ground to use trash receptacles, waste disposal facilities should be conveniently located near repair and maintenance areas, in parking lots, on docks, and in heavy-use areas, such as near grassy areas where people picnic and in parking lots. Covered trash receptacles do not fill up with water when it rains, do not lose their contents to strong winds, and are less likely to be invaded by scavenging mammals and birds. A loose cover also acts as an indicator that a receptacle is full. The best overfill prevention is frequent emptying by marina staff.

♦ *Provide trash receptacles at boat launch sites.*

Trash disposal can be a big problem at boat launch ramps. Boat launch sites are often the most convenient access point to waterbodies, and people from nearby areas, the non-boating public, or those not using the launch ramp for boat launching (e.g., those who use the site for picnicking, swimming, or shore fishing) deposit their trash in the receptacles provided for boaters at the site. If trash receptacles are provided at the launch site, this use can be expected, and a pick-up schedule should be arranged accordingly. Some states (e.g., Maine and Minnesota) have experimented with removing trash receptacles from boat launch sites because overflowing trash receptacles and litter strewn on the ground can result from providing trash receptacles that are insufficient to accommodate the trash from many users. Some people leave their trash atop an overflowing trash receptacle or beside one rather than taking it with them, thinking it will be picked up by someone whose job it is to do so. Maine and Minnesota have found that when trash receptacles are removed the boating public generally does not complain and takes their trash with them. Litter can actually cease to be a problem after trash receptacles are removed in these instances. If it is decided not to provide trash receptacles, posting signs that ask people to "*Pack it out!*" can reduce the amount of trash left at the site.

♦ *Provide facilities for collecting recyclable materials.*

Recycling of nonhazardous solid waste such as scrap metal, aluminum, glass, wood pallets, alkaline batteries, paper, fishing line and nets, and cardboard is recommended wherever feasible. Recyclable hazardous solid waste such as used lead-acid batteries and used oil filters, should be stored on an impervious surface, under cover, and sent to or picked up by an approved recyclable materials handler. Often a recycling rebate is paid to the marina for each battery.

Where recycling is available through the municipality, it can be a cost-effective way to decrease trash disposal costs. Public education is necessary if a recycling program is to be effective, though today many people recycle at their homes and already have a "recycle" consciousness. Hazardous and nonhazardous wastes are collected for recycling separately.

Although recycling is a preferred disposal method for reusable materials, not all municipalities provide the service free of charge. Recycling can be performed in-house, but private service providers are often costly. In such a case, the quantity of waste produced can be lessened by reusing materials and sharing leftover cleaning and maintenance supplies (e.g., excess varnish and paint) among customers. A marina can place a bulletin board up for notices from patrons about extra supplies that are available or can provide some sort of materials exchange program.

> The All Seasons Marina (New Jersey) cut its trash bill in half by taking advantage of the local solid waste recycling program. The Cap Sante Boat Haven (Washington) participates in a municipal recycling program and saves 10 to 20 percent on its annual trash removal bill. The marina rents 28 recycling bins from the town and places them at dock heads for customers' convenience (USEPA, 1996: *Clean Marinas—Clear Value*).

♦ *Encourage fishing line collection and recycling or disposal.*

Lost or discarded fishing line and netting in aquatic environments is extremely dangerous to aquatic life. Providing educational materials about the dangers these materials pose and receptacles or a location where marina patrons can dispose of unwanted fishing line and nets could help reduce the magnitude of the problem. Information on debris problems is available from the Center for Marine Conservation at <www.cmc-ocean.org>.

♦ *Provide boaters with trash bags.*

Boaters can be encouraged to bring all of the trash they generate while boating back to an onshore trash receptacle by providing them with a plastic bag or other suitable trash container. Imprinted with a marina's logo, the bag will carry the clear message that the marina cares about the environment.

♦ *Use a reusable blasting medium.*

New technologies are available that make use of a plastic blasting medium that can be reused several times until it wears out. The medium is used to remove antifoulant paint and is vacuumed into a hopper along with the debris for recovery, cleaning, and reclaiming (Figure 4-17). The much smaller volume of debris is collected and sent to a landfill.

♦ *Require patrons to clean up pet wastes and provide a specific dog walking area at the marina.*

Where floating piers extend far from the grassy areas of a marina, dog waste can become a problem, leading to many complaints from staff and boat owners. In many cities, dog owners are required to clean up after their pets when they

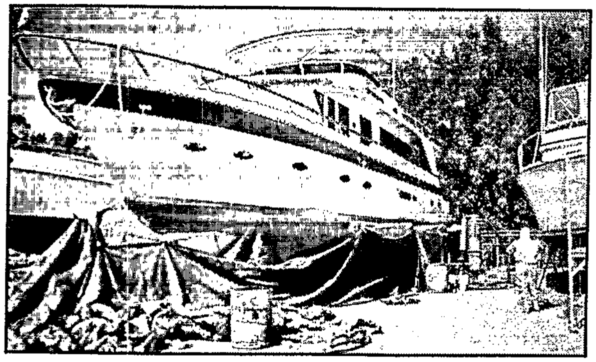

Figure 4-17. Associated Marine Technologies (Florida) took prevention of hull sand-blasting debris a step further by switching from a silica wet/dry sandblasting medium to a closed system that employs a reusable plastic material. The facility uses a high-capacity plastic-medium-blasting dry stripper and a media reclaimer that recovers the plastic material and separates it from the paint dust. This process significantly reduces the cost of cleanup and disposal, gives a higher-quality surface, and is much less aggressive on the gelcoats of fiberglass hulls (USEPA, 1996: *Clean Marinas—Clear Value*)

walk them on public streets and parks. A similar policy can take care of this problem at marinas.

BMP Summary Table 9 summarizes the BMPs for Solid Waste Management mentioned in this guidance.

BMP Summary Table 9. SOLID WASTE MANAGEMENT

MANAGEMENT MEASURE: Properly dispose of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of solid wastes to surface waters.

APPLICABILITY: All marinas. Many of the BMPs mentioned here are directed at boat owners and users, and information is provided here so that marina managers are aware of potential nonpoint source pollution problems.

ENVIRONMENTAL CONCERNS: Boat maintenance, painting and repair can result in a range of waste materials, such as sanding debris, antifoulant paint chips, scrap metal, fiberglass pieces, sweepings, and battery lead and acid. Other solid waste such as bottles, plastic bags, aluminum cans, coffee cups, six-pack rings, disposable diapers, wrapping paper, glass bottles, cigarette filters, and fishing line can come from general boating activities and marina use. Living organisms and the habitats of aquatic animals and plants are harmed by this type of debris after it enters the water. A litter-free marina is more attractive to present and potential customers. Reducing a marina's solid waste also reduces overall disposal costs.

SOLID WASTE MANAGEMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Encourage marina patrons to avoid doing any hull maintenance while their boats are in the water	Marina dock area; recommended	MODERATE; less debris will end up in the marina basin, improving appearance	LOW to MODERATE; any maintenance work on a boat in a slip is more likely to pollute and harder to control; reasonable attempts at cleaner practices will reduce pollution going into the water	LOW to MODERATE	LOW to MODERATE	Ensure that any in-water boat maintenance does not remove paint from the boat hull
Place trash receptacles in convenient locations for marina patrons. Covered dumpsters and trash cans are ideal	Marina-wide; universally recommended	HIGH; convenient trash containers will be used if placed near access to docks; encourages staff and customers to help keep grounds clean	HIGH; covers control animal and bird access and prevent windblown litter from entering the water	LOW per unit	LOW to MODERATE	Secure containers near docks or the water to avoid accidental spillage; label containers to promote placement of different waste types in separate containers
Provide trash receptacles at boat launch sites	Boat launch sites; universally recommended	HIGH; a litter-free launch site is more attractive to boaters; encourages them to keep it clean	MODERATE; use of trash containers reduces volume of litter entering water	LOW per unit	LOW to MODERATE	Isolated public launch ramps may become household dump for residents in rural areas, a problem that has many states discouraging use of trash receptacles
Provide facilities for collecting recyclable materials	Marina-wide; universally recommended	MODERATE to HIGH; recycling decreases trash disposal costs; popular with the public; good for business image; scrap metals have highest cost recovery value	MODERATE; recycling has environmental benefits beyond the marina by reducing volume going to landfills, and as resource for manufacturers	LOW	LOW	Recycling is best done where provided through the municipality; clearly mark each receptacle for different type of recyclable

BMP Summary Table 9. (cont.) SOLID WASTE MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Encourage fishing line collection and recycling or disposal	Marina-wide; universally recommended	NONE to LOW; marina may be collecting trash it otherwise wouldn't have to dispose of	MODERATE to HIGH; entanglement in discarded or lost fishing line takes the lives of thousands of aquatic animals each year	LOW	LOW	Appropriate to combine with a public education effort
Provide boaters with trash bags	Marina work area; generally recommended	HIGH; encourages boaters to collect their trash and not discard it overboard, in the marina or at sea; reduces time spent on cleanup at marina	HIGH; all trash collected does not go into the water or blow around the marina as litter	LOW	LOW	
Use a reusable blasting medium	Marina work area; generally recommended	HIGH; cost savings can result by separating out dust and reusing blasting material	HIGH; significantly reduces volume of waste for disposal	MODERATE	MODERATE	More practical and cost-effective for high-volume boatyards, which do a lot of hull blasting
Require patrons to clean up pet wastes and provide an area specifically for dog walking at the marina	Marina-wide; universally recommended	HIGH; pet waste on docks, walks, and beaches is a serious complaint by marina customers; signs and use of pest waste disposal bags work and reduce complaints from other boaters; when dogs have a place to go, the docks and walks are cleaner; saves cost of staff time to clean up	HIGH; pet waste contains harmful bacteria, lowers water quality, and contaminates shellfish; BMP reduces the possibility that pet waste will enter the water; keeps waters clean	LOW	LOW	Signs should clearly mark the dog walkingarea as well as encourage patrons to clean up after their pets; providing disposable scoop bags encourages this practice and saves staff cleanup time.

4.10. Fish Waste Management

Management Measure for Fish Waste Management:

Promote sound fish waste management through a combination of fish-cleaing restrictions, public education, and proper disposal of fish waste.

Management Measure Description

Fish waste can create water quality problems at marinas where a lot of fish are landed. This might be the case where long piers or breakwaters provide access to deep water or accommodation for many fishers, where fishing tournaments are held, or at any marina during the local high fishing season. The waste from fish cleaning shouldn't be disposed of into a marina basin because of the chance of overwhelming the natural ability of the waterbody to assimilate and decompose it. The dissolved oxygen consumed by the decomposing fish parts can cause anaerobic, foul-smelling conditions. Unconsumed or floating fish parts are also an unattractive addition to the marina property. Fish waste is better disposed of in offshore waters (if the state allows) where the fish are caught, or treated as waste like any other and deposited in trash containers.

Proper disposal of fish waste by marina patrons helps keep marinas clean and free of waste. Although only a few marinas deal with large amounts of fish waste or fishing within the basin, sport fishers can be found at most marinas, and it is a good idea for marinas to promote proper fish waste disposal. Fish cleaning stations provide convenient places for marina patrons to clean fish and dispose of their waste material, and they help to keep the rest of the marina clean. Marina managers often find that once a good fish cleaning station is available to fishing patrons, the patrons gladly use it because gutting a fish at a fish cleaning station avoids the mess created on a boat or dock. Non-fishing marina patrons are likely to appreciate not having fish waste on docks or floating near their boats.

Some states prohibit fish waste from being discarded in nearshore waters and require that marinas prohibit the practice. Without a designated place to clean fish, docks, piers, and bulkheads can become dirty quickly.

Applicability

This management measure is applicable to marinas where fish waste is determined to be a source of water pollution. Many of the BMPs mentioned for this management measure are implementable by marina patrons and are not directly under the control of marina managers.

Best Management Practices

♦ *Clean fish offshore where the fish are caught and discard of the fish waste at sea (if allowed by the state).*

Fish waste can be disposed of in the offshore ecosystems from which the fish are caught. The quantity of fish waste produced from recreational fishing generally should not cause any water quality problems in open waters. Some states (such as Florida) require that all game fish be brought ashore intact for measurement by fisheries officials, and this management practice does not apply.

♦ *Install fish cleaning stations at the marina and at boat launch sites.*

A fish cleaning station is a particular area set aside for cleaning fish that have been caught. It typically has a cutting table large enough to accommodate a few to many people, a freshwater hose or other form of running water, and receptacles for the waste. Boaters and fishers can be informed of the presence of the station and encouraged to use it. To keep the stations attractive and sanitary, they should be cleaned frequently, even as often as after each use. Making the station convenient to use and clean will encourage people to keep it clean themselves. Fish waste is placed in covered containers, and the collected waste is disposed of with other solid waste or by some other environmentally friendly means. (Refer to the next management practice.) If nutrient enrichment is not a problem in regional waters, fish cleaning stations can use garbage disposal units to grind the waste and then send the ground waste to a municipal sewer line for waste disposal. As always, when state or local regulations could be applicable, check with the environmental authority to determine whether they apply.

Where extensive fishing is done from a boat launch site, fish cleaning stations can be helpful. Fish waste disposal is a problem at boat launch sites because boaters return from fishing and usually want to clean their catch before they leave. Fish cleaning stations provide the ideal facility where fishers can gather to discuss their catch and clean it before heading home. As with a marina fish cleaning station, fish waste can be collected in covered containers and disposed of like regular trash or ground and emptied into a local sewage disposal system (where local regulations permit). An alternative approach would be to install an onsite disposal system with a holding tank, though this is not recommended where waterbodies have nutrient enrichment problems.

♦ *Compost fish waste where appropriate.*

A law passed in 1989 in New York forbids discarding fish waste, with exceptions, into fresh water or within 100 feet of shore. Contaminants in some fish leave few alternatives for disposing of fish waste, so Cornell University and the New York Sea Grant Extension Program conducted a fish composting project to deal with the more than 2 million pounds of fish waste generated by the salmonid fishery each year. In the demonstration project, fish parts were mixed with peat moss and the mixture quickly turned into an excellent compost suitable for gardens. The study found that even with this quantity of waste, if composting was done properly, the problems of odor, rodents, and insects were minimal and the process was effective. Another method of fish waste composting, described by the University of Wisconsin Sea Grant Institute, is suitable for amounts of compost ranging from a bucketful to the quantities produced by a fish-processing plant. A local Extension Service can be contacted for information on locally applicable composting procedures and equipment and where supplies can be purchased.

♦ *Freeze fish parts and reuse them as bait or chum on the next fishing trip.*

Fishers may consider recycling their own fish waste into bait for their next fishing trip. The fish parts from one fishing trip can be placed in a plastic bag, frozen, and then used on the next excursion as bait or offshore chum to attract game fish.

♦ *Encourage catch and release fishing, which does not kill the fish and produces no fish waste.*

The increasingly popular practice of "catch and release" by recreational and competitive fishermen is reducing the fish waste problem at many marinas.

BMP Summary Table 10 summarizes the BMPs for Fish Waste Management mentioned in this guidance.

BMP Summary Table 10. FISH WASTE MANAGEMENT

MANAGEMENT MEASURE: Promote sound fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.

APPLICABILITY: Marinas where fish waste is determined to be a source of water pollution. Many of the BMPs mentioned for this management measure are implementable by marina patrons and are not directly under the control of marina managers.

ENVIRONMENTAL CONCERNS: Sportfishing is very popular, but fish cleaning produces waste that can create water quality problems in marinas with poor circulation. Too much fish waste in a confined area can lower oxygen levels in the water, which leads to foul odor and fish kills. Floating fish parts are also an unsightly addition to marina waters.

FISH WASTE MANAGEMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Clean fish offshore where the fish are caught and discard of the fish waste at sea (if allowed by the state)	Boats offshore; generally recommended	HIGH; a marina free of fish waste is more pleasant to current and potential customers	HIGH; dispersed disposal of fish waste in open water causes no ecological problems; fish parts become food for seabirds and other animals	NONE	NONE	Check to see if offshore disposal of fish waste is allowed; encourage this practice where permitted
Install fish cleaning stations at the marina and at boat launch sites	Marina near docks; generally recommended	HIGH; fish cleaning stations are popular; avoids the mess created from cleaning fish on boat or dock; can reduce complaints from other marina customers about waste	HIGH; keeps fish waste out of the water if properly used; does not attract sea birds which can foul boats, docks, and the water	LOW to EXPENSIVE	LOW to MODERATE	Waste can be disposed of like regular trash or ground-up and emptied into local sewage system (where local regulations permit)
Compost fish waste where appropriate	Marina near fish cleaning station; generally recommended	HIGH; excellent natural way to convert waste into useful mulch and soil additive for marina landscape use; reduces waste disposal costs	MODERATE; composted fish waste makes a very effective soil additive, which also organically fertilizes marina landscaping	LOW	LOW	Contact a local Extension Service for information on how to compost properly
Freeze fish parts and reuse them as bait or chum on the next fishing trip	Fish cleaning station; generally recommended	HIGH; when practical, reusing fish parts for bait keeps waste out of marina	HIGH; produces no waste in the marina	NONE	NONE	Educate boaters to encourage this practice; a practical idea, but may not have occurred to all fishers
Encourage catch and release fishing, which does not kill the fish and produces no fish waste	Boats offshore; universally recommended	HIGH; keeps fish waste out of marina	HIGH; produces no waste; returns fish alive to their habitat	NONE	NONE	Can be a way to involve people who don't fish in an environmentally friendly way

4.11. Sewage Facility Management

> Management Measure for Sewage Facilities:
>
> ***Install pumpout, dump station, and adequate restroom facilities at marinas to educe the release of sewage to surface waters. Design these facilities to allow ease of access, and post signage to promote use by the boating public.***

Management Measure Description

Boat sewage can be a problem when discharged into surface waters without pretreatment. It is similar to situations in which discharges of municipal sewage close beaches when heavy rainstorms overburden sewer systems and rainwater mixed with raw sewage is discharged directly to surface waters through combined sewer overflows. Sewage from boats is more concentrated than that from either combined sewer overflows or sewage treatment plants because marine heads use little water for flushing and the sewage in marine heads is not diluted by water from bathing, dishwashing, or rain. Boat sewage contains nutrients that can stimulate growth of aquatic plants (algae and large aquatic plants) and pathogens (fecal coliform bacteria and viruses), which can cause human health problems directly through contact in the water or indirectly through the consumption of contaminated seafood.

Progress has been made toward eliminating discharges of sanitary waste from boats with the designation of no discharge zones, installation of pumpouts nationwide, and growing number of boater education programs. Efforts to reduce sewage discharges and to educate boaters about the damage they cause need to continue, and marinas can play a direct and important role in these matters.

Pumpout facilities and restrooms should be installed at new marinas and, where feasible, at existing marinas. Most states encourage the installation and use of pumpouts through the federal Clean Vessel Act (CVA) Grant Program and boater education.

Boaters and marinas are usually not considered primary sources of pathogen contamination in surface waters. Measurements of fecal coliform (*Escherichia coli*) bacteria are used as an indicator of sewage contamination in surface waters. It is often hard to attribute high coliform bacteria levels directly to any particular source, and within an area many potential sources are often present. Background coliform levels from runoff polluted with pet waste and droppings of waterfowl can be high, septic systems in an area might be poorly maintained or operating improperly, municipal sewage systems might have leaks, and boaters in marinas might be discharging untreated or insufficiently treated waste into surface waters. This management measure addresses all potential sources of sewage pollution to surface waters. Boaters and marinas, in particular, have a vested interest in clean waters, because the livelihood of marinas and the recreational benefits boaters derive from use of the waters are clearly linked to clean water.

Type I and II marine sanitation devices (MSDs) are used to pretreat boat sewage before discharging it overboard (except in a no discharge zone) if not prohibited by local ordinances. In an area designated as a no discharge zone, MSDs of all types must be configured to prevent discharge to surface waters and all sewage must be pumped out. Type III MSDs are holding tanks. They must be emptied into sewage treatment systems and cannot be discharged overboard. It is strongly recommended that holding tanks equipped with Y-valves have the valves in the closed position to prevent accidental discharge into boating waters. Pumpout use and no discharge zone designations have improved water quality in many areas, so that shellfishing and aquaculture, once prohibited because of high bacterial concentrations, are allowed again. A description of the types of MSDs is provided in Section 3.

Chemicals are used in holding tanks to retard the normal aerobic digestion of sewage and release of noxious odors. Some concern has been expressed about the effect that these chemicals might have on municipal sewage treatment systems (that is, the possibility of interfering with bacterial digestion in the first stages of sewage treatment) when boater sewage is transferred to a municipal sewage system. Studies of this effect have found that neither the chemicals nor the concentration of marine wastes is a problem for any properly operating public sewage treatment plant.

Two of the most important factors in successfully preventing sewage discharge from boats are providing adequate and reasonably available pumpout facilities and conducting a comprehensive boater education program. Congress passed the Clean Vessel Act (CVA) in 1992 to help reduce pollution from vessel sewage discharges by providing funding to states for the installation of adequate pumpout facilities (Figure 4-18). The act established a 5-year (1992–1997) federal grant program administered by the U.S. Fish and Wildlife Service that authorized funding from the Sport Fish Restoration Account of the Aquatic Resources Trust Fund for use by states. The act was renewed for a second 5-year period in 1998. Grants are available from the CVA grant program to both private and public marinas for the construction, renovation, operation, and maintenance of pumpout stations and waste reception facilities. Further information about CVA grants and the grant program is available at the U.S. Fish and Wildlife web site at <http://fa.r9.fws.gov/cva/cva.html>.

Applicability

This management measure is applicable to marinas where adequate pumpout, dump station, and restroom facilities do not exist.

Figure 4-18. Pumpout station logo (Clean Vessel Act).

Best Management Practices

♦ *Install pumpout facilities and dump stations. Use a system compatible with the marina's needs.*

Three types of onshore sewage collection systems to handle sewage from boat holding tanks and portable toilets are available—fixed point systems, portable/mobile systems, and dedicated slipside systems (Figure 4-19).

- Fixed-point systems.

Fixed-point collection systems include one or more centrally located sewage pumpout stations. The stations are usually located at the end of a pier, often on a fueling dock, so that fueling and pumpout operations can be done at the same time. A boat that needs pumpout service moves to the pumpout station; a flexible hose is connected to the wastewater fitting in the hull of the boat; and pumps or a vacuum system move the wastewater to an onshore holding tank, a public sewer system,a private treatment facility, or another approved disposal facility.

- Dump stations for portable toilets.

Where boats in a marina use only small portable (removable) toilets, a satisfactory disposal facility is a dump station, which is fundable with a CVA grant.

- Portable systems.

Portable/mobile systems are similar to fixed-point systems and in some situations can be used in

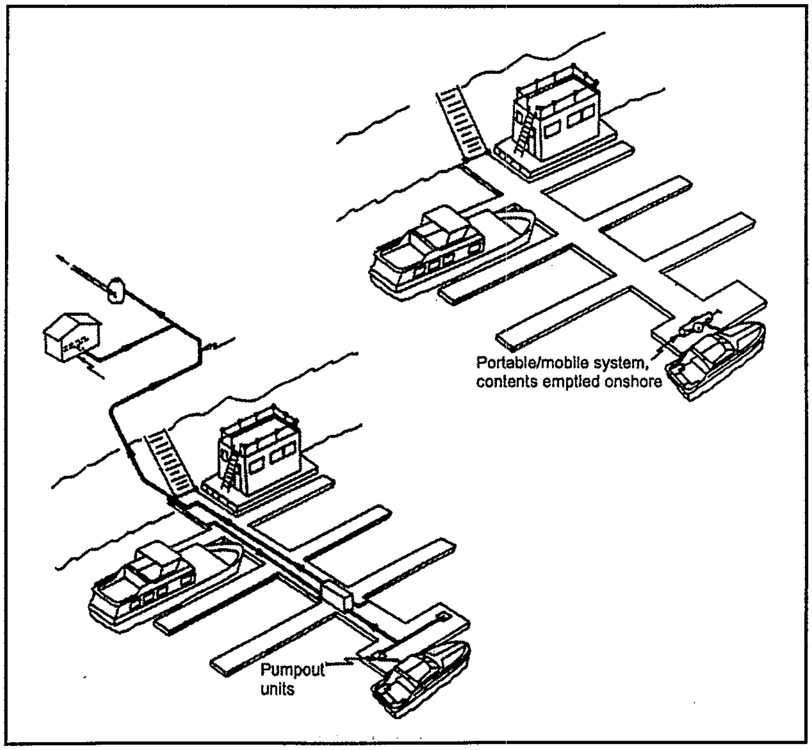

Figure 4-19. Examples of Pumpout systems

their place at a fueling dock. A portable unit includes a pump and a small storage tank. The unit is moved to a boat where the boat is docked. The unit is connected to the deck fitting on the vessel, and wastewater is pumped from the vessel's holding tank to the pumping unit's storage tank. When the storage tank is full, the portable unit is taken to a location where its contents can be discharged into a municipal sewage system or a holding tank for removal by a septic tank pumpout service.

Some marinas use a smaller mobile pumpout unit that does not have a holding tank attached but instead pumps directly from the boat, through a pump hose, and into a hose fitting in each slip that is connected to a below-dock, gravity-drained sewer pipe system.

Because boaters do not have to move their boats to a special location to use the systems and marinas do not have to install extensive dockside piping and pumping systems to provide pumpout service, portable pumpout facilities might be the most feasible, convenient, accessible, regularly used, and affordable way to ensure proper disposal of boat sewage.

Mobile systems have to be moved about a marina, and this factor should be considered when determining the correct type of system for a marina. One type of portable/mobile type of pumpout unit that is popular in the Great Salt Pond in Block Island, Rhode Island, is the radio-dispatched pumpout boat. The pumpout boat goes to a vessel in response to a radio-transmitted request, pumps the holding tank, and then moves on to the next vessel requesting a pumpout. This approach eliminates the inconvenience of lines, docking, and maneuvering vessels in high-traffic areas. Pumpout boats and mobile systems are also fundable with a CVA grant.

- Dedicated slipside systems.

Dedicated slipside systems provide continuous wastewater collection at select slips in a marina. Slipside pumpouts are particularly suited to liveaboard vessels, and dedicated slipside pumpout points can be provided to slips designated for liveaboards while the remainder of the marina is served by a fixed-point or mobile pumpout system.

In a dedicated system, direct connections are made between the boat and a below-dock gravity-drained sewer pipe system (Figure 4-20). This requires use of a vacuum-type pumpout system, which evacuates the entire line and the boat holding tank. The landside vacuum pumpout, which has its own holding tank, can discharge directly into a large inground holding tank or to a municipal sewer system.

♦ *Provide pumpout service at convenient times and at a reasonable cost.*

Use of pumpout stations increases if they are made available at times of day when customers want to use them. Pumpout availability during

Figure 4-20. Pumpout system at Hall of Fame Marina (Florida). Accommodating dozens of yachts more than 100 feet LOA, the marina's pumpout system includes below-dock sewer pipes and connectors of each slip (USEPA, 1996: *Clean Marinas—Clear Value).*

regular marina hours or when the fuel dock is also open (if the pumpout station is located next to the fuel station) has been found to work well. Pumpout stations should be available to all boats that are able to access them and cannot be restricted to marina members. Fees of up to $5 are federally allowed under the CVA grant program, and high fees often decrease pumpout use.

- ♦ *Keep pumpout stations clean and easily accessible, and consider having marina staff do pumpouts.*

Free pumpouts are certainly an attraction for customers, but cleanliness and ease of use are popular features as well. Customers are more likely to use pumpouts if they are kept clean and neat and directions for their use are clearly posted. Having a marina employee do pumpouts for patrons is a real service that patrons appreciate, especially if the staff person is skilled in use of the pumpout and is knowledgeable of the rules pertaining to marine sanitation devices (Figure 4-21). The ability of a pumpout station to attract new customers is magnified when pumpouts are free and done by marina staff.

- ♦ *Provide portable toilet dump stations near small slips and launch ramps.*

The vast majority of boats used in the United States are less than 26 feet in length, and more than half are less than 18 feet in length. Of those boats that have toilets onboard, most use portable units designed to be carried ashore for dumping into toilets. Boaters on these boats can be encouraged to dispose of their waste properly by providing portable toilet dump stations. The stations can be placed on docks or land where they are convenient to use and can be kept clean. Marinas should consider making at least one dump station available, even if the marina caters primarily to large boats. Public launch ramps should offer dump stations where feasible.

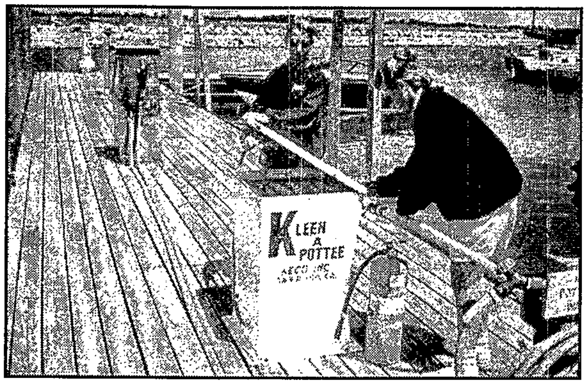

Figure 4-21. Management at Battery Park Marina (Ohio) found that most customers are willing to pump fuel but not their sewage. Dock staff at the marina, therefore, pump out the boats. Customers also often prefer to make a single stop for both fuel and a pumpout, and marinas that have made it convenient for boaters to do this (such as Battery Park Marina and Kean's Detroit Yacht Harbor in Michigan) have found that the arrange-ment leads to an increase in the volume of fuel sales as well as customer satisfaction (USEPA, 1996: *Clean Marinas—Clear Value).*

♦ *Provide restrooms at all marinas and boat ramps.*

Clean, dry, brightly lit restrooms in marinas are generally used in preference to boat toilets, especially if easy to access. Restrooms are the best way to reduce boat toilet use and thus decrease the potential for overboard discharge of untreated sewage. Where feasible, restrooms should be provided for those who use boat launch ramps. Restrooms are also an amenity that can increase user satisfaction.

♦ *Consider declaring marina waters to be a "no discharge" area.*

Federal law prohibits discharge of any untreated sewage into all territorial waters, including coastal waters to the 3-mile territorial limit, and inland waters of the Nation, but does allow use of Coast Guard-approved MSDs (Types I and II). A private marina that is not in a federal or state-designated no discharge zone may prohibit sewage discharges within the marina basin, if desired, with the addition of a clause to the slip rental contract stating that sewage discharge is not permitted (Figure 4-22). An attorney can add the appropriate language. Marina-specific no discharge policies will work if conditions are similar to those necessary to make federal or state-designated NDZs effective:

- Provision of adequate restroom facilities for marina patrons.
- Convenient and low-cost or free pumpout service at the marina.
- Adequate boater education.
- Signs that declare the marina's policy of no discharge.

Figure 4-22. An example of a sign declaring a "no discharge" marina.

- Contract language that is legally sufficient and easy to understand.
- Visible enforcement.

♦ *Establish practices and post signs to control pet waste problems.*

Many boats have dogs aboard, and the animals need an area to relieve themselves. The best way to control pet sewage is to provide a special area away from the shore for dogs to be taken and ask owners to clean up after their pets (Figure 4-23). A grassy area that is away from where people walk or children play is ideal.

♦ *Avoid feeding wild birds in the marina.*

The popular practice of feeding wild ducks, geese, swans, and seagulls around the docks attracts more birds and encourages all of them to become long-term residents at the marina. Such residential flocks can contaminate water, foul docks, and create a mess on boats. The best way to reduce this water pollution source is to prohibit people from feeding the birds.

The largest marina in the world, Marina Del Rey (California), is owned and operated by the County of Los Angeles. The county was forced to close one of its popular family bathing beaches for more than a year because of high fecal contamination in the water. Extensive tests proved that the source of the pollution problem was seagulls that spent the night on the beach, not boat sewage. Within days of stringing monofilament lines over the beach to discourage bird visits, water quality improved dramatically and the beach was eventually reopened.

♦ *Establish no discharge zones to prevent any boat sewage from entering boating waters.*

Every state has some no discharge boating waters that prohibit release of any treated or untreated sewage from all boats and vessels. No discharge zones (NDZs) are established specifically to control discharges of sewage from boats. Establishing an NDZ does not imply that other discharges, such as those from municipal sewage treatment facilities, industrial facilities, combined sewage outfalls, septic tanks, and nonpoint source runoff do not enter the waterbody. These sources

Figure 4-23. Elliott Bay Marina (Washington) solved the problem of dog droppings on its docks by providing free disposable plastic bags for owners to use to clean up after their pets. This inexpensive solution freed staff from having to clean the grounds of dog droppings periodically and virtually eliminated complaints from other boaters (USEPA, 1996: *Clean Marinas—Clear Value).*

are addressed by other permitting and regulatory programs.

EPA regulations define two types of NDZs—those that are NDZs by nature of their geography and those that can be designated by EPA and states. Waterbodies of the first type include freshwater lakes and reservoirs, and other freshwater impoundments whose entrance and exit points do not support traffic by the regulated vessels, i.e., by vessels with installed toilets. Rivers that do not support interstate vessel traffic are also NDZs by this rule. Waterbodies of the second type (that can be designated as NDZs by EPA or states) include coastal waters and estuaries, the Great Lakes and their interconnected waterways, and other flowing interstate waters that are navigable by vessels with installed toilets. Since 1975, when EPA approved the first state application for a no discharge zone, many states have established NDZs. Some states, including Michigan, Missouri, New Mexico, and Rhode Island, have designated all their waters as no discharge zones (Table 4-4). Most of Lake Michigan and Lake Superior have been declared to be NDZs.

A no discharge designation is particularly applicable to inland lakes and reservoirs where flushing may be limited, primary contact recreational activities (e.g., swimming, windsurfing) are popular, and surrounding homes might use on-site septic systems for sewage treatment. The CVA provides grants to coastal and inland states for pumpout stations and waste reception facilities to dispose of recreational boater sewage. A listing of existing no discharge zones is presented at the end of this management measure discussion.

For a no discharge designation to be successful, three key elements are necessary:

- Pumpout services in the area declared to be an NDZ should be reasonably available when customers need them and adequate for the number of boaters in the area.
- Boaters should be educated about the purpose and importance of the NDZ designation, how to properly comply with the designation, and the locations of pumpout services.
- The NDZ designation should be strictly enforced to ensure compliance. Enforcement can include boat inspection to make sure that through-hull valves from boat toilets or holding tanks are sealed shut and that Y-valves direct toilet waste into holding tanks.

♦ *Establish practices and post signs to control pet waste problems.Establish equipment requirement policies that prohibit the use of Y-valves on boats on inland waters.*

The U.S. Coast Guard has established equipment requirements for vessels with onboard toilets. Federal law prohibits the discharge of any untreated sewage from boats within the continental waters of the nation, including all rivers and lakes as well as coastal waters out to 3 nautical miles into the ocean. These requirements typically state that vessels must be configured so that the direct discharge of sewage, treated or untreated, to a waterbody is not possible. Only those relatively

Table 4-4. EPA-designated no-discharge zones in the United States (as of 2001).

States with all (or nearly all) waters designated as NDZs:

Michigan, Missouri, New Hampshire, New Mexico, Rhode Island, and Wisconsin

States with segments of their waters designated as NDZs:

California, Florida, Georgia, Massachusetts, Minnesota, New Jersey, Nevada, New York, South Carolina, Texas, and Vermont

Source: http://www.epa.gov/owow/oceans/vessel_sewage/vsdnozone.html

few boats that do travel out beyond the 3-mile limit may use a Y-valve to discharge overboard. The reality, however, is that many boats that never enter the ocean have Y-valves, seacocks, and thru-hulls installed. Most of these are boats built before there were sufficient numbers of pumpouts available. Y-valves (also called "cheater valves") have no purpose other than to bypass the holding tank to avoid using a pumpout. Doing this is clearly illegal and bad for water quality.

As with no-discharge policies, for laws that require specific equipment or configurations on boats to work, sufficient and suitable facilities for disposing of any waste (pumpout services or dump stations) should be available.

Another essential factor that promotes boater compliance is enforcement of regulations. On Lake Winnepeasaukee (New Hampshire), every boat is inspected for having a holding tank and no Y-valve or thru-hull discharge fitting. When a thru-hull fitting is discovered, it must be plugged solid before the boat may be used on the lake. This enforcement has been done successfully for over 30 years by state inspectors at all public launch ramps and by staff in private marinas around the lake.

BMP Summary Table 11 summarizes the BMPs for Sewage Facility Management mentioned in this guidance.

> Dramatic improvement in water quality have been recorded where pumpouts have been installed and their use enforced. Water testing in Avalon Harbor (California) and Block Island (Rhode Island) following implementation of no discharge designations revealed significant decreases in fecal coliform bacteria concentrations during the boating season. In Rhode Island, the decrease permitted the opening of a major shellfish bed on Block Island after 13 years of summer closure.

BMP Summary Table 11. SEWAGE FACILITY MANAGEMENT

MANAGEMENT MEASURE: Install pumpout, dump station, and restroom facilities where needed at new and expanding marinas to reduce the release of sewage to surface waters. Design these facilities to allow ease of access, and post signage to promote use by the boating public.

APPLICABILITY: Marinas where adequate pumpout, dump station, and restroom facilities do not exist.

ENVIRONMENTAL CONCERNS: Boat sewage can be a problem when dumped overboard without any treatment. Although the volume of sewage discharged from boats is not as massive as a typical sewage treatment plant outfall, boat sewage is very concentrated and can add to the overall problem of fecal coliform loading to the waterbody. Boat sewage also adds extra nutrients that use dissolved oxygen and can stimulate the growth of algae, which in worst cases can grow so fast that they use oxygen needed by fish and other organisms. When untreated sewage goes overboard, it can contaminate shellfish, leading to potentially serious human health problems.

SEWAGE FACILITY MANAGEMENT PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Install pumpout facilities and dump stations. Use a system compatible with the marina's needs	Marina docks and piers; universally recommended	HIGH; matching grant money is available through Clean Vessel Act grant program for installation of pumpout facility; free pumpouts at a marina can attract new customers	HIGH; reduces the chances that untreated sewage will enter the water; results in cleaner water quality and uncontaminated shellfish	MODERATE to HIGH	LOW to MODERATE	Types of systems: fixed point system, portable/mobile system, dump station, or dedicated slipside system; EPA recommends one pumpout per 300 vessels with marine toilets
Provide pumpout service at convenient times and at a reasonable cost	Marina basin; universally recommended	MODERATE; low fees (up to $5) or free service and pumpouts done by marina staff attract customers	HIGH; providing convenient pumpouts encourages use and therefore reduces direct discharge of sewage into nearshore waters	MODERATE to LOW	LOW to MODERATE	Pumpouts should be made available during normal marina hours or when the fuel dock is also open during the boating season
Keep pumpout stations clean and easily accessible, and consider having marina staff do pumpouts	Marina pumpout station; universally recommended	MODERATE to HIGH; pumpout service at a marina can attract new customers, especially when customers do not have to pump their own boats	HIGH; pumpouts reduce direct discharge of sewage into nearshore waters	MODERATE to LOW	LOW to MODERATE	Requires staff training
Provide portable toilet dump stations near small slips and launch ramps	Marina docks and ramps; generally recommended	MODERATE; makes it convenient for boaters to empty their portable toilet and reduces chances of unsightly and unsanitary spills	HIGH; providing convenient portable toilet dump stations encourages use and therefore reduces direct discharge of sewage into nearshore waters	LOW to MODERATE	LOW to MODERATE	One dump station may be all that a drystack or small boat marina needs; use signs to indicate proper dump station use; portable toilets should never be dumped overboard
Provide restrooms at all marinas and boat ramps	Marina dockside; universally recommended	HIGH; clean bathrooms attract customers; marina surveys show that a good restroom is a major reason why boaters select a marina	HIGH; good restrooms get used and reduce boat toilet use, and hence overboard discharge	MODERATE to HIGH	LOW to MODERATE	Clean, dry, convenient restrooms; bright lights and pleasant odor are important

BMP Summary Table 11. (cont.) SEWAGE FACILITY MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Consider declaring marina waters to be a "no discharge" area	Marina-wide; generally recommended	MODERATE to HIGH; such a policy can attract environmentally conscious customers; reduces sewage discharges; increases use of pumpout; good for public relations	HIGH; reduced risk of bacterial water pollution	LOW	NONE	Legally binding slip rental contracts with customers and transient visitors might be required; works best when restrooms are available, pumpouts are available, boaters are educated, signs are posted, and policy is enforced
Establish practices and post signs to control pet waste problems	Dock and upland areas; recommended	MODERATE to HIGH; a marina free of pet waste is more attractive to present and potential customers and will reduce complaints from boat owners	MODERATE; keeps pet waste with harmful bacteria from washing into marina basin	LOW	LOW	The best way to control pet waste is to create a dog walking area away from the shore
Avoid feeding wild birds in the marina	Marina wide; universally recommended	MODERATE to HIGH; keeps marina more free of waste and reduces complaints from boat owners; cleaner docks and boats	MODERATE; reduces harmful in marina basin and on docks and boats	LOW	NONE	The best way to control bird waste is to avoid attracting birds to the marina as a feeding ground
Establish no discharge zones to prevent any boat sewage from entering boating waters	Any boating waters; generally recommended	MODERATE to HIGH; increases pumpout use; creates perception, real or not, that water quality is good	HIGH; significant improvements in water quality have been shown in enforced no discharge zones; areas closed to shellfishing and swimming can be opened	MODERATE to HIGH	MODERATE to HIGH for enforcement and education	EPA and states are responsible for establising NDZs; marina managers can request that the state establish an NDZ
Establish equipment requirement policies that prohibit use of Y-valves on boats on inland waters	Inland boating waters; universally recommended for inland waters	HIGH; the simplest and most effective enforcement tool; allowing this equipment to remain on the boat encourages cheating	HIGH; decreases sewage loading to the waterbody and can help to improve overall water quality in inland lakes and reservoirs	MODERATE to HIGH	MODERATE to HIGH for enforcement and education	This is required on some waters under federal law

4.12. Maintenance of Sewage Facilities

Management Measure for Maintenance of Sewage Facilities:

Ensure that sewage pumpout facilities are maintained in operational condition and encourage their use.

Management Measure Description

Boaters are becoming increasingly aware of the need to protect the environment and of their role in maintaining healthy waters. Boaters today want to do what is proper for the environment, and maintaining sewage facilities in good operating condition at all times so that they are always accessible to boaters helps boaters achieve their environmental goals. This measure is important because it is the simplest and most effective way to prevent the failure of sewage facilities and to ensure their availability to boaters.

Sewage collection facilities, including sewage pumpout stations and portable toilet dump stations, help reduce the release of untreated sewage into marina and surface waters. Boaters can use the facilities, however, only when the facilities are operating properly. Nonfunctioning sewage collection and disposal facilities present a serious obstacle to boaters whose holding tanks are full, and in such circumstances boaters are left with few choices for sewage disposal—travel elsewhere to find an operable pumpout or dump station, discharge sewage directly overboard, or cease using their boat toilets. The first of these options is very inconvenient; the second is illegal in no discharge zones and legal otherwise only through an approved marine sanitation device in appropriate waters; and the third would mean "stop using the boat" to many boaters. Also, an inoperable pumpout or dump station at one marina can create an excessive demand at stations in the same area that are operable. Long lines at the pumpouts can result, and these can be discouraging and tempt people to discharge illegally. Finally, if pumpouts are free to those with slips at a marina and the pumpout at that marina is inoperable, patrons will not likely be pleased with having to pay for a pumpout elsewhere.

Applicability

This management measure is applicable to marinas with sewage disposal facilities.

Best Management Practices

♦ *Regularly inspect and maintain sewage facilities.*

Sewage disposal facilities can be kept operating properly with regular inspection and maintenance. Routine maintenance, performed according to instructions that come with the unit, can be done by marina staff, with major problems referred to qualified service personnel. Routine inspections of marina waste holding tanks and secondary containment areas will ensure their integrity. If septic tanks and leach fields are used for final disposal, the tanks will function most efficiently and at least cost if they are pumped out regularly to prevent overflows and clogging.

Boatyards and marina facilities capable of servicing and repairing boat toilet and holding tank systems can promote annual marine sanitation device inspections and maintenance by offering this service to boat owners. During the off season or winter storage months, this service can generate additional income for a marina. It is also one way that marinas can play a proactive role in boater education and the promotion of environmental awareness.

♦ *Disinfect the suction connection of a pumpout station (stationary or portable) by dipping it into or spraying it with disinfectant.*

Although not a practice to protect water quality, part of pumpout station maintenance is protecting pumpout operators, whether marina staff or boaters, against infection and illness. Risk of contact with bacteria or viruses while handling the pumpout nozzle can be minimized by providing a pail that contains water and a nontoxic disinfectant, such as common bleach, next to the pumpout station. The nozzle end can be dipped into the pail immediately following each use. Care should be taken to ensure that the disinfectant solution does not spill into marina waters. The mildest, least harmful disinfectant that will do the job is the best choice for this purpose. Use of the disinfectant solution can be added to instructions provided on how to use the pumpout.

♦ *Maintain convenient, clean, dry, and pleasant restroom facilities in the marina.*

An effective way to encourage boaters to dispose of their sewage properly and not to discharge it overboard is to have good shoreside restroom facilities available for customers and guests. Surveys have shown that a factor important to boaters when selecting a marina is the cleanliness, condition, and convenience of its restrooms. The surveys show that boaters prefer to use restrooms that are

- Clean and dry
- Close to docks and accessible at all hours
- Well maintained and brightly lit
- Free of insects
- Amply supplied with toilet paper and hand towels
- Equipped with private showers and dressing rooms
- Safe

♦ *Maintain a dedicated fund and issue a contract for pumpout and dump station repair and maintenance.*

Marinas and launch ramps can establish dedicated funds specifically to maintain pumpouts and dump stations in continuous operational condition. If a CVA grant was used to purchase and install the sewage station, the U.S. Fish and Wildlife Service requires that pumpout equipment be maintained in operational condition for boater use.

BMP Summary Table 12 summarizes the BMPs for Sewage Facility Maintenance mentioned in this guidance.

BMP Summary Table 12. MAINTENANCE OF SEWAGE FACILITIES MANAGEMENT

MANAGEMENT MEASURE: Ensure that sewage pumpout facilities are maintained in operational condition and encourage their use.

APPLICABILITY: Marinas with sewage discharge facilities.

ENVIRONMENTAL CONCERNS: When faced with nonfunctioning sewage collection and disposal facilities, boaters whose holding tanks are full have three choices: (1) go elsewhere to find an operable pumpout or dump station, which is inconvenient; (2) discharge sewage directly overboard, which is illegal in no discharge zones and legal otherwise only through an approved marine sanitation device in nearshore waters; or (3) cease using their boat toilets, which to some would mean "stop using the boat."Also, one inoperable pumpout may overload another one nearby, tempting boaters to discharge illegally, particularly if the alternative pumpout is not free or charges a higher fee.

MAINTENANCE OF SEWAGE FACILITIES PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Regularly inspect and maintain sewage facilities	Marina sewage collection facilities; universally recommended	HIGH; regular inspections help detect small maintenance needs before they become big problems and cost more to repair	MODERATE; properly operating pumpouts help reduce sewage pollution	LOW	LOW to MODERATE	Requires regular inspection; should keep records of each inspection
Disinfect the suction connection of a pumpout station (stationary or portable) by dipping it into or spraying it with disinfectant	Marina pumpout station; universally recommended	HIGH; protects pumpout operators from infection	LOW; be careful to avoid spilling disinfectant into waterbody	LOW	LOW	
Maintain convenient, clean, dry, and pleasant restroom facilities in the marina	Marina; universally recommended	HIGH; clean bathrooms attract customers; marina surveys show that a good restroom is a major reason why boaters select a marina	HIGH; good restrooms get used, reducing boat toilet use and thus overboard discharge	MODERATE to HIGH	LOW to MODERATE	Restrooms are also recommended at boat launch ramps where feasible
Maintain a dedicated fund and issue a contract for pumpout and dump station repair and maintenance	Marinas; generally recommended	HIGH; facilities funded by a CVA grant are required to be properly maintained; an annual service contract ensures regular maintenance and proper functioning	HIGH; reduces sewage discharge that can result when a pumpout is out of service	LOW	MODERATE	

4.13. Boating Cleaning

Management Measure for Boat Cleaning:

For boats that are in the water, perform cleaning operations to minimize, to the extent practicable, the release to surface waters of (a) harmful cleaners and solvents and (b) paint from in-water hull cleaning

Management Measure Description

Preventing the entry of chemicals from boat cleaners, cleaning solvents, and antifoulant paint into marina waters is the most direct way to prevent harm to the aquatic environment from these products. The management practices associated with this management measure are easily implemented. They can be practiced by boat owners and marina managers alike, and they do not interfere with the need to keep boats clean.

Marina employees and boat owners use a variety of boat cleaners, such as teak cleaners, fiberglass polishers, and detergents, and boats are usually cleaned while in the water or onshore adjacent to the water. Some of the cleaner used ultimately ends up in the water. Additionally, when boat bottoms are cleaned aggressively while boats are in the water, antifouling paint can be abraded off and deposited into marina waters and sediments. This management measure is aimed at minimizing the release of harmful ingredients in cleaners, bottom paints, and harmful residues on boat hulls to marina basin waters.

Many cleaners contain harsh chlorine, ammonia, phosphates, and other caustic chemicals that harm fish and other aquatic life. If a product's label warns about potential harm to people's skin or eyes, the product is most likely harmful to aquatic life. Some chemicals in these cleaners bioaccumulate in aquatic organisms (that is, they become more concentrated as they are ingested successively by animals higher on the food chain) and could eventually bioaccumulate in fish or shellfish that are be eaten by people, posing a health risk.

Under the Clean Water Act, the NPDES Storm Water Permit Program defines boat wash water as "processed water." Discharge of any processed water by a marina or boatyard is illegal nationwide without a formal permit from EPA or a state government. This permit requirement does not apply to boat owners who are cleaning their own boats, but it does apply to anyone who professionally cleans boats in a marina.

If work is done sensibly, chemicals and debris from washing boat topsides, decks, and wetted hull surfaces while boats are in the water can be kept out of the water.

Cleaning boats that are transported from one waterbody to another is important to preventing the spread of exotic species, and it is a highly recommended practice.

Applicability

This management measure primarily concerns the actions of boat owners, and the BMPs are to be implemented primarily by individual boat owners. The information contained here is provided to educate marina managers about the importance of these measures in maintaining a clean marina, and marina managers are encouraged to incorporate the BMPs mentioned here into education programs and staff activities.

Best Management Practices

- ♦ *Wash boat hulls above the waterline by hand. Where feasible, remove boats from the water and clean them where debris can be captured and properly disposed of.*

Washing the boat hull by hand (that is, *not* by pressure washing) reduces the amount of abrasion to the hull, which results in less paint chipped off and less debris lost to the marina basin. Where feasible, remove boats from the water and clean them where debris can be captured and properly disposed of.

♦ *Attempt to wash boats frequently enough that the use of cleansers will not be necessary.*

Frequent washings with water alone can prevent a boat from reaching a point at which abrasive or caustic cleansers are necessary to adequately clean the hull or topsides. This practice will help prevent the possibility of spilling chemicals into the water.

♦ *If using cleansers, buy and use ones that will have minimal impact on the aquatic environment.*

"Nontoxic" and "phosphate-free" cleaners are available and friendlier to the environment than products with toxic components. Products that carry safety warnings about the harm they can cause to people (Figure 4-24) can harm the environment as well.

Although "biodegradable" sounds good, it does not mean that a product is nontoxic. Biodegradable products are those which can be broken down by bacteria, other organisms, or natural processes. The degradation of "biodegradable" products in water uses dissolved oxygen, and therefore these products can lower dissolved oxygen levels. Also, some products might not biodegrade in aquatic environments—freshwater or marine.

♦ *Switch to long-lasting and low-toxicity or nontoxic antifouling paints.*

Considerable progress has been made in antifouling paint technology in recent years, and more improvements are expected that will reduce and effectively eliminate the toxicity of hull paints and increase their ability to keep hulls free of fouling growth for longer periods. Silicone-based and hard-surfaced, nonablative copper metal-based paints are such recent innovations. In general, harder paints last longer, and some reduce the need to repaint boat bottoms to once every 10 years. More information on antifoulant paints and specifications is available on the Internet (search on "antifoulants") or can be provided by a marine paint supplier.

♦ *Avoid in-the-water hull scraping or any abrasive process done underwater that could remove paint from the boat hull.*

Any hull cleaning performed in the water will remove the least amount of paint if done with something soft. Mechanical underwater scrubbing machines can scrape and chip off antifouling paint and encourage fouling growth on the hull.

Frequent hand washing of hulls should not cause any paint to abrade or chip off but can adequately remove scum and fouling organisms.

In-the-water hull cleaning performed by divers should also be done in a manner that does not remove paint from the hull.

♦ *Ensure that adequate precautions have been taken to minimize the spread of exotic and invasive species when boats are transferred from one waterbody to another.*

Boat owners should be aware of the importance of thoroughly cleaning boats taken from waters known to be inhabited by exotic or invasive species. Some species can be introduced to new waterbodies this way. Generally, the spread of exotic and invasive species can be controlled by washing a boat in hot water and letting it thoroughly dry for a minimum of 5 days before putting the boat into a different waterbody. The recom-

WARNING: EYE IRRITANT. Avoid contact with eyes. May cause skin irritation. For sensitive skin or prolonged use wear gloves. Use with adequate ventilation. FIRST AID: EYES—rinse eyes with water for 15 minutes, call a physician. SKIN—rinse with water. IF SWALLOWED—drink a glassful of water. Call a physician. KEEP OUT OF REACH OF CHILDREN.

Figure 4-24. Warning sign that indicates toxicity to both people and the environment.

Associated Marine Technologies (Florida) installed a closed-loop pressure washing system for boat bottoms.

- Green Cove Marina (New Jersey) designed its own sump drain system and lift pump under the boat lift. The system pushes dirty water into a filter and recycling system consisting of three 55-gallon filtering drums and a 225-gallon holding tank. The debris is dried and sent to a landfill.
- Harbour Towne Marina (Florida) installed a wastewater filtration system to clean the power wash water to meet the county's gray water standards for discharge into the municipal sewer system. A concrete washing pad slopes down to a central drain, where the washwater is filtered and treated with three different chemicals. The marina hauled and washed 650 boats in the 1994–1995 season.
- Summerfield Boat Works (Florida) installed a water filtration system that includes an ultraviolet light ozone generator to oxidize all dissolved pollutants and erase odor. The wastewater is then recycled within the marina. The boatyard pays for its wastewater treatment program by charging an Environmental Cost Obligation for each boat hauled for pressure washing.

(USEPA, 1996: *Clean Marina—Clear Value*)

mendations for specific species vary, and information should be provided to boaters about any exotic or invasive species known to occur in waterbodies connected to a marina's waters, or where patrons from a marina are known to visit.

♦ *Minimize the impacts of wastewater from pressure washing.*

There are several ways to treat the wastewater from pressure washing to remove the paint chips or particles that might be present:

- *Settling*: Trap the water in a container and allow it to sit long enough after washing to permit any particles to settle out of the water. This method will remove only the particles large enough to settle out of solution.
- *Filtration*: Wastewater can be passed through one or more filters that screen out particles. A filter cloth used at the wash site can be effective for straining out visible particles. Additional filtration is achieved by using a series of filters with smaller and smaller mesh sizes.
- *Treatment*: Chemical or biological cleaning technologies can be used to treat the wastewater and remove contaminants. Treatment can remove oil and grease, metals, or other contaminants. Once wastewater has been treated, it can be discharged into marina waters or a sanitary sewer (check local regulations) or can be reused at the marina for more boat washing or grounds watering.

Effluent from pressure washing usually requires a storm water discharge permit, issued by the state or locality. Closed loop or zero discharge pressure wash systems usually do not require a permit. Check with the appropriate environmental authority before discharging any effluent to a sewer system.

BMP Summary Table 13 summarizes the BMPs for Boat Cleaning mentioned in this guidance.

BMP Summary Table 13. BOAT CLEANING MANAGEMENT

MANAGEMENT MEASURE: For boats that are in the water, perform cleaning operations to minimize, to the extent practicable, the release to surface waters of (a) harmful cleaners and solvents and (b) paint from in-water hull cleaning.

APPLICABILITY: Boat owners. Marina managers should be aware of the issues presented and inform boaters to the extent feasible.

ENVIRONMENTAL CONCERNS: Many boat cleaners contain harsh chlorine, ammonia, phosphates, and other chemicals that can harm fish and other aquatic life. Some chemicals in these cleaners become more concentrated in aquatic organisms as they are ingested by other animals and can eventually find their way into fish and shellfish, which might be eaten by people. Chemicals and debris from washing boat topsides, decks, and hull surfaces can be kept out of the water by using some common sense boating practices.

BOAT CLEANING PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Wash boat hulls above the waterline by hand. Where feasible, remove boats from the water and clean them where debris can be captured and properly disposed of	Boats in marina basin; generally recommended	MODERATE; handwashing is less abrasive than other methods; works well if done frequently	MODERATE; washing by hand reduces abrasion, which chips antifouling paint into the water	LOW	LOW	
Attempt to wash boats frequently enough that the use of cleansers will not be necessary	Boats in marina basin; generally recommended	MODERATE; eliminates use of cleansers	MODERATE	LOW	LOW	Frequent handwashing with water and a cloth is recommended
If using cleansers, buy and use one that will have minimal impact on the aquatic environment	Boats in marina basin; generally recommended	MODERATE to HIGH; these products work well and are often less hazardous to humans	HIGH; reduces chance that harmful chemicals will enter aquatic/marine environment	LOW	LOW	Marina managers can encourage use of environmentally friendly products by stocking them in the marina store
Switch to long-lasting and low-toxicity or nontoxic antifouling paints	Marina store, work area, and boat; generally recommended	HIGH for boater; harder paints last longer and can last several seasons before needing repainting	MODERATE to HIGH; new antifouling paints are effective and less toxic or nontoxic to aquatic animals	LOW to MODERATE	LOW to MODERATE	Use of antifouling paint on boats kept in fresh water is discouraged except, for example, where zebra mussels are a problem
Avoid in-the-water hull scraping or any abrasive process done underwater that could remove paint from the boat hull	Boats in marina basin; generally recommended	LOW to MODERATE; depends on number of boaters who work on boat hulls in slips	MODERATE; can reduce greatly the amount of paint lost to the water	LOW	LOW	
Ensure that adequate precautions have been taken to minimize the spread of exotic and invasive species when boats are transferred from one waterbody to another	Boats in marina basin; generally recommended	MODERATE to HIGH; exotic species infestations can be very expensive to combat	MODERATE to HIGH; exotic and invasive species can harm native species and change ecosystem dynamics	LOW	LOW	Much less expensive to prevent infestations than to control established exotic and invasive species
Minimize the impacts of wastewater from pressure washing	Marina work area; generally recommended	MODERATE; removing larger particles from wastewater can reduce treatment needs	MODERATE; reduces potential for release of debris to surface waters	MODERATE	LOW	Wash water from hull washing is processed water and cannot be discharged directly to U.S. waters; check local regulations

4.14. Boat Operation

Management Measure for Boat Operation:

Manage boating activities where necessary to decrease turbidity and physical destruction of shallow water habitat.

Management Measure Description

No wake zones, motorized craft restrictions, and sign and buoy placement are widely used practices for protecting shallow-water habitats. Important aquatic vegetation should be protected from damage due to boat and personal watercraft propellers because of its ecological importance and value in preventing shoreline erosion. This management measure presents effective, easily implemented practices for protecting aquatic vegetation and shorelines.

Boat traffic (including personal watercraft) through shallow-water areas and in nearshore areas at wake-producing speeds can resuspend bottom sediment, uproot submerged aquatic vegetation, erode shorelines, and harm some animals, including manatees. Resuspended sediment and erosion along shorelines increases turbidity in the water column. Turbid waters can't support submerged aquatic vegetation to the same depths as clear waters because sunlight can't penetrate to as great a depth. With photosynthesis limited to the upper foot or so of water, less dissolved oxygen is produced.

Fish that locate prey primarily by sight have a harder time finding prey in turbid waters. Plant leaves can become coated with fine sediment, and bottom-dwelling organisms are continually covered by resettling sediment.

Resuspended sediment can also contain harmful chemicals that were discharged at the marina or elsewhere in the watershed and had been trapped in the sediment. Once in the water column, these chemicals are more likely to be ingested by fish and shellfish and to work their way up the food chain, possibly to someone's dinner table.

Uprooted submerged aquatic vegetation can no longer provide habitat for fish and shellfish or food for waterfowl. Instead of recycling nutrients released from matter decomposing in the waterbody, the vegetation adds more nutrients as it decomposes. It also cannot reduce wave energy at shorelines, so the shorelines become more exposed to the erosive forces of storm waves and the boat wakes that contributed to their initial loss. Replacing submerged aquatic vegetation once it has been uprooted or eliminated from an area is difficult, and the science of replacing it once it is lost is not well developed.

Many manatee mortalities are human-related, occurring from collisions with watercraft, and restrictions on boating activity in shallow water habitats favored by the animals could reduce the number of animals injured by propellers. West Indian manatees (*Trichechus manatus*) are found in shallow, slow-moving rivers, estuaries, saltwater bays, canals, and coastal areas. They are a migratory species, and in the United States they are concentrated in Florida in the winter but can be found in summer months as far west as Alabama and as far north as Virginia and the Carolinas. There are about 2,600 West Indian manatees left in the United States.

Manatees are protected under federal law by the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, which make it illegal to harass, hunt, capture, or kill any marine mammal. They are also protected by the Florida Manatee Sanctuary Act of 1978, which states:

Guidelines for Responsible Personal Watercraft Operation

Personal watercraft, include jet skis and waterbikes, are propelled by waterjet drives, have shallow draft designs, and are able to achieve planing speeds (65 mph and higher). Approximately one-third of all new boat sales in recent years have been personal watercraft. They are defined as Class A inboard boats by the U.S. Coast Guard and are required to follow most boating regulations. The personal watercraft industry encourages users of personal watercraft to adopt the following simple guidelines to preserve natural resources:

- Ride in main channels to avoid stirring bottom sediments; limit riding in shallow water.
- In coastal areas, be aware of low tide when seagrass beds, other delicate vegetation, and bottom organisms are more exposed.
- Operate away from shore as much as possible to avoid disturbing wildlife with wakes and noise and to avoid interfering with their feeding, nesting, and resting.
- Ride at controlled speeds in waters where sea otters, sea lions, manatees, whales, and sea turtles live and swim, so you can avoid hitting and injuring them.
- Avoid mangrove communities, kelp forests, seagrass beds, and coral reefs, since these are delicate ecosystems that are easily damaged.
- Avoid high speeds near the shore to minimize or eliminate your contribution to shoreline erosion.
- Wash your personal watercraft off after use and before trailering it to other waters to avoid spreading exotic, nonnative species to uninfected waters.

(PWIA, 1999)

"It is unlawful for any person, at any time, intentionally or negligently, to annoy, molest, harass, or disturb any manatee." Anyone convicted of violating Florida's state law faces a possible maximum fine of $1,000 and/or imprisonment for up to 60 days. Conviction on the federal level is punishable by a fine of up to $50,000 and/or 1 year in prison.

The manatee is mentioned to illustrate the harm that can be done to aquatic life by boats. Species other than manatees, such as seals or dolphins, might be more likely to be affected by boat operation in other regions of the country. The state natural resources agency can be contacted for state- or region-specific information.

Applicability

This management measure is applicable to state natural resource managers. Marina managers and boaters can become involved in efforts to protect sensitive aquatic habitats.

Best Management Practices

♦ *Restrict boater traffic in shallow-water areas.*

Where shallow areas that normally have submerged aquatic vegetation are found instead to have trenches (usually 10 to 24 inches wide) without vegetation running through them, boat propellers or personal watercraft are probably the reason. Seagrass beds usually grow in patches; the center of the patch is protected from erosive currents by vegetation at the edge of the patch. Trenches cut by boat propellers act like roads cut through a forest, exposing the center of the patch to currents and making the entire patch less stable. The sediment in the trench is also newly exposed to currents, making it difficult for new vegetation to establish itself. Further loss of submerged aquatic vegetation and sediment next to the trenches is likely after the initial loss.

To protect seagrass beds and bottom habitats, shallow-water areas can be established as "off limits" to boat traffic of any type, including personal watercraft. Signs or buoys in the water around the edges of these areas can help the public comply with shallow habitat protection efforts. Distribution of flyers with maps that show shallow areas and indicate permanent landmarks, so boaters can easily determine whether they are near shallow areas, is another effective tool. Boaters usually try to protect these habitats once they understand their ecological importance and are aware of their presence. Shallow-water habitat destruction is due more to a lack of knowledge than to negligence.

♦ *Establish and enforce no wake zones to decrease turbidity, shore erosion, and damage in marinas.*

No wake zones are more effective than speed limits in shallow surface waters for reducing turbidity and erosion caused by boat passage. Hull shape strongly influences wake formation, allowing some boats to go fast with little wake while other boats throw a large wake at slow, nonplaning speeds. In shallow areas, larger waves from the wakes of "speed-limited" watercraft are more likely to resuspend bottom sediments and create turbid waters.

Although the prime responsibility for creating, enforcing, and posting signs for no wake zones rests with government, marinas can *(and many do!)* post NO WAKE signs within their marina waters.

BMP Summary Table 14 summarizes the BMPs for Boat Operation mentioned in this guidance.

BMP Summary Table 14. BOAT OPERATION MANAGEMENT

MANAGEMENT MEASURE: Manage boating activities where necessary to decrease turbidity and physical destruction of shallow-water habitat.

APPLICABILITY: State natural resources managers. Marina managers and boaters can become involved in efforts to protect aquatic habitats.

ENVIRONMENTAL CONCERNS: Boat and personal watercraft traffic through very shallow water and nearshore areas at wake-producing speeds can resuspend bottom sediments and erode shorelines, all of which can increase turbidity in the water column. Turbidity blocks the penetration of sunlight to underwater plants that need light for survival, and it reduces visibility for fish who rely on sight to catch their prey. Vessel traffic can also uproot submerged aquatic vegetation (SAV), which is habitat for fish and shellfish and food for waterfowl, recycles nutrients released from matter decomposing in the waterbody, and reduces wave energy at shorelines, thus protecting them from erosion. Vessel traffic also might churn up harmful chemicals that had been trapped in the sediments and might contaminate fish and shellfish that people eat. Propellers or jet drives, when in contact with the bottom, dig visible furrows across the soil and the vegetation, which can take years to recover.

BOAT OPERATION PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Restrict boater traffic in shallow-water areas	Shallow-water boating areas; generally recommended	MODERATE; vegetated bottoms help limit erosion and resuspension of sediments	HIGH; shallow water habitats are important to many aquatic organisms for feeding, shelter	MODERATE	MODERATE	Mark areas with signs and buoys; include sensitive shallow area restrictions on navigation charts; post charts on marina bulletin boards
Establish and enforce no-wake zones to decrease turbidity, shoreline erosion, and damage in marinas	Near-shore areas; universally recommended	HIGH; wake control reduces damage to docks, floats, and shorelines and saves cost of maintenance dredging; wave-free marina basins are more pleasant for boaters	HIGH; reduces shoreline erosion; preserves biologically important nearshore habitats and the flora and fauna that live in them	LOW	LOW	Consider posting "no-wake" signs near shoreline areas in the marina; solicit the local government to establish no-wake zones where shoreline erosion might be a problem

4.15. Public Education

Management Measure for Public Education:

Public education, outreach, and training programs should be instituted for boaters, as well as marina owners and operators, to prevent improper disposal of polluting material.

Management Measure Description

Public education is one of the most effective ways to reduce pollution in and around marinas and from recreational boating. A boating public that understands the causes and effects of pollution is more likely to want clean waters and healthy aquatic environments. If the public is told about the simple and effective ways that they can reduce their impacts on the environment, they are usually happy to do their part. One of the primary factors in the success of any pollution prevention program is widespread support for the program by an educated public.

Public education is a low-cost, effective, proven method to improve and reinforce environmentally conscious behavior in all segments of the public, including the boating public. The availability of a variety of public education materials on virtually all environmental issues and for all segments of the public makes this management measure easy to implement, and creating an education program with a message that is consistent from the state level through the local level to the level of the private or public marina is an excellent way to ensure that the right message is reaching as wide a public as possible.

Many states, localities, public and private agencies and organizations, and marina owners are using public education as a tool for combating pollution. This management measure supports efforts already being made and encourages others to join the educational campaign with public education programs of their own. A state might target registered boat owners, an organization might target its membership, and a marina might focus on its patrons. Numerous examples of public education materials are available from national organizations like the National Marine Manufacturers Association, the National Clean Boating Campaign organized by the Marine Environmental Education Foundation, Inc. (or MEEF) (www.cleanboating.org), the National Oceanic and Atmospheric Administration's Sea Grant program (www.nsgo.seagrant.org), and EPA's Office of Water (www.epa.gov/OW). There is no reason to reinvent the wheel! Instead, time and effort can be saved by using available materials to create a program that focuses on a particular situation.

The EPA web site offers a couple of ways to find out who is involved in environmental activities in your watershed. One is from the homepage of the Office of Wetlands, Oceans, and Watersheds (OWOW), <www.epa.gov/owow>. A listing of specific groups involved in actions for watersheds throughout the United States can be found at the Surf Your Watershed homepage, <www.epa.gov/surf>. At this page, do the following:

- Click on *Locate your watershed.*
- Click on *Search by Map.*
- Select your state from the map.
- Within the state map, click on the watershed you're interested in.

The subsequent web page will tell you the name of the watershed you've chosen and the U.S. Geological Survey's cataloging unit number for it. Near the bottom of the page will be a section titled *People* that provides links to groups involved with watershed protection activities in that watershed.

Another way to find out who is involved in activities in your watershed from EPA's homepage (www.epa.gov) is by clicking on the *Concerned Citizens* option. One of the options at the *Concerned Citizens* page is *Acting Locally*. This option provides links to national organizations active at the local and watershed levels.

If you find that there are no groups listed as working in your watershed, try following the first three steps above, and at the *Watershed Information* page, under *Working in Your Watershed*, click on either *How can I get involved in my watershed?* or *How do I start a watershed team?* to find out how you can get yourself and others involved.

EPA publishes many documents and fact sheets on topics of interest to boaters. A list of publications related to a specific topic can be obtained from the EPA homepage (www.epa.gov). At the homepage, select *Publications* and then browse and search the National Publications Catalog using keywords such as "boat," "storm water," or "discharge" to find what you are interested in. Some of the documents are available on the Internet, or they can be ordered on-line from the *Publications* web site. Most are free of charge.

The National Sea Grant Program encourages the wise stewardship of marine resources through research, education, outreach, and technology transfer. Sea Grant is a partnership between the Nation's universities and the National Oceanic and Atmospheric Administration (NOAA). Congress passed the National Sea Grant College Program Act to create Sea Grant in 1966. Today 29 Sea Grant Colleges are focused on making the United States the world leader in marine research and the sustainable development of marine resources. Sea Grant produces and makes available a wealth of information on marine topics—from public school curriculum materials to the most advanced scientific research. Visit the Sea Grant homepage (www.nsgo.seagrant.org) to see what publications are available, where the Sea Grant programs are located, and what kinds of research and activities they are involved in.

The U.S. Coast Guard (USCG) homepage at <http://www.uscg.mil> offers a link to the USCG *Marine Safety and Environmental Protection* page. Links to other programs from the USCG can be found most easily by clicking on the link to *Services We Provide* and then choosing what is of interest on the subsequent page. For example, the Sea Partners Campaign is an environmental education and outreach program focused on communities at large to develop community awareness of maritime pollution issues and to improve compliance with marine environmental protection laws and regulations. A link to listings of publications of the USCG is also provided at this web page.

Searching through an Internet search engine, such as Infoseek or Altavista, on *clean boating* should produce a number of links to sites with information on campaigns and organizations involved with clean boating issues. A few of the pages likely to appear as a result of the search are:

- California Clean Boating Network (CCBN) homepage, <www.coastal.ca.gov/ccbn/ccbndx.html>.
- Marine Environmental Education Foundation National Clean Boating Campaign, <www.cleanboating.org>.
- California Department of Boating and Waterways, <www.dbw.ca.gov>.
- Sea Grant Extension (San Diego) Boating Pollution Prevention Section, <commserv.ucdavis.edu/CESanDiego/Seagrant/coastour.htm>.
- Save Our Shores dockwalkers, <www.saveourshores.org/dockwalkers.html>.

A portion of funding from the Clean Vessel Act can be used for educational outreach regarding the effects of boater sewage and what boaters can do to avoid improper sewage disposal. Public awareness campaigns occur annually, and marinas are encouraged to participate in the National Clean Boating Campaign (Figure 4-25). Visit the campaign's web site at <www.cleanboating.org>. Major national CVA educational products produced by the joint effort have included a poster for distribution to more than 22,000 marinas, press

Figure 4-25. National Clean Boating Campaign logo.

and training packets, and various public service announcements for radio, television, and print media. States have also held similar events and are producing their own educational products.

These efforts are also geared toward informing boaters and marina operators of sewage disposal problems, educating them about the use and advantages of pumpout and dump stations, and where it is best to locate such stations. Boaters and anglers can call 1-800-ASK-FISH, a toll-free number established by the Sportfishing Promotion Council, to find the location of pumpout and dump stations near them and to report malfunctioning facilities.

Signage is an important element in any public education campaign, both to remind the educated to practice what they know and to educate the unaware of what they can do to reduce their impact on the environment. Short, simple, positive messages should be prominently posted wherever they will be helpful.

Applicability

This management measure is applicable to all groups and entities involved in boater education. Effective education programs can be implemented by states, organizations, or marina managers.

Best Management Practices

♦ *Use signs to inform marina patrons of appropriate clean boating practices.*

Interpretive and instructional signs placed at marinas and boat-launching sites are a key method of providing information to the boating public. Boater cooperation can be substantially increased at modest expense by using signs.

In a Rhode Island best management practice demonstration project, the use of signs was ranked by boaters as the best method to inform them about best management practices in the marina. It ranked second in terms of its effectiveness for getting boaters to use best management practices. Signs can be more cost-effective than other methods of education because they need be installed only once, and once in place they are effective for a long time. Inexpensive yet effective signs can be produced by a marina employee with a little artistic talent. Common topics for marina signage include solid waste disposal, liquid waste disposal, pumpout locations and instructions, and spill response instructions. Figure 4-26 shows an example of wording on a sign in Ponaug Marina (Rhode Island).

In areas where boaters are of various ethnic and cultural backgrounds, publishing education materials in the various languages appropriate to the region is encouraged.

♦ *Establish bulletin boards for environmental messages and idea sharing.*

Bulletin boards are a form of signage, and they allow marinas to post recent or new information

> The Cap Sante Boat Yard (Washington) uses a materials exchange sheet in the harbor master's office that encourages sharing leftover varnishes, paints, and other boat maintenance products instead of discarding them. People with materials left over after a project list what they have on a sheet, and anyone who needs them can contact the person on the sheet (USEPA, 1996: *Clean Marinas— Clear Value*).

HARMFUL MATERIALS COLLECTION SITE. To ensure proper disposal, deposit harmful materials below. Liquids such as solvents, fuels, engine oils, and toxic antifreeze should be bottled and capped to prevent spillage. Keep incompatible liquids such as oil and antifreeze separate. Label all containers noting their content and origin. Oil filters and other absorbent materials should be packaged so as to prevent leakage. Thank you for helping to keep our marina and the boating envionrment clean.

Figure 4-26. Sign with instructions to patrons on proper disposal of materials.

for the benefit of their patrons. They are convenient places to post notices about the availability of dustless sanders for rent, environmentally friendly cleaners and antifouling paints, new practices and programs at the marina for reducing pollution, water quality monitoring results, how to maintain an engine to keep emission output low, or any other positive clean boating message. Marina patrons can be invited to post notices about leftover products (for example, varnish or paint) they have for sale or tips on practices they've found to be easy and effective for protecting the boating environment.

Bulletin boards are noticed more often if their contents are moved around or changed often and if the location of the bulletin board is changed occasionally as well.

♦ *Promote recycling and trash reduction programs.*

A New Jersey marina encouraged recycling by giving its patrons reusable tote bags with the marina's name printed on the side. The patrons used the bags to temporarily store recyclable glass, cans, and plastics from their boats for proper disposal later at a recycling collection point, and occasionally for grocery shopping. Promoting recycling is an effective way to reduce the quantity of solid and liquid waste placed in marina and surface waters.

♦ *Hand out pamphlets or flyers, send newsletters, and add inserts to bill mailings with information about how recreational boaters can protect the environment and have clean boating waters.*

The Washington State Parks and Recreation Commission designed a multifaceted public education program that encourages the use of marine sanitation devices and pumpout facilities, discourages impacts on shellfish areas, and provides information to boaters and marina operators about environmentally sound boat operation and maintenance. The commission prepared written materials, gave talks to boating groups, participated in events such as boat shows, and developed signs for placement at marinas and boat launches. Printed materials included maps of pumpout facility locations, booklets explaining how boats pollute, pamphlets on the dangers of plastic debris in the water, and articles on the environmental effects of improper boat operation.

Marina owners can do the same on a smaller scale. Written materials can be made available at a marina's office, its supply store, or other places frequently visited by boaters or included with bills mailed to patrons.

Fact sheets ranked second among boaters for informing them about best management practices in a University of Rhode Island demonstration project. Fact sheets had the highest effectiveness rating and ranked first in getting boaters to actually use best management practices, but boaters generally didn't pick up educational flyers where they saw them. An important lesson from this demonstration project was that boaters cannot be expected to voluntarily take the information: brochures should be placed directly into their hands. Inserting fact sheets and information in newsletters or monthly mailings or handing them out with slip lease agreements are effective ways to do this.

♦ *Organize and present enjoyable environmental education meetings, presentations, and demonstrations and consider integrating them into ongoing programs.*

Presentations at local marinas or other locations are a good way to discuss issues with boaters and marina owners and operators. Boater workshops can also be a useful tool for introducing new environmental practices at marinas, but this method was ranked last among methods for informing boaters about best management practices. Conducting successful formal workshops requires a considerable investment of time and resources. One of the best methods to inform marina patrons about best management practices is a walking tour of the facility with demonstrations of products and procedures so that participants see the benefits of management practices first-hand and gain hands-on experience in using the practices. Incentives for participation like door prizes, coupons for free pumpouts, or discounts at the marina store help bolster attendance.

♦ *Educate and train marina staff to do their jobs in an environmentally conscious manner and to be good role models for marina patrons.*

Marina staff who are fully educated and trained on all of the environmental management practices used at a marina—from how to use a pumpout station, where the recycling bins are located, and what can and can't be recycled to how storm water is treated and where it goes—can set an excellent example for patrons. Marina staff are the first people boaters will ask about a marina's environmental practices. An informed staff presents the image of an environmentally proactive marina, whereas an uninformed staff could make patrons think a marina is not concerned about environmental matters.

♦ *Insert language into facility contracts that promotes tenants' using certain areas and clean boating techniques when maintaining their boats. Use a contract that ensures that tenants will comply with the marina's best management practices.*

When a marina has established procedures for keeping the grounds and waters clean, cooperation from patrons is absolutely essential. The time and money spent to establish a clean marina can be negated by patrons who either don't share an enthusiasm for clean boating or mistakenly don't think it is their responsibility to keep the grounds and water clean. Language in slip contracts or other documents, such as dustless sander rental agreements, make them take notice and realize that the marina is serious about maintaining a clean marina, and clean boating in general. Some patrons might elect to dock their boats at other marinas, but most boaters are glad to cooperate with a good cause.

♦ *Have a clearly written environmental best management practices agreement for outside contractors to sign as a precondition to working on any boat in the marina.*

A facility is often legally responsible for pollution problems created by negligent outside contractors. Because of this significant liability, outside contractors need to be provided with information that clearly explains the facility's pollution prevention policies and best management practices and clearly states the contractor's responsibility to operate in accord with the marina's policies.

♦ *Participate with an organization that promotes clean boating practices.*

Public and private organizations are available to assist in developing or providing educational materials. These materials can be tailored to suit an individual marina or yacht club or to be used as public service announcements. Some marina-oriented organizations that might be able to provide assistance with environmental education efforts are listed in Appendix E.

Public Education Practices Applicable to Specific Management Measures

Some public education strategies specifically geared toward individual management measures are suggested below.

♦ *Provide MARPOL placards.*

International MARPOL law requires all boats of 25 feet or more in length to have a visible sign about trash disposal regulations posted where garbage is stored. Most boat retail stores and marinas have standard MARPOL signs available for sale to customers who need to comply with this legal requirement.

♦ *Paint signs on storm drains.*

Painted storm drains grab people's attention at a marina and help control disposal of solid and liquid wastes in inappropriate places. Cap Sante Boat

Haven (Washington) stencils its storm drains with pictures of crabs and fish and the words "DUMP NO WASTE – DRAINS TO BAY/LAKE/RIVER."

♦ *Establish and educate marina patrons about rules governing fish cleaning.*

Marinas can issue rules regarding the cleaning of fish at the marina, depending on the type of services offered by the marina and its clientele. Marinas not equipped to handle fish wastes can prohibit fish cleaning at the marina; those that host fishing competitions or that have a large fishing clientele can establish fish cleaning areas with specific, enforceable rules for their use. Signs can be used to attract fishers to fish cleaning stations and explain the rules for their use.

♦ *Educate boaters about good fish cleaning practices.*

Some boaters need to be educated about the problems created by discarding fish waste into marina waters, proper disposal practices, the ecological advantages of cleaning fish at sea, and discarding wastes into the water where the fish were caught (if allowed). Signs posted on docks (especially if fish cleaning has typically been done there) and talks with boaters during the course of other marina operations help educate boaters about marina rules governing fish cleaning, waste disposal, and cleanup.

♦ *Provide information on local waste collection and recycling programs.*

Information on used oil recycling and collection programs for used products that are contaminated with oil or other petroleum products can be inserted in monthly newsletters or monthly bills or provided with slip leasing contracts. A clause requiring the use of fuel/air vent spill preventors and bilge absorption pads on all boats can be added to contracts.

♦ *Hold clinics on safe fueling and bilge maintenance.*

During special clinics on environmental practices or general clinics of interest to boaters, demonstrate the proper use and disposal of bilge oil pads and other petroleum control devices.

♦ *Teach boaters how to fuel boats to minimize fuel spills.*

Boaters need to understand that whenever they spill even a few drops of oil or fuel, the environment is harmed. There are simple steps boaters can take to prevent fuel loss: use an oil absorption pad to catch drops when the fueling nozzle is removed from the boat; install a fuel/air separator on the air vent line; and place an oil-absorbing pad in the bilge. Teach boaters that when they top off a fuel tank from an underground storage tank, the cool fuel expands as it heats up and will overflow through the air vent onto the water if there is not enough expansion space in the fuel tank. Spills of this type are even more dangerous when boats are placed in dry rack storage in buildings, where the fuel is a fire hazard. Antisiphoning valves can be installed on the engines of larger boats on the fuel line near the fuel tank to prevent fuel from draining if the fuel line breaks during an accident or fire.

♦ *Stock phosphate-free, nontoxic cleaners and other environmentally friendly products.*

Marinas can stock, advertise, and promote the use of phosphate-free, nontoxic cleaners and other environmentally safe products.

♦ *Place signs in the water and label charts to alert boaters about sensitive habitat areas.*

Many harbors establish and mark no wake zones near marinas or in narrow channels using floating marker buoys. Signs and buoys could also be used to designate sensitive environmental areas where boaters should exercise particular caution. As with other public education materials, these signs should be in multiple languages if appropriate to the region.

♦ *Educate boaters to thoroughly clean their boats before boating in other waterbodies.*

The spread of many exotic and invasive aquatic species can be controlled by ensuring that they are not transported from one waterbody to another on trailered boats. See section 4.3, Habitat Assessment, for further information.

BMP Summary Table 15 summarizes the BMPs for Public Education mentioned in this guidance.

BMP Summary Table 15. PUBLIC EDUCATION MANAGEMENT

MANAGEMENT MEASURE: Public education, outreach, and training programs should be instituted for boaters, as well as marina owners and operators, to prevent improper disposal of polluting material.

APPLICABILITY: All groups and entities involved in public education for boaters.

ENVIRONMENTAL CONCERNS: A boating public that understands the causes and effects of pollution is more likely to want clean waters and healthy aquatic environments, and if they are told about the simple and effective ways that they can reduce their impact on the environment, they will usually be happy to do their part. Public education is one of the most effective ways to reduce pollution in and around marinas and from recreational boating.

PUBLIC EDUCATION PRACTICES

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Use signs to inform marina patrons of appropriate clean boating practices	Marinas and launch ramps; universally recommended	HIGH; cost-effective way to promote clean boating practices; every boater who boats cleaner helps keep the marina cleaner	MODERATE to HIGH; clean boating is good environmental practice	LOW to MODERATE	NONE to LOW	Boater cooperation can be substantially increased by using signs with positive messages; signs should be in all languages appropriate to the region.
Establish bulletin boards for environmental messages and idea sharing	Marinas where customers will stop and read; universally recommended	MODERATE; promotes an environmental image for the marina; inexpensive way to inform boaters of new policies and educational events; posting a materials exchange list for sharing leftovers will save money and reduce waste	MODERATE to HIGH; reduces waste produced and potentially limits water pollution, air pollution, solid and hazardous waste quantities	LOW	NONE to LOW	Move or change the contents often to increase visibility; locate a bulletin board where boaters will see it and where they spend a little time waiting, such as in a store or reception area; use several bulletin boards if necessary to reach all customers
Promote recycling and trash reduction programs	Marinas and launch ramps; generally recommended	MODERATE; recycling is often less expensive than waste hauling, especially if provided by a municipal recycling program	MODERATE; reduces the quantity of solid and liquid waste sent to landfills; reduces new resource use	LOW to MODERATE	LOW	Consider distributing reusable tote bags labeled with your marina's name for collecting and transporting recyclables to the recycling area.
Hand out pamphlets or flyers, send newsletters, and add inserts to bill mailings with information about how recreational boaters can protect the environment and have clean boating waters	Marinas and all boaters; universally recommended	MODERATE to HIGH; handouts promote clean boating practices; gives marina a positive environmental image	MODERATE; environmental harm is reduced with every person who boats with a conscious effort to protect the environment	NONE to LOW	NONE to LOW	Fact sheets are generally the most effective method of getting a message to boaters; many organizations and agencies have fact sheets available for photocopying and redistribution, e.g., NOAA, USFWS, EPA, local boating organizations, states, and others

BMP Summary Table 15. (cont.) PUBLIC EDUCATION MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Organize and present enjoyable environmental education meetings, presentations, and demonstrations and consider integrating them into other programs	Marina; universally recommended	MODERATE to HIGH; promotes a positive environmental image; boaters that are trained in proper procedure may reduce staff time spent on environmental cleanup	MODERATE to HIGH; educated boaters keep pollutants out of the water	LOW to MODERATE	LOW to MODERATE	Consider a walking tour of the facility with demonstrations of products and procedures; see National Clean Boating Campaign web site for examples: <www.cleanboating.org>
Educate and train marina staff to do their jobs in an environmentally conscious manner and to be good role models for marina patrons	Marina; universally recommended	HIGH; a trained staff can effectively prevent and respond appropriately to environmental problems; trained staff can teach good practices to boaters and give a positive, proactive clean marina image and can attract new customers	HIGH; prevention and quick response will help keep water clean	LOW to MODERATE	LOW to MODERATE	Marina staff are the first people boaters ask about a marina's environmental practices
Insert language into facility contracts that promotes tenants' using certain areas and clean boating techniques when maintaining their boats. Use a contract that ensures that tenants will comply with the marina's best management practices	Marina; universally recommended	HIGH; all boaters using the marina must use the same practices as those adopted by the marina to protect the environment; use of contract language and clean boating agreements legally binds customer to comply; helps share liability for cleanup costs; gives management an effective control tool for boater who does not want to comply	MODERATE to HIGH; good water quality results from cooperation of many boaters	LOW	NONE	Language in slip contracts gives customers notice of what is required and helps them realize that the marina is serious about maintaining a clean marina and promoting clean boating practices
Have a clearly written environmental best management practices agreement for outside contractors to sign as a precondition to working on any boat in the marina	Marina; universally recommended	HIGH; outside contractors comply with marina's best management practices; a signed contract can help distribute liability for cleanup costs and fines to outside contractors responsible for the problem	MODERATE; adherence to marina BMP standards helps protect water quality	LOW	NONE	A legally binding environmental agreement/contract lets outside contractors know the marina is serious about clean boating in general; agreement, signature, and compliance together form a common marina management tool

BMP Summary Table 15. (cont.) PUBLIC EDUCATION MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Participate with an organization that promotes clean boating practices	Marina; generally recommended	MODERATE to HIGH; by joining with existing environmental programs, the marina can use the materials (often free) provided for a local educational program	MODERATE; the environment is protected best when a common message is provided to all boaters	NONE to LOW	NONE to LOW	Become a Partner in the National Clean Boating Campaign; for more informa-tion visit their web site at <www.cleanboating.org>
Provide MARPOL placards	Boats; generally recommended	LOW; little effect on marina operations or costs	MODERATE; boaters return trash to shore-based facilities	NONE to LOW	NONE to LOW	Placards can be obtained from the U.S. Coast Guard or Center for Marine Conservation
Paint signs on storm drains	Storm drain inlets; generally recommended	MODERATE; lessens the chance that illegal substances will be discarded into storm drains	MODERATE; especially helpful where storm drains lead directly to surface waters	LOW	NONE to LOW	Paint in colorful, large, and obvious letters and pictures; indicate what surface waterbody receives the storm water, if applicable; having children help will raise their environmental awareness
Establish and educate marina patrons about rules governing fish cleaning	Marina; generally recommended	MODERATE; cooperative patrons lead to less work for marina staff	MODERATE; less fish waste discarded to basin waters	NONE to LOW	NONE to LOW	Rules are easy to follow when a convenient fish cleaning station is available
Educate boaters about good fish cleaning practices	Marina; generally recommended	LOW; lower cleanup costs and maintenance costs	MODERATE; less fish waste discarded to basin waters	NONE to LOW	NONE to LOW	See the Fish Waste management measure
Provide information on local waste collection and recycling programs	Marina; generally recommended	LOW to MODERATE; patrons might be more willing to take their recyclables to a local recycling center if none is available at the marina, reducing waste at the marina	MODERATE; recycling is an important waste reduction strategy	NONE to LOW	NONE to LOW	See the Solid Waste management measure
Hold clinics on safe fueling and bilge maintenance	Marina; generally recommended	MODERATE to HIGH; reduces the likelihood of a fuel spill and fire, of petroleum contamination in the water, and oil and grease spills on marina property	MODERATE; lowered incidence of fuel and other petroleum contamination	NONE to LOW	NONE to LOW	Spring, when many boaters are getting boats ready for the boating season, is a good time to hold clinics

BMP Summary Table 15. (cont.) PUBLIC EDUCATION MANAGEMENT

Best Management Practice Examples	Marina Location & Usage	Benefits to Marina	Projected Environmental Benefits	Initial Cost Estimate	Annual Operation & Maintenance Cost Estimate	Notes
Teach boaters how to fuel boats to minimize fuel spills	Marina; generally recommended	MODERATE to HIGH; reduces the likelihood of a fuel spill and fire, and of petroleum contamination in the water	MODERATE; lowered incidence of fuel and other petroleum contamination	NONE to LOW	NONE to LOW	See the Petroleum Control management measure
Stock phosphate-free, nontoxic cleaners and other environmentally friendly produts	Marina store; generally recommended	MODERATE to LOW; many such products are on the market, and patrons will welcome their availability for purchase at the marina	MODERATE; reduces the little spills that go unnoticed but add up to a lot of damage	NONE to LOW	NONE to LOW	See the Boat Cleaning management measure
Place signs in the water and label charts to alert boaters about sensitive habitat areas	Marina waters; generally recommended	MODERATE to HIGH; protection of shallow-water habitats helps protect shorelines from erosion	MODERATE; shallow-water environments are important ecologically	NONE to LOW	NONE to LOW	See the Boat Operation management measure; signs should be in multiple languages if appropriate.
Educate boaters to thoroughly clean their boats before boating in other waterbodies	Marina waters; generally recommended	MODERATE to HIGH; can prevent invasions of exotic species, which could be costly to control	MODERATE to HIGH; depends on whether the species has already established itself in the surrounding waters	NONE to LOW	NONE to LOW	

SECTION 5: DETERMINING POLLUTANT LOADS

Section 5 Contents

This section is included for those interested in the technical information used to determine the dynamics of water flow and water quality variations. Although numerical models provide an effective approach to evaluate design parameters, marina developers may use their own discretion in employing modeling techniques.

The use of an area for a marina might infringe on or preclude other uses of the resources, and it is this potential conflict that can be evaluated by using of water quality modeling. Marina basins can contain pollutants ranging from sanitary wastes to toxic metals leached from hulls and petroleum products discharged in engine exhaust. These wastes pose a variety of potential problems for water quality, including microbiological contamination of adjacent shellfish and swimming areas, depletion of dissolved oxygen in the water column or sediments, and toxic effects on estuarine biological resources. Water quality monitoring can be used before marina construction or expansion to determine the design (including basin shape and entrance locations and runoff controls) that will be the least disturbing to the surrounding aquatic environment. It can be used after marina construction to determine compliance with water quality criteria and what, if any, changes in design are necessary to meet any water quality criteria that have been violated.

Water quality criteria are based on pollutant concentrations. Concentrations of water quality constituents (such as dissolved oxygen [DO] or petroleum hydrocarbons) can be used to assess instantaneous conditions (water quality when the sample is taken) and conditions over time (samples taken daily for a week or a month). Concentrations of pollutants in water can be measured in storm water runoff before the runoff reaches a waterbody or in the waterbody of interest. If concentrations are measured in runoff, the timing is important. Pollutant concentrations usually vary widely during a rainstorm, typically being higher during the first wave or "first flush" of storm water, when pollutants accumulated since the previous storm are washed away, and lower later in the storm.

Concentrations also vary from storm to storm. Longer periods between storms allow more pollutants to accumulate on surfaces, whereas a storm that occurs shortly after a previous storm might carry very few pollutants in its runoff.

Time of year is also important. A storm that occurs during a week of peak boat maintenance activity is likely to carry more pollutants than a storm that occurs in the spring before the boating season begins. If nothing else, the pollutants carried by the storm runoff will be different. A storm in spring might carry more sediment and salt from winter road treatments, whereas one in summer might have more oil and debris from hull maintenance activities.

Pollutant loads in a marina basin can be measured by collecting samples at various times, depths, and places in the basin. For a simple assessment of water quality, samples of dissolved oxygen, fecal coliform bacteria, and perhaps water clarity (using a Secchi disk) might be performed. If sampling for assessment of meeting state water quality standards, samples for the constituents required by the state have to be taken and the samples might have to be analyzed by a state-approved laboratory.

Samples can be taken once for an indication of instantaneous water quality or over a period of time to assess average water quality conditions or trends in water quality (for example, whether water quality is worse over busy boating weekends or in particular seasons, or just after a storm and for how long after a storm has occurred). Comparison of samples of storm water runoff and samples of marina basin water quality might be used to determine whether degraded water quality during and shortly after storms is due to runoff from the marina property or from surrounding properties.

General water quality monitoring is discussed under the Water Quality Assessment management measure in Section 4. A discussion of models and monitoring, which supports their use for in-depth analyses of water quality and water quality changes that might occur from changes in marina configuration or marina construction, follows. The discussion is somewhat technical because it is anticipated that if these models are applied, they will be applied by persons trained in their use and familiar with their implementation. Those without a background in modeling can still benefit from reading the discussion to gain a general understanding of what modeling involves and to help decide whether modeling is appropriate for a particular marina and situation.

Example Models for Marina Flushing Assessment

Selection Criteria

To understand what is needed to apply a model, it is essential to focus on the physical, chemical, and biological processes that move water into and out of the marina area, control mixing with adjacent waters, regulate chemical reactions in the water and sediments, and facilitate biological growth and decay (die-off). A variable combination of winds, tides, currents, and density differences is responsible for the physical movement of water volumes and pollutants. The geometry of a site can also have a major effect on flushing and dispersion and is an important issue in selecting the model, collecting the data, and attaining the required water quality standards.

Biodegradation of organic material, growth and decay of bacteria and other organisms, nutrient uptake, and chemical transformations of various kinds are typical of the biochemical processes that affect contaminants. Physical, chemical, and biological processes should be combined to form a conceptual model of the site and its consequent contaminant assimilation potential. After the site in question has been conceptualized, the next step is to choose a model that incorporates the appropriate physical processes and biochemistry to predict water quality. Depending on the level of sophistication at which the assessment is taking place, the model selected might be a simple screening calculation (e.g., Tidal Prism Analysis) or a multidimensional numerical model (e.g., WASP4, DEM, WQM2D, or EFDC Hydrodynamic Model).

The models discussed here have been selected for the following reasons:

- They are in the public domain.

- They are available at a minimal cost from various public agencies.
- They are supported to a varying extent by federal or state agencies. The form of support is usually telephone contact with a staff of engineers and programmers who have experience with the model and can provide guidance (usually free of charge).
- They have been used extensively for various purposes and are generally accepted within the modeling profession.
- Together they form a sequence of increasingly more technically complex models; that is, each model takes additional phenomena into account in a more detailed manner than the preceding model.

Selection from among these models should be made on the basis of the model capabilities needed.

In addition to model capabilities, the two most important factors in the selection of a model are the adequacy of the documentation and the adequacy of the support available. The documentation should state the theory and assumptions in adequate detail, describe the program organization, and clearly present the input data requirements and format. A well-organized data scheme is essential. The support provided should include user access via telephone to programmers and engineers familiar with the model. Special support (including short courses or informational or personnel exchanges) might be available under existing intra-agency or interagency agreements or can be made available to the potential user. The support agency might also be able to provide the potential user with a list of local users who could be contacted for information regarding their past or current experience with the computer program. Table 5-1 presents documentation and user's support available for some of the models discussed in this section.

In addition to having adequate documentation and user's support, the selected model should address all marina water quality problems of concern.

The following section provides an overview of the best-qualified marina water quality model in each of the selected categories. These models are listed in Table 5-1, which provides information related to the operational features of the models. This information is provided to help in evaluating the estimated cost associated with and the ease of acquiring the model, getting the model running on the user's system, calibrating the model, and finally applying the model. Table 5-2 lists the level of effort involved in applying the models.

Models Selected

The most rigorous tools that can be used for assessing marina impacts on water quality are numerical models. Models range in complexity from simple desktop calculations to full three-dimensional models that simulate physical and chemical processes by solving equations of motion and rate equations for chemical processes.

The complexity of the model used and the quality of the input data determine the degree of resolution in the results. For example, in an early part of a study, the Tidal Prism Analysis strategy is used to obtain a general understanding of potential impacts caused by pollutant discharged from a proposed marina. It is likely that the simplified strategy will predict substantial impacts on the environment. Therefore, an advanced model is needed to conduct further detailed analyses. A mid-range model is used in situations where steady-state conditions may be assumed and tidal flushing is the predominant mode of flushing. A complex model is used in dynamic environments subject to complex circulation patterns and full biochemical kinetics, with sources and sinks for all dissolved constituents and for proposed marinas.

Simple Model

The methods listed here include desktop screening methodologies that calculate seasonal or annual mean pollutant concentrations based on steady-state conditions and simplified flushing time estimates. These models are designed to examine and isolate trouble spots for more detailed analyses. They should be used to highlight major water quality issues and important data gaps in the early stage of a study.

Methods presented in this section, particularly some of the mathematical descriptions, are

Table 5-1. Ease of application: Sources, support, and documentation.

Model	Source(s) of Model	Nature of Support	Adequacy of Documentation	Cost
Tidal Prism Analysis	USEPA, Region 4, Atlanta, GA. 1985. Chapter 4 of *Coastal Marinas Assessment Handbook*.	N/A	Excellent documentation with example application	Low
Flushing Characteristics Diagram	Christensen, B.A. 1989. Canal and marina flushing characteristics. *The Environmental Professional* 11:241-255.	N/A	Good illustrations with numerical example application	Low
NCDEM DO Model	North Carolina Dept. of Environmental Health and Natural Resources, Division of Environmental Management (919) 733-6510	Telephone contact	Good documentation with several applications	Medium
Tidal Prism Model	Virginia Institute of Marine Science, Gloucester Point, VA 23062 (804) 642-7212	Telephone contact	Excellent documentation of theory and assumptions; excellent user's guide with input and output information	Medium
WASP4	Center for Exposure Assessment Modeling, U.S. Environmental Protection Agency, Athens, GA 30613 (404) 546-3585	Software maintenance, workshop technical assistance through EPA channels	Excellent documentation of theory and assumptions; excellent user's guide with input and output information	High
EFDC Hydrodynamic Model	Virginia Institute of Marine Science, Gloucester Point, VA 23062 (804) 642-7212	Telephone contact	Excellent documentation of theoretical and computational aspects; excellent user's manual with input and output information; numerous papers written describing capabilities of the model	High

simplifications of more sophisticated techniques. These techniques, as presented, can provide reasonable approximations for screening potential impact problems when site-specific data are not available. The Tidal Prism Analysis was selected as the method of choice in this category. This method is capable of addressing all marina water quality issues of concern (e.g., dissolved oxygen and fecal coliform bacteria) and comes with excellent documentation. The primary strengths and advantages of the screening procedures are as follows:

- Excellent user documentation and guidance.

Table 5-2. Level of effort for best models.

Complexity	Model	Water Quality Problem	Approximate Level of Effort
Simple	Tidal Prism Analysis	DO, fecal coliform bacteria	1-2 Days
Mid-range	Tidal Prism Model	DO, BOD, nutrients, phytoplankton, fecal coliform	3-7 Days
Mid-range	NCDEM DO	DO	1-2 Days
Complex	WASP4	DO, BOD, nutrients, phytoplankton, toxics, fecal coliform	3-4 Weeks
Complex	EFDC Hydrodynamic	DO, BOD, temperature, salinity, nutrients, sediment, finfish, phytoplankton, shellfish, toxics, fecal coliform, eutrophication	4-6 weeks

Note: DO = dissolved oxygen, BOD = biological oxygen demand

- No computer is necessary because the procedures can be performed on hand calculators.
- Relatively simple procedures with minimal data requirements that can be satisfied from the user's manual when site-specific data are lacking.

The Tidal Prism Analysis procedures can be easily implemented in a computer program. This allows the user to test model sensitivity and determine the range of potential water quality impacts from a proposed marina quickly and efficiently.

Mid-Range Models

The recommended marina mid-range models are the Tidal Prism Model and the NCDEM DO Model. Both models are in the public domain, are easy to apply, and are supported with good documentation.

Tidal Prism Model

The Tidal Prism Model is a steady-state model capable of simulating up to 10 water quality variables, including dissolved oxygen and fecal coliform bacteria. The user's manual is well written and includes input/output examples, as well as guidance on how to calibrate and apply the model. Based on constituents modeled, the Tidal Prism Model is recommended as the best-qualified marina mid-range model. The primary strengths and advantages of the Tidal Prism Model are as follows:

- Excellent user documentation and guidance.
- Minimal computer storage requirements.
- Relatively simple procedures with data requirements that can be satisfied from existing data when site-specific time series data are lacking.

The Tidal Prism Model is applicable only to marinas where tidal forces are predominant with oscillating flow (e.g., an estuary or a tidal river). Therefore, the Tidal Prism Model can't be applied to marinas located on a sound, an open sea, or a lake or reservoir. Because the Tidal Prism Model is not applicable to most marina situations, the NCDEM DO model is recommended as an alternative best-qualified model for mid-range applications where the Tidal Prism Model isn't applicable.

NCDEM DO Model

The NCDEM DO model is a steady-state program that is capable of predicting only DO concentrations. The NCDEM DO model is applicable to one-, two-, and three-segment marinas. Model theory, assumptions, and input parameters are presented in adequate detail. Model documentation includes input and output examples of several applications as well as a listing of the model code. The model code is written in BASIC.

The NCDEM DO model incrementally mixes the ambient and marina waters as a function of the average lunar tides. The tidal variation is assumed to follow a sinusoidal distribution. For simplicity, a 12-hour tidal cycle is used. If this time-variable model is run through a sufficient number of tidal cycles, the average marina basin DO value approaches a steady-state value.

Complex Models

Complex models consist of two components—hydrodynamics and water quality. In this model category, hydrodynamics may be represented by numerical solution of the one-dimensional or the full two-dimensional equations of motion and continuity. Water quality conservation-of-mass equations are executed using the hydrodynamic output of water volumes and flows. The water quality component of the models calculates pollutant dispersion and transformation or decay, giving resultant concentrations over time. These models are very complex and require an extensive effort for specific applications.

Water Quality Analysis Simulation Program (WASP4)

The Water Quality Analysis Simulation Program, WASP4, is a dynamic compartment modeling system that can be used to analyze a variety of water quality problems in one, two, or three dimensions. WASP4 simulates the transport and transformation of conventional and toxic pollutants in the water column and benthos of ponds, streams, lakes, reservoirs, rivers, estuaries, and coastal waters. The WASP4 modeling system covers four major subjects—hydrodynamics, conservative mass transport, eutrophication-dissolved oxygen kinetics, and toxic chemical-sediment dynamics. The modeling system also includes a stand-alone hydrodynamic program called DYNHYD4, which simulates the movement of water. DYNHYD4 is a link-node model that can be driven by either constantly repetitive or variable tides. Unsteady inflows can be specified, as well as wind that varies in speed and direction. DYNHYD4 produces an output file of flows and volumes that can be read by WASP4 during the water quality simulation. WASP4 contains two separate kinetic submodels, EUTRO4 and TOXI4. EUTRO4 is a simplified version of the Potomac Eutrophication Model (PEM) and is designed to simulate most conventional pollutant problems. EUTRO4 can simulate up to eight state variables, including dissolved oxygen and fecal coliform. TOXI4 simulates organic chemicals, metals, and sediment in the water column and underlying bed.

The WASP4 model system is supported by the EPA's Center for Exposure Assessment Modeling (CEAM) in Athens, Georgia, and has been applied to many aquatic environments. The WASP4 model can be obtained from the CEAM web page (www.epa.gov/ceampubl/softwdos.htm). The water quality component is set up for a wide range of pollutants, and the model is the most versatile and most widely applicable of all models considered here. For these reasons WASP4 is the model of choice in this category. The primary strengths and advantages of the WASP4 model are as follows:

- *Documentation*: WASP4 has excellent user documentation and guidance. Theory and assumptions are presented in adequate detail; program organization and input data requirements and format are clearly presented.
- *Support*: User access is available by telephone to programmers and engineers familiar with the model. Occasional workshops, sponsored by CEAM, are available. The support agency (CEAM) can provide the potential user with a list of local users who could be contacted for information regarding their past or current experience with the computer program.

- *Flexibility*: Model users can add their own subroutines to model other constituents that might be more important to the specific application with minimal or virtually no programming effort required. The user can operate WASP4 at various levels of complexity to simulate some or all of these variables and interactions.

CEAM maintains and updates software for WASP4 and the associated programs. Continuing model development and testing within the CEAM community will likely lead to further enhancements and developments of the WASP4 modeling system. In fact, CEAM is currently supporting the development of a 3-dimensional (3-D) hydrodynamic model that will be linked to the WASP4 model.

EFDC Hydrodynamic Model

The environmental fluid dynamics code (EFDC) model was originally developed at the Virginia Institute of Marine Science (VIMS) for estuarine and coastal applications and is considered public domain software. It is a general-purpose modeling package for simulating three-dimensional flow, transport, and biogeochemical processes in surface water systems, including rivers, lakes, estuaries, reservoirs, wetlands, and coastal regions. In addition to hydrodynamic and salinity and temperature transport simulation capabilities, EFDC can simulate cohesive and noncohesive sediment transport, near-field and far-field discharge dilution from multiple sources, eutrophication processes, the transport and fate of toxic contaminants in the water and sediment phases, and the transport and fate of various life stages of finfish and shellfish. Special enhancements to the hydrodynamic portion of the code, including vegetation resistance, drying and wetting, hydraulic structure representation, wave-current boundary layer interaction, and wave-induced currents, allow refined modeling of wetland marsh systems, controlled flow systems, and nearshore wave-induced currents and sediment transport. The EFDC model has been extensively tested and documented for more than 20 modeling studies. The model is currently being used by a number of organizations, including universities, governmental organizations, and environmental consulting firms.

The structure of the EFDC model includes four major modules: (1) a hydrodynamics model, (2) a water quality model, (3) a sediment transport model, and (4) a toxics model (see Figure 5-1). The EFDC hydrodynamic model itself is composed of six transport modules—dynamics, dye, temperature, salinity, near-field plume, and drifter. Various products of the dynamics module (water depth, velocity, and mixing) are directly coupled to the water quality, sediment transport, and toxic models.

- *Documentation*: Extensive documentation of the EFDC model is available. Theoretical and computational aspects of the model are described by Hamrick (1992a). An excellent user's manual (Hamrick, 1996) is available and includes input file templates. A number of papers describe model applications and capabilities (Hamrick, 1992b, 1994; Hamrick and Wu, 1996; Moustafa and Hamrick, 1994; and Wu et al., 1996).

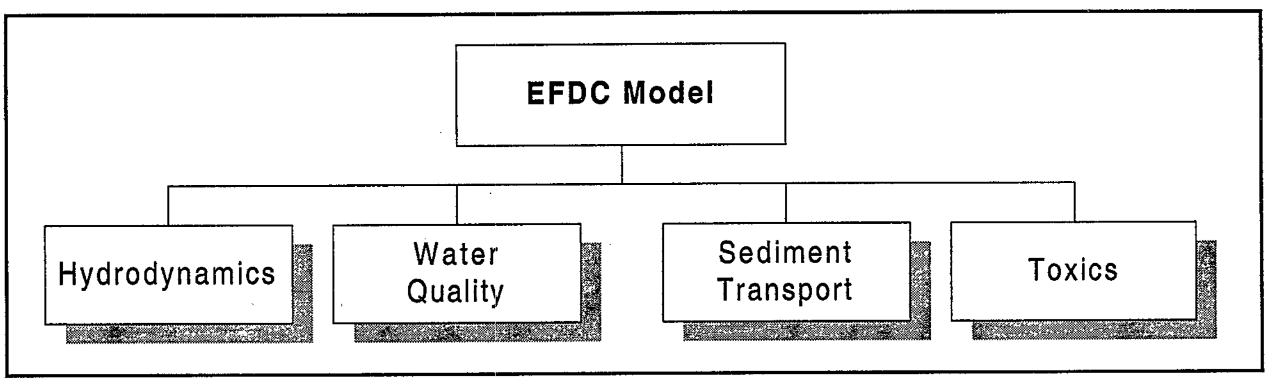

Figure 5-1. Structure of and modules associated with the EFDC model.

- *Support*: User access is available by telephone to programmers and engineers familiar with the model. VIMS can provide the potential user with a list of local users who could be contacted for model information.
- *Flexibility*: The EFDC model can be configured to execute all or a portion of a model application in reduced spatial dimension mode, including two-dimension depth or width averaged and one-dimension cross section averaged. The number of layers used in the three-dimension mode or two-dimension width averaged mode is readily changed by one line of model input. Model grid sections specified as two-dimension width-averaged are allowed to have depth-varying widths to provide representations equivalent to those of two-dimension width-averaged estuarine and reservoir models, such a CE-QUAL-W2.

Water Quality Monitoring in Marinas (for modeling applications)

Sampling Guidelines for Existing Marinas

General guidance is presented to develop the framework for a site-specific water quality sampling program suitable for an existing marina. A monitoring study at an existing marina may be requested by regulatory agencies if it is suspected that the marina is causing degradation of water quality standards. An overall monitoring program can consist of three phases or levels. In Level 1, preliminary screening is conducted to gather baseline information on the marina. If historical data on the marina are available, this level might not be needed or the quantity of data needed might be reduced. Based on the historical or Level 1 data, if it is established that the marina may be causing impacts on water quality, Level 2 sampling, which incorporates additional sampling of the receiving waters, would commence. If evaluation of Level 2 data also indicates that the marina is affecting water quality, marina design changes may be recommended and eventually implemented. Level 3 sampling would be initiated to evaluate the performance of any implemented marina design changes. Examples of potential marina design changes include removal of sills, which tend to trap water in the lower depths of a marina, and improvement of flushing by altering sharp corners within the marina or by enlarging the marina entrance.

Spatial Coverage

An intensive spatial coverage of the marina and the adjacent waterbody for some indicator or surrogate water quality parameter, such as salinity or turbidity, is generally needed to estimate spatial variability and to determine the model type and the segmentation required.

Generally, the spatial coverage of the modeled marina should extend away from the marina site to the extent that normal background levels for DO are encountered. At this location, model boundary conditions (i.e., surface elevations or current velocities) can be established. In this manner the total effect of the marina can be measured.

The preceding approach is appropriate when using complex models. Sampling stations for complex models should be spaced throughout the model grid system, with the spatial coverage being governed by the gradients in velocities and water quality constituents. For existing marinas, adjacent waterbodies are divided into a series of reaches for complex model application, with each reach described by a specific set of channel geometry dimensions (cross-sectional dimensions) and flow characteristics (flow rates, tidal range, velocities, and biochemical processes). The models assume that these conditions are uniform within each reach. Each reach is in turn divided into a series of model segments or computational elements to provide spatial variation for the water quality analysis. Each segment is represented by a grid point in the model where all water quality variables are computed. For the WASP4 model, the segment length is dependent on the degree of resolution desired and the natural variability in the system. Enough detail should be provided to characterize anticipated spatial variation in water quality.

The hydrodynamics of the Tidal Prism Model are based on the tidal prism volume at each segment. Therefore, the spatial coverage of a marina, using the Tidal Prism Model, includes the entire estuary/ river where the marina is located. The length of each segment is defined by the tidal excursion, the average distance traveled by a water particle on the flood tide, because this is the maximum length over which complete mixing can be assumed.

A sampling station for each model segment is the minimum requirement to calibrate the returning ratios of the Tidal Prism Model. Sampling stations should generally be located along the length of the estuary and in the main channel. The returning ratio is defined as the percentage of tidal prism that was previously flushed from the marina on the outgoing tide.

Constituents Sampled

The specific constituents that must be sampled, as well as the sampling frequency, depend to some extent on the particular modeling framework to be used in the analysis. The selected model should include all of the processes that are significant in the area under investigation without the unnecessary complexity of processes that are insignificant. A few preliminary measurements might be useful to define which processes are important.

The minimum sampling requirements for all dissolved oxygen studies should include dissolved oxygen, temperature, carbonaceous biochemical oxygen demand (CBOD), and total Kjeldahl nitrogen (TKN), because these parameters are fundamental to any dissolved oxygen analysis. Biochemical oxygen demand (BOD) is typically measured as 5-day BOD, but a few measurements of long-term BOD are also necessary. The Tidal Prism Model considers only the CBOD component, and therefore the model should be used only in situations where the nitrogenous components are known to be unimportant.

In addition to TKN, ammonia (NH_3) and nitrate (NO_{3G}) (or nitrite [NO_{2G}] plus nitrate) should be measured for dissolved oxygen investigations for both the Tidal Prism and WASP4 models. Even if ammonia, nitrate, and nitrite are not modeled, the data are useful for estimating the nitrogenous BOD decay rate or ammonia oxidation rate.

Concentrations of algal dry weight biomass or chlorophyll *a* should be measured because both the complex models and the Tidal Prism Model simulate algae growth for dissolved oxygen analysis. Light extinction coefficients (or Secchi depths) are also needed for the algal growth computations in dissolved oxygen analysis if the complex models are used.

In situ sediment oxygen demand (SOD) should be measured in situations where it is expected to be a significant component of the oxygen budget. This is most likely to occur in shallow areas where the organic content of the sediments is high or in deep marina basins where flushing is minimal. In developing a strategy for SOD measurement, it is logical to assume that those factors important in establishing model reaches or segments are also relevant to selecting SOD measurement sites. The more important of these factors are

- *Geometry*: depth and width.
- *Hydraulics*: velocity, slope, flow, and bottom roughness.
- *Water quality*: location of point sources, nonpoint source runoff, and abrupt changes in DO/SOD concentrations.

The most important factor for SOD is likely to be the location of abrupt changes in DO/BOD concentrations, such as areas surrounding the entrance channels of marinas and in the marina basin proper. The final point to consider is that SOD can vary with season. This observation is particularly relevant to marinas and adjacent areas dominated by algal activity and/or oxidation of organic and inorganic nutrients by benthic microorganisms, both of which can occur seasonally. The modeler should thus be aware of this potential concern and structure the SOD measurement times accordingly.

In addition to sampling for the constituents to be simulated, measurements are also necessary to help quantify the various coefficients and parameters included in the model equations. Coefficient values can be obtained in four ways: (1) direct measurement, (2) estimation from field data, (3) literature values, and (4) model calibration. Model calibration is usually required regardless of the selected approach. However, coefficients that tend to be site-specific or that can take on a wide range of values should be either measured directly or estimated from field samples. These could include the following parameters:

- CBOD decay rate
- CBOD settling rate
- NH_3 oxidation rate (nitrogenous BOD decay rate)
- SOD

In addition to the preceding model parameters, which are determined primarily from the results of field sampling surveys, several other rate coefficients can be measured in the field. For example, stream reaeration rates for the WASP4 model and returning ratios for the Tidal Prism Model can be measured using tracer techniques. WASP4 provides several options for the reaeration rate equation because many of the equations are applicable to only certain ranges of depth and velocity.

Sampling Locations

Water quality data should be collected at the downstream boundary of the study area for model calibration. Adjacent waters both upstream and downstream should also be sampled to determine background concentrations of water quality constituents. Although a single downstream station is the minimum requirement for short channel sections, additional sampling stations are desirable to provide more spatial data for calibrating the model. Logical locations for additional stations are sharp corners and dead end segments in the marina basin proper. If the marina is segmented for a complex model application, each segment should be sampled. However, water quality variations might be negligible at stations located upstream and downstream immediately outside marinas.

In the Tidal Prism Model, water quality is assumed to be well mixed and uniform over each segment of the stream. Therefore, samples taken immediately downstream of the marina would probably not match conditions in the model unless they were taken far enough downstream for complete cross-sectional mixing to occur. In general, increased sampling should be allocated to those areas of the marina and the adjacent water that have the most impact (along the shoreline). In general, all of the major water quality parameters of interest (DO, CBOD, TKN, NH_3, NO_3, fecal coliform bacteria, temperature, and so forth) should be measured at each station in the sampling network.

Rate coefficients and model parameters can be estimated from literature values before site-specific measurements are available. For important parameters such as the BOD decay rate, sensitivity analyses can be performed to evaluate the effects of different coefficient values in formulating DO concentrations. These analyses should provide enough information so that sampling stations can be located in critical areas.

Sampling Time and Frequency

The duration and frequency of water quality sampling depend to a large extent on whether the Tidal Prism Model or a complex model will be used. The Tidal Prism Model computes water quality conditions only at slack before ebb; thus, sampling at a higher rate is not necessary. The complex models have a user-specified time step, which means that sampling should be more frequent for shorter time steps.

Because the Tidal Prism Model assumes that conditions remain constant with time, it is important to conduct the sampling program during a period when this assumption is valid. Synoptic surveys (e.g., sampling all stations over 2 to 3 days) should be conducted to the extent possible so that water quality conditions at different locations are not affected significantly by changes in the weather or variations in the marina discharge that are not accounted for in the model. However, since temperature varies diurnally and temperature influences the process rates of most biological and chemical reactions, some variability in the sampling results will be inevitable. It should be noted that the Tidal Prism Model uses the first day of field data as initial and boundary condition input to the model. Field data from succeeding cycles are then used to compare the output simulations at the same cycle.

Complex models compute continuous changes that occur over time because of variations in stream flow, temperature, nonpoint and point source loadings, meteorology, and processes occurring within a marina and its adjacent waters. All of the factors that are assumed constant for a Tidal Prism analysis are free to vary continuously with time in a complex model. This feature allows an analysis of diurnal variations in temperature and water quality, as well as continuous prediction of daily variations or even seasonal variations in water quality.

Application of a complex model requires a much more detailed sampling program than that required by a mid-range model. Enough data should be collected to define the temporal variations in water quality throughout the simulation period at the model boundary conditions. Therefore, more frequent data collection should be conducted at the model boundary condition. Complex models investigate the temporal variations in dissolved oxygen and fecal coliform bacteria much better than mid-range models. To achieve this resolution, intensive surveys should be mixed with long-term trend monitoring. The significance of the temporal variations depends on the context of the problem. For example, if the daily average dissolved oxygen concentration is around 5 mg/L or less, a diurnal variation of less than 1 mg/L could be very important with respect to meeting water quality standards; if the average dissolved oxygen concentration is around 10 mg/L, diurnal variations are important and the sampling program should include 2 or 3 days of intensive sampling for dissolved oxygen and temperature at all of the key stations. As a minimum, these stations would include the stations designated as the model boundary, as well as the stations surrounding the marina and adjacent waters and stations within the marina. These locations satisfy the minimum requirements of defining the boundary and loading conditions, plus a few calibration stations in the critical areas for DO, SOD, and fecal coliform bacteria.

Long-term dynamic simulations of seasonal variations in stream water quality might be impractical. Where seasonal variation is of interest, the typical practice is to run the Tidal Prism Model or a complex model (with short-term simulations) several times for different sets of conditions that represent the full spectrum of conditions expected over the period of interest.

Enough data should be collected to characterize the seasonal variations and to provide adequate data for calibrating and applying the model. If possible, enough data should be collected to cover the full range of conditions of the model analysis. As a minimum, these should include conditions during the critical season for the water quality variable of interest. For DO, for example, the critical season occurs during the hot summer months (July through September).

Two general types of studies can be defined—*intensive surveys*, which are those used to identify short-term variations in water quality, and *trend monitoring*, which is used to estimate trends or mean values. Intensive surveys are intended to identify intertidal variations or variations that occur because of a particular event in order to make short-term forecasts. Intensive surveys should encompass at least four full tidal cycles. They should usually be conducted regardless of the type of modeling study being conducted. Boundary conditions should be measured concurrently with the monitoring of the marina basin and the adjacent water. A record of all point source waste loads located near the marina site during the week before the survey is recommended. Variables that should be sampled during the intensive surveys include tide, current velocity, salinity, DO, fecal coliform bacteria, nitrogen, and phosphorus, measured hourly.

Trend monitoring is conducted to establish seasonal and long-term trends in water quality. Trend sampling may take place on a biweekly or monthly basis for a year at a time. Stations should be sampled at a consistent phase of the tide and time of day to minimize tidal and diurnal influences on water quality variations. Some stations may be selected for more detailed evaluation during the intensive survey. Long-term trend monitoring should also be considered as a way to track changes in water quality between the intensive surveys.

Most states have water quality standards for the 24-hour average concentration and the instantaneous minimum concentration of DO. Therefore, it is important to collect DO data throughout a complete cycle, that is, from the high value, which normally occurs at mid-afternoon, to the low value, which usually occurs at dawn. This approach will allow the DO range in the model to be calibrated to specific field conditions. If the waterbody is stratified, samples should be collected at the surface, mid-depth (above and below the thermocline and pycnocline, if possible), and bottom. In general, it is necessary to collect samples at a 2-hour frequency over a 24-hour period to adequately define the daily average and the minimum DO concentrations.

Appendix A

Best Management Practices Checklist for Marinas and Recreational Boating

BEST MANAGEMENT PRACTICES CHECKLIST FOR MARINAS AND RECREATIONAL BOATING

Name of marina: ______________________________

Marina address: ______________________________

Name of person doing assessment: ______________________________

Date of assessment: ______________________________

This best management practices (BMP) checklist is designed to help marina owners and operators review the general activities associated with developing or expanding recreational marinas and boat ramps and operating existing marinas. Several BMPs and combinations of BMPs might be necessary at a marina to prevent or reduce runoff pollutants. Professionals can also use this checklist to review new marina development or expansion.

The BMP tables in the guidance provide detailed descriptions and the applicability of various management measures and practices. The lists provided here can be used to assemble information on the BMPs installed or used at the marina. If BMPs other than those listed are used, they may be identified in the space provided.

The scope of this guidance is broad, covering diverse nonpoint source pollutants from marinas and recreational boating. Because it includes all types of waterbodies, it does not provide all practices and techniques suitable to all regional or local marina or waterbody conditions. Also, BMPs are continually being modified and developed as a result of experience gained from their implementation and the innovation of marina owners and operators across the country.

The guidance can assist marina owners and managers in identifying potential sources of nonpoint source pollution and offer potential solutions. Finding the best solution to any nonpoint source pollution problem at a marina requires taking into account the many site-specific factors that together compose the setting of the marina. The applicability of BMPs to any particular marina or situation can be determined based on site-specific factors unique to the marina site.

1. MARINA FLUSHING

Site and design marinas such that tides and/or currents will aid in flushing of the site or renew its water regularly.

Marina water quality depends on water circulation within the boat basin, the level of pollutants present, and new amounts of pollutants entering the water. In a poorly flushed marina, pollutants tend to concentrate in the water and/or sediments. In a basin with poorly flushed corners or secluded or protected spots, pollutants and debris can tend to collect in those locations. Stagnant, polluted water can be the consequence. The flushing rate is the time required to replace the water in a basin. In tidal waters flushing is driven primarily by the ebb and flow of the tide, whereas in inland lakes and rivers flushing depends on wind-driven circulation and current speed. Pollutants tend to concentrate in water and/or sediments in poorly flushed coves and marinas. Fine sediment and organic debris can collect in uncirculated water, which can deplete the amount of oxygen in the water. Reduced dissolved oxygen in stagnant water hinders biological activity and can result in lifeless shores and offensive odors. Adequate marina flushing greatly reduces or eliminates the potential for water stagnation and helps maintain the biological productivity and aesthetic value of a marina basin. Good flushing can reduce pollutant concentrations in a marina basin by from 70 percent to almost 90 percent over a 24-hour period.

BMPs that should be considered and used where appropriate:

- ☐ *Ensure that the bottom of the marina and entrance channels are not deeper than adjacent navigable channels.*
- ☐ *Consider design alternatives in poorly flushed waterbodies to enhance flushing (open design instead of a semienclosed design, wave attenuators instead of fixed breakwaters).*
- ☐ *Design new marinas with as few enclosed water sections or separated basins as possible to promote circulation within the entire basin.*
- ☐ *Consider the value of entrance channels in promoting flushing when designing or reconfiguring a marina.*
- ☐ *Establish two openings at the most appropriate locations within the marina to promote flow-through currents.*
- ☐ *Consider mechanical aerators to improve flushing and water quality where basin and entrance channel configuration cannot provide adequate flushing.*
- ☐ *Other (describe):*

2. WATER QUALITY ASSESSMENT

Assess water quality as part of marina siting and design.

Water quality is assessed during the marina design phase to predict the effect of marina development on the chemical and physical health of the water and aquatic environment. Marina development can cause changes in flushing and circulation; and boat maintenance, boat operation, and the human activities in and around boats can be sources of solid and liquid wastes, pathogenic organisms, and petroleum compounds. The results of water quality predictions or sampling are compared to state or federal water quality standards. Water quality assessments for dissolved oxygen concentration and pathogenic organisms can be used as indicators of the general health of an aquatic environment. Water quality assessments can be useful in determining the suitability of a location for marina development, the best marina design for ensuring good water quality, and the causes and sources of water quality problems.

BMPs that should be considered and used where appropriate:

- ☐ *Use water quality sampling and/or monitoring to measure water quality conditions.*
- ☐ *Use a water quality modeling methodology to predict postconstruction water quality conditions.*
- ☐ *Monitor water quality using indicators.*
- ☐ *Use rapid bioassessment techniques to monitor water quality.*
- ☐ *Establish a volunteer monitoring program.*
- ☐ *Other (describe):*

3. HABITAT ASSESSMENT

Site and design marinas to protect against adverse effects on shellfish resources, wetlands, submerged aquatic vegetation, or other important riparian and aquatic habitat areas as designated by local, state, or federal governments.

The construction of a new marina in any waterbody type has the potential to disrupt aquatic habitats. These habitats include fish spawning areas, shellfish harvesting areas, designated wetlands, beds of submerged aquatic vegetation, and the habitats of threatened or endangered species. Marinas can be designed and located to help support the aquatic plants and animals that were present in the waters before the marina's construction. A marina can be operated as a valuable habitat for plants and animals that do well in quiet, sheltered waters.

BMPs that should be considered and used where appropriate:

- ☐ *Conduct habitat surveys and characterize the marina site, including identifying any exotic or invasive species.*
- ☐ *Assess habitat function (e.g., spawning area, nursery area, feeding area) to minimize indirect effects.*
- ☐ *Use rapid bioassessment techniques to assess effects on biological resources.*
- ☐ *Redevelop waterfront sites that have been previously disturbed and expand existing marinas.*
- ☐ *Consider alternative sites where adverse environmental effects will be minimized or positive effects will be maximized.*
- ☐ *Create new habitats or expand habitats in the marina basin.*
- ☐ *Minimize disturbance of riparian areas.*
- ☐ *Use dry stack storage.*
- ☐ *Other (describe):*

4. SHORELINE AND STREAMBANK STABILIZATION

Where shoreline or streambank erosion is a nonpoint source pollution problem, shorelines and streambanks should be stabilized. Vegetative methods are strongly preferred unless structural methods are more cost-effective, considering the severity of wave and wind erosion, offshore bathymetry, and the potential adverse impact on other shorelines, streambanks, and offshore areas.

Protect shorelines and streambanks from erosion due to uses of either the shorelands or adjacent surface waters.

Erosion in any waterbody is a natural process that results when moving water and waves undermine, collapse, and wash out banks and shorelines. Banks erode along nontidal lakes, rivers, and streams; shorelines erode along intertidal portions of coastal bays and estuaries. Eroding streambanks and shorelines and streambanks do not protect the land and structures during storm events. Such erosion contributes to nonpoint source pollution problems, turbidity, and shoaling and increases the need for maintenance dredging in marina basins and channels. Vegetation and structural methods have been shown to be effective for mitigating shoreline erosion and for filtering pollutants from overland and storm water runoff.

BMPs that should be considered and used where appropriate:

- ☐ *Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows.*
- ☐ *Where shorelines need structural stabilization and where space and use allow, riprap revetment is preferable to a solid vertical bulkhead.*
- ☐ *Where reflected waves will not endanger shorelines or habitats and where space is limited, protect shorelines with structural features such as vertical bulkheads.*
- ☐ *At boat ramps, retain natural shoreline features to the extent feasible and protect disturbed areas from erosion.*
- ☐ *Other (describe):*

5. STORM WATER RUNOFF MANAGEMENT

Implement effective runoff control strategies that include the use of pollution prevention activities and the proper design of hull maintenance areas.

Reduce the average annual loadings of total suspended solids (TSS) in runoff from hull maintenance areas by 80 percent. For the purposes of this measure, an 80 percent reduction of TSS is to be determined on an average annual basis.

Sanding dust, paint chips, metal filings, and other such solids that drop on the ground during boat repair and maintenance can all be swept into the water by the next rainstorm's runoff. Oils, grease, solvents, paint drippings, and fuel spilled or dripped onto the ground are also be carried away in runoff. Unless runoff is treated in some manner, all of these pollutants end up in the marina basin, where they create unsightly surface films or float until they adhere to a surface, such as a boat hull. Some of these pollutants sink to the bottom, where they can be eaten by bottom-feeding fish or filter-feeding shellfish, or settle onto the leaves of aquatic vegetation and clog their pores.

BMPs that should be considered and used where appropriate:

- ☐ *Perform as much boat repair and maintenance work as possible inside work buildings.*
- ☐ *Where an inside work space is not available, perform abrasive blasting and sanding within spray booths or tarp enclosures.*
- ☐ *Where buildings or enclosed areas are not available, provide clearly designated land areas for boat repair and maintenance.*
- ☐ *Design hull maintenance areas to minimize contaminated runoff.*
- ☐ *Use vacuum sanders both to remove paint from hulls and to collect paint dust and chips.*
- ☐ *Restrict the types and/or amount of do-it-yourself work done at the marina.*
- ☐ *Clean hull maintenance areas immediately after any maintenance to remove debris, and dispose of collected material properly.*
- ☐ *Capture and filter pollutants out of runoff water with permeable tarps, screens, and filter cloths.*
- ☐ *Sweep and/or vacuum around hull maintenance areas, roads, and driveways frequently.*
- ☐ *Sweep parking lots regularly.*
- ☐ *Plant grass between impervious areas and the marina basin.*
- ☐ *Construct new or restore former wetlands where feasible and practical.*
- ☐ *Use porous pavement where feasible.*
- ☐ *Install oil/grit separators to capture petroleum spills and coarse sediment.*
- ☐ *Use catch basins where storm water flows to the marina basin in large pulses.*
- ☐ *Add filters to storm drains that are located near work areas.*
- ☐ *Place absorbents in drain inlets.*

- ☐ *Use chemical and filtration treatment systems only where necessary.*
- ☐ *Other (describe):*

6. FUELING STATION DESIGN

Design fueling stations to allow for ease in cleanup of spills.

Spills of gasoline and diesel oil during boat fueling are a common source of pollution in marina waters. Usually these are very small spills that occur from overfilling boat fuel tanks, but these small spills can accumulate to create a larger pollution problem. The hydrocarbons in oil harm juvenile fish, upset fish reproduction, and interfere with the growth and reproduction of bottom-dwelling organisms. Oil and gas ingested by one animal can be passed to the next animal in the food chain, ultimately resulting in a potential risk to human health. In a marina, petroleum spills also deteriorate the white Styrofoam in floats and docks and discolor boat hulls, woodwork, and paint. Gasoline spills are also a safety problem because of the flammability of this product. The most effective way to minimize fuel spills and petroleum hydrocarbon pollution at a marina is to locate, design, build, and operate a boat fuel dock or station so that most spills are prevented and those that do occur are quickly contained and cleaned up.

BMPs that should be considered and used where appropriate:

- ☐ *Use automatic shutoffs on fuel lines and at hose nozzles to reduce fuel loss.*
- ☐ *Remove old-style fuel nozzle triggers that are used to hold the nozzle open without being held.*
- ☐ *Install personal watercraft (PWC) floats at fuel docks to help drivers refuel without spilling.*
- ☐ *Regularly inspect, maintain, and replace fuel hoses, pipes, and tanks.*
- ☐ *Install a spill monitoring system.*
- ☐ *Train fuel dock staff in spill prevention, containment, and cleanup procedures.*
- ☐ *Install easy-to-read signs on the fuel dock that explain proper fueling, spill prevention, and spill reporting procedures.*
- ☐ *Locate and design boat fueling stations so that spills can be contained, such as with a floating boom, and cleaned up easily.*
- ☐ *Write and implement a fuel spill recovery plan.*
- ☐ *Have spill containment equipment storage, such as a locker attached or adjacent to the fuel dock, easily accessible and clearly marked.*
- ☐ *Other (describe):*

7. PETROLEUM CONTROL

Reduce the amount of fuel and oil from boat bilges and fuel tank air vents entering marina and surface waters.

Although more than half of the oil that spills into the water evaporates, less than a cup of oil can create a very thin sheen over more than an acre of calm water. Small amounts of oil spilled from numerous boats can accumulate to create a large oil sheen, which blocks oxygen from moving through the surface of the water and can be harmful to animals and larvae that must break the surface to breathe. The hydrocarbons in oil harm juvenile fish, upset fish reproduction, and interfere with the growth and reproduction of bottom dwelling organisms. Oil and gas ingested by one animal can be passed to the next animal in the food chain, ultimately resulting in a risk to human health. In a marina, petroleum spills also dissolve the white Styrofoam in floats and docks and discolor boat hulls, woodwork, and paint. Gasoline spills, which evaporate quickly, are also a safety problem because of the flammability of gasoline.

BMPs that should be considered and used where appropriate:

- ☐ *Promote the installation and use of fuel/air separators on air vents or tank stems of inboard fuel tanks to reduce the amount of fuel spilled into surface waters during fueling*
- ☐ *Avoid overfilling fuel tanks*
- ☐ *Provide doughnuts or small petroleum absorption pads to patrons to use while fueling to catch splashback and the last drops when the nozzle is transferred back from the boat to the fuel dock.*
- ☐ *Keep engines properly maintained for efficient fuel consumption, clean exhaust, and fuel economy. Follow the manufacturer's specifications.*
- ☐ *Routinely check for engine fuel leaks and use a drip pan under engines.*
- ☐ *Avoid pumping any bilge water that is oily or has a sheen. Promote the use of materials that either capture or digest oil in bilges. Examine these materials frequently and replace as necessary.*
- ☐ *Extract used oil from absorption pads if possible, or dispose of it in accordance with petroleum disposal guidelines.*
- ☐ *Prohibit the use of detergents and emulsifiers on fuel spills.*
- ☐ *Other (describe):*

8. LIQUID MATERIALS MANAGEMENT

Provide and maintain appropriate storage, transfer, containment, and disposal facilities for liquid material, such as oil, harmful solvents, antifreeze, and paints, and encourage recycling of these materials.

Liquid material such as fuels, oils, solvents, paints, pesticides, acetone, cleaners, and antifreeze are potentially harmful or deadly to wildlife, pets, and humans and are toxic to fish and other aquatic organisms when they enter a waterbody. This is true for other types of liquid waste, such as waste fuel, used oil, spent solvents, battery acid, and used antifreeze. Waste oils include waste engine oil, transmission fluid, hydraulic fluid, and gear oil. Waste fuels include gasoline, diesel, gasoline/oil blends, and water contaminated by these fuels.

BMPs that should be considered and used where appropriate:

- ☐ *Build curbs, berms, or other barriers around areas used for liquid material storage to contain spills.*
- ☐ *Store liquid materials under cover on a surface that is impervious to the type of material stored.*
- ☐ *Storage and disposal areas for liquid materials should be located in or near repair and maintenance areas, undercover, protected from runoff with berms or secondary containment, and away from flood areas and fire hazards.*
- ☐ *Store minimal quantities of hazardous materials*
- ☐ *Provide clearly labeled, separate containers for the disposal of waste oils, fuels, and other liquid wastes.*
- ☐ *Recycle liquid materials where possible.*
- ☐ *Change engine oil and suction oily water from bilges using nonspill vacuum-type systems for spill-proof oil changes.*
- ☐ *Use antifreeze and coolants that are less toxic to the environment.*
- ☐ *Use alternative liquid materials where practical.*
- ☐ *Follow manufacturer's directions and use nontoxic or low-toxicity pesticides.*
- ☐ *Burn used oil used as a heating fuel where permitted by law.*
- ☐ *Prepare a hazardous materials spill recovery plan and update it as necessary.*
- ☐ *Keep adequate spill response equipment where liquid materials are stored.*
- ☐ *Other (describe):*

9. SOLID WASTE MANAGEMENT

Properly dispose of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of solid wastes to surface waters.

Boat maintenance, painting, and repair can result in a range of waste materials, such as sanding debris, antifoulant paint chips, scrap metal, fiberglass pieces, sweepings, and battery lead and acid. Other solid waste such as bottles, plastic bags, aluminum cans, coffee cups, six-pack rings, disposable diapers, wrapping paper, glass bottles, cigarette filters, and fishing line can come from general boating activities and marina use. Living organisms and the habitats of aquatic animals and plants are harmed by this type of debris after it enters the water. A litter-free marina is more attractive to present and potential customers. Reducing a marina's solid wastes also reduces overall disposal costs.

BMPs that should be considered and used where appropriate:

- ☐ *Encourage marina patrons to avoid doing any debris-producing hull maintenance while their boats are in the water. When maintenance is done with the boat in the water (for small projects and where necessary), prevent debris from falling into the water.*
- ☐ *Place trash receptacles in convenient locations for marina patrons. Covered dumpsters and trash cans are ideal.*
- ☐ *Provide trash receptacles at boat launch sites.*
- ☐ *Provide facilities for collecting recyclable materials.*
- ☐ *Provide boaters with trash bags.*
- ☐ *Use a reusable blasting medium.*
- ☐ *Require patrons to clean up pet wastes and provide a specific dog walking area at the marina.*
- ☐ *Other (describe):*

10. FISH WASTE MANAGEMENT

Promote sound fish waste management through a combination of fish-cleaning restrictions, public education, and proper disposal of fish waste.

Sportfishing is very popular, but fish cleaning produces waste that can create water quality problems in marinas with poor circulation. Too much fish waste in a confined area can lower oxygen levels in the water, which leads to foul odor and fish kills. Floating fish parts are also an unsightly addition to marina waters.

BMPs that should be considered and used where appropriate:

- ☐ *Clean fish offshore where the fish are caught and discard of the fish waste at sea (if allowed by the state).*
- ☐ *Install fish cleaning stations at the marina, and at boat launch sites.*
- ☐ *Compost fish waste where appropriate.*
- ☐ *Freeze fish parts and reuse them as bait or chum on the next fishing trip.*
- ☐ *Encourage catch-and-release fishing, which does not kill the fish and produced no fish waste.*
- ☐ *Other (describe):*

11. SEWAGE FACILITY MANAGEMENT

Install pumpout, dump station, and restroom facilities where needed at new and expanding marinas to reduce the release of sewage to surface waters. Design these facilities to allow ease of access and post signage to promote use by the boating public.

Boat sewage can be a problem when dumped overboard without any treatment. Although the volume of sewage discharged from boats is not as massive as a typical sewage treatment plant outfall, boat sewage is very concentrated and can add to the overall problem of fecal coliform bacteria loading to the water body. Boat sewage also adds extra nutrients that use dissolved oxygen and can stimulate the growth of algae, which in the worst case can grow so fast that they use oxygen needed by fish and other organisms. When untreated sewage goes overboard, it can contaminate shellfish, leading to potentially serious human health risks.

BMPs that should be considered and used where appropriate:

- ☐ *Install pumpout facilities where needed. Use a system compatible with the marina's needs (fixed-point systems, dump stations for portable toilets, portable systems, dedicated slipside systems).*
- ☐ *Provide pumpout service at convenient times and at a reasonable cost.*
- ☐ *Keep pumpout stations clean and easily accessible, and consider having marina staff do pumpouts.*
- ☐ *Provide portable toilet dump stations near small slips and launch ramps.*
- ☐ *Provide restrooms at all marinas and boat ramps.*
- ☐ *Consider declaring marina waters to be a "no discharge" area.*
- ☐ *Establish practices and post signs to control pet waste problems.*
- ☐ *Avoid feeding of wild birds in the marina.*
- ☐ *Establish no discharge zones to prevent any sewage from entering boating waters.*
- ☐ *Establish equipment requirement policies that prohibit the use of Y-valves on boats on inland waters.*
- ☐ *Other (describe):*

12. MAINTENANCE OF SEWAGE FACILITIES

Ensure that sewage pumpout facilities are maintained in operational condition and encourage their use.

When faced with nonfunctioning sewage collection and disposal facilities, boaters whose holding tanks are full have three choices: (1) go elsewhere to find an operable pumpout or dump station, which is inconvenient; (2) discharge sewage directly overboard, which is illegal in no discharge zones and legal otherwise only through an approved marine sanitation device in nearshore waters; or (3) cease using their boat toilets, which to some would mean "stop using the boat." In addition, one inoperable pumpout might overload another pumpout nearby, tempting boaters to discharge illegally, particularly if the other one is not free or charges a higher fee.

BMPs that should be considered and used where appropriate:

- ☐ *Maintain a dedicated fund and issue a contract for pumpout and dump station repair and maintenance (applies to government-operated marinas, pumpout stations, and dump stations only).*
- ☐ *Regularly inspect and maintain sewage facilities.*
- ☐ *Disinfect the suction connection of a pumpout station (stationary or portable) by dipping it into or spraying it with disinfectant.*
- ☐ *Maintain convenient, clean, dry, and pleasant restroom facilities in the marina.*
- ☐ *Other (describe):*

13. BOAT CLEANING

For boats that are in the water, perform cleaning operations to minimize, to the extent practicable, the release to surface waters of (a) harmful cleaners and solvents and (b) paint from in-water hull cleaning.

Many boat cleaners contain harsh chlorine, ammonia, phosphates, and other chemicals that can harm fish and other aquatic life. Some chemicals in these cleaners become more concentrated in aquatic organisms as they are ingested by other animals and might eventually find their way into fish and shellfish that are eaten by people. Chemicals and debris from washing boat topsides, decks, and hull surfaces can be kept out of the water with some common sense boating practices.

BMPs that should be considered and used where appropriate:

- ☐ *Wash boat hulls above the waterline by hand. Where feasible, remove boats from the water and clean them where debris can be captured and properly disposed of.*
- ☐ *Buy and use detergents and cleaning compounds that will have minimal impact on the aquatic environment.*
- ☐ *Avoid in-the-water hull scraping or any abrasive process that is done underwater that could remove paint from the boat hull.*
- ☐ *Switch to long-lasting and low-toxicity or nontoxic antifouling paints.*
- ☐ *Minimize the impacts of wastewater from pressure washing.*
- ☐ *Other (describe):*

14. BOAT OPERATION

Manage boating activities where necessary to decrease turbidity and physical destruction of shallow-water habitat.

Boat and personal watercraft traffic through very shallow water and nearshore areas at wake-producing speeds can resuspend bottom sediments and erode shorelines, all of which can increase turbidity in the water column. Turbid waters block the penetration of sunlight to underwater plants that need light for survival, and they reduce visibility for fish that rely on sight to catch their prey. Vessel traffic can also uproot submerged aquatic vegetation which is habitat for fish and shellfish and food for waterfowl, recycles nutrients released from matter decomposing in the waterbody, and reduces wave energy at shorelines, thus protecting them from erosion. Vessel traffic might also churn up harmful chemicals that have been trapped in the sediments and might contaminate fish and shellfish that people eat. Propellers or jet drives, when in contact with the bottom, dig visible furrows across the soil and the vegetation, which can take years to recover.

BMPs that should be considered and used where appropriate:

- ☐ *Restrict boater traffic in shallow-water areas.*
- ☐ *Establish and enforce no wake zones to decrease turbidity, shore erosion, and damage in marinas.*
- ☐ *Other (describe):*

15. PUBLIC EDUCATION

Public education, outreach, and training programs should be instituted for boaters, as well as marina owners and operators, to prevent improper disposal of polluting material.

A boating public that understands the causes and effects of pollution is more likely to want clean waters and healthy aquatic environments. If they are told about the simple and effective ways that they can reduce their impact on the environment, they will usually be happy to do their part. Public education is one of the most effective ways to reduce pollution in and around marinas and from recreational boating.

BMPs that should be considered and used where appropriate:

- ☐ *Use signs to inform marina patrons of appropriate clean boating practices.*
- ☐ *Establish bulletin boards for environmental messages and idea sharing.*
- ☐ *Promote recycling and trash reduction programs.*
- ☐ *Hand out pamphlets or flyers, send newsletters, and add inserts to bill mailings with information about how recreational boaters can protect the environment and have clean boating waters.*
- ☐ *Organize and present enjoyable environmental education meetings, presentations, and demonstrations.*
- ☐ *Educate and train marina staff to do their jobs in an environmentally conscious manner and to be good role models for marina patrons.*
- ☐ *Insert language into facility contracts that ensures that tenants use certain areas and clean boating techniques when maintaining their boats. Use an environmental agreement that ensures that tenants will comply with the marina's best management practices.*
- ☐ *Have a clearly written environmental best management practices agreement for outside contractors to sign as a precondition to working on any boat in the marina.*
- ☐ *Participate with an organization that promotes clean boating practices.*
- ☐ *Provide MARPOL placards to boaters.*
- ☐ *Paint signs on storm drains indicating that anything placed in it or runoff to it drains directly to surface waters (where drainage is not to a treatment plant).*
- ☐ *Establish and educate marina patrons about rules governing fish-cleaning.*
- ☐ *Educate boaters about good fish cleaning practices.*
- ☐ *Provide information on local waste collection and recycling programs.*
- ☐ *Hold clinics on safe fueling and bilge maintenance.*
- ☐ *Teach boaters how to fuel boats to minimize fuel spills.*
- ☐ *Stock phosphate-free, nontoxic cleaners and other environmentally friendly products.*
- ☐ *Place signs in the water and label charts to alert boaters about sensitive habitat areas.*
- ☐ *Other (describe):*

Appendix B

Example
Oil Spill Response Plan

(Note that text in Arial *font should be replaced by facility-specific information.)*

Oil Spill Response Plan

Name of Marina

EMERGENCY RESPONSE ACTION:

Reaction

- Identify the source of the spill if possible.
- Attempt to secure the source of the spill.
- If a spill is observed at the fueling dock, immediately cease all fueling activities.
- Make a preliminary assessment as to what the spill material is and approximately how much has entered the waterway. This information will dictate what equipment needs to be deployed.
- Advise the facility manager or spill response manager if necessary.

Reporting

• U.S. Coast Guard	1-800-424-8802
• State department of environmental protection	Business hours; 24 hours

All spills that result in a slick or a sheen on the water require that the Coast Guard and state department of environmental protection be contacted and provided with pertinent information.

Note: All fuel spills, no matter how small, must be reported to the U.S. Coast Guard.

Response

Gasoline spill:

If the spill is small (5 gallons or less):

- Allow natural weathering to reduce and eliminate the spill.
- Do not allow smoking during any spill.
- Do not contain or collect gasoline because confined gasoline might create a risk of explosion and fire.

For larger spills (more than 5 gallons):

- Implement the reporting requirements.
- Secure all electricity.
- Make sure everyone is away from the affected area.
- Do not allow anyone to enter the affected area.
- Use water hoses to wash the spill away to protect docks and boats.
- Contact the fire department and harbormaster.

Other oil spills (crude and refined residual oils, diesel fuel, and kerosene):

- Contain the oil spill using a curtain boom to prevent spreading. When possible, completely surround the source.
- If the oil was spilled in an upland area, use an absorbent boom and pads to contain the material and prevent it from entering the waterbody.
- If more oil than can be contained by the boom was spilled, contact: name of primary contact for additional spill equipment.
- Once the spill is contained, use absorbent material to collect the oil. Absorbent pads can be placed within the boomed area, retrieved, wrung out, and placed back in the boomed area.
- If spreading is occurring too rapidly or other conditions prevent the containment of the oil, use the boom to deflect the oil from critical or sensitive areas.

PERSONNEL

Spill Manager

Name of person responsible for maintaining plan and equipment inventory.

Qualified Staff

List marina staff authorized to implement the spill plan.

Marina spokesperson: One person who is responsible for communicating to enforcement officials, customers, and the media. Using one person helps to ensure a consistent message.

Contact for Additional Assistance

In the event that this facility needs the services of a professional oil spill response company, contact: list the name of a professional oil spill response company with whom prior arrangements exist.

This service should be requested only by the facility manager or the spill response manager.

THREATS

Maximum Threat(s)

Overfilling of gasoline during fueling, creating explosion hazard: The most common spill occurrence will result from overfilling of gasoline and diesel fuel tanks at the fueling dock. Gasoline, because of its flammability, is the greatest threat.

Vessel spill

Under a worst-case scenario, the largest on-board fuel tank is aboard a 50-foot powerboat that carries approximately 200 gallons of diesel fuel and 20 gallons of crankcase oil. This would pose a maximum threat if this vessel was to sink within the marina perimeter.

Spill from fuel storage tank or connections to pumping station

On-site there is a ___gallon in-ground storage tank that is connected to the fuel pumping station by a series of flexible and rigid hoses. A fuel spill could result from the failure of one of the connections. A spill could also result when the fuel tank is being filled.

Minimum Threats

Spill from waste oil receptacle: On site there is a 200-gallon waste oil receptacle. It is located 100 yards from the coastal edge and is surrounded by an impervious berm designed to retain 110 percent of the receptacle's volume.

SPILL RESPONSE EQUIPMENT

Available On-site Resources

(1) 150-foot harbor curtain boom (3 times the length of the vessel with the largest fuel tank)

Operational characteristics: deflects and contains oil in the water. Curtain boom is susceptible to wind, waves, and current. These factors can cause oil to escape over the top and under the bottom of the boom.

Deployment: Can be attached to a fixed structure or to an anchor. Place downstream of oil spill. If surface current is moving greater than 0.7 knot, the boom will not contain oil acting at a right angle to it. The boom angle will need to be adjusted to decreasing angles as the speed of the current increases.

Disposal: The boom, if maintained properly, can be used multiple times. The average life span for the boom is approximately 5 to 10 years, depending on the use it receives.

Maintenance: Rinse thoroughly with fresh water. Be sure to collect with absorbents any remaining oil on the boom. Store out of sunlight in a manner that allows quick deployment.

(2) 80 feet of 5-inch absorbent boom (37.5 ft^3; 84 lb)

Operational characteristics: Boom has little inherent strength and might need extra flotation to keep from sinking when laden with oil.

(3) 200 individual absorbent pads (3/8 in. x 18 in. x 18 in.)

Operational characteristics: Use absorbents only in low current velocity situations.

Deployment: Place absorbents on spilled oil. Recovery efficiency decreases rapidly once outer layer is oil-soaked.

Disposal: May be wrung out and reused. (See manufacturer's specifications.) At the end of the useful life, wring out and store in a sealed container. The container will be disposed of by a contracted waste hauler.

Maintenance: When possible, wring out and dry after use. (See manufacturer's specifications.) Otherwise, material will be disposed of properly.

(4) Empty 55-gallon drum with lid for storage of collected oil

(5) Gloves

(6) Pitchfork

(7) Two 15-lb Danforth anchors

(8) Mooring lines

(9) Standard mop or laundry wringer

Location

The spill response equipment is stored in the spill response shed located adjacent to the maintenance shed. Key number 000, which the manager holds on the master ring, opens the spill response shed.

Additional Equipment

If the rapid deployment of additional resources is necessary, we have secured permission to use equipment from: List local sources of equipment and how they can be reached, e.g., neighboring marina, they can be reached on VHF CH 68 or by calling 555-0000.

Coast Guard oil spill response trailer is also available as a first-aid measure.

NOTES

Do not use dispersants on oil/fuel spills. Dispersants include products manufactured specifically for that purpose and more common products such as detergent. Using them simply forces the oil into the water column, where it might be more harmful. Dispersants may be used only with the approval of the Coast Guard federal on-scene coordinator.

On the downstream side of the marina is a salt marsh that should be protected from a large oil spill. A floating oil boom should be used to deflect spilled oil away from this critical area.

This response plan will be tested twice a year, with a least one test occurring at the beginning of the boating season. All of the spill response equipment will be inspected at the time of the tests.

RECORDS

Staff Readiness Drills

Date	Drill Simulation	Who participated	Supervisor
date	Sinking vessel	List of staff members who participated	Signature

Inspection

Date	Inspected by:	Condition/Notes
date	Name	Notes on equipment condition

Emergency Phone List

- United States Coast Guard, Marine Safety Office: (###) ### - ####
- State Department of Environmental Management: (###) ### - ####
- Local Harbormaster Department: (###) ### - ####
- Local Police Department: (###) ### - ####
- Local Fire Department: (###) ### - ####

Plan last updated: date

Updated by: name

Appendix C

Table of Costs and Benefits of Marina Best Management Practices

(Originally published in USEPA, 1996: Clean Marinas—Clear Value)

Appendix C: Costs and Benefits of Clean Marina Examples (Source: USEPA, 1996)

Environmental change(s)	Initial investment	Years to amortize	Annualized cost of investment	Change in annual operations costs	Change in annual revenue	1995 net benefits from environmental change	Notes
1. Trash recycling - All Season's Marina, NJ	$5,000	10	$648	($4,100)	$0	$3,452	Net benefit is estimated by avoided trash removal cost less estimated labor costs for recycling.
2. Closed-loop hull-blasting system with reused plastic blasting medium - Associated Marine Technologies, FL	$25,849	5	$5,971	$8,617	$58,173	$43,585	Income from entire hull-blasting operation; difference in costs and revenues from conventional system revenues unknown; system installation required by county to continue service.
3. Pumpout service used as staff incentive - Battery Park Marina, OH	$2,450	10	$317	$20	$12,500	$12,163	Improved staff morale and productivity.
4. Sewage meter for pumpout station and entire marina - Brewer's Cove Haven Marina, RI	$6,800	10	$881	($2,603)	$0	$1,722	Savings from metered sewage flow; federal and state grants paid for installation of meter; however, initial cost included here to demonstrate benefits even with full cost.
5. Public education and free recycling - Cap Sante Boat Haven, WA	$0	N/A	$0	($10,800)	$0	$10,800	Waste disposal savings, less the cost of renting recycle bins.
6. Habitat assessment and scallop farming under docks - Cedar Island Marina, CT	$0	20	$0	$33,500	$46,000	$12,500	Cost of docks no more than conventional docks; operations costs are biologists' salaries; cost savings from extended dredging season; in addition to net benefits, $5,000 of annual "free publicity" is attributed to improvements.
7. Inland boatyard and repair sites - Conanicut Marine Services, RI	($1,807,000)	20/10	($138,688)	($72,125)	$75,000	$285,813	Initial land savings on buying inland versus waterfront, including permit saving; land amortized over 20 yr, trailer over 10 yr; property tax and land value savings are estimated to demonstrate benefit of inland yard.
8. Overall changes: pumpout service, dustless sanders, grounds maintenance - Deep River Marina, CT	$21,000	10/5	$3,329	$13,000	$86,800	$70,471	Additional benefits from new slip rentals, winter storage, added fuel sales; additional value was realized from "free publicity"; pumpout amortized over 10 yr, sanders over 5 yr.
9. Overall changes: environmental contract, pumpout service, solid waste and liquid materials management - Edwards Boatyard, MA	$116,400	20/10	$9,459	$18,100	$100,000	$72,441	Pumpout cost amortized over 10 yr, other investments over 20 yr; also attributed the equivalent of $10,000 of "free publicity."
10. Overall changes: habitat creation, pollution control, water conservation, etc. - Elliot Bay Marina, WA	N/A	1	N/A	($3,620)	$0	$3,620	Savings from avoided hazardous waste pickup paid for labor time; dog waste bags, distributed free to customers, save labor costs.
11. Overall changes: wash water recycling, trash recycling, portable pumpout station - Green Cove Marina, NJ	$6,800	10	$881	($750)	$28,700	$28,569	Change in costs are added labor and service costs less savings from decrease in disposal services; initial outlay for portable pumpout and recycling setup less permit savings; pumpout partially paid for with state grant but full initial cost included here to demonstrate benefits even with the full cost.
12. Pumpout capabilities at every dock - Hall of Fame Marina, FL	$16,200	10	$2,098	$3,788	$300,000	$294,114	Increased revenue due to special dockside pumpout service.

Appendix C: Costs and Benefits of Clean Marina Examples (Source: USEPA, 1996)

Environmental change(s)	Initial investment	Years to amortize	Annualized cost of investment	Change in annual operations costs	Change in annual revenue	1995 net benefits from environmental change	Notes
13. Seaweed recycled as garden fertilizer and mulch - The Hammond Marina, IN	$0	N/A	$0	($800)	$0	$800	Expected to save $17,500 on weed control in 1996.
14. Filtration of pressure wash water - Harbour Towne Marina, FL	$46,415	10	$6,011	$24,000	$270,000	$239,989	Difference in revenues and costs compared to conventional system unknown; system installation required by county to continue service.
15. Full-service pumpout and fueling - Kean's Detroit Yacht Harbor, MI	$12,000	10	$1,554	$1,040	$11,000	$8,406	New revenue from dockside pumpout and fuel services.
16. Recycled crushed concrete controls runoff - Lockwood Boat Works, NJ	($360,000)	20	($28,888)	$0	$0	$28,888	Initial investment is negative because of savings of using recycled concrete surfacing rather than blacktop.
17. Dustless vacuum sanding - The Lodge of Four Seasons Marina, MO	$3,724	5	$860	$8,643	$20,000	$10,497	Net of initial outlay and estimated labor and materials cost; saved 30% of conventional costs; difference in revenues unknown.
18. Floating pumpout and restroom barge to serve transients - Oak Harbor Marina, WA	$0	N/A	$0	($5,230)	$0	$5,230	State grant funded $58,600 cost of pumpout barge. The city hauls the marina's septic waste for free, which saved an equivalent of $8,220 in septic hauling cost.
19. Outdoor boat repairs done over screen tarps - Port Annapolis Marina, MD	$2,000	1	$2,000	($2,000)	$2,000	$2,000	Savings on cleanup costs, less the cost of labor and screen tarps.
20. Opening in breakwater to improve flushing - Puerto del Rey Marina, PR	$30,000	20	$2,407	$0	$50,000	$47,593	Additional dock rental income attributed to better water quality.
21. Wash water recycled without chemicals - Summerfield Boat Works, FL	$30,075	10	$3,895	$3,300	$93,750	$86,555	Savings in water cost.
22. Used oil burner installed to heat boat repair building - West Access Marina, IL	$7,000	10	$907	($9,894)	$9,495	$18,482	Cost savings on disposal and energy, less annual maintenance costs, plus additional boat repair income.
23. Floating personal watercraft (PWC) fueling dock prevents spillage - Winter Yacht Basin, NJ	$3,138	10	$406	$400	$6,366	$5,560	Additional personal watercraft fuel sales business.
24. Environmental changes at boatyard chain - Brewer Yacht Yards; NY, CT, RI, MA, ME	N/A	N/A	N/A	N/A	N/A	+	No calculations because chain-wide efforts made it difficult to attribute benefits to any one particular change; owners, however, felt strongly that chain-wide improvements made good business sense.
25. Environmental changes at marina chain - Westrec Marinas, Inc.; national	N/A	N/A	N/A	N/A	N/A	+	

Appendix D

Federal Laws Related to Marinas and Recreational Boating

Table D. Federal Laws Related to Marinas and Recreational Boating

Activity	Permit, License or Title	Authority	Purpose	Requirements
Any construction activity that disturbs 1 or more acres	NPDES Storm water Permit for Construction Activity	Clean Water Act, Section 402, for storm water discharge permits and 40 CFR 122.26	Maintains after development, as nearly as possible, the predevelopment runoff conditions.	All projects that disturb 1 or more acres must submit a Notice of Intent
Discharge of boat and equipment wash water, storm water runoff from boat maintenance areas, noncontact cooling water, and condensate discharges	NPDES General Permit for Discharges from Marinas	Clean Water Act, Section 402, for storm water discharge permits and 40 CFR 122.26	Controls pollution generated from runoff associated with industrial activity.	Any marina or boat yard that conducts boat maintenance activities, including washing, and has wastewater or storm water discharges must apply for coverage under this permit unless they have a valid individual discharge permit or coverage under 97-SW(1). To receive coverage under this permit, applicants must develop and implement a storm water pollution prevention plan
Operate a paint spray booth	Air Quality Permit to Construct	Clean Air Act, Section 110, and Title V, 42 U.S.C. 7401 et seq.	Ensures that any new, modified, replaced, or relocated source of air pollution complies with all air quality requirements. Air quality standards have been adopted to protect public health, vegetation, and forests.	Pre-Approval: Before an air pollution source is constructed or modified, a permit must be obtained from the state environmental agency. Post-Approval: Periodic emission tests and /or reports may be required depending on the nature of the operation and its emissions.
Any of the following activities in a nontidal wetland or its buffer: grading or filling; excavating or dredging; changing existing draining patterns; disturbing the water level or water table; and destroying or removing vegetation.	Proposed Activities in Nontidal Wetlands (Nontidal Wetlands and Waterways Permits)	Rivers and Harbors Act of 1899, Section 10; Clean Water Act, Section 404 Section 10 of the Rivers and Harbors Act of 1899 gives the Army Corps of Engineers authority to regulate all work and structures in navigable waters of the U.S. Section 404 of CWA regulates discharges of dredged or fill material into navigable waters, including wetlands. If USACE Section 404 permit is required, the state must investigate the site prior to construction.	Prevents, wherever possible, further degradation and losses of nontidal wetlands due to human activity; and wherever practical and feasible, to offset unavoidable losses or degradations through the deliberate restoration or creation of nontidal wetlands.	Wetland mitigation construction or monitoring requirements may be required in many instances and may extend well beyond construction of an approved mitigation project.
Discharge of sewage and grey water from a marina's private sewage treatment plant to surface water	Surface Water Discharge Permit	Clean Water Act	Maintains water quality standards in the water receiving the discharge.	Must be included in county water and sewer plan. Must meet all effluent limits, monitoring requirements, and other permit conditions

Table D. Federal Laws Related to Marinas and Recreational Boating (cont.)

Activity	Permit, License or Title	Authority	Purpose	Requirements
Apply antifoulant paints containing tributyl tin (TBT)	TBT Applicators License	Organotin Antifoulant Paint Control Act of 1988 (33 U.S.C. 2401) EPA is required to certify that each antifouling paint containing organotin does not release more than 4.0 micrograms per square centimeter per day.	Prohibits the use of antifouling paints containing organotin (TBT) on vessels that are 25 meters or less in length, unless the vessel hull is aluminum.	It is unlawful for any person other than an owner or agent of a commercial boatyard to possess, distribute, sell, offer for sale, use, or offer for use any paint containing a TBT compound (except for spray can less than or equal to 16 ounces).
Generate 100 kg of hazardous waste in a calendar month or accumulate this amount at any one time	Notification of Hazardous Waste; EPA Identification Number for Generators, Transporters, and Treatment/Storage/ Disposal (TSD) Facilities	RCRA, Section 3010; 40 CFR 262.12, 263.11, and 264.11	Ensures proper storage and disposal of hazardous wastes.	A generator may not treat, store, dispose of, transport, or offer for transportation hazardous waste without having received an EPA Identification Number. A generator may not offer hazardous waste to transporters or to a TSD facility that has not received an EPA Identification Number.
Construction where the habitat of an endangered species or the species itself could be affected	N/A	Federal Endangered Species Act, (16 U.S.C. 1531-1543; P.L. 93-205) National Marine Fisheries Service (NMFS) regulations concerning ESA listing procedure are published at 50 CFR Parts 217-227. Joint regulations (USFWS and NMFS) - 50 CFR Parts 402 and 424-453. FWS coordinates ESA activities for terrestrial and freshwater species, while NMFS is responsible for marine species and Pacific salmon.	Provides conservation of species which are in danger of extinction throughout all or a significant portion of their range. All proposed development sites must be assessed by USFWS and USDOC for endangered and threatened species and habitat protection areas.	A species must be listed if it is threatened or endangered - because of present or threatened destruction, modification, or curtailment of its habitat or range - overutilization for commercial, recreational, scientific, or educational purposes - disease or predation - inadequacy of existing regulatory mechanisms - other natural or manmade factors affecting its continued existence.
Fueling, bilge water discharge, oil changing	N/A	Clean Water Act	Prohibits discharge of oil or oily waste into or upon the navigable waters of the U.S.	Prohibits discharge of oil or oily waste into or upon the navigable waters of the U.S. or the waters of the contiguous zone if such discharge causes a film or sheen upon, or discoloration of, the surface of the water, or causes a sludge or emulsion beneath the surface of the water.
Boat cleaning	N/A	Clean Water Act, (33 CFR 153.305)	Prohibits the use of soaps or other dispensing agents.	Prohibits the use of soaps or other dispensing agents to dissipate oil on the water or in the bilge without the permission of the Coast Guard.

Table D. Federal Laws Related to Marinas and Recreational Boating (cont.)

Activity	Permit, License or Title	Authority	Purpose	Requirements
Fueling, liquid material management	Spill Prevention, Contaminant, and Countermeasure (SPCC) Plan	EPA, Oil Pollution Prevention Regulation 40 CFR Part 112	Develops and implements plan to prevent discharge of oil into or upon navigable waters of the U.S. or adjoining shorelines.	Requires that marinas prepare and implement a plan to prevent any discharge of oil into navigable waters or adjoining shorelines if the facility has: - an above-ground oil capacity storage > 660 gal in a single container - an aggregate above-ground storage capacity of > 1,320 gal or a total underground storage capacity of > 42,000 gal.
Pumpouts, sewage discharge	N/A	Clean Vessel Act of 1992, Subtitle (V)(F) of P.L. 102-587 The Clean Vessel Act is a cost-reimbursable program, i.e., the grantees must spend their money to conduct approved activities and then request reimbursement for up to 75% of the costs. Grantee must provide at least 25% of project funding from a non-federal source.	Allows the Secretary of Interior to issue grants to coastal and inland states for pumpout stations and waste reception facilities to dispose of recreational boater sewage.	Directs the Secretary of Interior to provide grants to states to pay for the construction, renovation, operation, and maintenance of pumpout stations and waste reception facilities; requires each coastal state to conduct a survey to determine the number and location of all operational pumpout facilities and the number of recreational vessels with MSD Type III or portable toilets; requires each coastal state to develop and submit a plan for the construction and/or renovation of an adequate number of pumpout stations and waste reception facilities within the coastal zone of the state.
Pumpouts, boat toilet use, sewage discharge	Marine Sanitation Device Standard	Clean Water Act, Section 312, U.S.C., Title 33, Section 1322, 40 CFR Part 140 The Water Quality Act of 1987 requires EPA to develop standards designed to prevent the discharge of untreated or inadequately treated sewage into the U.S. waters. Section 312 requires the U.S. Coast Guard (USCG) to promulgate and enforce regulations governing the design, construction, installation, and operation of MSDs.	Eliminates discharge of untreated sewage from vessels into the U.S. waters, including the territorial seas (within 3 miles of the coast). It is illegal to discharge raw sewage in U.S. territorial waters.	Requires the installation of a U.S. Coast Guard certified MSD Type I, Type II, or Type III on all vessels with installed toilet systems operating in the navigable waters of the U.S. Portable toilets are not considered installed toilets; however, direct overboard discharge of portable toilet wastes is a violation of state water quality regulations.
Sewage discharge	Marine Sanitation Device Standard, Complete Prohibition, No Discharge	Clean Water Act, Section 312 (f) (3), U.S.C. Title 33, Section 1322, 40 CFR, Part 140.4 The EPA may allow a state to prohibit all discharges from marine toilets, thus declaring the area a "No Discharge Zone"	Eliminates discharge of untreated sewage from vessels into the U.S. waters, including the territorial seas (up to 3 miles).	Part 140.4 indicates that a state may completely prohibit the discharge from all vessels of any sewage, whether treated or not, into some or all of the waters within such state by making a written application to the EPA Administrator and by receiving the Administrator's affirmative determination pursuant to Section 312(f)(3) of the Act.

Table D. Federal Laws Related to Marinas and Recreational Boating (cont.)

Activity	Permit, License or Title	Authority	Purpose	Requirements
MSD design	Marine Sanitation Devices; General, Certification Procedures, Design, Construction, and Testing	Clean Water Act, Section 312, U.S.C. Title 33, Section 1322, 40 CFR Part 159 The U.S. Coast Guard will maintain and make available a list that identifies certified MSDs.	Prescribes regulations governing the design and construction of marine sanitation devices and procedures for certifying that the MSDs meet the regulations and the standards of EPA promulgated under Section 312.	Section 159.7 (a) addresses requirements for vessel operators. It states that no person may operate any vessel equipped with installed toilet facilities unless it is equipped with: - an operable Type II or III device that has a label on it under Sec. 159.12 or Sec. 159.12a; or - an operable Type I device that has a label on it under Sec. 159.16 or that is certified under Sec. 159.12, if the vessel is 65 feet or less in length.
Sewage discharge	Marine Sanitation Device Standard, Establishment of Drinking Water Intake No Discharge Zone	Clean Water Act, Section 312 (f) (4) (B), U.S.C. Title 33, Section 1322, 40 CFR Part 140	Eliminates discharge of untreated sewage from vessels into the U.S. waters, including the territorial seas (up to 3 miles). The discharge of sewage from a vessel, whether treated or untreated, is prohibited in No Discharge Zones.	Section 312 (f)(4)(B) provides that "Upon application by a State, the EPA Administrator shall, by regulation, establish a drinking water intake zone in any waters within such State and prohibit the discharge of sewage from vessels within that zone."
Oil discharges from boats	N/A	Oil Pollution Act of 1990 (OPA), Public Law 101-380 (33 U.S.C. 2701 et seq; 104 Stat. 484) OPA requires FWS consultation on developing a fish and wildlife response plan for the National Contingency Plan, input to Area Contingency Plans, review of Facility and Tank Vessel Contingency Plans, and conducting of damage assessments associated with oil spills.	Establishes new requirements and amended the Federal Water Pollution Control Act to provide enhanced capabilities for oil spill response and natural resource damage assessment by the FWS. Addresses commercial oil shipping (e.g., tankers must be double-hulled, captains may lose their license if operating vessel under the influence of drugs or alcohol).	Some requirements are applicable to recreational boating. The responsible party for any vessel or facility that discharges oil is liable for the removal costs of the oil and any damages to natural resources; real or personal property; subsistence uses; revenues, profits, and earning capacity; and public services such as providing increased or additional public services.

Table D. Federal Laws Related to Marinas and Recreational Boating (cont.)

Activity	Permit, License or Title	Authority	Purpose	Requirements
Garbage dumping at sea	Chapter 33: Prevention of Pollution from Ships	Marine Plastic Pollution Research and Control Act,1987, MPPRCA (Title II of P.L. 100-220), U.S.C. Title 33, Chapter 33 MPPRCA is the U.S. Law implementing MARPOL Annex V, an international pollution prevention treaty. The U.S. Coast Guard is primarily responsible for enforcement of the law and development of the regulations.	Restrict garbage dumping at sea. Applies to all domestic and international ships operating in the U.S. Exclusive Economic Zone (EEZ) and in U.S. navigable waters.	Prohibits ocean dumping of plastics by ships and restricts the ocean dumping of other types of garbage within 25 miles from any land. Requires ports and terminals to provide garbage reception facilities. It is prohibited to discharge garbage in inland waters or in the ocean within 3 nautical miles of shore. A placard which notifies the crew and passengers of the MARPOL Annex V is required on vessels 26 feet and over. A plan and logbook are required on vessels 40 feet and over.
Ocean Dumping; research	N/A	Marine Protection Research and Sanctuaries Act of 1972, 33 U.S.C. 1441-1445; Title II of P.L. 92-532, as amended	Authorizes research and monitoring related to ocean dumping as well as research on possible effects of pollution, overfishing, and human-induced changes of the ocean system.	Provides for long-range research on the effects of human-induced changes to the marine environment and authorizes research and demonstration activities related to phasing out sewage and industrial waste dumping in marine environment.

Appendix E

Web Sites with Information Related to Marinas and Recreational Boating

SOME WEBSITES TO VISIT

U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds

http://www.epa.gov/owow/

Information on the control of nonpoint source pollution, the condition of the water-related environment, and the management and restoration of watersheds.

U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response

http://www.epa.gov/swerrims/

Provides policy, guidance, and direction for the land disposal of hazardous wastes, underground storage tanks, solid waste management, encouragement of innovative technologies, source reduction of wastes, and the Superfund Program.

U.S. Environmental Protection Agency,Office of Wetlands, Oceans, and Watersheds Publications On Line

http://www.epa.gov/OWOW/info/PubList/publist4.html

http://earth1.epa.gov/OWOW/info/NewsNotes/

A variety of EPA publications related to Nonpoint Source Pollution that can be ordered or read on the Internet.

U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds Publications On Line

http://www.epa.gov/OWOW/info/PubList/publist4.html

http://earth1.epa.gov/OWOW/info/NewsNotes/

A variety of EPA publications related to Nonpoint Source Pollution that can be ordered or read on the Internet.

U.S. Environmental Protection Agency, Index of Watershed Indicators

http://www.epa.gov/surf/iwi

Maps and information about watersheds nationwide. Locate your own watershed and learn about the quality of the waters in it, sources of pollution, and organizations active in protecting it.

U.S. Coast Guard Kids' Corner

http://www.uscg.mil/hq/g-cp/kids/kidindx.html

Activities and information for kids about safety and clean boating practices; "The Adventures of Captain Cleanwater: An Activity Book for Kids About Clean and Safe Boating" and "The True Story of Inky the Whale."

National Sea Grant National Depository

http://nsgd.gso.uri.edu

Searchable archive of all Sea Grant-funded documents since 1967, including hundreds of studies on boating, marinas, and the environment, plus many educational flyers, brochures, and fact sheets; well worth the visit.

National Sea Grant College Program

http://www.mdsg.umd.edu/NSGO/

Information about the National Sea Grant program and links to state Sea Grant programs nationwide.

U.S. Fish and Wildlife Service, Clean Vessel Act Program

http://fa.r9.fws.gov/cva/cva.html

Information on the CVA program, which provides grants for pumpout and dump stations for boaters to dispose of human waste in an environmentally safe manner.

Tennessee Valley Authority

http://www.tva.gov/river/recreation/index.htm

Information on the camping and recreation areas operated by the TVA. TVA operates some 100 public recreation areas throughout the Tennessee Valley, including campgrounds, day-use areas, and boat launching ramps. Their opening and closing dates are listed at this site, as well as contact numbers.

U.S. Army Corps of Engineers

http://www.usace.army.mil/inet/functions/cw/cecwo/recrea.htm

Information about all of the lakeside parks that are administered by the Army Corps of Engineers. The Lakeside Recreation Resource page shows a map. Just click on an area of the country that you are interested in and the maps will show you all the information you need about the USACE park system.

Canadian Coast Guard

http://www.pacific.ccg-gcc.gc.ca/Epages/offboat/pae/pme.htm

Protecting the Aquatic Environment: A Boater's Guide with valuable information on managing waste, boat maintenance, antifouling paint, batteries, introduced species, tips for protecting the aquatic environment, spill reporting, and more.

Florida Department of Environmental Protection

http://www.dep.state.fl.us

Information and management practices for managing the following types of waste:

- Distress signal flares
- Batteries (lead acid marine/auto and rechargeable)
- Mercury-containing devices: bilge pump float switches, air conditioning thermostats
- Mercury containing lamps: fluor-escent and high-intensity discharge
- Refrigerants and asbestos.

Maryland Department of Natural Resources

http://www.dnr.state.md.us/boating/

Links to a variety of pages with information of interest to boaters, including:

- Boating Regulations
- Boating Safety
- Clean Marina Initiative
- Public Boating Facilities
- Pumpout Program
- Vessel Requirements
- Weather.

National Safe Boating Council

http://www.safeboatingcouncil.org/

The mission of the NSBC is to provide a forum for advancing and fostering safe boating, and for educating the public in safe boating principles, by developing and facilitating an ongoing series of campaigns to promote safe boating principles and practices; facilitating the distribution and dissemination of information on safe boating; promoting the development of research initiatives to support boating education and safety awareness; improving the professional development of boating safety educators; and encouraging the development and implementation of outstanding boating safety programs.

Marina Operators Association of America (MOAA)

http://www.nmma.org/affiliates/usa/moaa

MOAA works for the enhancement of the recreational marina industry through:

- Stimulating a continuing exchange of ideas
- Updating marina operators on new information
- Banding together to maintain a strong national voice
- Encouraging marina operators to institute the best management practices
- Joining to establish a clean marina program
- Encouraging marina operators to be proactive in their customer's boating experience.

National Marine Manufacturers Association

http://www.nmma.org

NMMA members—more than 1,600 companies—produce every conceivable product used by recreational boaters. NMMA provides a wide variety of programs and services tailored to member needs: technical expertise, standards monitoring, government relations avocation, industry statistics, and more. NMMA produces boat shows, including the world's largest marine trade show, the International Marine Trades Exhibit & Convention (IMTEC), in key North American markets.

International Marina Institute

http://www.imimarina.com

IMI is a nonprofit membership organization serving the global marine industry. It offers management training, education, and information about research, legislation, and environmental issues affecting the marina industry. IMI is a marine trade organization that encompasses all segments of the marina business both nationally and internationally.

Marine Environmental Education Foundation

http://www.meef.org

MEEF is a national, nonprofit, tax-exempt, charitable foundation founded to bring together national specialists to develop education programs and research on marine environmental issues. Its goal is to create and present educational programs that will result in cleaner waters for the boating public. MEEF is the creator and sponsor of the National Clean Boating Campaign.

National Boating Federation

http://outdoorsource.com/nbf

The largest nationwide alliance of recreational boating organizations, yacht and boating clubs, and individual members focused on promoting recreational boating activities. The National Boating Federation often appears before congressional committees to testify on boating matters.

Boat Owners Association of the United States

http://www.boatus.com

Provides services including representing the interests of boat owners on Capitol Hill; insuring members' boats; operating an on-the-water towing network; and providing discount boating equipment through the Internet, mail order, and marine centers. BoatU.S. publishes widely circulated publications for boaters, serves as an educator in marine safety and environmental issues, and routinely tests and reports on boating safety equipment and other products.

Marine Retailers Association of America

http://www.mraa.com

MRAA is the nation's largest marine retailers trade association, representing an industry with more than 100,000 employees and nearly $20 billion in sales annually. The mission of the MRAA—Progress through Participation with Industry Partners—is accomplished by promoting programs and services and helping create an environment that helps marine retailers to operate. MRAA promotes and furthers the interests of all its member companies and the marine industry in general.

Center for Marine Conservation

http://www.cmc-ocean.org

The Center for Marine Conservation is committed to protecting ocean environments and conserving the global abundance and diversity of marine life. Through science-based advocacy, research, and public education, CMC promotes informed citizen participation to reverse the degradation of our oceans.

BoatFacts Online

http://www.boatfacts.com/home.asp

Information on boating products, publications, marinas, classifieds, engines, boats, legislative issues, organizations, discussion forums, and a boating calendar.

Appendix F

Storm Water Runoff Management Practice Tables

Table F-1. Advantages and disadvantages of management practices (MDE, 2000).

Management Practice	Advantages	Disadvantages	Comparative Cost[a]
Runoff control ponds			
Wet pond	• Can provide peak flow control • Can serve large developments; most cost-effective for larger, more intensively developed sites • Enhances aesthetics and provides recreational benefits • Little ground water discharge • Permanent pool in wet ponds helps to prevent scour and resuspension of sediments • Provides moderate to high removal of both particulate and soluble urban runoff pollutants	• Not economical for drainage area less than 10 acres • Potential safety hazards if not properly maintained • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors • Requires considerable space, which limits use in densely urbanized areas with expensive land and property values • Not suitable for hydrologic soil groups "A" and "B" (USDA-NRCS classification) unless a liner is used • With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life	Moderate to high compared to conventional runoff detention
Infiltration practices			
Infiltration basin	• Provides ground water recharge • Can serve large developments • High removal capability for particulate pollutants and moderate removal for soluble pollutants • When basin works, it can replicate predevelopment hydrology more closely than other BMP options • Basins provide more habitat value than other infiltration systems	• Possible risk of contaminating ground water • Only feasible where soil is permeable and there is sufficient depth to rock and water table • Fairly high failure rate • If not adequately maintained, can be and eyesore, breed mosquitoes, and create undesirable odors • Regular maintenance activities cannot prevent rapid clogging of infiltration basin	Construction cost moderate but rehabilitation cost high
Infiltration trench	• Provides ground water recharge • Can serve small drainage areas • Can fit into medians, perimeters, and other unused areas of a development site • Helps replicate predevelopment hydrology, increases dry weather baseflow, and reduces bankfull flooding frequency	• Possible risk of contaminating ground water • Only feasible where soil is permeable and there is sufficient depth to rock and water table • Since not as visible as other BMPs, less likely to be maintained by residents • Requires significant maintenance	Cost-effective on smaller sites Rehabilitation costs can be considerable
Porous pavement	• Provides ground water recharge • Provides water quality control without additional consumption of land • Can provide peak flow control • High removal rates for sediment, nutrients, organic matter, and trace metals • When operating properly can replicate predevelopment hydrology • Eliminates the need for runoff drainage, conveyance, and treatment systems off-site	• Requires regular maintenance • Possible risk of contaminating ground water • Only feasible where soil is permeable, there is sufficient depth to rock and water table, and there are gentle slopes • Not suitable for areas with high traffic volume • Need extensive feasibility tests, inspections, and very high level of construction workmanship (Schueler, 1987) • High failure rate due to clogging • Not suitable to serve large off-site pervious areas	Cost-effective compared to conventional asphalt when working properly
Concrete grid pavement	• Can provide peak flow control • Provides ground water recharge • Provides water quality control without additional consumption of land	• Requires regular maintenance • Not suitable for areas with high traffic volume • Possible risk of contaminating ground water • Only feasible where soil is permeable, there is sufficient depth to rock and water table, and there are gentle slopes	Information not available

Table F-1. (cont.)

Management Practice	Advantages	Disadvantages	Comparative Cost[a]
Filtering practices			
Filtration basin	• Ability to accommodate medium-size development (3-80 acres) • Flexibility to provide or not provide ground water recharge • Can provide peak volume control	• Requires pretreatment of stormwater through sedimentation to prevent filter media from prematurely clogging	Information not available
Open channel practices			
Grassed swale	• Requires minimal land area • Can be used as part of the runoff conveyance system to provide pretreatment • Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians • Economical	• Low pollutant removal rates • Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	Low compared to curb and gutter
Structural management practices that do not fully meet the 80% TSS requirement			
Vegetated filter strip	• Low maintenance requirements • Can be used as part of the runoff conveyance system to provide pretreatment • Can effectively reduce particulate pollutant levels in areas where runoff velocity is low to moderate • Provides excellent urban wildlife habitat • Economical	• Often concentrates water, which significantly reduces effectiveness • Ability to remove soluble pollutants highly variable • Limited feasibility in highly urbanized areas where runoff velocities are high and flow is concentrated • Requires periodic repair, regrading, and sediment removal to prevent channelization	Low
Water quality inlet: catch basin with sand filter	• Provide high removal efficiencies of particulates • Require minimal land area • Flexibility to retrofit existing small drainage areas • Higher removal of nutrient as compared to catch basins and oil/grit separator	• Not feasible for drainage areas greater than 5 acres • Only feasible for areas that are stabilized and highly impervious • Not effective as water quality control for intense storms	Information not available
Water quality inlet: oil/grit separator	• Captures coarse-grained sediments and some hydrocarbons • Requires minimal land area • Flexibility to retrofit existing small drainage areas and applicable to most urban areas • Shows some capacity to trap trash, debris, and other floatables • Can be adapted to all regions of the country	• Not feasible for drainage area greater than 1 acre • Minimal nutrient and organic matter removal • Not effective as water quality control for intense storms • Concern exists for the pollutant toxicity of trapped residuals • Require high maintenance	High, compared to trenches and sand filters
Extended detention dry pond with micropool	• Can provide peak flow control • Possible to provide good particulate removal • Can serve large development • Requires less capital cost and land area when compared to wet pond • Does not generally release water or anoxic water downstream • Provides excellent protection for downstream channel erosion • Can create valuable wetland and meadow habitat when properly landscaped	• Removal rates for soluble pollutants are quite low • Not economical for drainage area less than 10 acres • If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors	Lowest cost alternative in size range

[a]Comparative cost information from Schueler, 1992

Table F-2. Costs of selected management practices (Claytor and Scheuler, 1996; Brown and Schueler, 1997).

Management practice	Construction costs[a]	Useful life (years)	Total annual costs
Infiltration basin[b]			
Average	$0.55/ft^3 storage	25[c]	–
Report range	$0.22–$1.31/ft^3	–	$0.03–$0.05/ft
Probable range	$0.44–$0.76/ft^3	–	–
Infiltration trench[b]			
Average	$4.36/ft^3 storage	10[c]	–
Report range	$0.98–$10.04/ft^3	–	$0.03–$0.10/ft
Probable range	$2.73–$8.18/ft^3	–	–
Infiltration practices[d]			
Average	$2.99/ft^3 storage	–	–
Report range	$2.13-4.27/ft^3 storage	–	–
Vegetated swales[b]			
Established from seed			
Average	$7.09/linear ft	50[e]	$1.09/linear ft
Report range	$4.91–$9.27/linear ft	–	–
Established from sod			
Average	$21.82/linear ft	50[e]	$2.18/linear ft
Report range	$8.73–$54.56/linear ft	–	–
Porous pavement[b]			
Average	$1.64/ft^2	10[f]	$0.16/ft
Report range	$1.09-$2.18/ft^2	–	–
Concrete grid pavement[b]			
Average	$1.09/ft^2	20	$0.05/ft
Report range	$1.09–$2.18/ft^2	–	–
Filtration basins[b]			
Average (probable)	$5.46/ft^3 storage	25[g]	–
Report range	$1.09–12.00/ft^3	–	$0.11–$0.87/ft
Probable range	$2.18–9.82/ft^3	–	–
Filtration practices[d]			
Average	$2.63/ft^3 storage	–	–
Range	$2.13-6.40/ft^3 storage	–	–
Water quality inlet[b,h]			
Average	$2,182 each	–	$164 each
Report range	$1,200–3,273 each	–	–
Probable range	–		–
Water quality inlet with sand filter[b,h]			
Average (probable)	$10,900/drainage acre	50	$764/drainage acre
Oil/grit separator[b,h]			
Average	$19,640/drainage acre	50	$1,091/drainage acre
Report range	$16,370–$21,820/ drainage acre	–	–

Table F-2. (cont.)

Management practice	Construction costs[a]	Useful life (years)	Total annual costs
Stabilization with ground cover[b,h]			
From existing vegetation	$0	50	Natural: $109/acre
Average	–	–	Managed: $873/acre
Report range			
From seed	$436/acre	50	Natural: $131/acre
Average	$218–$1,091/acre	–	Managed: $900/acre
Report range			
From seed and mulch	$1,637/acre	50	Natural: $218/acre
Average	$872–$3,819/acre	–	Managed: $982/acre
Report range			
From sod	$12,330/acre	50	Natural: $764/acre
Average	$4,910–$52,375/acre	–	Managed: $1,528/acre
Report range			
Ext. Detention Dry Pond[b,h]			
Average	$0.55/ft^3 storage	50	–
Report range	$0.05–$3.49/ft^3	–	$0.008–$0.33/ft
Probable range	$0.10–$5.46/ft^3	–	–
Wet Pond and Extended Detention Wet Pond[b]			
Storage vol. < 1 million ft^3			
Average	$0.55/ft^3 storage	50	$0.009–$0.08/ft
Report range	$0.05–$1.09/ft^3	–	–
Probable range	$0.55–$1.09/ft^3	–	–
Storage vol. > 1 million ft^3			
Average (probable)	$0.27/ft^3 storage	50	–
Report range (probable)	$0.05–$0.55/ft^3	–	$0.009–$0.08/ft
Probable range	$0.11–$0.55/ft^3	–	–

[a] Costs updated to 2000 dollars using the Bureau of Labor Statistics Consumer Pricing Indexes Inflation Calculator (BLS, 2000).
[b] Claytor and Schueler, 1996.
[c] References indicate the useful life for infiltration basins and infiltration trenches at 25-50 and 10-15 years, respectively. Because of the high failure rate, infiltration basins are assumed to have a useful life span of 25 years and infiltration trenches are assumed to have a useful life span of 10 years.
[d] Brown and Schueler, 1997.
[e] Useful life is assumed to equal the life of the project, assumed to be 50 years.
[f] No information was available for porous pavement. It is assumed to be similar to infiltration trenches.
[g] No information was available for filtration basins. It was assumed to be similar to infiltration basins.
[h] These practices do not meet the 80 percent TSS removal, thus it is recommended that they be used with other management practices in a treatment train.

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GLOSSARY

Bathymetric: Pertaining to the depth of a waterbody.

Bed load transport: Sediment transport along the bottom of a waterbody due to currents.

Benthic: Associated with the bottom of a waterbody.

Biocriteria: Biological measures, such as the incidence of cancer in benthic fish species, that indicate the health of an environment.

BOD: Biochemical oxygen demand; the quantity of dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter and oxidizable inorganic matter by aerobic biological action.

CBOD: Carbonaceous biochemical oxygen demand; the quantity of dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter by aerobic biological action.

Circulation cell: See *gyre*.

Conservative pollutant: A pollutant that remains chemically unchanged in the water.

Critical habitat: A habitat determined to be important to the survival of a threatened or endangered species, to general environmental quality, or for other reasons as designated by the state or federal government.

CVA: Clean Vessel Act of 1992 (P.L. 102-587, Subtitle F); provides funding to states for the construction, renovation, operation, and maintenance of additional pumpout facilities and sanitary waste reception facilities at marinas and other vessel facilities.

CWA: Clean Water Act. Popular name for the Federal Water Pollution Control Act (33 U.S.C. 1251–1376), amended in 1972 by the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

CZARA: Coastal Zone Act Reauthorization Amendments of 1990. Amended the Coastal Zone Management Act of 1972 (16 U.S.C. 1451–1464, Chapter 33; Public Law 92-583).

DO: Dissolved oxygen; the concentration of free molecular oxygen in the water column.

Drogue-release study: A study of currents and circulation patterns using objects, or drogues, placed in the water at the surface or at specified depths.

Dye-release study: A study of dispersion using nontoxic dyes.

EPA: The United States Environmental Protection Agency, the federal agency charged with ensuring that federal laws protecting human health and the environment are enforced fairly and effectively.

Exchange boundary: The boundary between one waterbody, e.g., a marina, and its parent waterbody; usually the marina entrance(s).

Fecal coliform bacteria: Bacteria present in mammalian feces, used as an indicator of the presence of human feces, bacteria, viruses, and pathogens in the water column.

Fixed breakwater: A breakwater constructed of solid, stationary materials.

Floating breakwater: A breakwater constructed to possess a limited range of movement.

Flushing time: Time required for a waterbody, e.g., a marina, to exchange its water with water from the parent waterbody.

GIS: geographical information system; a computer-based system for representing geographical data and information.

Gyre: A mass of water circulating as a unit and separated from other circulating water masses by a boundary of relatively stationary water.

Hydrographic: Pertaining to ground or surface water.

Ichthyofauna: Fish.

Macrophytes: Plants visible to the naked eye.

Mathematical modeling: Predicting the performance of a design based on mathematical equations.

Micron: Micrometer; one one-millionth (0.000001) of a meter.

NCDEM DO model: A mathematical model for calculating dissolved oxygen (DO) concentrations developed by the North Carolina Division of Environmental Management (NCDEM).

No-discharge zone, or NDZ: An area where the discharge of polluting materials is not permitted.

NPDES: National Pollutant Discharge Elimination System. A permitting system for point source polluters regulated under section 402 of the Clean Water Act.

Numerical modeling: See *mathematical modeling*.

Nutrient transformers: Biological organisms, usually plants, that remove nutrients from water and incorporate them into tissue matter.

OPA: Oil Pollution Act of 1990 (33 USCA 2701-2761).

Organics: Carbon-containing substances such as oil, gasoline, and plant matter.

PAH: Polynuclear aromatic hydrocarbon; multiringed carbon molecules resulting from the burning of fossil fuels, wood, etc.

Physical modeling: Using a small-scale physical structure to simulate and predict the performance of a full-scale structural design.

Rapid bioassessment: An assessment of the environmental degradation of a waterbody based on a comparison between a typical species assemblage in a pristine waterbody and that found in the waterbody of interest.

Removal efficiency: The capacity of a pollution control device to remove pollutants from wastewater or runoff.

Residence time: The length of time water remains in a waterbody. Generally the same as *flushing time*.

Riparian: For the purposes of this report, riparian refers to areas adjoining coastal waterbodies, including rivers, streams, bays, estuaries, coves, and the like.

Sensitivity analysis: Modifying a numerical model's parameters to investigate the relationship between alternative [marina] designs and water quality.

Shoaling: Deposition of sediment causing a waterbody or location within a waterbody to become more shallow.

Significant: A quantity, amount, or degree of importance determined by a state or local government.

SOD: Sediment oxygen demand; the biochemical oxygen demand of microorganisms living in sediments.

Suspended solids: Solid materials that remain suspended in the water column.

Tidal prism: The difference in the volume of water in a waterbody between low tide and high tide.

Tidal range: The difference in height between mean low tide and mean high tide.

Velocity shear: Friction created by two masses of water moving in different directions or at different speeds in the same direction.

WASP4 model: A generalized modeling system for contaminant fate and transport in surface waters; may be applied to biochemical oxygen demand, dissolved oxygen, nutrients, bacteria, and toxic chemicals.