California Nonpoint Source Encyclopedia

Prepared for State Water Resources Control Board by Tetra Tech, Inc

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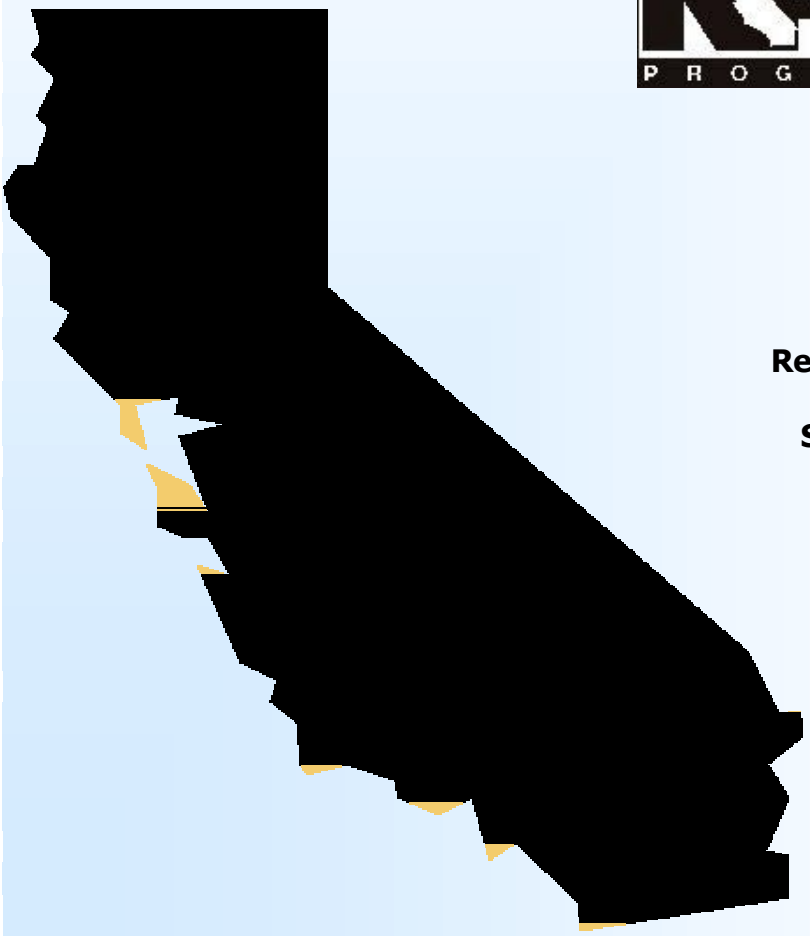

Prepared for
California State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Prepared by
Tetra Tech, Inc.
10306 Eaton Place
Suite 340
Fairfax, VA 22030

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To ensure that the NPS Encyclopedia includes the most pertinent and current information available, it will be updated semiannually. Comments and suggestions for the addition of new material will be accepted on a continuous basis. Please forward any questions, comments, or suggested additions to Diane Edwards by e-mail (edwad@swrcb.ca.gov) or phone (916-341-5908).

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1. INTRODUCTION

The goal of this guidance document is to provide the best, most relevant information to State agencies, regional boards, local agencies, and nonpoint source (NPS) practitioners to assist them in identifying and implementing practices to protect high-quality waters and restore impaired waters. This guidance document is not applicable to any facilities that are considered point sources under the Clean Water Act, including confined animal facilities that are Concentrated Animal Feeding Operations (CAFOs) as defined by USEPA. The guidance is organized around the six NPS categories identified in the *Plan for California's Nonpoint Source Pollution Control Program* of 2000: agriculture, forestry, urban areas, marinas and recreational boating, hydromodification, and wetlands/riparian areas/vegetated treatment systems. It supports the plan's goal of implementing the 61 NPS management measures by 2013. It also supports the implementation of NPS total maximum daily loads (TMDLs), as well as the development of TMDL implementation plans and watershed plans. A companion set of tools will also be available through the Internet to assist users in identifying potential management practices and estimating the effectiveness of those practices in managing pollution.

The Management Measures Concept. Management measures establish performance expectations and, in many cases, describe actions that can be taken to prevent or minimize nonpoint source pollution or other negative impacts associated with uncontrolled and untreated runoff. Specific actions or practices for achieving the performance expectations are not included in the management measure statement. This is by design. Local officials and other practitioners need the flexibility to choose management practices that best achieve the management measure's performance expectations given their own unique circumstances. To aid in their decision, however, this guidance presents a selection of management practices that can be used to achieve each management measure.

1.1 Regulatory Background

California's legal framework for implementing the NPS program is based on two primary federal laws—the Clean Water Act and Coastal Zone Management Act (CZMA)—and State and local law. In California, the Porter-Cologne Act is the principal State law governing water quality in California, and it provides the primary back-up authority to implement the NPS management measures. However, other State and local authorities are also critical components of the legal framework that address NPS pollution in California. In addition to the Porter-Cologne Act, this section describes the California Coastal Act, the California Environmental Quality Act (CEQA), and the California planning, zoning, and development laws. Additional details on these and other authorities that are part of this framework are identified in the *Plan for California's Nonpoint Source Pollution Control Program Volume II: California Management Measures for Polluted Runoff* (http://www.swrcb.ca.gov/nps/cammpr.html). Details on the State Water Resource Control Board's and California Coastal Commission's statutory authority for addressing nonpoint sources are included in Appendix B of the *Plan for California's Nonpoint Source Pollution Control Program Volume 1: Nonpoint Source Program Strategy and Implementation Plan (1998-2013)*, entitled Legal Opinions (http://www.swrcb.ca.gov/nps/docs/planvol1.doc).

1.1.1 Federal Laws

The Federal Water Pollution Control Act, known as the Clean Water Act (33 United States Code [USC] sections 1251 et seq.), is the principal federal statute for water quality protection. In California, the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs) implement many of the Clean Water Act's provisions. The Clean Water Act requires the State to adopt water quality standards and to submit those standards for approval by the U.S. Environmental Protection Agency (USEPA). For point source discharges to surface water, the Clean Water Act authorizes USEPA or approved states to administer the National Pollutant Discharge Elimination System (NPDES) program. Clean Water Act section 303(d) requires states to list surface waters not attaining (or not expected to attain) water quality standards after the application of technology-based effluent limits, and states normally must prepare and implement a TMDL for all waters on the Clean Water Act section 303(d) list. The Clean Water Act also establishes a loan program—the State Revolving Fund (SRF)—for the construction of water quality projects, including NPS projects.

In the 1987 Clean Water Act amendments, Congress added Clean Water Act section 319 (33 USC section 1329), which required states (1) to develop assessment reports that described the states' NPS problems, (2) to establish management programs to address these problems, and (3) to provide funding to support implementation of the programs. California's *Nonpoint Source Management Plan* (SWRCB, 1988) outlined a general approach to address persistent NPS problems using education and outreach, financial and technical assistance, and regulatory authorities when necessary. To enhance activities to address NPS pollution, states are currently encouraged to upgrade their NPS programs. In 1996, USEPA issued Clean Water Act section 319 program guidance that identified "nine key elements" that must be addressed to receive USEPA approval for upgraded NPS plans. Pursuant to the 1998 Clean Water Action Plan, states with upgraded NPS programs will receive increased funding based on a federal appropriation for state NPS programs above $100 million. For California to receive additional funding in fiscal year 2000 and beyond, USEPA must certify that California's NPS Program has been upgraded consistent with the nine key elements.

The CZMA of 1972 (16 USC sections 1451 et seq.) established a national framework for effective management, protection, development, and beneficial use of the coastal zone. Pursuant to the CZMA, California prepared the California Coastal Management Program that was approved by the National Oceanic and Atmospheric Administration (NOAA). The bulk of California's coast is within the jurisdiction of the California Coastal Commission pursuant to the Coastal Act of 1976 (Public Resources Code [PRC] sections 30000 et seq.), while the San Francisco Bay Conservation and Development Commission has jurisdiction in San Francisco Bay pursuant to the McAteer-Petris Act (MPA) (Government Code sections 66600 et seq.). The State Coastal Conservancy is a third partner agency in the California Coastal Management Program.

Recognizing that the CZMA did not specifically mention water quality, in 1990 Congress amended CZMA section 306(d)(16) (16 USC section 1455[d][16]) and added section 6217 (16 USC section 1455b) to focus on NPS pollution problems and the protection of coastal waters. Coastal Zone Act Reauthorization Amendments (CZARA) section 6217 requires state coastal zone management agencies, in coordination with state water quality agencies, to develop and implement management measures to restore and protect coastal waters from adverse impacts of NPS pollution. Similarly, CZMA section 306(d)(16)(16 USC section 1455[d][16]) requires that state coastal zone management programs contain enforceable policies and mechanisms to implement applicable requirements of CZARA section 6217. To achieve these goals, states were directed to coordinate and integrate their existing coastal zone management and water quality plans and programs, including the states' NPS management plans.

1.1.2 Porter-Cologne Water Quality Control Act

The Porter-Cologne Act is the principal law governing water quality regulation in California. It establishes a comprehensive program to protect water quality and the beneficial uses of water. The Porter-Cologne Act applies to surface waters, wetlands, and ground water and to both point and nonpoint sources of pollution. Pursuant to the Porter-Cologne Act (California Water Code section 13000 et seq.), the policy of the State is as follows:

- That the quality of all the waters of the State shall be protected,
- That all activities and factors affecting the quality of water shall be regulated to attain the highest water quality within reason, and
- That the State must be prepared to exercise its full power and jurisdiction to protect the quality of water in the State from degradation.

The Porter-Cologne Act established nine RWQCBs and the SWRCB, which are charged with implementing its provisions and which have primary responsibility for protecting water quality in California. The SWRCB provides program guidance and oversight, allocates funds, and reviews RWQCB decisions. In addition, the SWRCB allocates rights to the use of surface water. The RWQCBs have primary responsibility for individual permitting, inspection, and enforcement actions within each of nine hydrologic regions. The SWRCB and RWQCBs have numerous NPS-related responsibilities, including problem monitoring and assessment, planning, financial assistance, and regulatory and non-regulatory management.

The RWQCBs regulate discharges under the Porter-Cologne Act primarily through issuance of NPDES permits for point source discharges and waste discharge requirements for NPS discharges. Anyone discharging or proposing to discharge materials that could affect water quality (other than to a community sanitary sewer system regulated by an NPDES permit) must file a report of waste discharge. The SWRCB and the RWQCBs can make their own investigations or may require dischargers to carry out water quality investigations and report on water quality issues. The Porter-Cologne Act provides several options for enforcing WDRs and other orders, including cease and desist orders, cleanup and abatement orders, administrative civil liability orders, civil court actions, and criminal prosecutions.

The Porter-Cologne Act also implements many provisions of the Clean Water Act, such as the NPDES permitting program. Section 401 of the Clean Water Act gives the SWRCB the authority to review any proposed federally permitted or federally licensed activity that may impact water quality and to certify, condition, or deny the activity if it does not comply with State water quality standards. If the SWRCB imposes a condition on its certification, those conditions must be included in the federal permit or license.

Except for dredge and fill activities, injection wells, and solid waste disposal sites, WDRs may not "specify the design, location, type of construction or particular manner in which compliance may be had" (Porter-Cologne Act section 13360). Thus, WDRs ordinarily specify the allowable discharge concentration or load or the resulting condition of the receiving water, rather than the manner by which those results are to be achieved. However, the RWQCBs may impose discharge prohibitions and other limitations on the volume, characteristics, area, or timing of discharges and can set discharge limits such that the only practical way to comply is to use management practices. RWQCBs can also waive WDRs for a specific discharge or category of discharges on the condition that management measures identified in a water quality management plan approved by the SWRCB or RWQCB are followed.

The Porter-Cologne Act also requires adoption of water quality control plans that contain the guiding policies of water pollution management in California. A number of statewide water quality control plans

have been adopted by the SWRCB. In addition, regional water quality control plans, commonly referred to as basin plans, have been adopted by each of the RWQCBs. All basin plans identify the existing and potential beneficial uses of waters of the State and establish water quality objectives to protect these uses. The basin plans also contain implementation, surveillance, and monitoring plans. Water quality control plans include enforceable prohibitions against certain types of discharges, including those that may pertain to nonpoint sources. Basin plans have been adopted for each of the nine regions.

Portions of water quality control plans are also subject to review by USEPA. When approved by USEPA, the water quality objectives and beneficial use designations become water quality standards under the Clean Water Act. In most cases, water quality objectives contained in a water quality control plan are not directly enforceable unless implemented through WDRs or water right permits.

1.1.3 California Coastal Act

The State Legislature enacted the California Coastal Act (PRC section 30000 et seq.) to provide for the conservation and planned development of the State's coastline. The Coastal Act mandates the protection and restoration of coastal waters pursuant to several sections in the PRC. Mandated activities include the following:

- To carry out a public education program to promote coastal conservation.
- To maintain, enhance, and, where feasible, restore marine resources.
- To maintain and, where feasible, restore biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes through, among other means, minimizing adverse effects of wastewater discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging wastewater reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.
- To protect against spillage of crude oil, gas, petroleum products, or hazardous wastes.
- To limit the alteration of wetlands, coastal waters, and estuaries and provide for feasible mitigation measures to minimize adverse environmental effects.
- To phase out or upgrade, where feasible, existing marine structures causing water stagnation contributing to pollution problems and fish kills.
- To limit hydromodification of rivers and streams. Channelization, dams, and other substantial alterations of rivers and streams must incorporate best mitigation measures feasible.
- To protect environmentally sensitive habitat areas (ESHAs). To site and design new development in areas adjacent to ESHAs to prevent significant adverse impacts.
- To protect long-term productivity of soils and timberlands.
- To site and design new development so as to not have significant adverse impacts either individually or cumulatively on coastal resources.
- To minimize alteration of natural landforms.

- To ensure that new development is stable, has structural integrity, and does not contribute significantly to erosion.
- To control impacts of dredging in specified port areas.
- To minimize harmful effects on coastal waters, including water quality, from fill within ports.
- To locate, design, and construct port-related development to minimize substantial environmental impacts and protect beneficial uses.

In carrying out the mandates of the Coastal Act, the California Coastal Commission (CCC) certifies local coastal programs (LCPs) prepared by local governments (PRC section 30500). The CCC also certifies plans prepared by port districts (PRC section 30711 et seq.), colleges and universities (PRC section 30605), and proponents of public works projects (PRC section 30605). In addition, the CCC approves coastal development permits (CDPs), energy projects, and federal (federally approved, conducted, or funded) projects consistent with Coastal Act policies. The Coastal Act also contains several means to deter and discipline violators of its provisions. In order to prevent imminent or further damage of coastal resources, the Executive Director of the SWRCB or the CCC can issue a cease and desist order to any party that is undertaking a development without a permit or in a manner inconsistent with the terms of a previously issued permit (PRC sections 30809 and 30810). The CCC can also order the restoration of a site (PRC section 30811). Civil liability fines for violations of the Coastal Act are specified in PRC sections 30820, 30821.6, and 30822. In practice, the CCC protects water quality primarily through (1) managing coastal development that generates runoff or creates spills, (2) assisting local coastal governments and other agencies to address land-use and development activities that may produce NPS pollution, and (3) implementing educational and technical assistance programs.

1.1.4 California Environmental Quality Act

California is one of 20 states with an environmental impact assessment law, called the California Environmental Quality Act (CEQA), which is modeled after the National Environmental Policy Act (NEPA). The SWRCB, RWQCBs, and all State and local government agencies must comply with CEQA. CEQA applies to discretionary activities proposed to be carried out by government agencies, including approval of permits and other entitlements. CEQA has six objectives:

1. To disclose to decision-makers and the public the significant environmental effects of proposed activities,
2. To identify ways to avoid or reduce environmental damage,
3. To prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures,
4. To disclose to the public reasons for agency approvals of projects with significant environmental effects,
5. To foster interagency coordination, and
6. To enhance public participation.

CEQA sets forth procedural requirements to ensure that the objectives are accomplished and also contains substantive provisions requiring agencies to avoid or mitigate, when feasible, impacts disclosed in an

Environmental Impact Report. In addition, CEQA sets forth a series of broad policy statements encouraging environmental protection. These policies have led the courts to interpret CEQA "so as to afford the fullest possible protection to the environment within the reasonable scope of the statutory language" (*Friends of Mammoth v. Board of Supervisors [1972] 8 Cal 3d 247, 259, 104 Cal. Rptr. 761*).

1.1.5 Planning, Zoning, and Development Laws

The legal framework within which California cities and counties exercise local planning and land use functions, which can play a critical role in addressing NPS pollution, is provided in the California Planning and Zoning Law (Government Code sections 65000 et seq.) and the Subdivision Map Act (SbMA) (Government Code sections 66410 et seq.), as well as in the Coastal Act.

Under State planning law, each city or county must adopt a comprehensive, long-term general plan for the physical development of the city or county and any land outside its jurisdiction that bears relation to its planning. Pursuant to Government Code section 65302, general plans must contain seven elements: (1) land use, (2) circulation, (3) housing, (4) conservation, (5) open space, (6) noise, and (7) safety. The following elements are the most relevant to NPS pollution prevention and control:

- Land Use. Designates categories such as housing, industry, and natural resources, including density and intensity of use.
- Conservation. Applies to conservation, development, and use of natural resources (e.g., soils, forests, rivers and other water bodies, and harbors). May also cover watershed protection, land or water reclamation, prevention or control of the pollution of streams and other coastal waters, regulation of land uses along stream channels and in other areas required to implement the conservation plan (e.g., buffer areas), to control or correct soil erosion, and for flood control.
- Open Space. Applies to the preservation of natural resources, including fish and wildlife habitat, rivers, streams, bays and estuaries, and open space.
- Circulation. Plans infrastructure, including water, sewage, and storm drainage.

While the general plan is a long-range look at the future of a community, a zoning ordinance spells out the immediate allowable uses for each property in the community. Each property in the community is assigned a "zone" listing the kinds of uses that will be allowed on that land (e.g., single family residential, multi-family residential, neighborhood commercial, light industrial, agricultural) and setting development standards (e.g., minimum lot size, maximum building height, minimum front-yard depth). The distribution of residential, commercial, industrial, and other zones is based on the pattern of land uses established in the community's general plan. Zoning is adopted by ordinance and carries the weight of local law. All local governments use some form of permitting process whereby a permit is issued for a specific project and can be conditioned based on compliance with the zoning ordinance.

Subdivision regulation, like zoning, is an exercise of police power and is a principal instrument for implementing a general plan. The SbMA (Government Code sections 66410 et seq.) sets forth other mandates that must be followed for subdivision processing.

The local government's corporate and police powers and zoning and subdivision ordinances are tools commonly used to implement general plans. Preferential assessment of real property can also offer landowners an economic incentive for keeping their land in agricultural, timber, or open space uses. This can serve to implement the land use, open space, and conservation elements of a general plan by reserving areas designated for agriculture, timber, open space, scenic resources, and natural resource use.

The Coastal Act also requires cities and counties that are located wholly or partially in the coastal zone to have an "eighth element" (the local coastal program or LCP) for that portion of the local government's jurisdiction in the coastal zone. When an LCP is certified by the CCC as being consistent with the goals and policies of the Coastal Act, coastal permit authority for that area is delegated to the local government. However, development in State tidelands, submerged lands, and public trust lands still requires a permit from the CCC, and certain types of local government decisions on coastal permits made under certified LCPs may be appealed to the CCC.

1.1.6 SWRCB Antidegradation Policy

A key policy of California's water quality program is the State's Antidegradation Policy. This policy, formally known as the *Statement of Policy with Respect to Maintaining High Quality Waters in California* (SWRCB Resolution No. 68-16), restricts degradation of surface and ground waters. In particular, this policy protects water bodies where existing quality is higher than necessary for the protection of beneficial uses.

Under the Antidegradation Policy, any actions that can adversely affect water quality in all surface and ground waters must (1) be consistent with maximum benefit to the people of the State, (2) not unreasonably affect present and anticipated beneficial use of the water, and (3) not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the Federal Antidegradation Policy (40 Code of Federal Regulations [CFR] section 131.12) developed under the Clean Water Act.

1.2 Structure of Document

The *California Nonpoint Source Encyclopedia* is designed to facilitate a general understanding of NPS management techniques and to provide quick access to essential information from a variety of sources. Direct links to Internet resources will enhance the usefulness of the guidance. The guidance is structured according to the 61 management measures so that the user can easily identify areas of interest, review the measures, and access additional information for selected topics. See Table 1-1 for a complete list of management measures by NPS category.

Fact sheets prepared for each of the 61 management measures provide a brief discussion of the essential elements and intent of each management measure and useful information sources and references. Each fact sheet contains the following sections:

- *Programs:* A description of several State and federal programs related to implementation of the management measure. For example, the fact sheets prepared for management measures related to urban runoff would include a discussion of the SWRCB and RWQCBs' NPDES storm water program, as well as the planning and land use permitting functions of other State agencies such as the California Coastal Commission.

- *Management Practices:* A list of specific practices that can be used to achieve the goals outlined in each management measure. This information includes a description of management practices or categories of practices and how they will contribute to meeting each management measure, as well as their applicability to situations in California and their cost-effectiveness in different climatic and land use settings. This information summarizes some of the best information from various documents and data sources, both national and state-specific.

- *Information Resources:* A list of some of the most useful "additional resources" such as Internet sites, technical reports, guidance manuals, and other references. These resources are intended to assist the user in understanding and implementing management practices to meet the management measure.

- *Case Studies:* Examples of successful implementation of the management measure or one or more management practices in California.

- *References:* Information resources that were used to compile the information contained in the fact sheet.

Table 1-1 provides a summary list of NPS categories and the California management measures that fall under each category.

Table 1-1. NPS Categories and Management Measures

NPS Category	Management Measures
Agriculture	1A Erosion and Sediment Control 1B Facility Wastewater and Runoff from Confined Animal Facilities 1C Nutrient Management 1D Pesticide Management 1E Grazing Management 1F Irrigation Water Management 1G Education and Outreach
Forestry	2A Preharvest Planning 2B Streamside Management Areas (SMAs) 2C Road Construction/Reconstruction 2D Road Management 2E Timber Harvesting 2F Site Preparation and Forest Regeneration 2G Fire Management 2H Revegetation of Disturbed Areas 2I Forest Chemical Management 2J Wetlands Forest Management 2K Postharvest Evaluation 2L Education/Outreach
Urban Areas	3.1 Runoff From Developing Areas 3.1A Watershed Protection 3.1B Site Development 3.1C New Development 3.2 Runoff from Construction Sites 3.2A Construction Site Erosion and Sediment Control 3.2B Construction Site Chemical Control 3.3 Runoff from Existing Development 3.3A Existing Development 3.4 Runoff from Onsite Disposal Systems (OSDSs) 3.4A New OSDSs 3.4B Operating OSDSs 3.5 Transportation Development (Roads, Highways, and Bridges) 3.5A Planning, Siting, and Developing Roads and Highways 3.5B Bridges 3.5C Construction Projects 3.5D Chemical Control 3.5E Operation and Maintenance 3.5F Road, Highway, and Bridge Runoff Systems 3.6 Education/Outreach 3.6A Pollution Prevention/Education: General Sources
Marinas and Recreational Boating	4.1 Assessment, Siting, and Design 4.1A Marina Flushing 4.1B Habitat Assessment

NPS Category	Management Measures
	4.1C Water Quality Assessment 4.1D Shoreline Stabilization 4.1E Storm Water Runoff 4.1F Fueling Station Design 4.1G Sewage Facilities 4.1H Waste Management Facilities 4.2 Operation and Maintenance 4.2A Solid Waste Control 4.2B Fish Waste Control 4.2C Liquid Material Control 4.2D Petroleum Control 4.2E Boat Cleaning and Maintenance 4.2F Maintenance of Sewage Facilities 4.2G Boat Operation 4.3 Education/Outreach 4.3A Public Education/Outreach
Hydromodification	5.1 Channelization and Channel Modification 5.1A Physical and Chemical Characteristics of Surface Waters 5.1B Instream and Riparian Habitat Restoration 5.2 Dams 5.2A Erosion and Sediment Control 5.2B Chemical and Pollutant Control 5.2C Protection of Surface Water Quality and Instream and Riparian Habitat 5.3 Streambank and Shoreline Erosion 5.3A Eroding Streambanks and Shorelines 5.4 Education/Outreach 5.4A Educational Programs
Wetlands, Riparian Areas, and Vegetated Treatment Systems	6A Protection of Wetlands and Riparian Areas 6B Restoration of Wetlands and Riparian Areas 6C Vegetated Treatment Systems 6D Education/Outreach

1.2.1 References

SWRCB. 1988. *Nonpoint Source Management Plan*. State Water Resources Control Board, Division of Water Quality, Sacramento, CA. November 1988.

SWRCB. 2000. *Plan for California's Nonpoint Source Pollution Control Program*. Volume 1: Nonpoint Source Program Strategy and Implementation Plan (1998-2013) and Volume II: California's Management Measures for Polluted Runoff (CAMMPR). State Water Resources Control Board and the California Coastal Commission, Sacramento, CA.

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2. MANAGEMENT MEASURE CATEGORIES

2.1 Agriculture

Agriculture Category Links:
- Erosion and Sediment Control
- Facility Wastewater and Runoff from Confined Animal Facilities
- Nutrient Management
- Pesticide Management
- Grazing Management
- Irrigation Water Management
- Education/Outreach

2.1.1 Introduction

The California State Water Resources Control Board (SWRCB), California Coastal Commission (CCC), and other state agencies have identified seven management measures to address agricultural nonpoint source (NPS) pollution of State waters. The management measures consist of a suite of plans, practices, technologies, operating methods, or other alternatives that may be used in combination to control NPS pollution. Associated with each management measure are management practices that are designed to reduce the quantities of pollutants entering receiving waters. Many of the practices listed under each management measure were approved for use by the California Natural Resources Conservation Service (NRCS). Some practices are recommended by the U.S. Department of Agriculture (USDA) NRCS as components of Resource Management Systems (RMSs). RMSs, also known as conservation planning, are whole-farm plans that incorporate economic, social, and ecological considerations to meet the demands of crop and animal production and long-term environmental sustainability. RMSs contain pollution control criteria for soil, air, water, plant, animal, and human resources, which are described in the USDA NRCS *Field Office Technical Guide*. Not all components of RMSs are included in the management measures and practices—only those that are related to water quality. The fact sheet prepared for each management measure informs readers of the programs, resources, and case studies specific to California and the management measure.

The NPS pollutants typically associated with agriculture are nutrients, animal waste, sediments, and pesticides. Agricultural NPS pollution enters receiving waters by direct runoff to surface waters or seepage to ground water. Runoff of nutrients can result from excessive application of fertilizers and animal waste to land, and from improper storage of animal waste. Farming activities can cause excessive erosion, which results in sediment entering receiving waters. Improper use and overapplication of pesticides causes pesticide pollution. Improper grazing management can cause erosion, soil compaction, and excessive nutrients, all of which impair sensitive areas. Overapplication of irrigation water can cause runoff of sediments and pesticides to enter surface water or seep into ground water. Sediment, pesticides, and excess nutrients all affect aquatic habitats by causing eutrophication, turbidity, temperature increases, toxicity, and decreased oxygen.

Programs established to control NPS pollution from agriculture in California include joint efforts by local, State, and federal agencies. The SWRCB and the CCC oversee the statewide program, with assistance from the Department of Pesticide Regulation for pesticide pollution and the Department of Water Resources for irrigation water management. Local governments administer programs for general planning and local coastal plans. The California NRCS and the University of California Cooperative Extension Service provide technical and financial services for farmers. Resource Conservation Districts also provide guidance, training, and technical assistance. The programs administered by these various agencies are

listed under the Programs heading in each fact sheet; sources of information specific to each management measure are listed under Information Resources.

The California *Management Measures for Polluted Runoff* defines the seven agriculture management measures as follows:

- **1A. Erosion and Sediment Control.** Management Measure 1A addresses NPS problems associated with soil erosion and sedimentation. Where erosion and sedimentation from agricultural lands affects coastal waters and/or water bodies listed as impaired by sediment, landowners must design and install or apply a combination of practices to reduce solids and associated pollutants in runoff during all but the larger storms. Alternatively, landowners may apply the erosion component of an RMS as defined in the USDA NRCS *Field Office Technical Guide*, which contains standards and specifications for installing these practices.
- **1B. Facility Wastewater and Runoff from Confined Animal Facilities That Are Not CAFOs.** Pursuant to Management Measure 1B, facility wastewater and contaminated runoff from confined animal facilities that are not CAFOs must be contained at all times. Storage facilities should be of adequate capacity to allow for proper wastewater use and should be constructed so they prevent seepage to ground water, and stored runoff and accumulated solids from the facility should be managed through a waste use system that is consistent with Management Measure 1C or removed from the site.
- **1C. Nutrient Management.** Management Measure 1C addresses the development and implementation of comprehensive nutrient management plans for areas where nutrient runoff is a problem affecting coastal waters and/or water bodies listed as impaired by nutrients. Such plans would include a plant tissue analysis to determine crop nutrient needs; crop nutrient budget; identification of the types, amounts, and timing of nutrients necessary to produce a crop based on realistic crop yield expectations; identification of hazards to the site and adjacent environment; soil sampling and tests to determine crop nutrient needs; and proper calibration of nutrient equipment. When manure from confined animal facilities that are not CAFOs is to be used as a soil amendment and/or is disposed of on land, the plan should discuss steps to ensure that subsequent irrigation of that land does not leach excess nutrients to surface or ground water.
- **1D. Pesticide Management.** Management Measure 1D is intended to reduce contamination of surface water and ground water from pesticides. Implementation of this measure will primarily occur through cooperation with the Department of Pesticide Regulation as provided in a Management Agency Agreement with the SWRCB. Elements of this measure include development and adoption of reduced risk pest management strategies (including reductions in pesticide use); evaluation of pest, crop, and field factors; use of Integrated Pest Management (IPM); consideration of environmental impacts in choice of pesticides; calibration of equipment; and use of anti-backflow devices. IPM is a key component of pest control. IPM strategies include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. When used, pesticides should be selected based on their effectiveness to control target pests and environmental impacts such as their persistence, toxicity, and leaching potential.
- **1E. Grazing Management.** Management Measure 1E is intended to protect sensitive areas (including streambanks, lakes, wetlands, estuaries, and riparian zones) by reducing direct loadings of animal wastes and sediment. This may include restricting or rotationally grazing livestock in sensitive areas by providing fencing and livestock stream crossings, and by locating salt, shade, and alternative drinking sources away from sensitive areas. Upland erosion can be reduced by, among other methods, (1) maintaining the land consistent with the California Rangeland Water Quality Management Plan or Bureau of Land Management and USDA Forest

Service activity plans or (2) applying the range and pasture components of a Resource Management System (USDA NRCS *Field Office Technical Guide*). This may include prescribed grazing, seeding, gully erosion control such as grade stabilization structures and ponds, and other critical area treatment.

- **IF. Irrigation Water Management.** Management Measure 1F promotes effective irrigation while reducing pollutant delivery to surface and ground waters. Pursuant to this measure, irrigation water would be applied uniformly based on an accurate measurement of cropwater needs and the volume of irrigation water applied, considering limitations raised by such issues as water rights, pollutant concentrations, water delivery restrictions, salt control, wetland, water supply, and frost/freeze temperature management. Additional precautions would apply when chemicals are applied through irrigation.
- **1G. Education/Outreach.** The goals of Management Measure 1G are to implement pollution prevention and education programs to reduce NPS pollutants generated by the following activities, where applicable:
    - Activities that cause erosion and loss of sediment on agricultural land and land that is converted from other land uses to agricultural land;
    - Activities that cause discharge from confined animal facilities (excluding CAFOs) to surface waters;
    - Activities that cause excess delivery of nutrients and/or leaching of nutrients;
    - Activities that cause contamination of surface water and ground water from pesticides;
    - Grazing activities that cause physical disturbance to sensitive areas and the discharge of sediment, animal waste, nutrients, and chemicals to surface and ground waters;
    - Irrigation activities that cause NPS pollution of surface waters.

2.1.2 General Resources

There are several federal and State agencies and programs that can provide general information to promote sustainable agriculture and prevent NPS pollution from entering receiving waters. The agencies and programs listed below can provide assistance and information for all seven management measures. Resources specific to each of the seven agriculture management measures can be found on the corresponding fact sheet.

- **University of California Cooperative Extension Service** (http://ucanr.org/CES.CEA.shtml): The Cooperative Extension Service has 50 offices in California with experienced staff to provide technical assistance to landowners on farm management and environmental protection. Local cooperative extension service offices can provide specific, local information on programs and information resources available to address many of the agriculture management measures.
- **California NRCS** (http://www.ca.nrcs.usda.gov/): For local assistance, contact USDA NRCS California State Office, 430 G Street #4164, Davis, CA 95616-4164 (Telephone: 530-792-5600; Fax: 530-792-5790). The California NRCS works with landowners and provides technical and financial assistance to conserve natural resources on private lands. In California, assistance is provided to land users through cooperative partnerships with more than 100 Resource Conservation Districts and other agencies and organizations. Soil and resource conservationists, soil scientists, agronomists, foresters, wildlife biologists, engineers, water quality specialists, information specialists, and other resource management professionals work together to address locally identified and nationally prioritized conservation issues. County USDA NRCS offices can

provide specific, local information on programs and information resource available to address many of agriculture management measures. Use the Web site listed above to locate the USDA NRCS office for each county.

- **California Department of Food and Agriculture, Office of Agriculture and Environmental Stewardship** (http://www.cdfa.ca.gov/exec/aep/AES_home.htm): This office identifies and prioritizes environmental conservation and protection issues related to agriculture and provides the agricultural community and the general public with accurate and timely information as well as technical support to identify, develop, and implement actions that enhance environmental conservation and protection.
- **California Association of Resource Conservation Districts** (http://www.carcd.org/): Resource Conservation Districts (RCDs) are special districts of the State of California, set up under California law to be locally governed agencies with their own locally appointed, independent boards of directors. RCDs implement projects on private and public lands and educate landowners about resource conservation. Each RCD can provide local information on project and programs to control agricultural NPS pollution. The California Association of Resource Conservation District's Web site provides a link to each RCD. The California Association of Resource Conservation Districts is a voluntary association whose primary purpose is to provide a unified means for California RCDs to meet major conservation goals.
- **USDA NRCS Electronic *Field Office Technical Guide*** (http://www.nrcs.usda.gov/technical/efotg/): Technical guides are the primary technical references for USDA NRCS. They contain technical information about the conservation of soil, water, air, and related plant and animal resources. Technical guides used in each field office are localized so that they apply specifically to the geographic area for which they are prepared. These documents are referred to as *Field Office Technical Guides* (FOTGs). The FOTG is maintained in each USDA NRCS field office as a compilation of technical knowledge, resource data references, and conservation practice standards. Click on California for a direct link to the California FOTG.
- **USDA NRCS, CORE4 *Conservation Practices Training Guide*** (http://www.nrcs.usda.gov/technical/ECS/agronomy/core4.pdf): The purpose of this workbook is to enhance the technical knowledge of USDA NRCS personnel and their colleagues in both the public and private sector and to assist them in helping landowners effectively use conservation tillage, nutrient management, pest management, and conservation buffers.
- **USEPA, *National Management Measures to Control Nonpoint Source Pollution from Agriculture*** (http://www.epa.gov/owow/nps/agmm/): This is a technical guidance and reference document for use by state, local, and tribal managers in the implementation of NPS pollution management programs. It contains information on the best available, economically achievable means of reducing pollution of surface and ground water from agriculture.
- **USEPA, National Agriculture Compliance Assistance Center** (http://www.epa.gov/agriculture/index.html): The National Agriculture Compliance Assistance Center (the Ag Center) provides information about environmental requirements that affect the agricultural community. The USEPA, with the support of USDA, created the Ag Center.
- **Livestock and Poultry Environmental Stewardship Curriculum** (http://www.lpes.org/): This project delivers a national curriculum and supporting educational tools to U.S. livestock and poultry industry advisors, who help producers acquire certification and achieve environmentally sustainable production systems. Producers will also benefit directly from the information and assessment tools that the curriculum provides.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.1.3 Management Measure 1A Erosion and Sediment Control

Management Measure

Apply the erosion component of a conservation management system (CMS) as defined in the *Field Office Technical Guide* of the U.S. Department of Agriculture's Natural Resources Conservation Service (USDA NRCS) to minimize the delivery of sediment from agricultural lands to surface waters, or design and install a combination of management and physical practices to settle the settleable solids and associated pollutants in runoff delivered from the contributing area for storms of up to a 25-year, 24-hour frequency.

2.1.3.1 Programs

- The Sonoma County Agricultural Commission, Agriculture Division, administers the Sonoma County Vineyard Erosion and Sediment Control Ordinance. Growers planting new vineyards or replanting existing vineyards are required to use recognized conservation practices, and management practices and provide for riparian setback to protect the environment and watersheds of the county (http://www.sonoma-county.org/agcomm/agcomm_division/aboutus.htm).
- The California Tahoe Conservancy has undertaken a comprehensive program to reduce the sources of soil erosion and the amount of sediment and algae-encouraging nutrients that reach Lake Tahoe (http://www.tahoecons.ca.gov/programs/soil/prg_soil.html).

2.1.3.2 Management Practices

The purpose of this management measure is to prevent and reduce the amount of soil entering surface water. California-approved USDA NRCS standards and practices should be used to prevent and reduce erosion on the field or to trap and settle sediment at the edge of the field. Strategies used to control rill and sheet erosion, streambank erosion, soil mass movement, and irrigation-induced erosion should be used as required in the erosion component of a conservation management system (CMS). Recommended practices include the following:

- Erosion can be reduced or prevented by leaving crop residues on the field, planting cover crops or other vegetative cover, and applying mulch to bare fields. In addition, fields can be graded to reduce slope length, steepness, or unsheltered distance (i.e., contour farming), and terraces and diversions can be used to reduce slope length. Finally, cross-wind strips can be installed and hedgerows, trees, and shrubs can be maintained along edges of fields or against prevailing winds to prevent wind erosion.
- Soil quality can be maintained through crop rotation, which involves planting crops in a recurring sequence on the same field, and by using conservation tillage to improve soil properties and improve water infiltration.
- Eroded sediment and associated pollutants can be trapped before leaving the site by installing filter strips, field borders, fiber mats, and buffers to filter and trap sediment. Grassed waterways can be installed to prevent gullies and to filter and trap sediment, and sediment ponds, basins, and traps can be used to treat sediment-laden runoff.

- Techniques such as prescribed grazing, designated animal crossings over streams, and exclusion of animals from streambanks can prevent excessive erosion of fields and riparian areas from hoof traffic.
- Irrigation management techniques can be used to control erosion caused by irrigation.

2.1.3.3 Information Resources

- **The Wine Institute** (http://www.wineinstitute.org/communications/highlight/hom_1jan02.htm): The Wine Institute provides information on sustainable winegrowing practices. This Web site features cover cropping and highlights the experiences and expertise of Trinchero Family Estates, Cinnabar Vineyards, and Winery and Domaine Chandon.
- **University of California, Davis, Cooperative Extension, Sample Erosion Control Plan for the XYZ Ranch** (http://agronomy.ucdavis.edu/calrng/sample_ECP.HTM): This Web site features an erosion control plan that was submitted for several acres in the Garcia River. The plan identifies areas of sediment delivery, identifies areas at risk of sediment delivery, and presents a schedule to control all sediment delivery associated with past and present land management activities.
- **California Buffer Initiative: Common Sense Conservation** (http://www.ca.nrcs.usda.gov/programs/buffer.html): The Web site provides information and links on the initiative to create conservation buffers and filter strips in California.
- **USDA NRCS Conservation Buffers Initiative** (http://www.nrcs.usda.gov/feature/buffers/): This Web site provides information on buffers, how to use buffers, and technology specifications. It describes success stories, and provides links for more information.
- **CORE4, Crop Residue Management Facts** (http://www.ctic.purdue.edu/Core4/CT/Definitions.html): This fact sheet provides information on crop residue management and conservation tillage.
- **CORE4, Ten Benefits of Conservation Tillage** (http://www.ctic.purdue.edu/Core4/CT/CTSurvey/10Benefits.html): This fact sheets describes the 10 benefits of conservation tillage.
- **University of Illinois, College of Agriculture, Cooperative Extension Service, *60 Ways Farmers Can Protect Their Surface Water*** (http://www.thisland.uiuc.edu/60ways/60ways.html): This Web site includes information on managing surface cover on agricultural lands and controlling water flow on steep slopes.
- **Yolo County Resource Conservation District. *Benefits from Row Crop Tailwater Ponds*** (http://www.yolorcd.org/ponds/tailwater/tailwater.shtml).

2.1.3.4 Case Studies

Protecting Hillsides and Fish Habitat at Navarro Vineyards. The steep slopes of Anderson Valley in Mendocino County have some of the thinnest soils and heaviest rainfalls in California, averaging 40 to 90 inches annually. Controlling soil erosion is important for local vintners, including the husband-wife team of Ted Bennett and Deborah Cahn of Navarro Vineyards in Philo. Bennett and Cahn control erosion to help keep pollutants carried with sediment out of the fish habitat in the Navarro River. They mapped the property to determine the main watershed areas and then developed management practices for the vineyards and roads—critical areas that are often conduits for runoff.

Each year the winery regrades the roads on a slant to direct the water flow to the inside slope. As the water runs down the inside channel, it falls into one of 60 stone drop boxes that catch the flow and divert it safely off the sides of the roads through underground culvert drains. Piles of rocks dissipate the impact of the water as it comes out of the culverts. The Navarro vineyard staff check the culverts after every big rain to clear any debris. The roads are also closed after a storm so that vehicles do not tear up the roads. The Navarro vineyard staff also maintain the roads by planting a ground cover of hydro-seed, a special slurry of straw, water, and grass seed, applied on the banks or potential erosion sites before the rains. They protect eroded areas with biodegradable material such as straw matting and coconut husks. Perennial grasses are grown in the waterways so that runoff will not form erosion gullies. In the vineyards, the staff composts and irrigates grass cover crops on all rows to help hold the soil in place during winter. Later, alternating rows are mowed and tilled or, in very steep areas, just mowed. Navarro is vigilant in keeping rodent populations in check, because rodent tunnels speed soil erosion (http://www.wineinstitute.org/communications/highlight/hom_1oct02.htm).

The California Integrated Waste Management Board (CIWMB). The board has funded four erosion control and NPS pollution projects in California. Three of these projects involve commercial grape and citrus growers using mulch (http://www.ciwmb.ca.gov/Organics/GreenTeam/Target6/ProjMap.htm).

The Central Coast Vineyard Team. The Team reported that cover crops of clover, barley, and rye were planted to prevent the Robert Mondavi vineyards' soils from eroding after the vines were first planted last year (http://www.vineyardteam.org/news/waterquality.htm).

California NRCS Buffer Initiative. A vineyard owner in Napa Valley established 50- to 100-foot setbacks to protect streams from the effects of erosion and chemical application. The size of his vineyards was reduced in some cases by 10 percent, resulting in less revenue, but capital costs for stabilizing the stream periodically with riprap were eliminated. Establishment of the buffer contributed positively to water quality by visibly reducing the turbidity of the stream (http://www.nrcs.usda.gov/feature/buffers/calif.html).

2.1.3.5 References

USDA. Nd. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

USEPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.1.4 Management Measure 1B Facility Wastewater and Runoff from Confined Animal Facilities That Are Not CAFOs

Management Measure

Limit the discharge from the confined animal facility that is not a CAFO by:

1. Containing both facility wastewater and the contaminated runoff from confined animal facilities at all times, up to and including storms exceeding a 25-year, 24-hour frequency event [storage facilities should be of adequate capacity to allow for proper wastewater utilization and should be constructed so they prevent seepage to ground water]; and

2. Managing stored runoff and accumulated solids from the facility through an appropriate waste utilization system that is consistent with Management Measure 1C.

2.1.4.1 Programs

- The California Dairy Quality Assurance (CDQA) Program was created to assist dairy producers with navigating and complying with the rules and regulations governing the industry. The CDQA program is a voluntary partnership between dairy producers, government agencies, and academia to address environmental stewardship, animal welfare, and food safety issues. The environmental stewardship module has three components: education, self-assessment, and third-party evaluation, terminating in certification, and focuses on compliance with federal, state, and local water quality regulations. A comprehensive checklist is used as the assessment tool in the certification process (http://www.cdqa.org/).
- The Equine Facilities Assistance Program. In July of 1997, the Council of Bay Area Resource Conservation Districts launched the program entitled "Non-Point Source Water Pollution Reduction through Improved Animal Waste and Resource Management at Equestrian Facilities in the San Francisco Bay Area," to promote sound conservation practices at horse facilities. A manual and fact sheets can be found at the project's Web site (http://www.baysavers.org/projects/equine/equinefacilities.html).

2.1.4.2 Management Practices

The purpose of this management measure is to limit the discharge of manure, litter, and process wastewater from a confined animal facility that is not a Concentrated Animal Feeding Operation (CAFO). Facilities that are defined as CAFOs under USEPA regulations (40 CFR §122.23) are considered point source dischargers and must secure coverage under an NPDES permit. Such facilities are subject to the terms and conditions of that permit.

All other confined animal facilities are considered nonpoint sources. These nonpoint sources, however, must still comply with animal waste discharge standards found at sections 22560 through 22565 of Title 27 of the California Code of Regulations (http://www.calregs.com) and with any applicable waste discharge requirements or waiver. The following practices are recommended for controlling and preventing NPS pollution from confined animal facilities. These practices may also be helpful in achieving compliance with statewide requirements:

- Liquid manure storage structures should be designed to store facility wastewater and the contaminated runoff from confined animal facilities at all times, up to and including storms exceeding a 25-year, 24-hour frequency event, and should be consistent with nutrient management plans designed for the facility.
- Dry manure should be stored in production buildings or storage facilities, or otherwise covered to prevent manure from coming into contact with rainwater and entering surface waters through runoff.
- Each facility should have a nutrient management plan (USDA NRCS Standard 590) and land-apply manure and process wastewater in accordance with the plan.
- Clean water should be diverted from contact with feedlots and holding pens, animals, and manure storage facilities through the use of berms, diversions, roofs, or enclosures.
- Dead animals should be managed in a way that does not affect water quality.
- Seepage of liquid wastes to ground and surface water should be prevented through the use of impermeable linings for liquid storage ponds and concrete pads for solid storage and animal traffic areas.

2.1.4.3 Information Resources

- **University of California, Davis, Animal Science Extension, *Dairy Manure Management Series*** (http://animalscience.ucdavis.edu/extension/WasteManagement.htm): This Web site series provides information on dairy waste management.
- **Orange County, CA, *Water Quality Guidelines for Horse and Livestock Activities*** (http://www.ocwatersheds.com/brochures/horses.pdf): This brochure has been prepared to inform residents in Orange County of the guidelines recommended for horse and livestock management in order to protect the water quality in storm drains, channels, creeks, bays, and the ocean.
- **USEPA Region 9, Animal Waste Management** (http://www.epa.gov/region09/cross_pr/animalwaste/index.html): This Web site provides information on waste management programs for animal feeding operations in USEPA Region 9.
- **USEPA, National Agriculture Compliance Assistance Center** (http://www.epa.gov/agriculture/anafobmp.html): This Web site provides information on operating procedures, schedules of activities, maintenance procedures, and other management practices that confined animal facilities can use to prevent or reduce pollution.
- **USDA NRCS, Nation Water and Climate Center, Animal Waste Management** (http://www.wcc.nrcs.usda.gov/awm/): This Web site contains links to tools and information related to the development of animal waste management systems and comprehensive nutrient management plans (CNMPs) for confined animal facilities.
- **USDA NRCS, Animal Feeding Operations** (http://www.nrcs.usda.gov/programs/afo/). This Web site has information on comprehensive nutrient management planning for animal feeding operations.
- **USDA NRCS, *Agricultural Waste Management Field Handbook*** (http://www.ftw.nrcs.usda.gov/awmfh.html). This handbook provides technical assistance for facilities designing agricultural waste management systems.
- **Council of Bay Area Resource Conservation Districts, *Horse Keeping: A Guide to Land Management for Clean Water*** (http://www.baysavers.org/projects/equine/factsheets.html): This

Web site has a series of informational materials on environmentally sound horse-keeping practices.

- **Livestock and Poultry Curriculum, *Module C Manure Storage and Treatment* and *Module D Land Application and Nutrient Management*** (http://www.lpes.org/les_plans.html): The Livestock and Poultry Curriculum is a national curriculum and supporting educational tools developed for U.S. livestock and poultry industry advisors and producers to help them acquire certification and achieve environmentally sustainable production systems. Modules C and D provide presentations and material on manure storage, storage technology, treatment technologies, manure utilization plans, land application management practices, record keeping, and sampling.
- **University of Illinois, College of Agriculture, Cooperative Extension Service, *60 Ways Farmers Can Protect Their Surface Water*** (http://www.thisland.uiuc.edu/60ways/60ways.html): This Web site provides information on managing livestock waste effectively.

2.1.4.4 Case Study

The Dairy Biologically Integrated Farming Systems (BIFS) Project: Integrating Forage Production with Dairy Manure Management in the San Joaquin Valley. In California's Central Valley, dairy manure has been identified as a source of nitrate that contributes to ground water pollution. The Dairy BIFS project encourages dairy farmers to manage manure as a valuable source of nutrients for forage crops used in the same dairy. This reduces environmental pollution while decreasing dairy production costs. Participating farmers have been able to drastically reduce, and in some cases, completely forgo, the application of synthetic nitrogen to their crops without affecting yield. Recent results indicate a substantial reduction in nitrogen, potassium, and phosphorus inputs without reductions in yield (http://dairybifs.uckac.edu/).

2.1.4.5 References

USDA. ND. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

USEPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington DC. (http://www.epa.gov/owow/nps/agmm/)

Fact Sheet Links:
- Programs
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- References

2.1.5 Management Measure 1C Nutrient Management

Management Measure

Develop, implement, and periodically update a nutrient management plan to (1) apply nutrients at rates necessary to achieve realistic crop yields, (2) improve the timing of nutrient application, and (3) use agronomic crop production technology to increase nutrient use efficiency. When the source of the nutrients is other than commercial fertilizer, determine the nutrient value and the rate of availability of the nutrients. Determine and credit the nitrogen contribution of any legume crop. Soil and plant tissue testing should be used routinely. Nutrient management plans contain the following core components:

1. Farm and field maps showing acreage, crops, soils, and water bodies.

2. Realistic yield expectations for the crop(s) to be grown, based primarily on the producer's yield history, State Land Grant University yield expectations for the soil series, or USDA NRCS Soils-5 information for the soil series.

3. A summary of the nutrient resources available to the producer, which at a minimum include (a) soil test results for pH, phosphorus, nitrogen, and potassium; (b) nutrient analysis of manure, sludge, mortality compost (birds, pigs, etc.), or effluent (if applicable); (c) nitrogen contribution to the soil from legumes grown in rotation (if applicable); and (d) other significant nutrient sources (e.g., irrigation water).

4. An evaluation of the field limitations based on environmental hazards or concerns such as (a) sinkholes, shallow soils over fractured bedrock, and soils with high leaching potential; (b) lands near surface water; (c) highly erodible soils; and (d) shallow aquifers.

5. Use of the limiting nutrient concept to establish a mix of nutrient sources and requirements for the crop based on realistic yield expectations.

6. Identification of timing and application methods for nutrients to: (a) provide nutrients at rates necessary to achieve realistic yields, (b) reduce losses to the environment, and (c) avoid applications as much as possible to frozen soil and during periods of leaching or runoff.

7. Provisions for the proper calibration and operation of nutrient application equipment.

8. Steps to ensure that when manure from confined animal facilities (excluding CAFOs) is to be used as a soil amendment or is disposed of on land, subsequent irrigation of the land does not leach excess nutrient to surface or ground waters.

2.1.5.1 Programs

- Pacific Northwest Collaborative Nutrient Management Education Program works to increase the ability of agricultural professionals to support landowners in sustainable nutrient management decisions that minimize negative impacts of nutrients on the environment and human health (http://wsare.usu.edu/projects/2002/EW00-011.pdf).

- University of California, Davis, Department of Animal Sciences offers assistance with planning and designing dairy waste management facilities and estimating the nutrient application rate of dairy manure (http://animalscience.ucdavis.edu/java/DairyWasteMgt/default.htm).

2.1.5.2 Management Practices

The purpose of this management measure is to reduce the nutrient loss from agricultural lands, which occurs through edge-of-field runoff or leaching from the root zone. The most effective way to manage nutrients is to develop a nutrient management plan (NMP) in accordance with USDA NRCS Standard 590. NMPs should be updated at least once every 5 years or once per crop rotation period. Records of nutrient use and sources should be maintained for easy reference. Components of an NMP include the following:

- Farm and field maps showing acreage, crops, soils, and water bodies.
- Realistic yield expectations for the crop(s) to be grown based primarily on the producer's yield history, State Land Grant University yield expectations for the soil series, or USDA NRCS Soils-5 information for the soil series.
- A summary of the nutrient resources available to the producer, which at a minimum include (a) soil test results for pH, phosphorus, nitrogen, and potassium; (b) nutrient analysis of manure, sludge, mortality compost (birds, pigs, etc.), or effluent (if applicable); (c) nitrogen contribution to the soil from legumes grown in rotation (if applicable); and (d) other significant nutrient sources (e.g., irrigation water).
- An evaluation of the field limitations based on environmental hazards or concerns such as (a) sinkholes, shallow soils over fractured bedrock, and soils with high leaching potential; (b) lands near surface water; (c) highly erodible soils; and (d) shallow aquifers.
- Use of the limiting nutrient concept to establish a mix of nutrient sources and requirements for the crop based on realistic yield expectations.
- Identification of timing and application methods for nutrients to (a) provide nutrients at rates necessary to achieve realistic yields, (b) reduce losses to the environment, and (c) avoid applications as much as possible to frozen soil and during periods of leaching or runoff.
- Provisions for the proper calibration and operation of nutrient application equipment.
- Provisions to ensure that, when manure from confined animal facilities (excluding CAFOs) is to be used as a soil amendment or is disposed of on land, subsequent irrigation of the land does not leach excess nutrient to surface or ground waters.

2.1.5.3 Information Resources

- **California Department of Food and Agriculture's Fertilizer Research and Education Program (FREP)** (http://www.cdfa.ca.gov/is/frep/index.htm): This program was created to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. FREP facilitates and coordinates research and demonstration projects by providing funding and developing and disseminating information. It funds research to develop information on crops, irrigation methods, and nitrate in the soil as well as other environmental issues related to fertilizer use, such as heavy metals.
- **University of California, Davis, Pomology Department, Nitrogen Fertilization Recommendation for Almond** (http://fruitsandnuts.ucdavis.edu/almond/html/almond_n_model.html): This model calculates the

nitrogen requirement for almond production based upon the yield history, current conditions, and previous nitrogen applications. This model can be used to calculate both timing and rate of fertilizer application required to maintain optimum yield. Site-specific information is required for accurate projection of nitrogen requirement; hence this model should be applied to each distinct management unit, such as a block or field. The data used in this model were derived from exhaustive tree-nitrogen budget determinations.

- **CORE4, Crop Nutrient Management** (http://www.ctic.purdue.edu/Core4/nutrient/nutrmgmt.html): This Web site provides information, links, and resources on crop nutrient management planning.
- **California Certified Crop Advisors** (http://www.cacca.org/): The California Certified Crop Advisors (CCA) can help producers grow economically and environmentally sound crops. The California CCA program is a voluntary certification program for individuals who provide advice to growers on crop management and inputs. Their Web site lists certified crop advisors for California. For more information contact the California CCA (Telephone: 916-928-1625).
- **USDA Draft Comprehensive Nutrient Management Planning Technical Guidance** (http://www.nrcs.usda.gov/programs/afo/cnmp_guide_index.html): USDA NRCS guide on comprehensive nutrient management planning.
- **Colorado Comprehensive Nutrient Management Plan Workbook** (http://www.colostate.edu/Depts/SoilCrop/extension/Soils/cnmp/): This Web site is designed to take livestock producers through the process of developing a comprehensive nutrient management plan, step-by-step. Livestock producers of all kinds including cattle-feeders, dairies, cow-calf operations, horse owners, and poultry and pork producers can use the Comprehensive Nutrient Management Plan Workbook.
- **Livestock and Poultry Curriculum, *Module A Introduction* and *Module D Land Application and Nutrient Management*** (http://www.lpes.org/les_plans.html): The Livestock and Poultry Curriculum is a national curriculum and supporting educational tools developed for U.S. livestock and poultry industry advisors and producers to help them acquire certification and achieve environmentally sustainable production systems. Modules A and D provide presentations and material on whole farm nutrient planning, manure utilization plans, land application management practices, phosphorus management, record keeping, and sampling.
- **National Agriculture Compliance Center, Crops** (http://www.epa.gov/agriculture/crops.html): This page provides information about environmental requirements specifically relating to the production of many types of agricultural crops, including food, feed, and fiber crops, and specialty crops, such as tobacco, herbs, spices, mushrooms, seed crops, and aquatic plants.
- **University of Illinois, College of Agriculture, Cooperative Extension Service, *60 Ways Farmers Can Protect Their Surface Water*** (http://www.thisland.uiuc.edu/60ways/60ways.html): This Web site includes information on managing nutrients effectively.
- **California Dairy Quality Assurance (CDQA) Program** (http://www.cdqa.org): This project assists dairy producers to comply with the regulations governing confined animal facilities by providing educational resources and funding in the areas of food safety, animal health and welfare, and environmental stewardship.

2.1.5.4 References

USDA. Nd. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

USEPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

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2.1.6 Management Measure 1D Pesticide Management

Management Measure

To reduce contamination of surface water and ground water from pesticides.

1. Evaluate the pest problems, previous pest control measures, and cropping history.

2. Evaluate the soil and physical characteristics of the site including mixing, loading, and storage areas for potential leaching or runoff of pesticides. If leaching or runoff is found to occur, steps should be taken to prevent further contamination.

3. Use integrated pest management (IPM) strategies that (a) apply pesticides only when an economic benefit to the producer will be achieved (i.e., applications based on economic thresholds), and (b) apply pesticides efficiently and at a time when runoff losses are unlikely.

4. When pesticides applications are necessary and a choice of registered materials exists, consider the persistence, toxicity, runoff potential, and leaching potential of products.

5. Periodically calibrate pesticide spray equipment.

6. Use anti-blackflow devices on hoses used for filling tank mixtures.

2.1.6.1 Programs

- The California *Pesticide Management Plan for Water Quality* is a joint effort by the Department of Pesticide Regulation (DPR) and the SWRCB to protect water quality from the potential adverse effects of pesticides. It describes how DPR and the County Agricultural Commissioners work in cooperation with the SWRCB and the Regional Water Quality Control Boards (RWQCBs) to protect water quality from the use of pesticides (http://www.cdc.gov/nasd/docs/d000901-d001000/d000990/d000990.html#ii).
- The Department of Pesticide Regulation's Surface Water Quality Program addresses both agricultural and nonagricultural sources of pesticide residues in surface waters. It has preventive and response components that reduce the presence of pesticides in surface waters. The preventive component includes local outreach to promote management practices that reduce pesticide runoff. Prevention also relies on DPR's registration process in which potential adverse effects on surface water quality, particularly those in high-risk situations, are evaluated. The response component includes mitigation options to meet water quality goals, recognizing the value of self-regulating efforts to reduce pesticides in surface water as well as the regulatory authorities of DPR, the SWRCB, and the RWQCBs (http://www.cdpr.ca.gov/docs/sw/).
- The Department of Pesticide Regulation's Ground Water Quality Program addresses both agricultural and nonagricultural sources of pesticide residues in ground waters. The DPR is proposing to revise the Ground Water Quality Program by changing the current ground water regulations. For more information go to http://www.cdpr.ca.gov/docs/gwp/.

- The Coalition for Urban/Rural Environmental Stewardship (CURES) has two programs to promote the environmental friendly use of pesticides. The Water Steward Orchard Program is designed to promote awareness of pesticide runoff from products used in dormant orchard sprays. The Water Steward Rice Program is a rice pesticide stewardship plan launched by CURES, the California Rice Commission, and a broad coalition of grower and industry interests. The purpose of this program is to raise awareness of rice pesticides and impacts on the drinking water quality of the Sacramento River (http://www.curesworks.org/).
- California Department of Pesticide Regulation, Pest Management Alliance (http://www.cdpr.ca.gov/docs/ipminov/ipmmenu.htm): This program provides support for agricultural, nonagricultural, and urban groups to develop and demonstrate pest management systems that reduce risks associated with pesticide use, including risks to surface and ground waters. The Web site has Alliance project evaluations, reports, and other technical information available for pest management systems in various commodities such as almonds, stone fruit, and strawberries.

2.1.6.2 Management Practices

The purpose of this management measure is to reduce or eliminate pesticide runoff into surface water. The most effective approach is to apply pesticides as prescribed on the label with respect to timing and rate of chemical application. The following practices should be considered to reduce the likelihood that pesticides will pollute surface and ground water.

- *Evaluate pest control needs*: Determine the extent of the pest problems, previous pest control measures, and cropping history. Consider using integrated pest management (IPM) to reduce the amount of chemicals needed to manage pest damage. See the University of California Statewide Integrated Pest Management Program (http://www.ipm.ucdavis.edu/). Pest management practices should be updated when crop rotation, pest problems, or type of pesticide used have changed.
- *Reduce the risk of accidental spills*: Know the physical and soil characteristics of the area and evaluate the site for runoff potential to surface water and leaching potential to ground water. Note the location and proximity of the mixing, loading, and storage areas relative to surface water. Use anti-backflow devices on hoses used for filling tank mixtures and on chemigation systems.
- *Maintain application equipment*: Calibrate application equipment once a season and inspect application equipment for wear and damage.
- *Follow the label*: Apply and use pesticides as prescribed on the label and at times when leaching and runoff are least likely (not just before a rainstorm).
- *Protect surface waters from spills and contaminated runoff:* Install perimeter controls such as vegetative buffers to help prevent pesticide runoff into streams.

2.1.6.3 Information Resources

- **University of California Statewide Integrated Pest Management Program** (http://www.ipm.ucdavis.edu/): The UC IPM Program Web site contains information for practitioners on how to identify and manage pests, including educational resources, databases, publications, projects, and other resources.
- **University of California Statewide Integrated Pest Management Program, Dormant Spray Alternatives Calculator** (http://www.ipm.ucdavis.edu/WATER/OPCALC/): This calculator estimates the costs of using organophosphate dormant sprays and selected alternative practices. When compared to conventional organophosphate dormant sprays, the alternatives listed in the

calculator offer favorable levels of pest control efficacy with comparable ranges of cost, while affording a reduced risk of aquatic toxicity.

- **The National Integrated Pest Management Network (NIPMN)** (http://www.reeusda.gov/agsys/nipmn/index.htm): NIPIMN is the result of a public-private partnership dedicated to making the latest and most accurate pest management information available on the World Wide Web. For projects and IPM techniques specific to the Western Region visit http://www.colostate.edu/Depts/IPM/index.html.
- **University of California Cooperative Extension Service, Pests of Agricultural Crops, Floriculture and Ornamental Nurseries, and Commercial Turfgrass, *University of California Pest Management Guidelines*** (http://www.ipm.ucdavis.edu/PMG/crops-agriculture.html): This handbook includes guidelines for pest management in California.
- **The Coalition for Urban/Rural Environmental Stewardship** (http://www.curesworks.org/): The Coalition for Urban/Rural Environmental Stewardship (CURES) was founded in 1997 to support educational efforts for agricultural and urban communities focusing on the proper and judicious use of pest control products.
- **CORE4, *Weed and Pest Management*** (http://www.ctic.purdue.edu/Core4/ipm/IPM.html): This Web site provides information and resources related to weed and pest management.
- **University of Illinois, College of Agriculture, Cooperative Extension Service, *50 Ways Farms Can Protect Their Groundwater*** (http://www.thisland.uiuc.edu/50ways/50ways.html): This Web site provides information on how to reduce contamination of ground water from fertilizers, herbicides, and insecticides; how to use integrated pest management; and how to improve chemical application.
- **University of Illinois, College of Agriculture, Cooperative Extension Service, *60 Ways Farmers Can Protect Their Surface Water*** (http://www.thisland.uiuc.edu/60ways/60ways.html): This Web site includes information on reducing insecticide and pesticide use, selecting appropriate pesticides, and handling pesticides safely and efficiently.
- **Florida Department of Agriculture and Consumer Services and Florida Department of Environmental Protection, *Best Management Practices for Agrichemical Handling and Farm Equipment Maintenance*** (http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/agbmp3p.pdf).

2.1.6.4 Case Studies

National Integrated Pest Management Network Success Story: Integrated Methods Keep Good Pears from Going Bad in Oregon. Oregon IPM researchers have developed a protocol for maintaining high-quality pears in storage for many months. This methodology comprises a variety of environmentally friendly techniques, unlike traditional programs that rely on fungicides (http://www.colostate.edu/Depts/IPM/index.html).

Central Coast Vineyard Team Exploring Reduced Pesticide Use. The Central Coast Vineyard Team (CCVT) is a community-based partnership of wine grape growers, wineries, University of California Cooperative Extension farm advisors, consultants, and the Department of Pesticide Regulation (DPR). Robert Mondavi Winery provided the leadership to create the team in 1995 to investigate ways to reduce pesticide use in the tri-county area. In 1996 the team received a grant from DPR to create California's first Positive Points System (PPS) for wine grapes. The PPS is being used to measure growers' environmental enhancement by evaluating their integrated farm management plans (http://www.vineyardteam.org/about/index.htm).

Almond Pest Management Alliance. The Almond Pest Management Alliance—with partners such as the Almond Hullers and Processors Association, the Community Alliance with Family Farmers, the University of California Statewide Integrated Pest Management Project, and University of California Cooperative Extension—is evaluating the possibility of reducing pesticide inputs in California almonds. Research began in 1998 when the California Department of Pesticide Regulation awarded its first grant to the Almond Pest Management Alliance. This effort was initiated because of two major concerns: The implementation of the federal Food Quality Protection Act, with the possible loss of some traditional crop protection tools, and growing public concern over water quality standards in the San Joaquin River and Sacramento River watersheds, with possible links to pesticides used by almond growers.

The evaluation consists of three regional projects to encompass the variability of the almond-growing area of California. Each project compares conventional treatment areas with reduced risk treatment areas using practices appropriate for local conditions. The fourth year of the Almond Pest Management Alliance has also demonstrated that (a) extensive orchard monitoring is the key to the success of this approach, (b) reduced risk practices appear to be controlling the pests below economic damage levels, (c) other pests may begin to build populations after spray programs are altered, and (d) growers are interested in reduced risk practices and continue to be proactive. As the Almond Pest Management Alliance entered its fifth year in mid-2002, its goals included involving more pest control advisors (PCAs) and growers in monitoring during the crop season and through the dormant season; implementing smaller, more frequent, more regionally based field meetings regarding reduced risk practices; creating guidelines or protocols for reduced risk pest management in almonds based on what has been learned in the Pest Management Alliance project, and using a continuing Pest Management Alliance as an umbrella sponsorship entity to continue IPM and related agricultural stewardship research (http://www.cdpr.ca.gov/docs/empm/alliance/00-01/00-0210S.pdf).

Lodi-Woodbridge Winegrape Commission (LWWC) Sustainable Viticulture Program. There are three parts to LWWC's Sustainable Viticulture Program: grower outreach, field implementation, and area-wide implementation. Grower outreach involves providing information to LWWC growers and PCAs about sustainable farming practices that are appropriate for use in their vineyards. This information is provided in a range of different ways briefly discussed below. The field implementation component involves working with a core group of 40 LWWC growers and about 15 PCAs in 60 different vineyards. Various sustainable farming practices are implemented in these vineyards so the growers and other LWWC members can see the effects of these practices. Area-wide implementation involves encouraging all LWWC members to become more active in implementing sustainable viticultural practices in their vineyards. The *Lodi Winegrower's Workbook* (http://www.lodiwine.com/winegrowersworkbook1.shtml) was written to help achieve area-wide implementation. More information about the Sustainable Viticulture Program can be found at http://www.lodiwine.com/viticultureprogram1.shtml.

2.1.6.5 References

USDA. Nd. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

USEPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

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2.1.7 Management Measure 1E Grazing Management

Management Measure

Protect range, pasture, and other grazing lands by

1. Implementing one or more of the following to protect sensitive areas (such as streambanks, wetlands, estuaries, ponds, lake shores, and riparian zones): (a) exclude livestock, (b) provide stream crossings or hardened access to watering areas, (c) provide alternative drinking water locations away from surface waters, (d) locate salt and additional shade, if needed, away from sensitive areas, or (e) use improved grazing management (e.g., herding) to reduce the physical disturbance and reduce direct loading of animal waste and sediment caused by livestock; and

2. Achieving either of the following on all range, pasture, and other grazing lands not addressed under (1) above: (a) implement the range and pasture components of a CMS as defined in the USDA NRCS *Field Office Technical Guide* by applying the progressive planning approach of the USDA NRCS to reduce erosion, or (b) maintain range, pasture, and other grazing lands in accordance with activity plans established by the Bureau of Land Management of the U.S. Department of the Interior or the USDA Forest Service or the California Rangeland Water Quality Management Plan.

2.1.7.1 Programs

- The California Board of Forestry's, California Rangeland Water Quality Management Plan is a voluntary plan developed by the California Cattlemen's Association, in collaboration with University of California Cooperative Extension and USDA NRCS. The plan was officially approved in 1995 and includes rangeland water quality management strategies, policy and coordination mechanisms, as well as sample plans and sources of assistance. The California Board of Forestry is responsible for administering the plan http://www.calcattlemen.org/CRWQMP.htm).
- The Bureau of Land Management (BLM) has begun implementing the standards for rangeland health and guidelines for livestock grazing that apply to public lands administered by BLM in central and northern California and northwestern Nevada (http://www.ca.blm.gov/caso/sg_8-99.html).
- The California Cattlemen's Association's Rangeland and Water Quality Web site provides access to the California Rangeland Water Quality Management Plan, which addresses both governmental policy and management strategies. The Grazing for Change booklet features nine California rancher's range and watershed management success stories. The ongoing Riparian Grazing Project serves as another useful tool for range managers (http://www.calcattlemen.org/rwq.htm).
- The California Grazing Academy is a unique and exciting program emphasizing practical application of controlled grazing principles to improve the environment and increase ranch profit. This challenging course consists of a minimum of lecture and a maximum of hands-on experience and learning (http://ceplacer.ucdavis.edu/Livestock/California_Grazing_Academy_-_Low-Stress_Livestock_Handling_School.htm).

- The California Department of Pesticide Regulation, Pest Management Alliance. DPR's Pest Management Alliance program provides funding support, when funds become available, to encourage increased implementation of biologically intensive, reduced-risk pest management. This program is designed to create a collaborative, interdisciplinary team that uses a systems approach—the assumption is that team members have already solved pest problems and other specialized components through applied research. The Alliance is part of a problem-solving continuum, taking the data collected from research and preparing for the next stage—education through demonstration, and ultimately implementation. An overview of the program is available at http://www.cdpr.ca.gov/docs/empm/alliance/overview.htm; project summaries since 1998 are available at http://www.cdpr.ca.gov/docs/empm/alliance/allisums.htm.

2.1.7.2 Management Practices

The purpose of this management measure is to protect sensitive areas in range, pasture, and other grazing lands. California-approved USDA NRCS standards required for a conservation management systems should be applied to the entire grazing area. These components include erosion control, adequate pasture stand density, and rangeland condition. Recommended practices include the following:

- Carefully plan the use of grazing areas by developing a ranch plan with the goal of improving or maintaining water quality. Use prescribed grazing techniques to manage the intensity, frequency, and duration of grazing.
- Prevent erosion from wind or water by maintaining enough vegetative cover.
- Keep animals out of surface waters: exclude animals, people, or vehicles to protect and maintain plant and water quality and prevent or minimize direct loading of animal waste and sediment into surface waters. Install alternative drinking sources to keep animals away from sensitive waters and install hardened access points so animals have access to drinking water sources. Use fences, hedgerows, moats, and other practices to keep animals away from sensitive areas and place salt and additional shade away from sensitive areas.
- Provide stream crossings to minimize impacts on stream habitat and water quality.
- Use structural range improvements, like access roads, grade stabilizers, sediment ponds, stalk trails or walkways, troughs and tanks, pipelines, and streambank protection.
- Use practices such as prescribed burning, range seeding, brush management, stream corridor improvement, wetland and upland wildlife management to manage vegetation, prevent erosion, and protect wildlife habitat.

2.1.7.3 Information Resources

- **USDA Forest Service, *Grazing Management Assessment*** (http://www.caltrout.org/comm/otherpubs/GMA2001.pdf): The California Native Plant Society and California Trout have conducted research on California's USDA Forest Service Grazing Management Program. This document includes a summary of some of the research projects.
- ***Grazing for Change, Range and Watershed Management Success Stories in California***. For information about ordering a copy of this booklet, contact the California Cattlemen's Association (Telephone: 916-444-0845; E-mail: staff@calcattlemen.org).
- **University of California, Davis, California Rangelands Research Information Center** (http://agronomy.ucdavis.edu/calrng/range1.htm): The purpose of this Web site is to develop

research and extension education initiatives and to foster collaboration between California rangeland researchers and educators.

- **University of California, Davis, Cooperative Extension, Controlled Grazing** (http://www.foothill.net/~ringram/gzoption.htm): This Web site provides information on controlled grazing, which is a flexible management method that balances plant and animal requirements.
- **USDA NRCS, Grazing Land Conservation Initiative** (http://www.nrcs.usda.gov/programs/glci/): The Grazing Land Conservation Initiative (GLCI) is a nationwide collaborative process of individuals and organizations working to maintain and improve the management, productivity, and health of the nation's privately owned grazing land. This process has formed coalitions that represent the grassroots concerns that impact private grazing land. The coalitions actively seek sources of funding to increase technical assistance and pursue public awareness activities that maintain or enhance grazing land resources.
- **Marin Coastal Watershed Enhancement Project, *Ranch Plan Workbook*** (http://www.sarep.ucdavis.edu/NEWSLTR/v8n3/sa-4.htm): The workbook includes a working copy of a ranch plan to assist with writing planned management practices, a fact sheet on management measures and practices by the Rangeland Watershed Program, and *Appropriate Animal Waste Guidelines*.
- **The USDA Forest Service's *Proposed Range Standards and Guidelines to Amend the Land and Resource Management Plans of the Tahoe and Eldorado National Forests*** (http://www.epa.gov/fedrgstr/EPA-IMPACT/1997/August/Day-13/i21345.htm):
- **Montana Department of Natural Resources and Conservation, *Best Management Practices for Grazing*** (http://www.homepage.montana.edu/~harries/): This Web site presents grazing management practices for a water quality demonstration project.
- **National Agriculture Compliance Center, Pasture, Grazing, and Rangeland Operations** (http://www.epa.gov/agriculture/anprgidx.html): This Web site provides information about environmental requirements specifically relating to livestock production in pastures and rangeland, as well as other grazing operations.

2.1.7.4 Case Study

The Sustainable Ranching Research and Education Project. The project is a long-term effort to improve the economic, environmental, and social sustainability of ranching (http://ceplacer.ucdavis.edu/livestock/publications/sustranchovervw.pdf).

The Morro Bay Watershed Project. Morro Bay, one of the few intact natural estuaries along California's coast, is being impaired primarily by sediment. Brushland, rangeland, and streambank erosion contribute the largest portion of sediment deposited in the bay. The Morro Bay Watershed project is evaluating the effectiveness of sediment-reducing management practices, such as the creation of smaller pastures, installation of cattle watering systems, stabilization and revegetation of streambanks, and installation of water bars and culverts on farm roads. At one of the watershed study sites, a 49 percent reduction in turbidity was documented. A suite of management practices, including improved grazing management, riparian fencing, and revegetation, was responsible for the reduction in turbidity. These practices have also proved to be effective in reducing bacteria levels in adjacent streams in the watershed (http://www.bae.ncsu.edu/programs/extension/wqg/section319/page1.htm).

2.1.7.5 References

USEPA. 2002. Chapter 4 Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

USDA. Nd. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

SWRCB. 1995. *California Rangeland Water Quality Management Plan*. State Water Resources Control Board, Division of Water Quality, NPS Program, Sacramento, CA.

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2.1.8 Management Measure 1F Irrigation Water Management

Management Measure

To reduce NPS pollution of surface and ground waters caused by irrigation.

1. Operate the irrigation system so that the timing and amount of irrigation water applied match crop water needs. This requires, as a minimum, (a) the accurate measurement of soil-water depletion volume and the volume of irrigation water applied, and (b) uniform application of water.

2. When chemigation is used, include backflow preventers for wells, minimize the harmful amounts of chemigation waters that discharge from the edge of the field, and control deep percolation. In cases where chemigation is performed with furrow irrigation systems, a tailwater management system may be needed.

2.1.8.1 Programs

- The California Department of Water Resources' California Irrigation Management Information System (CIMIS) helps agricultural growers and turf managers who administer parks, golf courses, and other landscapes to develop water budgets for determining when to irrigate and how much water to apply (http://www.cimis.water.ca.gov/).
- The Department of Water Resources' Agriculture Water Management Planning Program provides technical, financial, and administrative assistance to the Agricultural Water Management Council and to the water districts throughout the State to develop water management plans and to help implement cost-effective, efficient water management practices (http://www.owue.water.ca.gov/agmanage/index.cfm).
- AgLine Online, the Kings River Conservation District's AgLine information system, provides crop water use information for the Kings River service area. Information provided for each crop includes crop water use for the past 7 days, predicted water use for the next 7 days, and total crop water use for the season to date. The numbers are updated every Friday and can be used to assist growers in irrigation management decisions. AgLine includes crop water use data for 31 cropping cases (http://krcd.org/).
- Westland Water District's Water Conservation Cost-Share Programs continues to offer the Expanded Irrigation System Improvement Program (EISIP) to district water users and landowners. This program offers low interest rates to water users for the lease-purchase of irrigation system equipment funded by State Revolving Fund loans. The EISIP offers the opportunity to lease portable aluminum irrigation equipment and other improved irrigation systems, including microirrigation, linear move and center pivots, and tailwater reuse systems. The Agricultural Pumping Efficiency Program is available for all agricultural electric and natural gas utility accounts that are used for pumping water and paying the Public Goods Charge (customers of Pacific Gas and Electric Company, Southern California Edison Company, Southern California Gas Company, or San Diego Gas and Electric Company) (http://www.westlandswater.org/wtrcon/costshare.htm).

2.1.8.2 Management Practices

The purpose of this management measure is to reduce NPS pollution of surface and ground waters caused by irrigation. Irrigation water should be applied in a manner that ensures efficient use and distribution of the water and minimizes runoff and soil erosion. Recommended practices include the following:

- Determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner. This entails knowing the daily water use of the crop, the water-holding capacity of the soil, and the lower limit of soil moisture for each crop and soil. It is also important to measure the amount of water applied to the field.
- Controlling the manner and application of water to minimize water runoff and soil erosion. USDA NRCS-recommended irrigation systems include microirrigation, sprinklers, surface and subsurface systems, and tailwater recovery systems.
- Designing irrigation water transport systems to eliminate as much water loss as possible.
- Lining irrigation channels to prevent seepage to ground water.
- Using a pipeline and apparatus to convey water to the irrigation system.
- Using a structure that controls the rate and timing of water conveyed to the irrigation system.
- Installing storage reservoirs to keep water for irrigation.
- Managing the drainage water from the irrigation system to control deep percolation, to move tailwater to the reuse system, and to control erosion and adverse impacts on surface and ground waters.
- Using filter strips to capture sediment and pollutants running off fields.
- Use grassed waterways to capture and trap sediment entering receiving waters.
- When irrigation water is conveyed down slopes that increase the velocity, causing erosion, install erosion controls, such as drops, chutes, buried pipelines, or erosion-resistant ditch linings.
- When using a chemigation system, install backflow preventers on wells to minimize the harmful amounts of chemigation waters that discharge from the edge of the field and to control deep percolation. In cases where chemigation is performed with furrow irrigation systems, a tailwater management system may be needed.

2.1.8.3 Information Resources

- **Water Conservation Field Services Program, Demonstration of Innovative Technologies** (http://www.usbr.gov/uc/progact/waterconsv/wtr_demo.html): Area programs are supporting local demonstration of projects such as improved water measurement, use of automation and telemetry control, approaches to minimizing canal and ditch seepage, and on-farm irrigation management methods. Activities include (1) assist with research, evaluation, and demonstration; (2) sponsoring conservation demonstration projects and activities; and (3) coordinating financial assistance for joint projects and partnerships with other agencies.
- **The U.S. Bureau of Reclamation's National Irrigation Water Quality Program (NIWQP)** (http://www.usbr.gov/niwqp/): The NIWQP is an intra-departmental program that evaluates Department of the Interior irrigation projects, considers drainwater contamination and related impacts on endangered species and migratory birds, assesses legal responsibilities associated with environmental laws, and develops and implements alternatives for remediation.

- **The U.S. Bureau of Reclamation's *Managing Water on the Farm*** (http://www.usbr.gov/mp/watershare/resources/agriwater/index.cfm): This Web site provides basic information on three types of irrigation systems: gravity flow surface irrigation, pressurized sprinkler irrigation, and low-pressure micro irrigation.
- **WATERIGHT** (http://www.wateright.org/index.asp): The WATERIGHT site was developed by the Center for Irrigation Technology at California State University, Fresno, with significant support from the U.S. Bureau of Reclamation. WATERIGHT is designed to be a multifunction, educational resource for irrigation water management. The site is designed for three audiences: homeowners, commercial turf growers, and farmers.
- **University of California, Davis, Cooperative Extension Service, Irrigation Management** (http://lawr.ucdavis.edu/irrigation/index.htm): This program is dedicated to the study of irrigation problems and techniques. The Cooperative Extension Service develops and extends research based information that promotes environmentally sound agricultural practices and that improves the efficient utilization of California's valuable water resource.
- **USDA NRCS Irrigation Page** (http://www.wcc.nrcs.usda.gov/nrcsirrig/): This Web site provides links to water management models, irrigation components, facts, handbooks and manuals, training, and information sites.
- **University of California Cooperative Extension Service Water Management Series Publications** are available for purchase from the Cooperative Extension Service for $15 to $25. Titles include: Agricultural Salinity and Drainage, Drip Irrigation for Row Crops, Irrigation Pumping Plants, Microirrigation of Trees and Vines, Scheduling Irrigations: When and How Much Water to Apply, Surface Irrigation, and Surge Irrigation. The order form and links to brief descriptions of the publications can be found at http://lawr.ucdavis.edu/irrigation/manuals.htm.
- **The U.S. Bureau of Reclamation's *A Guidebook for Preparing Agricultural Water Conservation Plans: Achieving Effective Water Management*** (http://www.usbr.gov/pn/programs/wat/publications/guidemstr.pdf).
- **California Farm Water Coalition, *The Water Fact Book: California Agriculture and Its Use of Water*** (http://www.cfwc.com/factbook.html).
- **The Pacific Northwest Cooperative Agricultural Weather Network, *AgriMet Irrigation Guide*** (http://www.usbr.gov/pn/agrimet/irrigation.html).

2.1.8.4 Case Study

Water Use Efficiency Pilot Program 2001. The Yolo County Resource Conservation District undertook a 1-year pilot program funded by the CALFED Water Use Efficiency Program from December 2000 through December 2001. The District was selected for this pilot program because of its history as an innovator in on-farm water quality improvement techniques, especially those employing native perennial grasses, wetland plants, shrubs, and trees.

The District's intent in taking on the pilot program was to initiate a more rigorous analysis of the assumed water quality benefits of practices it has long promoted: especially those of tailwater ponds, sediment traps and winter cover cropping. The actual water quality improvements associated with those conservation techniques had never been rigorously quantified. In light of the changing regulatory climate regarding farm runoff water quality, the information gathered may prove particularly useful for (a) informing regulators of acceptable and measurable water conservation techniques that can be used to meet their goals, and (b) informing farmers and water managers of proven tools that they can employ in their desire to best manage the water under their control.

The District works closely with local farmers and agricultural industry and is familiar with the stresses and realities of agricultural operations and the families who run them. The District is committed to exploring and promoting means of voluntary compliance without direct regulation to enable farmers to continue their business while properly managing public resources such as air, water, and wildlife.

Under this pilot program, tailwater ponds and sediment traps clearly served their function as devices that entrain sediment, especially when properly designed and maintained. Most of the traps and ponds studied provided some nutrient capture during the initial irrigations as well, although that aspect of their function requires further study.

The winter cover crop study also demonstrated both runoff flow attenuation and sediment reduction. Further study of the degree of success relative to planting date (likely the earlier, the better) and cover crop growth stage would help to gauge the most effective application of this technique.

Water use efficiency is compelling for farmers at the very least because of a potential decrease in pumping costs.

Although the District considers the information gathered through the pilot program to be useful to CALFED in its aim to promote locally led, on-farm water use efficiency programs, the pilot program has also provided an excellent opportunity for the District to refine its on-farm monitoring program and understanding of potential collaboration to promote water use efficiency in Yolo County.

Yolo County Resource Conservation District, Water Quality and Irrigation Ecosystem Management Project. The overall objective of this grant-funded program was to address both natural resources and stakeholders within the practical realities of farming, water delivery, and county road safety and maintenance. Funded by the SWRCB, with support from RWQCB 5, this project offered an integrated management approach that combined volunteer landowners and agency participation in a working partnership involving innovative practices. Applying these coordinated practices, the Yolo County Resource Conservation District (RCD) worked to improve water quality and biodiversity by targeting and installing tailwater retention basins as well as canal, roadside, and riparian vegetation systems.

Working in the Willow Slough watershed, the Yolo County RDC found that water problems are interrelated and circular. Contaminated with pesticides, sediment, and nutrients, agricultural tailwater runs freely through a degraded biological system where canals, creeks, and roadsides double as agricultural drains. The task was to find and demonstrate farm-friendly, cost-effective, and practical solutions.

This program implemented a set of structural and vegetative solutions in 1995-97, including five vegetated tailwater retention basins, 1 mile of vegetated canal bank, 1 mile of vegetated roadside, and one-quarter mile of riparian revegetation on a local slough. To extend these projects beyond the grant period, RCD staff provided training to local irrigation district canal tenders, farmers, and county road crews to install and maintain these restored areas in the future. (http://www.yolorcd.org/programs/irrigation_ecosystem/irrigatesys.shtml)

2.1.8.5 References

USDA. Nd. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

USEPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

Fact Sheet Links:
➔ Programs
➔ Management Practices
➔ Information Resources
➔ Case Studies
➔ References

2.1.9 Management Measure 1G Education and Outreach

Management Measure

Implement educational programs to provide greater understanding of watersheds, and to raise awareness and increase the use of applicable agricultural management measures and practices where needed to control and prevent adverse impacts on surface and ground waters. Public education, outreach, and training programs should involve user groups and the community.

2.1.9.1 Programs

- The California Grazing Academy is a unique and exciting program emphasizing practical application of controlled grazing principles to improve the environment and increase ranch profit. This challenging course consists of a minimum of lecture and a maximum of hands-on experience and learning (http://ceplacer.ucdavis.edu/Livestock/California_Grazing_Academy_-_Low-Stress_Livestock_Handling_School.htm).
- The Pacific Northwest Collaborative Nutrient Management Education Program has as its goal to increase the ability of agricultural professionals to support landowners in sustainable nutrient management decisions that minimize negative impacts of nutrients on the environment and human health (http://wsare.usu.edu/projects/2002/EW00-011.pdf).
- The Code of Sustainable Wine Growing Practices project organizes information workshops and distributes workbooks to all workshop attendees at no charge. The Wine Institute and the California Association of Winegrape Growers are working with California regional wine associations, vintners, and growers to organize and carry out workshops in each winegrowing region in the State. Regional associations or individual vintner and grower companies or both can host these workshops (http://www.wineinstitute.org/communications/SustainablePractices/workshops.htm).
- The University of California Sustainable Agriculture Research and Education Program is a statewide program administered by the university's Agriculture and Natural Resources Department. It has three mandates: administer competitive grants for research on sustainable agriculture practices and systems, develop and distribute information through publications and on-farm demonstrations, and support long-term research in sustainable farming systems on University of California farmlands (http://www.sarep.ucdavis.edu/grants).
- Yolo County Total Resource Management/Model Farm Program (http://www.yolorcd.org/programs/trm_model_farms/modelfarm.shtml): Through a challenge grant from the U.S. Bureau of Reclamation, the Yolo County Resource Conservation District along with four other conservation districts and the California Association of Resource Conservation Districts worked with regional experts and six local growers to determine what form and impact Total Resource Management can have on Yolo County farms. The District selected its cooperators to represent a diversity of cropping systems and geographical locations within the county, including foothill rangelands, an organic walnut orchard, and high-production field and row crops. In October 2000 the District completed the 6-year project.

2.1.9.2 Management Practices

The purpose of this management measure is to implement educational programs to provide greater understanding of watersheds, and to raise awareness and increase the use of applicable agricultural standards and practices to control and prevent adverse impacts on surface and ground waters. Educational materials on agricultural NPS pollution and pollution prevention programs should be developed for the following:

- Activities that cause erosion and sediment loss and the practices that control erosion and sediment on agricultural lands.
- Activities that cause animal waste discharges from storage structures at confined animal facilities and appropriate application of nutrients to cropland.
- Activities that cause excess nutrient runoff into surface water or nutrient leaching into ground water and the measures that can control and prevent runoff.
- Prevention of pesticide runoff into surface water and pesticide leaching into ground water.
- Grazing activities that cause physical disturbance in sensitive areas and the discharge of sediment, animal waste, nutrients, and chemicals to surface and ground waters.
- Irrigation activities that cause NPS pollution of surface waters.

Public education and outreach programs should be developed at the appropriate level for the stakeholder group or audience it is designed to reach, using the following methods to educate and disseminate information to the specified audience:

- Use training programs to teach proper application of agriculture management practices.
- Establish bulletin boards for environmental messages and idea sharing.
- Hand out fact sheets, flyers, and pamphlets on controlling agricultural NPS pollution.
- Develop a handbook for local or regional producers and growers with recommended practices and standards to meet the requirements of the management measures.
- Organize meetings with local stakeholders.
- Develop an “Ag Center” or “one-stop shop” for farmers, growers, and producers to obtain information on NPS pollution prevention techniques, technologies, information resources, and idea exchange.
- Make available a directory of farm advisors, crop advisors, and nutrient management planners for producers and growers to contact for technical advice.
- Work with the local extension service offices and USDA NRCS offices to establish certification and continuing education programs in comprehensive nutrient management planning, grazing, irrigation, and pesticide management.

2.1.9.3 Information Resources

- **California Department of Pesticide Regulation, Pest Management Alliance** (http://www.cdpr.ca.gov/docs/empm/alliance/pmagrnts.htm): California DPR’s Pest Management Alliance program Web site provides links to past and ongoing projects that were completed under

the Pest Management Alliance Program. The program provides funding support to encourage increased implementation of biologically intensive, reduced-risk pest management, and several successful projects are under way that can serve as examples for future pest management projects and innovations.

- **The University of California Sustainable Agriculture Research and Education Program** (http://www.sarep.ucdavis.edu/): The Sustainable Agriculture Research and Education Program is a statewide program administered by the university's Agriculture and Natural Resources Department. Its Web site contains newsletters, publications, news releases and other media, educational programs, and funding opportunities related to such topics as crop and livestock production, biologically integrated farming systems (BIFS), organic farming, and local food systems.
- **The University of California Cooperative Extension Service** (http://ucanr.org/CES.CEA.shtml): The UC Cooperative Extension Service Web site offers information about food and nutrition, farming, pest control, natural resources, animal agriculture, gardening, and many other topics. Its publications page contains a variety of practical, research-based educational media such as publications, videos, slide presentations, interactive distance learning, audio recordings, and electronic multimedia. *California Agriculture*, the UC Agriculture and Natural Resources quarterly magazine, can also be accessed here.
- **The Coalition for Urban/Rural Environmental Stewardship (CURES)** (http://www.curesworks.org/): The Coalition for Urban/Rural Environmental Stewardship was founded in 1997 to support educational efforts for agricultural and urban communities focusing on the proper and judicious use of pest control products. The publications available from the CURES Web site include information on application stewardship, farm worker safety, ground application timing, and water quality protection.
- **Missouri Department of Natural Resources, Environmental Assistance Office (EAO)** (http://www.dnr.state.mo.us/oac/ag.htm): The Agricultural Assistance Unit within EAO assists farmers and agriculture-related businesses with their environmental needs. Much of that assistance includes guidance for environmental permits, natural resource stewardship, third-party site environmental assessments, and referrals as appropriate.
- **Louisiana State University, Ag Center** (http://www.lsuagcenter.com/subjects/masterfarmer/): The Master Farmer Program is an effort to demonstrate that agricultural producers can voluntarily reduce the impact that agricultural production has on Louisiana's environment. The Master Farmer Program has three components: environmental stewardship, agricultural production, and farm management/marketing.

2.1.9.4 Case Study

Monterey Bay National Marine Sanctuary. The Agriculture and Rural Lands Action Plan was developed in 1999 to address agricultural water quality issues related to the sanctuary such as erosion control, nutrient runoff, and persistent pesticides. The plan had several components, including an agriculture industry network, technical information and outreach, education and public relations, regulatory coordination and streamlining, funding mechanisms and incentives, and public lands and rural roads. The technical information and outreach and the education and public relations sections of the plan are as follows:

Technical Information and Outreach: Although extensive technical information exists on agricultural techniques and tools to improve water quality, this information is not always readily available or easily usable for growers and ranchers who have many other facets of their business to attend to. The general

intent of the strategies in this section of the plan is to make this information more accessible and useful through increased support for existing technical outreach services, development of networks, cross-training of outreach staff, packaging of easily understood information, and conducting onsite follow-up with workshop participants. Recent accomplishments and activities:

- The California NRCS has hired new technical staff for the sanctuary watershed region, including an agronomist, a water quality specialist and a rural roads engineer. Their work includes conducting technical workshops and providing technical assistance for site-specific concerns.
- Partners have begun a compilation of existing technical outreach materials to identify information gaps.
- University of California Cooperative Extension is researching the costs of common conservation measures in order to demonstrate the costs and benefits involved for landowners.
- Partners are working on the development and promotion of self-monitoring tools so that landowners can track changes over time.

Education and Public Relations: There is a need for improved education of the public about agricultural conservation issues, and of public and agricultural groups about watershed issues as a whole. The intent of the strategies in this section of the plan is to enhance public, grower, government agency, and media knowledge about watershed issues, and develop a better recognition and expansion of conservation practices that the agricultural community employs. Accurate, readily understandable information shared among these interest groups should serve as a basis for productive partnerships.

The following are recent accomplishments and activities:

- Regular media columns highlighting watershed issues and agricultural conservation efforts are being developed for local and regional newspapers and journals.
- A marketing firm has been hired to encourage farmer participation and public support for implementation of the plan.
- A Web site is being developed for use by multi-agency field staff, growers, and the public.

(http://www.mbnms.nos.noaa.gov/resourcepro/ag.html)

2.2 Forestry

Forestry Category Links:

- Preharvest Planning
- Streamside Management Areas
- Road Construction/ Reconstruction
- Road Management
- Timber Harvesting
- Site Preparation and Forest Regeneration
- Fire Management
- Revegetation of Disturbed Areas
- Forest Chemical Management
- Wetlands Forest Management
- Postharvest Evaluation
- Education/Outreach

2.2.1 Introduction

The California State Water Resources Control Board (SWRCB), California Coastal Commission (CCC), and other State agencies have identified 12 management measures to address various phases of forestry operations relevant to controlling nonpoint sources of pollution that affect State waters. The forestry management measures are for the most part a system of practices used and recommended by the Board of Forestry and Department of Forestry and Fire Protection in rules or guidance. Associated with each management measure are management practices that are designed to reduce the quantities of pollutants entering receiving waters. Forestry management practices are harvest and engineering techniques that help reduce nonpoint source (NPS pollution). Those who own and harvest the land are responsible for implementation of the management measures and management practices to minimize water quality impairment. Management practices that protect water quality are required by the California Forest Practice Rules. Many rules are specific to the regions or counties where forest management occurs. A registered professional forester can be of great assistance in navigating local regulations and developing a timber harvest plan. A fact sheet has been prepared for each management measure to inform readers of the programs, resources, and case studies specific to California and the management measure.

Silviculture contributes approximately 3 to 9 percent of NPS pollution to the nation's waters. This figure can be higher in some watersheds where silviculture is a major economic activity. Without adequate controls, forestry operations may degrade the characteristics of waters that receive drainage from forestlands. For example, sediment concentrations can increase because of accelerated erosion, water temperatures can increase because of removal of overstory riparian shade, dissolved oxygen can be depleted because of the accumulation of slash and other organic debris, and concentrations of organic and inorganic chemicals can increase because of harvesting and fertilizers and pesticides.

The NPS pollutant of greatest concern with respect to forestry activities is sediment. The potential for sediment delivery to streams from almost all timber-harvesting activities and from forest roads regardless of their level of use or age is a long-term concern. Other pollutants of significance, including nutrients, toxic chemicals and metals, organic matter, pathogens, herbicides, and pesticides, are also of concern; problems associated with these other pollutants and increases in temperature generally do not extend beyond 2 years from the time of harvest or are associated with a specific activity, such as an herbicide application. Nevertheless, all of these pollutants have the potential to affect water quality and aquatic habitat. Minimizing their delivery to surface water and ground water deserves serious consideration before and during forestry activities. Forest harvesting can also affect the hydrology of a watershed, and hydrologic alterations within a watershed have the potential to degrade water quality and adversely affect wetlands.

The California *Management Measures for Polluted Runoff* defines the 12 forestry management measures as follows:

- **2A. Preharvest Planning.** Pursuant to Management Measure 2A, silvicultural activities should be planned to reduce potential delivery of pollutants to surface waters. Components of Management Measure 2A address aspects of forestry operations, including the timing, location, and design of harvesting and road construction; site preparation; identification of sensitive or high-erosion risk areas; and the potential for cumulative water quality impacts.
- **2B. Streamside Management Areas (SMAs)**. SMAs protect against soil disturbance and reduce sediment and nutrient delivery to waters from upland activities. Management Measure 2B is intended to safeguard vegetated buffer areas along surface waters to protect the water quality of adjacent streams.
- **2C. Road Construction/Reconstruction.** Pursuant to Management Measure 2C, road construction/reconstruction should be conducted so as to reduce sediment generation and delivery. This can be accomplished by, among other means, following preharvest plan layouts and designs for road systems, incorporating adequate drainage structures, properly installing stream crossings, avoiding road construction in SMAs, removing debris from streams, and stabilizing areas of disturbed soil such as road fills.
- **2D. Road Management.** Management Measure 2D describes how to manage roads to prevent sedimentation, minimize erosion, maintain stability, and reduce the risk that drainage structures and stream crossings will fail or become less effective. Components of this measure include inspections and maintenance actions to prevent erosion of road surfaces and to ensure the effectiveness of stream-crossing structures. They also address appropriate methods for closing roads that are no longer in use.
- **2E. Timber Harvesting.** Management Measure 2E addresses skid trail location and drainage, management of debris and petroleum, and proper harvesting in SMAs. Timber harvesting practices that protect water quality and soil productivity also have economic benefits by reducing the length of roads and skid trails, reducing equipment and road maintenance costs, and providing better road protection.
- **2F. Site Preparation and Forest Regeneration.** Impacts of mechanical site preparation and regeneration operations—particularly in areas that have steep slopes or highly erodible soils, or where the site is located in close proximity to a water body—can be reduced by confining runoff onsite. Management Measure 2F addresses keeping slash material out of drainageways, operating machinery on contours, timing of activities, and protecting ground cover in ephemeral drainage areas and SMAs. Careful regeneration of harvested forestlands is important in protecting water quality from disturbed soils.
- **2G. Fire Management.** Prescribed fire practices for site preparation and methods to suppress wildfires should, as feasible, be conducted in a manner that limits loss of soil organic matter and litter and that reduces the potential for runoff and erosion. Prescribed fires that remove forest litter down to mineral soil on steep slopes or adjacent to streams are most likely to affect water quality.
- **2H. Revegetation of Disturbed Areas.** Management Measure 2H addresses the rapid revegetation of areas disturbed during timber harvesting and road construction—particularly areas within harvest units or road systems where mineral soil is exposed or agitated (e.g., road cuts, fill slopes, landing surfaces, cable corridors, or skid trails) with special priority for SMAs and steep slopes near drainageways.
- **2I. Forest Chemical Management.** Application of pesticides, fertilizers, and other chemicals used in forest management should not lead to surface water contamination. Pesticides must be properly mixed, transported, loaded, and applied, and their containers disposed of properly.

Fertilizers must also be properly handled and applied since they also may be toxic depending on concentration and exposure. Components of Management Measure 2I include applications by skilled workers according to label instructions, careful prescription of the type and amount of chemical to be applied, use of buffer areas for surface waters to prevent direct application or deposition, and spill contingency planning.

- **2J. Wetlands Forest Management.** Forested wetlands provide many beneficial water quality functions and provide habitat for aquatic life. Activities in wetland forests should be conducted to protect the aquatic functions of forested wetlands.
- **2K. Postharvest Evaluation.** The goals of Management Measure 2K are to incorporate postharvest monitoring, including (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.
- **2L. Education/Outreach.** The goals of Management Measure 2L are to implement pollution prevention and education programs to reduce NPS pollutants generated by applicable silvicultural activities.

2.2.2 General Resources

There are several federal and State agencies and programs that can provide general information to promote sustainable forestry practices and prevent NPS pollution from entering receiving waters. The agencies and programs listed below can provide assistance and information for all 12 management measures. Resources specific to each of the forestry management measures can be found on the corresponding fact sheet.

- **Contact a Forest Advisor** to help with understanding local regulations and developing a timber management plan (http://www.fire.ca.gov/ResourceManagement/PDF/ForestAdvisorList.pdf).
- **California Forest Stewardship Program** (http://ceres.ca.gov/foreststeward/index.html): This program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners.
- **Forest Stewardship Helpline** (Telephone: 1-800-738-TREE)**:** This helpline can answer questions and provide referrals on any forest-related topic.
- **California Forest Improvement Program** (http://www.fire.ca.gov/ResourceManagement/CFIP.asp): The purpose of the California Forest Improvement Program (CFIP) program is to encourage private and public investment in, and improved management of, California's forestlands and resources. This focus is to ensure adequate high-quality timber supplies; related employment and other economic benefits; and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations. For more information, download the **California Forest Improvement Program, *Users Guide*** (http://www.ceres.ca.gov/foreststeward/html/CFIP.html#Anchor-Download-18066).
- **California Department of Forestry and Fire Protection's Fire and Resource Assessment Program (FRAP)** (http://frap.cdf.ca.gov/index.htm): FRAP assesses the amount and extent of California's forests and rangelands, analyzes their conditions, and identifies alternative management and policy guidelines.

- **USDA NRCS *National Forestry Handbook* and *National Forestry Manual*** (http://www.nrcs.usda.gov/technical/ECS/forest/): The handbook and manual provide information for USDA NRCS personnel on forest planning and harvesting on nonpublic lands. The manual has information on the USDA NRCS Forest Policy.
- **North Coast Regional Water Quality Control Board (RWQCB)** (http://www.swrcb.ca.gov/rwqcb1/programs/timber.html): The North Coast RWQCB has been active in regulating discharges from logging, construction, and associated activities since 1972. Implementation of the Forest Practice Rules, which affect timber harvesting near streams, has a direct influence on water quality throughout the North Coast Region. The RWQCB staff perform regulatory activities including pre- and post-harvest inspections, watershed analysis, stream monitoring, and TMDL development.
- **California Department of Fish and Game** (http://www.dfg.ca.gov/habitats/private.html): The Department of Fish and Game provides information and recommendations to private landowners on programs and activities for the protection, management, and enhancement of native wildlife, fish, plants, and habitats. A variety of programs and partnerships between the State and private landowners are available. These initiatives could include timber management in the context of improving wildlife habitat.
- **USDA Forest Service** (http://www.fireplan.gov/content/activity_in_your_state/?StateID=5&LanguageID=1): The USDA Forest Service is working toward goals of the National Fire Plan to put information, materials, and funds in the hands of local organizations and communities. The State Fire Assistance program, with $3.6 million for California, helps build an optimal level of state firefighting capability, supports training and equipment for state firefighters, funds hazard mitigation projects on state and local land, and promotes Firewise training so homeowners can create defensible space and reduce fire risk around their homes and in their communities.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.2.3 Management Measure 2A Preharvest Planning

Management Measure

1. Perform advance planning for forest harvesting that includes the following elements where appropriate:

Element 1. Identify (a) the area to be harvested including the location of water bodies and sensitive areas such as wetlands, threatened or endangered aquatic species habitat areas, or high-erosion-hazard areas (landslide-prone areas) within the harvest unit; and (b) the hydrologic unit where the project is located and the water bodies that the project is tributary to.

Element 2. Time the activity for the season or moisture conditions to avoid degradation of water quality and prevent impacts on beneficial uses. Avoid any activities that cause soil disturbance or discharge from road surfaces during wet weather, except emergency maintenance work.

Element 3. Consider potential water quality impacts and erosion and sedimentation control in the selection of silviculture and regeneration systems, especially for harvesting and site preparation.

Element 4. Reduce the risk of landslides and severe erosion by identifying high-erosion-hazard areas and avoiding timber operations where they may exacerbate risk.

Element 5. Consider cumulative effects from timber operations or roads on any known existing water quality impairments or problems in watersheds.

2. Perform advance planning for forest road systems that includes the following elements where appropriate:

Element 1. Locate and design road systems to minimize potential sediment generation and delivery to surface waters. Key activities are (a) locate roads, landings, and skid trails to avoid steep grades and steep or unstable hillslope areas, and to decrease the number of stream crossings; (b) avoid to the extent practicable locating new roads and landings in Streamside Management Areas (SMAs); and (c) determine road usage and select the appropriate road standard.

Element 2. Locate and design temporary and permanent stream crossings to prevent failure and control impacts from the road system. Key activities are (a) size, design, and site crossing structures to prevent failure and minimize diversion potential; and (b) design crossings to facilitate fish passage in fish-bearing streams.

Element 3. Ensure that the design of the road prism and the road surface drainage is appropriate to the terrain and that road surface design is consistent with the road drainage structures.

Element 4. Use suitable materials for surface roads planned for all-weather use to support truck traffic.

Element 5. Design road systems to avoid high erosion or landslide hazard areas. Identify these areas and consult a qualified specialist for the design of any roads that must be constructed in these areas.

2.2.3.1 Programs

The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever. The Timber Harvesting Plan (THP) is the blueprint submitted by a landowner to CDF outlining what timber they want to harvest, how it will be harvested, and the steps that will be taken to prevent damage to the environment. CDF reviews and approves THPs (http://www.fire.ca.gov/ResourceManagement/THinCA.asp).

2.2.3.2 Management Practices

A Timber Harvest Plan must be prepared and submitted to the regional CDF director before timber is harvested for commercial purposes. A Registered Professional Forester (RPF) usually prepares a THP. The RPF preparing the plan will submit to the Director, with the plan, a Notice of Intent to Harvest Timber (Notice of Intent) under a number of circumstances where the timber harvest could have an effect on neighboring property or downstream water bodies (CDF, 2003, Article 2 and sections 1032-1037 of the California Forest Practice Rules). In addition to a Notice of Intent, a Cumulative Watershed Effects (CWE) analysis is now required as part of THPs in California. In evaluating cumulative impacts, the RPF considers factors such as the watershed(s) in which the site is located; soil productivity; biological, recreational, and visual resources; and traffic. Specific watershed factors to be addressed are sediment, water temperature, organic debris, chemical contamination, and peak flow. The CDF, as lead agency, makes the final determination regarding assessment sufficiency and the presence or absence of significant cumulative impacts. This determination is based on a review of all sources of information provided and developed during review of the THP (CDF, 2003).

There are numerous factors that should be considered when developing THPs and CWEs, but in general a thorough evaluation of the site should identify areas that require special protection, such as land adjacent to watercourses, steep slopes with high erosion potential, natural springs, wetlands, and areas that could provide habitat for endangered species. Site features to be protected and other considerations for developing THPs and CWEs are outlined in detail in USEPA's draft *National Management Measures to Control Nonpoint Source Pollution From Forestry* (USEPA, 2002), which can be downloaded in PDF format from http://www.epa.gov/owow/nps/forestrymgmt/ (see Chapter 3, Section 3A Preharvest Planning).

2.2.3.3 Information Resources

- **California Licensed Foresters Association** (http://www.clfa.org/what_is_a_registered_professiona.htm): This Web site has information about contacting professional foresters.
- **California Forest Practice Act** (http://www.fire.ca.gov/ResourceManagement/pdf/2000RULE198254.pdf): The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever.
- ***California Forest Practice Rules*** (http://www.fire.ca.gov/ResourceManagement/pdf/FPR200301.pdf): The purpose of the Forest Practice Rules is to implement the provisions of the Forest Practice Act of 1973. The rules ensure that forestry practices are consistent with environmental quality programs in the State.

- **California Department of Forestry and Fire Protection, *CDF's Role in Timber Harvesting*** (http://www.fire.ca.gov/ResourceManagement/pdf/CDFSROLE2002.pdf): This fact sheet describes CDF's role in timber harvesting, and the review and approval of Timber Harvest Plans.
- **FishXing Web site** (http://www.stream.fs.fed.us/fishxing/index.html): This Web site provides software and learning systems for calculating fish passage through culverts (USEPA, 2002).
- **The USDA Forest Service's Roads Analysis Procedure** (http://www.fs.fed.us/r6/columbia/roads_analysis/roads_analysis_process_handbook.pdf#xml): This procedure is designed to help national forest managers bring their road systems into balance with current social, economic, and environmental needs (USDA Forest Service, 1999). Roads Analysis uses a six-step procedure with a set of analytical questions to be used in tailoring analysis techniques to individual situations. Roads analysis is primarily a stand-alone procedure, but the conceptual framework and resources for analysis may be readily integrated into any analytical process in which the roads are examined.

2.2.3.4 Case Study

The Casper Creek Experimental Watershed Study. This watershed study on the Jackson Demonstration State Forest near Fort Bragg, California, is a cooperative venture of the Redwood Sciences Laboratory and the California Department of Forestry and Fire Protection. The study has been conducted continuously since 1962. The research focus is on learning more about how watersheds respond to logging. Research data on hydrology and sedimentation are available on the laboratory's Web site (http://www.rsl.psw.fs.fed.us/projects/water/caspar.html).

2.2.3.5 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USDA Forest Service. 1999. *Roads Analysis: Informing Decisions About Managing the National Forest Transportation System*. Miscellaneous Report FS-643. USDA Forest Service, Washington, DC.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.2.4 Management Measure 2B Streamside Management Areas

Management Measure

1. Establish and maintain a Streamside Management Area (SMA) along surface waters that is sufficiently wide and includes a sufficient number of canopy species to serve as a buffer against detrimental changes in the temperature regime of the water body, to provide bank stability, and to withstand wind damage.

2. Manage the SMA, including flood-prone areas, in such a way as to protect against soil disturbance in the SMA and delivery to the stream of sediments and nutrients generated by forestry activities, including harvesting.

3. Manage the SMA canopy species to provide a sustainable source of large woody debris needed for instream channel structure and aquatic species habitat.

2.2.4.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of all of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

Although SMAs can protect water quality, leaving timber for an SMA results in less timber harvested from the stand. Dykstra and Froehlich (1976) calculated that, in an Oregon timber sale, leaving an SMA 55 feet wide resulted in a 0 to 6 percent timber volume forgone per million board feet of timber. Likewise an SMA 150 feet wide resulted in 6 to 17 percent timber volume forgone.

2.2.4.2 Management Practices

Under the California Forest Practice Rules, SMAs are called Watercourse and Lake Protection Zones (WLPZs). A Registered Professional Forester (RPF) preparing the Timber Harvest Plan (THP) should conduct a field examination of all lakes and watercourses and map all lakes and watercourses that occur in the vicinity of the planned harvest.

The following are general practices that can be used to establish SMAs:

- *Evaluate sensitive conditions:* Evaluate areas near, and areas with the potential to directly impact, watercourses and lakes for sensitive conditions including existing and proposed roads, skid trails and landings, unstable and erodible watercourse banks, unstable upslope areas, debris, jam potential, inadequate flow capacity, changeable channels, overflow channels, flood prone areas, and riparian zones.

- *Spawning/rearing habitat:* Map the location of spawning and rearing habitat for anadromous salmonids, and evaluate the condition of the habitat using habitat typing that, at a minimum, identifies the pool, flatwater, and riffle percentages.
- *Establish a Watercourse and Lake Protection Zone:* Determine the required width of the WLPZ according to the guidelines in California Forest Practice Rules. WLPZs vary between 50 and 150 feet depending on the steepness of the terrain and the class of the watercourse the WLPZ is designed to protect.
    - *Protect vegetation in the WLPZ:* Within the WLPZ, retain at least 75 percent surface cover and undisturbed area to act as a filter strip, for raindrop energy dissipation, and for wildlife habitat. Mark trees in WLPZs before other preharvest activities begin to ensure retention of the shade canopy filter strip properties of the WLPZ and the maintenance of a multi-storied stand to protect water quality values. Provide for future large woody debris for instream habitat by retaining at least two living conifers per acre at least 16 inches diameter breast high and 50 feet tall within 50 feet of perennial streams.
    - *Protect soils in WLPZs to prevent erosion:* Treat exposed mineral soil in the WLPZ adjacent to perennial streams with mulch, riprap, grass seed, or chemical soil stabilizers to reduce soil loss. This does not apply to the traveled surface of roads. Where necessary to protect beneficial uses of water from timber operations, use protection measures such as seeding, mulching, or replanting to retain and improve the natural ability of the ground cover within the standard width of the WLPZ to filter sediment, minimize soil erosion, and stabilize banks of watercourses and lakes.
- *Establish an Equipment Limitation Zone*: Where operations occur adjacent to certain watercourses, designate an Equipment Limitation Zone (ELZ) where required by the California Forest Practice Rules. Excluding heavy equipment from streamside areas helps to prevent soil disturbance, erosion, and sedimentation in streams.

2.2.4.3 Information Resources

- **Southern California National Forest Management Plan Revisions** (http://www.sw-center.org/swcbd/Programs/forests/so-cal-forest-plans.html): The 400-plus page Conservation Alternative is a scientifically based forest management plan that emphasizes the value of preserving species, ecosystems, habitat, watersheds, and wilderness as well as maintaining opportunities for low-impact recreation in the most highly visited national forests in the nation.
- **Department of Forestry and Research, Mississippi State University, Streamside Management Zones (SMZs)** (http://www.cfr.msstate.edu/fwrc/forestry/streamside.htm): The Departments of Forestry and Wildlife and Fisheries embarked on a project designed to evaluate the effectiveness of SMZs in protecting the water quality and habitat that support fish and macroinvertebrate populations in 15 streams in north-central Mississippi.

2.2.4.4 Case Study

The Use of Alternative Buffers and Filter Strips in Oregon. The costs associated with the use of alternative buffers and filter strips were analyzed in an Oregon study (Olsen, 1987). In that study, increasing the SMA width from 35 feet on each side of a stream to 50 feet reduced the value per acre by $75 (discounted cost) to $103 (undiscounted cost), or an approximate 2 percent increase in harvesting cost per acre (from $3,163 discounted to $5,163 undiscounted). Doubling the SMA width from 35 to 70 feet on each side of a stream reduced the dollar value per acre by approximately three times, adding approximately 8 percent to the discounted harvesting costs (USEPA, 2002).

2.2.4.5 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Dykstra, D.P., and Froehlich, H.A. 1976. Costs of Stream Protection During Timber Harvest. *Journal of Forestry* 74(10): 684-687.

Olsen, E.D. 1987. A Case Study of the Economic Impact of Proposed Forest Practices Rules Regarding Stream Buffer Strips on Private Lands in the Oregon Coast Range. In *Managing Oregon's Riparian Zone for Timber, Fish and Wildlife*, NCASI Technical Bulletin No. 514, pp. 52-57.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
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2.2.5 Management Measure 2C Road Construction/Reconstruction

Management Measure

1. Follow preharvest planning (as described under Management Measure 2A) when constructing or reconstructing roadways.

2. Follow designs planned under Management Measure 2A for road surfacing and shaping.

3. Install road drainage structures according to designs planned under Management Measure 2A and regional storm return period and installation specifications. Match these drainage structures with terrain features and with road surface and prism designs.

4. Guard against the production of sediment when installing stream crossings.

5. Protect surface waters from slash and debris material from roadway clearing.

6. Use straw bales, silt fences, mulching, or other favorable practices on disturbed soils on cuts, fill, etc.

7. Avoid constructing new roads in SMAs to the extent practicable.

2.2.5.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

The USDA Forest Service adopted a new road management policy in January 2001, which directs the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. The policy includes a science-based roads analysis process designed to help managers make better decisions on roads. The USDA Forest Service is looking at ways to make the road management policy work better and is conducting an internal review of the policy (http://www.fs.fed.us/eng/road_mgt/index.shtml).

2.2.5.2 Management Practices

Logging roads and landings have the potential to be one of the greatest sources of sediment from managed forestlands. According to the California Forest Practice Rules, all logging roads and landings in the logging area need to be planned, located, constructed, reconstructed, used, and maintained in a manner that is consistent with long-term enhancement and maintenance of the forest resource and that prevents degradation of water quality.

Existing roads should be used whenever possible and new roads should be laid out in systematic patterns to reduce overall mileage. To reduce disturbance to natural site features, new roads should be tailored to the natural topography and should not be placed in unstable areas that are subject to erosion or deterioration, such as near canyon bottoms or through wetlands. Ideally they would be located on natural benches, flatter slopes, and areas of stable soils to minimize effects on watercourses.

2.2.5.3 Information Resources

- **California Forest Stewardship Program.** ***Proper Road Design Minimized Stream Impacts*** (http://ceres.ca.gov/foreststeward/html/roads.html): This fact sheet provides information on properly designing forest roads.
- **California Forest Stewardship Program.** ***Preparing Your Road for Rain*** (http://ceres.ca.gov/foreststeward/html/prepare.html): This fact sheet provides information on reducing runoff pollution from forest roads.
- **USDA Forest Service, Road Management Policy** (http://www.fs.fed.us/eng/road_mgt/policy.shtml): In 2001, the USDA Forest Service published a final policy governing the national forest transportation system. This Web site provides links to the policy and interim direction revising the policy.
- **Geomorphic Impacts of Culvert Replacement and Removal** (http://www.clfa.org/CulvertReplacementGuidelines21103.pdf): These guidelines are used by the U.S. Fish and Wildlife Service in culvert replacement and removal projects, and are recommended practices for the design and construction of stream crossings. These guidelines serve to assist with any culvert-related endangered species consultation requirements. Compliance with these guidelines should help minimize or avoid impacts during project construction activities and result in long-term benefits to threatened or endangered species.
- **SEDMODL** (http://frap.cdf.ca.gov/projects/nchip_sediment/abstractframes.html): Previous studies in forested watersheds in northern California have shown that the location and condition of road within a watershed can have a significant effect on the amount of erosion associated with the road system. A road sedimentation model, SEDMODL, was applied to the Caspar Creek watershed on the Jackson Demonstration State Forest. The model was run on Caspar Creek to evaluate the contribution of roads as part of the basin's sediment budget and to assist in identifying roads that produce relatively high amounts of sediment.
- **Mendocino County Resource Conservation District,** ***Handbook for Forest and Ranch Roads*****.** (June 1994). This document is a guide and field manual for anyone involved with roads in forests or on ranches. It contains many helpful photographs and illustrations, charts, and tips on approaching road building from planning through construction, maintenance, and closure. The publication can be requested by calling the Mendocino County Resource Conservation District (Telephone: 707-468-9223).

2.2.5.4 Case Study

Fisher Creek Watershed Improvement Project. As part of this project in the Payette National Forest, Idaho, Rygh (1990) examined the costs of ripping and scarification using different techniques and specifically compared the relative advantages of using track hoes for ripping and scarification versus using large tractor-mounted rippers. Track hoes were found to be preferable to tractor-mounted rippers for a variety of reasons, including the following:

- A reduction in furrows and resulting concentrated runoff caused by tractors
- Improved control over the extent of scarification
- Increased versatility and maneuverability of track hoes
- Cost savings

The study concluded that the cost of ripping with track hoes ranged from $406 to $506 per mile compared with $686 per mile for ripping with D7 or D8 tractors (1998 dollars).

2.2.5.5 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Rygh, J. 1990. *Fisher Creek Watershed Improvement Project Final Report*. Payette National Forest, ID.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Fact Sheet Links:
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2.2.1 Management Measure 2D Road Management

Management Measure

1. Avoid using roads for timber hauling or heavy traffic during wet or thaw periods on roads not designed and constructed for these conditions.

2. Evaluate the future needs for a road and close roads that will not be needed. Leave closed roads and drainage channels in a stable condition to withstand storms.

3. Remove drainage crossings and culverts if there is a reasonable risk of plugging or failure from lack of maintenance.

4. After harvest, close and stabilize temporary spur roads and seasonal roads to control and direct water away from the roadway. Remove all temporary stream crossings.

5. Inspect roads to determine the need for structural maintenance. Conduct maintenance practices, when conditions warrant, including cleaning and replacement of deteriorated structures and erosion controls, grading or seeding of road surfaces and, in extreme cases, slope stabilization or removal of road fills where necessary to maintain structural integrity.

6. Conduct maintenance activities, such as dust abatement, so that contaminants or pollutants are not introduced into surface waters.

7. Properly maintain permanent stream crossings and associated fills and approaches to reduce the likelihood (a) that stream overflow will divert onto roads, and (b) that fill erosion will occur if the drainage structures become obstructed.

2.2.5.6 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

The USDA Forest Service adopted a new road management policy in January 2001, which directs the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. The policy includes a science-based roads analysis process designed to help managers make better decisions on roads. The USDA Forest Service is looking at ways to make the road management policy work better and is conducting an internal review of the policy (http://www.fs.fed.us/eng/road_mgt/index.shtml).

2.2.5.7 Management Practices

Sound planning, design, and construction measures often reduce road maintenance needs after construction. Minimum maintenance is required of roads constructed with a minimum width in stable terrain and with frequent grade reversals or dips. Unfortunately, older roads remain one of the greatest sources of sediment from managed forestlands. After harvesting, roads are often forgotten, and erosion problems might go unnoticed until after severe resource damage has occurred (USEPA, 2002)

The following are practices that can be used to minimize the adverse environmental impact of logging roads:

- *Prescribed maintenance:* At a minimum of once per year, prescribed maintenance should be performed to control erosion on permanent, seasonal roads, landings, and drainage structures that are not abandoned.
- *Abandonment of temporary roads:* Temporary roads and associated landings should be abandoned upon completion of timber operations in accordance with existing CDF regulations.
- *Bridges, drainage structures, and berms*: Bridges and drainage structures should be kept open to the unrestricted passage of water. Drainage structures not adequate to carry water from the 50-year flood level should be removed in accordance with CDF regulations by the first day of the winter period before the flow of water exceeds their capacity if operations are conducted during the winter period, or by the end of timber operations (whichever occurs first). Properly functioning drainage structures on roads that existed before timber operations need not be removed (CDF, 2003). Trash racks or similar devices can be installed where needed at culvert inlets in a manner that minimizes culvert blockage. Roadside berms should be removed from logging roads or breached before the beginning of the winter period, except where needed to control erosion. Drainage ditches should be maintained to allow free flow of water and minimize soil erosion. Each drainage structure and trash rack should be maintained and repaired as needed to prevent blockage and to provide adequate carrying capacity. Where not present, new trash racks can be installed if there is evidence that woody debris is likely to significantly reduce flow through a drainage structure.
- *Stable road surfaces:* Road surfaces should be treated as necessary during timber operations to prevent excessive loss of road surface materials using methods such as rocking, watering, chemically treating, asphalting, or oiling.
- *Slope protection:* Actions should be taken to prevent failures of cut, fill, or sidecast slopes. This may involve installing or renewing soil stabilization treatments on road or landing cuts, fills, or sidecast slopes when such treatment could minimize surface erosion that threatens the beneficial uses of water (CDF, 2003).

2.2.5.8 Information Resources

- **USDA Forest Service Roads Analysis: Informing Decisions About Managing the National Forest Transportation System** (http://www.fs.fed.us/eng/road_mgt/DOCSroad-analysis.shtml): This is a complete science-based roads analysis designed to inform management decisions about the benefits and risks of constructing new roads in unroaded areas; relocating, stabilizing, changing the standards of, or decommissioning, unneeded roads; access issues; and increasing, reducing, or discontinuing road maintenance.
- **California Forest Stewardship Program.** ***Preparing Your Road for Rain*** (http://ceres.ca.gov/foresteward/html/prepare.html): This fact sheet provides information on reducing runoff pollution from forest roads.

- **California Forest Stewardship Program. *Road Retirement*** (http://ceres.ca.gov/foreststeward/html/unneeded.html): This fact sheet provides information on how to properly close forest roads.
- **SEDMODL** (http://frap.cdf.ca.gov/projects/nchip_sediment/abstractframes.html): Previous studies in forested watersheds in northern California have shown that the location and condition of a road within a watershed can have a significant effect on the amount of erosion associated with the road system. A road sedimentation model, SEDMODL, was applied to the Caspar Creek watershed on the Jackson Demonstration State Forest. The model was run on Caspar Creek to evaluate the contribution of roads as part of the basin's sediment budget and to assist in identifying roads that produce relatively high amounts of sediment.
- **Mendocino County Resource Conservation District, *Handbook for Forest and Ranch Roads***. This document is a guide and field manual for anyone involved with roads in forests or on ranches. It contains many helpful photographs and illustrations, charts, and tips on approaching road building from planning through construction, maintenance, and closure. This publication can be requested by calling the Mendocino County Resource Conservation District (Telephone: 707-468-9223).
- **USDA Forest Service, *Water/Road Interaction Technology Series*** (http://www.stream.fs.fed.us/water-road/): This series offers an excellent discussion of the relationship between forest roads and drainage.

2.2.5.9 Case Study

Road Decommissioning. Abandoning roads without first performing corrective measures can create erosion problems that persist for decades. When a road is no longer needed, it can be restored to a more natural state by removing road improvements and reestablishing vegetation in a process called decommissioning. Road decommissioning can significantly reduce water quality effects from unused roads, and road closure and decommissioning can help realize many objectives and purposes (Harr and Nichols, 1993), including the following:

- Eliminate or discourage access to roads to reduce maintenance expenditures.
- Eliminate the potential for drainage structure failure and stream diversion.
- Reduce soil loss, embankment washout, mass wasting, failures, slides, slumps, sedimentation, turbidity, and damage to fish habitat.
- Provide cover and organic matter to soil, and improve the quality of wildlife and fish habitat.
- Enhance the visual qualities of road corridors and disturbed areas.
- Attempt to restore the natural pre-road hydrology to the site.

Road decommissioning can lead to improvements in fish habitats where sediment-laden runoff from old forest roads enters streams. The practice was used in a watershed in northwest Washington as part of watershed rehabilitation to improve fish habitats and water quality and to reduce flood hazards. On unused, 30- to 40-year-old, largely impassable roads and landings, fills were stabilized, stream crossings were removed, slopes were recontoured, and drainage patterns were reestablished at an average cost of $3,950 per kilometer (with a range of $1,500 to $7,500 per kilometer) (1998 dollars). Costs were lowest where little earthmoving was involved; costs were higher where a lot of brush had to be cleared away and sidecast material had to be pulled upslope, and highest where fills were removed at stream crossings and landings. Afterward, however, the obliterated roads and landings sustained much less damage from storms than unused roads that were not obliterated (Harr and Nichols, 1993).

2.2.5.10 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Harr, R.D., and R.A. Nichols. 1993. Stabilizing forest roads to help restore fish habitats: A northwest Washington example. *Fisheries* 18(4): 18-22.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Fact Sheet Links:
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2.2.6 Management Measure 2E Timber Harvesting

Management Measure

The timber harvesting management measure consists of implementing the following:

1. General

Element 1. Conduct timber harvesting operations with skid trails or cable yarding following layouts determined under Management Measure 2A.

Element 2. Install landing drainage structures to minimize erosion and prevent sedimentation.

Element 3. Construct landings away from steep slopes and reduce the likelihood of fill slope failures. Protect landing surfaces used during wet periods. Locate landings outside Streamside Management Areas (SMAs).

Element 4. Protect stream channels and significant ephemeral drainages from logging debris and slash material.

Element 5. Use appropriate areas for petroleum storage and equipment maintenance and service. Establish procedures to contain and treat spills. Recycle or properly dispose of all waste materials.

2. For cable yarding

Element 1. Limit yarding corridor gouge or soil plowing by properly locating cable yarding landings.

Element 2. Locate corridors for SMAs following Management Measure 2B.

3. For groundskidding

Element 1. Within SMAs, operate ground-skidding equipment only at stream crossings. In SMAs, fell and endline trees to avoid sedimentation and damage to residual vegetation.

Element 2. Use improved stream crossings for skid trails that cross flowing drainages. Construct skid trails to disperse runoff and with adequate drainage structures.

Element 3. On steep slopes, use cable systems rather than ground-skidding where ground-skidding may cause excessive erosion.

2.2.6.1 Programs

The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately owned lands in California. These laws are found in the Forest Practice Act, which was enacted in 1973 to ensure that logging was done in a manner that would preserve California's fish, wildlife, forests, and streams and other water sources forever (http://www.fire.ca.gov/ResourceManagement/THinCA.asp).

The USDA Forest Service's National Forest Timber Harvest must conform to the 1976 National Forest Management Act (NFMA). The NFMA requires that each national forest develop a comprehensive plan, using substantial public involvement and sound science, to guide future management. Many national forests are now working to revise those plans by addressing inadequacies, new information, changed conditions, and/or new issues or trends. More information on forest management in the California National Forests is available at http://www.fs.fed.us/r5/forests.html.

2.2.6.2 Management Practices

The following are practices that can be used to minimize the adverse environmental impacts of timber harvest:

- *Felling trees:* Trees should be felled in a direction away from watercourses and lakes. Also, damage to desirable residual trees and tree seedlings of commercial species should be avoided during felling and while operating heavy equipment. Slash and debris from timber operations should not be bunched adjacent to residual trees required for silvicultural or wildlife purposes or placed in locations where they could be discharged into a Class I or II watercourse or lake (CDF, 2003).

- *Skidding logs:* Logs should be skidded uphill to log landings whenever possible, and the ends of the logs should be raised to reduce rutting and gouging. This practice disperses water on skid trails away from the landing. Skidding uphill lets water from trails flow onto progressively less-disturbed areas as it moves downslope, reducing the likelihood of erosion. Skidding downhill concentrates surface runoff on lower slopes along skid trails, resulting in significant erosion and sedimentation hazard (USEPA, 2002). If it is not possible to skid uphill, logs should be skidded along the contour (perpendicular to the slope), and skidding should be avoided on slopes greater than 40 percent. Following the contour reduces soil erosion and encourages revegetation. Skid trail layouts that concentrate runoff into draws, ephemeral drainages, or watercourses and skidding up or down ephemeral drainages should be avoided. Endlining, using care to avoid soil plowing or gouging, should be used to winch logs out of SMAs, or, alternatively, trees can be felled directionally so the tops extend out of SMAs, allowing the trees to be skidded without having to operate equipment within the SMAs. Ground skidding should be suspended during wet periods, when excessive rutting and churning of the soil begins, or when runoff from skid trails is turbid and no longer infiltrates within a short distance from the skid trail. Further limitation of ground skidding of logs, or the use of cable yarding, might be needed on slopes where there are sensitive soils and/or during wet periods.

- *Heavy equipment operation:* Tractors should be operated in a manner that complies with CDF regulations. Heavy equipment with a blade should not be operated on skid roads or slopes that are so steep as to require the use of the blade for braking. Heavy equipment should not be used on slopes steeper than 65 percent, slopes steeper than 50 percent where the erosion hazard rating is high or extreme, and slopes over 50 percent that lead without flattening to sufficiently dissipate water flow and trap sediment before it reaches a watercourse or lake. Heavy equipment should also not be used on unstable areas, but if such areas are unavoidable, the Registered Professional Forester (RPF) should develop specific measures to minimize the effect of operations on slope instability.

- *Roads:* Tractor roads should be limited to the minimum necessary extent and width for removal of logs. Existing tractor roads should be used instead of constructing new tractor roads. Where

tractor roads are constructed, timber operators should use tractor roads only, both for skidding logs to landings and on return trips.

- *Spill prevention and waste management:* Equipment used in timber operations should not be serviced in locations where servicing will allow grease, oil, or fuel to pass into lakes or watercourses. Non-biodegradable refuse, litter, trash, and debris resulting from timber operations should be disposed of in a manner approved by State and local authorities. Practices should be implemented that prevent mobilization by rainfall or runoff of pollutants from wastes that are temporarily stored on the site.

- *Cable yarding:* The natural topography and timber types should be used to maximum efficiency so that cable yarding operations protect residual trees. Residual trees required to be left upon completion of timber operations should not be used for rub trees, corner blocks, rigging, or other cable ties unless effectively protected from damage. Tight-lining for the purpose of changing location of cable lines should not be used unless such practice can be carried on without damaging residual trees. Tractors should not be used in areas designated for cable yarding except to pull trees away from streams, to yard logs in areas where deflection is low, to construct firebreaks and/or layouts, and to provide tail-holds. Cabling systems or other systems should be used when ground skidding would expose excess mineral soil and induce erosion and sedimentation. Use high-lead cable or skyline cable systems on slopes greater than 40 percent and on average-profile slopes of less than 15 percent (the latter to avoid soil disturbance from sidewash).

  Cable yarding should be avoided in or across watercourses. When cable yarding across streams cannot be avoided, full suspension should be used to minimize damage to channel banks and vegetation in the SMA. Cableways should be cut or cleared across SMAs where SMAs must be crossed. This reduces the damage to trees remaining and prevents trees next to the stream channel from being uprooted.

- *Waterbreaks:* Waterbreaks should be installed on skid trails and tractor roads no later than the beginning of the winter period of the current year of timber operations. If logging occurs during the winter, waterbreaks should be installed before the end of the day if the U.S. Weather Service forecasts a “chance” (30 percent or more) of rain before the next day, and prior to weekends or other shutdown periods. Waterbreaks should be constructed concurrently with the construction of firebreaks and immediately upon conclusion of use of tractor roads, roads, layouts, and landings that do not have permanent and adequate drainage facilities, or drainage structures. Waterbreaks should be cut diagonally a minimum of 15.2 centimeters (cm) (6 inches) into the firm roadbed, cable road, skid trail, or firebreak surface, and a continuous firm embankment of at least 15.2 cm (6 in.) in height should be shaped immediately adjacent to the lower edge of the waterbreak cut. According to California Forest Practice Rules, the maximum permitted distance between waterbreaks is based upon the road gradient and soil erosion hazard rating, and varies from 50 to 300 feet.

  Waterbreaks should be located to allow water to be discharged into some form of vegetative cover, duff, slash, rocks, or less erodible material. They should be constructed so that water will be discharged and spread to minimize erosion. Where waterbreaks cannot effectively disperse surface runoff, other erosion controls should be installed as needed to comply with CDF regulations. Waterbreaks or any other erosion controls should be maintained on skid trails, cable roads, layouts, firebreaks, abandoned roads, and site preparation areas during the prescribed maintenance period and during timber operations, or at least once per year. The CDF may

prescribe a maintenance period extending 3 years after timber operations are complete (CDF, 2003).

- *Watercourse crossings:* Watercourse-crossing facilities on tractor roads should be kept to a minimum. A prepared watercourse crossing using a structure such as a bridge, culvert, or temporary log culvert can be used to protect the watercourse from siltation where tractor roads cross a watercourse. Crossings should be designed to allow for the unrestricted passage of all life stages of fish that could be present in the watercourse. Watercourse-crossing facilities on tractor roads not constructed to permanent crossing standards should be removed before the beginning of the winter period.

- *After harvesting:* Skid trails should be retired by installing water bars or other erosion control and drainage devices, removing culverts, and mulching and reseeding. Logging slash should be distributed through the skid trails to supplement the water bars. Cross drains can be built on abandoned skid trails to protect stream channels or side slopes. Logging slash should be distributed throughout skid trails to supplement water bars and seeding to reduce erosion on skid trails.

2.2.6.3 Information Resources

- **California Forest Stewardship Program, *Salvage Timber Harvesting Considerations*** (http://ceres.ca.gov/foreststeward/html/salvage.html): This fact sheet provides information salvage harvesting.
- **Lolo National Forest, Montana, *Soil and Water Best Management Practices Effectiveness Monitoring Report*** (http://www.fs.fed.us/r1/lolo/resources-natural/soil-water/monitoring-bmp-rpt/b-toc.pdf): This document contains fact sheets and case studies for timber harvesting and other forestry management practices.
- **USEPA, *Watershed Academy Web: Forestry Best Management Timber Harvesting*** (http://www.epa.gov/watertrain/forestry/sube1.htm): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **Wisconsin Department of Natural Resources, *Timber Harvesting*** (http://www.dnr.state.wi.us/org/land/forestry/usesof/bmp/bmptimberharvesting.htm#Planning): This fact sheet, part of Wisconsin's BMP Field Manual, provides information on management practices related to timber harvesting.
- **University of Nebraska and Nebraska Forest Service, *Timber Harvesting*** (http://www.ianr.unl.edu/pubs/forestry/nfs/nfs-1.htm#th): This fact sheet is part of the online document, *Forestry Best Management Practices for Nebraska: A Reference Guide for Loggers, Landowners and Managers*. It provides documentation on management practices for timber harvesting.
- **Wisconsin Department of Natural Resources and University of Wisconsin, Madison, Department of Forestry, *Timber Harvesting*** (http://forest.wisc.edu/extension/publications/7.pdf): This fact sheet is part of *Wisconsin's Forestry Best Management Practices for Water Quality* series, *Forestry Facts*. It provides information on timber harvesting practices to protect water quality.
- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality (4th Edition)*** (http://www.vdof.org/wq/wq-bmp-guide.shtml): This

comprehensive manual contains clear, well-organized background information and fact sheets on timber harvesting, as well as related management practices.

2.2.6.4 Case Study

NPS Impacts from Forestry Activities. The amount of soil disturbance caused by yarding depends on the slope of the area, the volume yarded, the size of the logs, and the logging system. A study by Megahan (1980) ranked yarding techniques based on percent area disturbed per yarding technique. Aerial and skyline cable techniques were found to be far less damaging than other yarding techniques. Percent soil disturbance results were as follows: tractor (21 percent average), ground cable (21 percent, one study), high-lead (16 percent average), skyline (8 percent average), jammer in clear cut (5 percent, one study), and aerial techniques (4 percent average).

Impacts of Forest Practices on Surface Erosion. The amount of road needed to harvest timber also varies considerably with yarding technique. A study by Sidle (1980) examined the amount of road area needed for different timber yarding techniques. Skyline techniques were found to use the least amount of road area, with only 2 to 3.5 percent of the land area required for roads. Tractor and single-drum jammer techniques used the greatest amount of road area (10 to 15 percent and 18 to 24 percent of total area, respectively). High-lead cable techniques fell in the middle, with 6 to 10 percent of the land used for roads. Compared with the skyline and aerial techniques, the tractor, jammer, and high-lead cable methods resulted in significantly higher amounts of disturbed soil (Megahan, 1980).

2.2.6.5 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Megahan, W.F. 1980. Nonpoint source pollution from forestry activities in the western United States: Results of recent research and research needs. In *U.S. Forestry and Water Quality: What Course in the 80s?*, Proceedings of the Water Pollution Control Federation Seminar, Richmond, VA, June 19, 1980, pp. 92-151.

Sidle, R.C. 1980. *Impacts of Forest Practices on Surface Erosion*. Pacific Northwest Extension Publication PNW-195, Oregon State University Extension Service.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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2.2.7 Management Measure 2F Site Preparation and Forest Regeneration

Management Measure

Confine onsite potential NPS pollution and erosion resulting from site preparation and the regeneration of forest stands. The components of the management measure for site preparation and regeneration are as follows:

1. Select a method of site preparation and regeneration suitable for the site conditions.

2. Conduct mechanical tree planting and ground-disturbing site preparation activities on the contour of sloping terrain.

3. Do not conduct mechanical site preparation and mechanical tree planting on Streamside Management Areas (SMAs).

4. Protect surface waters from logging debris and slash material.

5. Suspend operations during wet periods.

6. Locate windrows at a safe distance from drainages and SMAs to control movement of the material during high runoff conditions.

7. Conduct bedding operations in high-water-table areas during dry periods of the year. Conduct bedding in sloping areas on the contour.

8. Protect small ephemeral drainages when conducting mechanical tree planting.

2.2.7.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

The Forestry Incentives Program (FIP) is a cooperative program involving the California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service. FIP's purpose is to enhance the productivity of private, nonindustrial forestland by providing financial and technical assistance for timber stand improvement and reforestation, such as site preparation and seedling planting (http://www.fire.ca.gov/ResourceManagement/ForestryIncentiveProgram.asp).

2.2.7.2 Management Practices

The goals of site preparation activities are to encourage maximum timber productivity, minimize fire hazards, prevent substantial adverse effects on soil resources and on fish and wildlife habitat, and prevent degradation of water quality. Site preparation has both short- and long-term components. Short-term goals can include treating logging slash to reduce the risk of wildfire and eliminate habitat for disease organisms. Long-term goals are aimed at creating conditions favorable to growing the next rotation of desired timber species. Site preparation and regeneration techniques influence the concentration of nutrients, pesticides, and sediment in runoff several years after timber harvest.

Site Preparation Practices

- *Timber harvest plan addendum:* Where site preparation will occur on the logging area, site preparation details should be included in an addendum to the timber harvest plan (THP). Relevant details include the general methods of site preparation to be used, the types of equipment, if any, to be used for mechanical site preparation and firebreak construction, the methods for protecting any desirable residual trees in accordance with CDF regulations, a map identifying the boundaries of site preparation areas, and a timetable of site preparation operations.

- *Streamside Management Areas:* Provide SMAs of sufficient width to protect streams from sedimentation by the 10-year storm and do not conduct mechanical site preparation in SMAs.

- *Runoff control and dispersal:* Use undisturbed areas to control and disperse concentrated runoff from roads, landings, tractor roads, firebreaks, and erosion control facilities where it flows into site preparation areas.

- *Slash management:* Logging slash that poses a fire hazard to homes, roads, or recreation areas should be lopped, removed, chipped, or piled and burned according to CDF regulations. Broadcast burning should be conducted so that it does not fully consume the larger organic debris that retains soil on slopes and stabilizes watercourse banks. Slash should not be placed in perennial or intermittent drainages, and any slash that accidentally enters drainages should be removed. Slash can clog the channel and cause alterations in drainage configuration and increases in sedimentation, and extra organic material can lower the dissolved oxygen content of the stream. Slash also allows silt to accumulate in the drainage and to be carried into the stream during storm events.

- *Windrows:* These should be located a safe distance from drainages to prevent material from moving into the drainages during high-flow conditions. Locating windrows above the 50-year floodplain usually prevents windrowed material from entering floodwaters.

- *Pest control:* Timber operations should be conducted in such a way as to minimize the buildup of destructive insect populations and the spread of forest diseases. Site preparation measures should be carried out to mitigate adverse infestation or infection impacts from the timber operation. Insects breeding in pine logging slash can be a significant problem. Measures to reduce insect diseases include removing logging slash from the site, piling and burning, chipping, debarking, treating with an appropriate pesticide, or piling and covering the slash with clear plastic.

- *Erosion control:* Soil movement should be minimized when shearing, piling, or raking. Incorporation of soil material into windrows and piles during their construction should be avoided. A rake, rather than a blade, should be used to move slash. If using a blade is unavoidable, the blade should be kept above the soil surface. This helps retain nutrient-rich

topsoil, which promotes rapid site recovery and tree growth and increases the effectiveness of the windrow in minimizing sedimentation.

- *Heavy equipment:* Heavy equipment for site preparation should not be used under saturated soil conditions. Mechanical site preparation (except drum chopping) should not be conducted on slopes greater than 30 percent. On sloping terrain greater than 10 percent, or on highly erosive soils, mechanical site preparation equipment should be operated on the contour.

Forest Regeneration Practices

USEPA (1993) recommends that seedlings be distributed evenly across the site and be ordered well in advance of planting time to ensure their availability. On highly erodible sites and steep slopes, and within SMAs, it is recommended that seedlings be planted by hand rather than using heavy equipment. Heavy equipment used in other areas should be operated along the contour of the slope to avoid forming ditches that can concentrate runoff and exacerbate erosion. Machines should not be operated on soils with steep slopes or excess moisture because they can become unstable and result in erosion or mass wasting, which could lead to injuries or pollution. Slits dug for planting seedlings should be closed at numerous points along their length to reduce the likelihood of channeling flows.

2.2.7.3 Information Resources

- **California Forest Stewardship Program, *Developing Your Forest Stewardship Plan*** (http://ceres.ca.gov/foreststeward/html/stewardplan.html): This fact sheet provides information on the benefits of a forest stewardship plan.
- **Wisconsin Department of Natural Resources and University of Wisconsin, Madison, Department of Forestry, *Site Preparation and Tree Planting*** (http://forest.wisc.edu/extension/publications/8.pdf): This fact sheet is part of *Wisconsin's Forestry Best Management Practices for Water Quality* series, *Forestry Facts.* It provides information on site preparation and tree planting to protect water quality.
- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality, Fourth Edition*** (http://www.vdof.org/wq/index-bmp-guide.shtml): This comprehensive manual contains clear, well-organized background information and fact sheets on site preparation, as well as related practices.

2.2.7.4 Case Study

Impact of Forest Management on Northern Forest Soils. Ballard (2000) reviewed the effects of forest management on forest soils. Mechanical site preparation, he noted, has benefits and causes problems. Nutrient depletion is one adverse effect. A study in northern British Columbia concluded that 500 kilograms of nitrogen per hectare were removed on a large area that had been bladed, raked, and piled for burning. However, Piatek and Allen (2000) found that the nutrients removed during site preparation had no observable effect on foliage production when measured 15 years after planting on the site.

Economic Impacts of Erosion Control in Forests. Dissmeyer (1986) analyzed the economic benefits of controlling erosion during site preparation. Site preparation methods that increased soil exposure, displacement, and compaction increased site preparation costs and erosion from the site prepared and decreased timber production. Light site preparation techniques such as a single chop and burn reduced erosion, increased timber production on the site, and cost less per unit area treated than more intensive site preparation methods. Heavy site preparation techniques such as shearing and windrowing removed nutrients, compacted soil, increased erosion and site preparation costs, and resulted in a lower present net value of timber.

2.2.7.5 References

Ballard, T.M. 2000. Impacts of forest management on northern forest soils. *Forest Ecology and Management* 133: 37-42.

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

Dissmeyer, G.E. 1986. Economic impacts of erosion control in forests. In *Proceedings of the Southern Forestry Symposium*, November 19-21, 1985, Atlanta, GA, edited by S. Carpenter, Oklahoma State University Agricultural Conference Series, pp. 262-287.

Piatek, K.B., and H.L. Allen. 2000. Site preparation effects on foliar N and P use, retranslocation, and transfer to litter in 15-year old *Pinus taeda*. *Forest Ecology and Management* 129: 143-152.

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. (http://www.epa.gov/owow/nps/MMGI/index.html)

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2.2.8 Management Measure 2G Fire Management

Management Measure

Prescribe fire for site preparation and control or suppress wildfire in a manner that reduces potential NPS pollution of surface waters.

1. Intense prescribed fire should not cause excessive erosion due to the combined effect of removal of canopy species and the loss of soil-binding ability of subcanopy and herbaceous vegetation roots, especially in Streamside Management Areas (SMAs), in streamside vegetation for small ephemeral drainages, or on very steep slopes.

2. Prescriptions for prescribed fire should protect against excessive erosion or prevent sedimentation.

3. All bladed fire lines, for prescribed fire and wildfire, should be plowed on contour or stabilized with water bars and/or other appropriate techniques if needed to control excessive sedimentation or erosion of the fire line.

4. Rehabilitation and salvage logging areas burned by wildfires should be managed to minimize erosion and prevent sedimentation.

2.2.8.1 Programs

The Vegetation Management Program (VMP) administered by the California Department of Forestry (CDF) is a cost-sharing program that focuses on the use of prescribed fire, and mechanical means, for addressing wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands (http://www.fire.ca.gov/ResourceManagement/VegetationManagement.asp).

The California Fire Plan is the State's road map for reducing the risk of wildfire. By placing the emphasis on what needs to be done long before a fire starts, the Fire Plan looks to reduce fire fighting costs and property losses, increase firefighter safety, and contribute to ecosystem health. The California Fire Plan is a cooperative effort between the State Board of Forestry and Fire Protection and the CDF (http://www.fire.ca.gov/FireEmergencyResponse/FirePlan/FirePlan.asp).

The CDF's Fire Emergency and Response team responds to wildfires within the State (http://www.fire.ca.gov/FireEmergencyResponse/FireEmergencyResponse.asp).

The CDF's Fire and Resource Assessment Program assesses the amount and extent of California's forests and rangelands, analyzes their conditions, and identifies alternative management and policy guidelines (http://frap.cdf.ca.gov/index.htm).

2.2.8.2 Management Practices

Fire management practices are changing as the benefits of fire to forest ecosystems are becoming more widely accepted. Prescribed burning reduces hazardous fuels and reduces the potential for crown fires that kill timber trees. Fire is also essential for forest management where tree species are ecologically dependent on fire for regeneration or maintenance of healthy stands (USEPA, 2002). However, prescribed fire used for site preparation, fuel hazard reduction, and activities associated with wildfire suppression can sometimes create NPS pollution and erosion. The following management measures can be used to reduce the adverse impacts of fire on water quality:

- *Fire intensity:* High-intensity fires should be avoided, especially severe burns on steep slopes or highly erodible soils. High-intensity fires that remove vegetation and litter down to the mineral soil are most likely to adversely affect water quality. Furthermore, chemical changes in the soil following fire may create an increased resistance to water infiltration in the upper soil layer, and this can increase surface runoff and sheet erosion (USEPA, 2002). Periodic, low-intensity prescribed fires should be used to reduce the forest fuel loads. Low-intensity fires usually have little effect on water quality because burned areas with an intact litter layer yield little sediment and revegetate more quickly.

- *Timing of prescribed burns:* Burning should be planned to take into account weather, time of year, and fuel conditions so that these factors help achieve the desired results and minimize effects on water quality.

- *Logistics of prescribed burns:* The prescribed burn should be executed with an agency-qualified crew and burn boss. Burning permits must be obtained before burning. Every year, if required, either before April 1 or before the start of timber operations, a fire suppression resources inventory should be submitted to the CDF.

- *SMAs and wetlands:* Prescribed burning and site preparation activities that involve piling and burning for slash removal should not be conducted in SMAs. When applying prescribed fire in wetlands, burns should be conducted in a manner that does not completely remove the organic layer of the forest floor. Prescribed burns conducted in wetlands have the potential to be the most severe because of the increased fuels available. The fire should be conducted to minimize the potential to increase surface runoff and soil erosion. Fire lines should not be placed in sensitive areas such as wetlands, marshes, prairies, and savannas unless absolutely necessary.

- *Fire lines*: Fire line construction involves removing all organic material to expose mineral soil, and this can result in excessive erosion and water quality degradation. Natural or in-place barriers (e.g., roads, streams, and lakes) should be used to minimize the need for fire line construction in situations where construction of artificial fire lines could result in excessive erosion and sedimentation. Conditions that require extensive blading of fire lines with heavy equipment should be avoided when planning burns. Hand lines, firebreaks, and hose lays should be used to minimize blading of fire lines.

  Fire lines need to be constructed in a manner that minimizes erosion and sedimentation and prevents runoff from directly entering watercourses. When crossing water bodies with plowing equipment, the plow should be raised to prevent connecting the fire line directly to the water body. Water bodies can be used as fire lines to avoid unnecessarily disturbing riparian zones. Also, construction of fire lines straight up and down hill should be avoided. The location of fire lines should be balanced with the potential for a larger fire that would consume greater amounts

of material. Where possible, alternatives to plowed lines such as harrowing, foam lines, wet lines, or permanent grass should be considered.

- *Revegetation:* Once the fire is put out, vegetative cover on fire lines and disturbed areas should be reestablished as soon as possible using native species, as feasible, to control soil erosion.

- *Runoff controls:* Grades, ditches, and water bars to fire lines should be installed as soon as it is safe to begin rehabilitation work. Water bars should be installed on any fire line running up and down the slope, and runoff should be directed onto a filter strip or sideslope, not into a drainage area.

- *Fire retardants:* Whenever possible, a 300-foot buffer should be left on both sides of a waterway when fire retardants are applied from the air. If it is necessary to apply retardant within the 300-foot zone, the application method that most accurately keeps the retardant from entering the stream should be used. Fire retardant chemicals that contain sodium ferrocyanide should be avoided because a recent study revealed that mixtures with the chemical can decompose to produce amounts of cyanide that exceed USEPA water quality guidelines for freshwater organisms.

- *Fire detection/prevention:* A diligent aerial or ground inspection should be conducted within the first 2 hours after cessation of felling, yarding, or loading operations each day during the dry period when fire is likely to spread. The person conducting the inspection should have adequate communication available for prompt reporting of any fire that may be detected (CDF, 2003).

  Laws and ordinances prohibiting or otherwise regulating smoking should be obeyed and smoking by persons engaged in timber operations should be limited to occasions when they are not moving about and are confined to cleared landings and areas of bare soil at least 3 feet in diameter.

- *Public safety:* Management practices for fire lines, road construction, and stream crossings should be suspended during wildfire emergencies to benefit public safety and should be restored as soon as possible. Remediation should begin after the emergency is controlled.

Costs associated with prescribed fire depend on the size of the fire crew, the amount of heavy equipment needed at the site to control the burn, the areal extent and intensity of the burn, and the topography of the area being burned. Costs for prescribed burning vary from approximately $80 to $500 per acre; costs are higher in mountainous terrain than on flat land (USEPA, 2002).

2.2.8.3 Information Resources

- ***The Defensible Space and Healthy Forest Handbook: A Guide to Reducing the Wildfire Threat*** (http://ceres.ca.gov/foresteward/html/firesafehandbook.html): This handbook is an excellent resource, prepared by the Placer Hills Fire Protection District, Placer County RCD and the USDA NRCS for residents of the Sierra Nevada foothills. The booklet is available for $15.
- ***Protect Your Forest from Wildfire*** (http://ceres.ca.gov/foresteward/html/protectforest.html): This Web site provides information on protecting private land from wildfires.
- **California Fire and Resource Assessment Program, *Fire Management for California Ecosystems*** (http://frap.cdf.ca.gov/projects/fire_mgmt/fm_main.html): This paper discusses the use of an ecosystem management focus for fire management.

- **California Fire and Resource Assessment Program, *Prefire Management*** (http://frap.cdf.ca.gov/projects/prefire_mgmt/pfm_main.html): This Web site provides information on prefire management of California's forests.
- **California Fire and Resource Assessment Program, *Turning Plantations into Healthy, Fire Resistant Forests, Outlook for the Granite Burn*** (http://frap.cdf.ca.gov/projects/granite_burn/gb_exec.html): This paper explores individual stand conditions of Granite Burn and current fuel and forest structure problems. It offers general recommendations for reducing risks to these stands in the future.
- **California Department of Forestry and Fire Protection, *The Benefits of Fire*** (http://www.fire.ca.gov/FireEmergencyResponse/pdf/TheBenefitsofFire.pdf): The fact sheet discusses the benefits of fires to forests.
- ***Fire Protection and Resource Management: A Necessary Alliance*** (http://ceres.ca.gov/foresteward/html/necessary.html): This fact sheet discusses the importance of controlled forest fires in forest resource management.
- **California Fire Alliance** (http://www.cafirealliance.org/): This is an association of cooperating agencies addressing fire issues in California.

2.2.8.4 Case Study

Cone Fire in Lassen National Forest. The Cone Fire that occurred September 2002 on the Lassen National Forest (NF) provided wildland fire experts and forestry researchers a way to study the effects of fuel treatments on an active wildfire. Areas in the Lassen NF had been managed with different forest fuel treatments over the years, including prescribed fire and tree thinning. Initial observations indicate that high intensity burns occurred in areas that had received no management with thinning or prescribed fire. The timber stands that had been treated with thinning, prescribed fire, or both, experienced a low-intensity ground fire, resulting in lower tree mortality. Some treatments were observed to be very effective in slowing, and sometimes even stopping, the fire (http://www.cafirealliance.org/success_conefire.php).

Gasquet Community Fire Protection Successes. The community of Gasquet in the Smith River National Recreation Area, Six Rivers National Forest, had been identified as a community at risk from wildfire. In the spring on 1996, fuel reduction activities were implemented in forest lands surrounding the community in an area called the Gasquet Shaded Fuelbreak. Prescribed fire reduced the density of smaller branches, twigs, and needles, which are known to foster the spread of fire. In September 1996, the Panther Fire threatened Gasquet. When the Panther Fire burned into the Gasquet Shaded Fuelbreak, the fire lost intensity, allowing fire crews to contain the advancing head of the fire. No structures in Gasquet were lost or damaged (http://www.cafirealliance.org/success_nfp.php).

2.2.8.5 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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2.2.9 Management Measure 2H Revegetation of Disturbed Areas

Management Measure

Reduce erosion and prevent sedimentation by rapid revegetation of areas disturbed by timber operations.

1. Revegetate disturbed areas (using seeding or planting) promptly after completion of earth-disturbing activity. Local growing conditions will dictate the timing for establishment of vegetative cover.

2. Use mixes of species and treatments developed and tailored for successful vegetation establishment for the region or area.

3. Concentrate revegetation efforts initially on priority areas such as disturbed areas in Streamside Management Areas (SMAs) or the steepest areas of disturbance near drainages.

2.2.9.1 Programs

California Department of Forestry and Fire Protection, State Nurseries. The Lewis A. Moran Reforestation Center in Yolo County and the Magalia Reforestation Center In Butte County make up the CDF Nursery System. The purpose of the reforestation centers is to provide native species seedlings for purchase by landowners for specific purposes, including reforestation, erosion control and watershed protection, windbreaks, Christmas trees, fuel wood, and approved research projects (http://www.fire.ca.gov/ResourceManagement/StateNurseries.asp).

2.2.9.2 Management Practices

A recently harvested or burned site is highly susceptible to erosion and should be protected immediately with a combination of new vegetation and more temporary controls to hold soil in place while the plantings take hold. The following are the major considerations for site revegetation:

- *Plant selection*: For revegetation efforts, native species should be selected as much as possible. Mixtures of seeds adapted to the site and annuals should be used to allow natural revegetation of native understory plants. Mixtures should include annual grasses (for quick growth), perennial grasses (for their better root systems), and legumes (for nitrogen). Especially preferable are species that have adequate soil-binding properties to control erosion. Seeds should be planted immediately after soil disturbance and a minimum of 6 weeks before periods of drought or frost. Fall seeding is best. Native woody plants planted in rows, cordons, or wattles are best on steep slopes.

- *Timing and methodology*: Seeding should be done as soon as is practical after soil disturbance, preferably before rain, to increase the chance of successful establishment. Seeding can be done by hand or vehicle or by hydraulic seeding from a pump truck or trailer. The seed should be evenly distributed to provide continuous cover. Soil should be mulched as needed to hold seeds in place, reduce the erosive impact of raindrops, and to preserve soil moisture. Fertilizer should be applied according to product labels and site-specific conditions. Fertilizers may be necessary in severely

disturbed subsoils and cutbanks. Soils should be tested for nutrient content to ensure that the proper amount of fertilizer is applied.

- *Maintenance*: Once areas are seeded, they should be protected from grazing and vehicle damage until plants are well established. All seeded areas should be inspected for failures and repairs, and reseeding should be accomplished within the planting season. During non-growing seasons, temporary, interim surface stabilization methods should be used to control surface erosion. These can include mulching, spraying bare soils with tackifiers, or covering exposed areas with turf reinforcement mats.

2.2.9.3 Information Resources

- **Shasta County University of California Cooperative Extension, *Recovering from Wildfire*:** This publication covers emergency resources, how to assess damages, erosion control measures, road protection, salvage harvesting, and forest regeneration. There are tips on contracting with a registered professional forester and a short discussion of tax implications. There is also a section on cost-share programs and a list of contacts. Request a copy from Shasta County University of California Cooperative Extension, Forestry, 1851 Hartnell Avenue, Redding, CA 96002 (Telephone: 530-224-4902) or call the California Stewardship Helpline (Telephone: 1-800-PET-TREE).

- ***Evaluating the Effectiveness of Postfire Rehabilitation Treatments*** (http://www.fs.fed.us/rm/pubs/rmrs_gtr63.html): A west-wide evaluation of the effectiveness of USDA Forest Service burned area emergency rehabilitation (BAER) treatment was undertaken as a joint project by USDA Forest Service Research and National Forest System staffs. This evaluation covers 470 fires and 321 BAER projects, from 1973 through 1998 in USDA Forest Service Regions 1 through 6. A literature review, interviews with key regional and USDA Forest Service BAER specialists, analysis of burned area reports, and review of USDA Forest Service and district monitoring reports were used in the evaluation.

- **California Exotic Pest Plant Council** (http://www.caleppc.org): This council works to protect California wildlands from invasive plants through research, restoration, and education.

- **Alabama Forestry Commission, *Revegetation/Stabilization*** (http://www.forestry.state.al.us/publication/bmp/Revegetations_Stabilization.pdf): This fact sheet, part of *Alabama's Best Management Practices for Forestry*, provides guidance on techniques for revegetating disturbed areas.

- **USEPA, *Watershed Academy Web: Forestry Best Management. Revegetation and Forest Regeneration*** (http://www.epa.gov/watertrain/forestry/subf1.htm): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.

2.2.9.4 Case Study

Restoring the land after the Pendola Fire. After 2 days of the Pendola Fire in October 1999, dozens of landowners were burned out and over 11,000 acres of forestland destroyed. The community immediately turned to restoration, and within a few weeks, applications for CFIP (California Forest Improvement Program) cost-share funds began to come in. "We've been impressed with the aggressive manner in which people are reforesting their land," noted Gary Brittner, who manages CFIP for the CDF for the Nevada-Yuba-Placer Unit. "This is high-quality land and reforestation after a fire is an important priority." The effort to start the restoration work has involved landowners, registered professional foresters (RPFs), and

government agencies such as CDF. In addition to CFIP, other emergency funds such as CFIP (California Forestry Improvement Program) are available to landowners who have been affected by fire (http://ceres.ca.gov/foreststeward/html/pendola.html).

2.2.9.5 References

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Weaver, W., and D. Hagans. 1994. *Handbook for Forest and Ranch Roads: A Guide For Planning, Designing, Constructing, Reconstructing, Maintaining and Closing Wildland Roads*. Mendocino County Resource Conservation District, Ukiah, CA.

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2.2.10 Management Measure 2l Forest Chemical Management

Management Measure

Use chemicals when necessary for forest management in accordance with the following to reduce NPS pollution impacts due to the movement of forest chemicals offsite during and after application:

1. Ensure that applications are performed by skilled and licensed applicators according to the registered use, with special consideration given to impacts on nearby surface waters.

2. Carefully prescribe the type and amount of pesticides appropriate for the insect, fungus, or herbaceous species.

3. Prior to applications of pesticides and fertilizers, inspect the mixing and loading process and the calibration of equipment, and identify the appropriate weather conditions, the spray area, and buffer areas for surface waters and mixing and loading areas.

4. Establish and identify buffer areas for surface waters to protect beneficial uses. (This is especially important for aerial applications.)

5. Immediately report accidental spills of pesticides or fertilizers into surface waters to the California Office of Emergency Services (Cal/OES). Develop an effective spill contingency plan to contain spills.

2.2.10.1 Programs

California Department of Forestry and Fire Protection Pest Management Program. Forest pest specialists help protect the State's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands (http://www.fire.ca.gov/ResourceManagement/ForestPest.asp).

California Department of Pesticide Regulation has programs to protect human health and the environment by regulating the sale and use of pesticides, and by fostering reduced-risk pest management in California (http://www.cdpr.ca.gov/).

2.2.10.2 Management Practices

Pesticides and fertilizers are occasionally used in forestry to reduce mortality of desired tree species and improve forest production. Because pesticides can be toxic if misused, they must be mixed, transported, loaded, and applied correctly (according to label instructions) to prevent potential NPS pollution. Fertilizers can also be toxic or can shift the ecosystem's energy dynamics when used improperly, so it is important that they also be handled and applied in accordance with instructions on the label (USEPA, 2002).

Methods of chemical application: Generally, chemicals are applied by hand, from an airplane or helicopter (aerial spray), or mechanically. When forest chemicals are applied mechanically, it is most common to use a vehicle-mounted boom sprayer. The cost of chemical management depends on the method of application. Hand application costs approximately $100 per acre, while aerial application is less expensive at $55 to $70 per acre.

Using slow-release fertilizers when possible can reduce adverse impacts on the environment. This practice reduces potential nutrient leaching to ground water and it increases the availability of nutrients for plant uptake. Fertilizers should be applied during maximum plant uptake periods to minimize leaching. Fertilizers and herbicides should not be used in streams or Streamside Management Areas. If designed properly, forested buffer areas around watercourses can effectively reduce adverse effects on water quality from fertilizers (Megahan, 1980).

Riekerk and others (1989) found that the greatest risk to water quality from pesticide application in forestry operations occurred from aerial application because of drift, wash-off, and erosion processes. They found that aerial applications of herbicides resulted in surface runoff concentrations roughly 3.5 times greater than those for application on the ground. Therefore, where possible, aerial application of pesticides should be avoided. Alternatively, tree injection or hand application of herbicides should be used. Research results suggest that tree injection application methods, although labor intensive, are the least hazardous for water pollution (Riekerk et al., 1989).

When aerial spray applications are used, drift or accidental application of chemicals directly to surface waters should be avoided. Appropriate buffer widths should be determined by considering the altitude of application, weather conditions, and drop size distribution. Careful and precise marking of application areas for aerial applications helps avoid accidental contamination of open waters (USEPA, 2002).

Pesticides and fertilizers should be applied only during favorable atmospheric conditions. Pesticides should not be applied when wind conditions increase the likelihood of significant drift. It is also best to avoid pesticide application when temperatures are high or relative humidity is low because these conditions influence the rate of evaporation and enhance losses of volatile pesticides.

Following the label: Pesticide users need to abide by the current pesticide label, which could specify the following: whether users be trained and certified in the proper use of the pesticide; allowable use rates; safe handling, storage, and disposal requirements; and whether the pesticide may be used only under the provisions of an approved State Pesticide Management Plan.

Spill prevention: Areas where mixing, loading, and equipment cleaning occur should be located where pesticide residues cannot enter streams or other water bodies. Pesticide wastes and containers should be disposed of according to State and federal laws and precautions should be taken to prevent leaks and spills.

Integrated Pest Management: Ideally, the use of pesticides should be considered as only one part of an overall program to control pest problems. Integrated Pest Management (IPM) strategies have been developed to control forest pests without total reliance on chemical pesticides. The IPM approach uses all available techniques, including both chemical and nonchemical methods. An extensive knowledge of both the pest and the ecology of the affected environment is necessary for IPM to be effective.

2.2.10.3 Information Resources

- **Tree Notes** (http://ceres.ca.gov/foresteward/html/treenotes.html): Tree Notes is a series of short papers produced by the California Department of Forestry and Fire Protection to provide information on various pests and threats to forests. These resources are available from the local forester at any CDF Unit or call or write Jesse Rios, Forest Pest Specialist, P.O. Box 944246, Sacramento, CA 94244 (Telephone: 916-653-9476).
- ***Pest Management In Perspective*** (http://ceres.ca.gov/foresteward/html/pest.html): This is an article about pest management in forests.
- Norris et al., 1991. ***Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats***. American Fisheries Society Special Publication 19, pp. 207-296.
- **USDA Forest Service, Pacific Southwest Region, Forest Health Protection (FHP), *Forest Pests*** (http://www.fs.fed.us/r5/spf/about/fhp_forest_pests.htm): FHP is responsible for protecting, monitoring, and reporting on the health of all forest lands in the Pacific Southwest Region. FHP provides assistance in pest and pathogen identification.
- **University of California Statewide Integrated Pest Management Program (UC IPM)** (http://www.ipm.ucdavis.edu/): UC IPM develops and promotes the use of integrated, ecologically sound pest management programs in California. UC IPM's mission is to reduce the pesticide load in the environment and develop pest control programs that are economically, environmentally, and socially acceptable.
- **Spray Drift Task Force** (http://www.agdrift.com/): The Spray Drift Task Force, in collaboration with USEPA and USDA, co-developed AgDRIFT, a new model, to provide estimates of spray drift deposition under different pesticide application and meteorological conditions.
- **USDA Forest Service Cramer-Barry-Grim (FSCBG)** (http://www.fs.fed.us/foresthealth/technology): The FSCBG spray dispersion model analyzes data on aircraft, meteorology, pesticides, and target areas to predict deposition and drift. A personal computer version of the model is available. It combines and implements mathematical models to assist forest managers in planning and implementing aerial spray operations.
- **USEPA, *Watershed Academy Web: Forestry Best Management, Forest Chemicals.*** (http://www.epa.gov/watertrain/forestry/subh1.htm): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **University of California Statewide Integrated Pest Management Program, *Forest and Right-of-Way Pest Control*** (http://www.ipm.ucdavis.edu/IPMPROJECT/ADS/manual_forestrightofway.html): This book is a guide to pest management in forests, as well as rights-of-way and commercial nurseries. It is geared specifically toward pesticide professionals in California.

2.2.10.4 Case Study

Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. A nitrogen loss study cited in Norris and others (1991), compared nitrogen loss from a watershed treated with 224 kilograms (kg) urea-nitrogen per hectare with nitrogen loss from an untreated watershed. The study demonstrated that the loss of nitrogen from the fertilized watershed was 28.02 kg/hectare whereas the loss of nitrogen from the unfertilized watershed was only 2.15 kg/hectare.

Norris and others (1991) also compiled information from multiple studies that evaluated the peak concentrations of insecticides in soils, lakes, and streams. It was demonstrated that the concentration of insecticides in streams was significantly greater when the chemicals were applied without a buffer strip to protect the watercourse. In one study, when streams were unbuffered, the peak concentrations of applied malathion ranged from 0.037 to 0.042 milligrams per liter (mg/L). When buffers were provided, however, concentrations of malathion were reduced to levels that ranged from undetectable to 0.017 mg/L. In another experiment, the peak concentrations of carbaryl ranged from 0.000 to 0.0008 mg/L when watercourses were protected with a buffer, but they increased to 0.016 mg/L when watercourses were unbuffered.

2.2.10.5 References

Megahan, W.F. 1980. Nonpoint source pollution from forestry activities in the western United States: Results of recent research and research needs. In *U.S. Forestry and Water Quality: What Course in the 80s?* Proceedings of the Water Pollution Control Federation Seminar, Richmond, VA, June 19, 1980, pp. 92-151.

Norris, L.A., H.W. Lorz, and S.V. Gregory. 1991. *Forest Chemicals. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats*. American Fisheries Society Special Publication 19, pp. 207-296.

Riekerk, H., D.G. Neary, and W.J. Swank. 1989. The magnitude of upland silviculture nonpoint source pollution in the South. In *Proceedings of the Symposium: Forested Wetlands of the Southern United States*, July 12-14, Orlando, FL, pp. 8-18.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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2.2.11 Management Measure 2J Wetlands Forest Management

Management Measure

Plan, operate, and manage normal, ongoing forestry activities (including harvesting, road design and construction, site preparation and regeneration, and chemical management) to adequately protect the aquatic functions of forested wetlands.

2.2.11.1 Programs

The California Wetlands Information System is a program of the California Resources Agency. This Wetlands Information System is designed to provide comprehensive wetlands information to the general public, the educational community, and government agencies. It is a compilation of public and private sector information, including maps, environmental documents, agency roles in wetlands management, restoration and mitigation activities, regulatory permitting, and wetland policies. It also includes a wetlands database and inventory (http://ceres.ca.gov/wetlands/).

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

2.2.11.2 Management Practices

Forested wetlands provide beneficial ecosystem functions such as flood-flow alteration, sediment trapping, nutrient retention and removal, provision of important habitat for fish and wildlife, and provision of timber products. Wetlands in the continental United States have declined greatly in the past 40 years because of conversion to other land uses. In the past 200 years, California lost 91 percent of its original wetlands, mostly because of conversion to agriculture (Yuhas, 2003).

Practices that help maintain forested wetlands include the following:

- *Road building/maintenance:* Road construction and maintenance can adversely affect forested wetlands and should be avoided. Wetlands can fill with sediment runoff generated by road construction and the use of heavy equipment. Wetlands can also be degraded by improper road construction and ditching that alters wetland hydrology. In an effort to prevent these potential adverse effects, section 404 of the Clean Water Act (for more information about section 404, see http://www.epa.gov/owow/wetlands/regs/sec404.html) requires the use of appropriate management practices for road construction and maintenance in wetlands so that flow and circulation patterns are not impaired.

Temporary roads should be used in forested wetlands whenever possible. Temporary roads can be constructed to provide adequate crossroad drainage at all natural drainageways. Temporary drainage structures include culverts, bridges, and porous material such as corduroy or chunkwood. The root mat in any wetland that has grass mounds or other uneven vegetation should not be disturbed. Any temporary wetland crossing is enhanced by using a root or slash mat to provide additional support to the equipment.

Where construction of fill roads is necessary, a permeable fill material such as gravel or crushed rock should be used for at least the first layer of fill. The use of pervious materials helps maintain the natural flow regimes of subsurface water. Adequate cross drainage should be provided to maintain the natural surface and subsurface flow of the wetland.

- *Chemical use:* Wetland contamination can result from improper application or use of herbicides and fertilizers. Application of herbicides with toxicity to aquatic life should be avoided. Instead, herbicide formulations that are approved for use in or near water should be used where feasible and applicable. These herbicides should be applied by injection to individual stems to reduce losses to surface waters. Fertilizers should be applied when leaching will be minimal, and slow-release fertilizers should be chosen when possible. This practice reduces the potential of the nutrients to leach in to ground water, and it increases the availability of nutrients for plant uptake.
- *Site preparation:* Site preparation techniques that degrade wetlands onsite or downstream should be avoided. Extensive site preparation on bottoms where frequent flooding occurs can cause excessive erosion and stream sedimentation. The degree of acceptable site preparation is governed by the amount and frequency of flooding, soil type, and species suitability and depends on the regeneration method used.
- *Permits:* Local, State, and federal agencies should be conferred with to identify applicable wetland regulations and obtain necessary permits to work in wetlands. Some forestry activities in wetlands are exempt from federal permitting requirements under section 404(f) of the Clean Water Act, while others are not.
- *Harvesting:* Harvest methods that cause less soil disturbance and compaction, such as cable logging or helicopter logging, should be considered. If using heavy equipment, low-ground-pressure, ultrawide, or high-flotation tires on logging trucks and skidders should be used to reduce soil compaction and erosion. Ground skidding harvesting operations should be suspended during wet periods in seasonally flooded wetlands.

2.2.11.3 Information Resources

- **Save The Bay, *Protecting Local Wetlands: a Toolbox for Your Community*.** (http://www.savesfbay.org/Wetlands%20Handbook.html): This document, produced by Save The Bay, in conjunction with the attorneys of Shute, Mihaly, and Weinberger, LLP, is designed to help government officials, resource agencies, nonprofit organizations, community activists, and landowners protect and restore their local wetlands throughout the San Francisco Bay-Delta Estuary.
- **USDA Forest Service, USDA NRCS, and USEPA, *Forested Wetlands Functions, Benefits, and Use of Best Management Practices*** (http://www.na.fs.fed.us/spfo/pubs/n_resource/wetlands/index.htm#Table%20of%20Contents): The purpose of this publication is to present an array of management practices to protect the function of forested wetlands.

- **Virginia Department of Forestry, *BMP Guide: Virginia's Forestry Best Management Practices for Water Quality, 4th Edition*** (http://www.vdof.org/wq/index-bmp-guide.shtml): This comprehensive manual contains clear, well-organized background information and fact sheets on forested wetlands, as well as related practices.
- **Alabama Forestry Commission, *Forested Wetland Management*** (http://www.forestry.state.al.us/publication/bmp/Forest_Wetland_Management.pdf): This fact sheet, part of *Alabama's Best Management Practices for Forestry*, provides background information on the management of forested wetlands.
- **USEPA, *Watershed Academy Web: Forestry Best Management. Forest Wetland Management*** (http://www.epa.gov/watertrain/forestry/subc1.htm): This Web site serves as a forestry management module, with a series of interactive fact sheets on forestry management practices. The Web site includes diagrams, photographs, and review questions.
- **USEPA, *Forested Swamps*** (http://www.epa.gov/owow/wetlands/types/swamp.html#forested): This Web site provides information on various types of forested wetlands.

2.2.11.4 References

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry.* Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Yuhas, R.H. 2003. *Loss of Wetlands in the Southwestern United States*. U.S. Geological Survey. (http://geochange.er.usgs.gov/sw/impacts/hydrology/wetlands/). Accessed March 27, 2003.

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2.2.12 Management Measure 2K Postharvest Evaluation

Management Measure

Conduct post-operation evaluation of the effectiveness of the State's forest practices requirements as implemented. The components of this are (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.

2.2.12.1 Programs

California Department of Forestry and Fire Protection, Resource Management Program. Maintaining the sustainability of California's natural resources is the goal of the CDF Resource Management Program. The Department achieves this goal by administering State and federal forestry assistance programs for landowners, demonstrating sound management practices on eight demonstration State forests, enforcing the California Forest Practice Act on all nonfederal timberlands, providing research and educational outreach to the public on forest pests such as Sudden Oak Death, and coordinating efforts for fuel reduction to reduce the risk of fire and improve the quality of California's ecosystems. CDF's mission emphasizes the management and protection of California's natural resources. The Resource Management Program is an integral part of that responsibility (http://www.fire.ca.gov/ResourceManagement/ResourceManagement.asp).

2.2.12.2 Management Practices

Timber harvest plan: Post-harvest evaluations of forest practices should be incorporated into the timber harvest plan (THP) if proposed timber operations have the potential to degrade drinking water supplies, lakes, or streams. Under the California Forest Practice Rules, the CDF may require a postharvest evaluation of the effectiveness of the mitigations and practices designed to protect the domestic water supply as a condition of THP approval. Problems to be identified include potential land failures, accelerated rate of road construction or harvesting within a watershed, or a concentration or intensity of harvesting activity near streams or springs (CDF, 2003). Where timber operations will be conducted within a Watercourse and Lake Protection Zone (WLPZ), the CDF may also require a postharvest evaluation of the effectiveness of the mitigation measures and practices designed to protect the water quality as a condition of THP approval.

Monitoring program: One should define the goals and objectives, or purpose, of the monitoring program. Detailed monitoring program objectives enable the designer of the program to define precisely which data will be gathered to meet the management goals and determine when management has failed or been successful. Postharvest evaluations can review the timber operator's procedures for effectiveness and implementation monitoring or existing landowner monitoring programs, or use photographic monitoring techniques. A review of scientific and technical literature pertaining to water quality studies previously conducted in the region will help to determine whether existing data provide sufficient information to address the monitoring goals and to identify data gaps.

Implementation assessments: It is helpful to identify project constraints such as funding, staffing, equipment, time, and effort necessary to complete postharvest evaluations. The duration of monitoring

and the geographic scale needed to achieve monitoring goals should be determined. Implementation assessments can be done on several scales. Site-specific assessments can be used to assess individual management practices or management measures, while watershed assessments can be used to look at the cumulative effects of implementing multiple management measures. Determination should be made as to which management measures should be evaluated, and a baseline should be established from which decisions can be made regarding the need for additional incentives for implementation of management measures.

A team of experts should be assembled to perform postharvest monitoring. Teams should include a state forester who is familiar with management practice standards for both implementation and effectiveness. Where possible, the survey team should be accompanied by the landowner on whose property the survey is being conducted, the logger who conducted the harvest, and the state forester who prepared the harvest plan, if applicable. Other experts could be specialists in fields such as watershed science, soil science, wildlife biology, hydrology, fishery management, or road engineering. Separate organizations might also be represented, such as environmental organizations or representatives of the timber industry.

If feasible, audits should be conducted soon after harvests are completed so that improvements can be made to management practices found to be inadequately implemented and to minimize the water quality impacts of those practices.

Preharvest notification system: A preharvest notification system should be established to assist in selecting an adequate and unbiased sampling population of harvest sites, to reduce the cost of site selection, and to help determine, prior to a site visit, that selected sites meet many of the selection criteria such as time since harvest and size of harvest. Harvest sites need to be chosen randomly. Stratification based on desired characteristics of sites is perfectly acceptable, but if this is done, sampling within the strata must be random to ensure the validity of results.

*QA/QC: Q*uality assurance (QA) and quality control (QC) procedures should be implemented to ensure the accuracy of all analytical measurements made in postharvest evaluations. QA/QC procedures are cost-effective measures used to determine how to allocate project energies and resources toward improving the quality of research and the legal sufficiency of project results.

Critical watersheds: If the geographic extent of an audit includes a critical watershed, a separate statistically valid sample population should be created for the watershed and information from harvests within the watershed should not be grouped with information from other harvests. It is important to maintain separate information for watersheds that have been designated “critical” and to sample them separately if the information obtained is to be related to and useful for programs instituted to protect the watersheds.

2.2.12.3 Information Resources

- Numerous guidance documents have been developed, or are in development, to assist resource managers in developing and implementing monitoring programs that address all aspects of monitoring design. **Appendix A in *Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls*** presents a review of more than 40 monitoring guidance manuals for both point and NPS pollution. These guidance manuals discuss virtually every aspect of NPS pollution monitoring, including monitoring program design and objectives, sample types and sampling methods, chemical and physical water quality variables, biological monitoring, data analysis and management, and quality assurance and quality control (USEPA, 2002). This document is available through the National Service Center for Environmental Publications (Telephone: 800-490-9198).

- ***Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures—Forestry*** (http://www.epa.gov/owow/nps/forestry/index.html): Sampling design, approaches to conducting the evaluation, data analysis techniques, and ways to present evaluation results are described in this manual.

2.2.12.4 References

CDF. 2003. *California Forest Practice Rules*. California Department of Forestry and Fire Protection, Resource Management, Forest Practice Program, Sacramento, CA.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

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2.2.13 Management Measure 2L Education/Outreach

Management Measure

Implement educational programs to provide greater understanding of watersheds, and to raise awareness and increase the use of applicable forestry management measures and practices where needed to control and prevent adverse impacts on surface and ground waters. Public education, outreach, and training programs should involve user groups and the community.

2.2.13.1 Programs

- The California Department Forestry and Fire Protection's Fire and Environmental Education Program consists of school programs, fair exhibits, posters, flyers and thousands of other printed materials, radio and television spots, community meetings, one-on-one contact with wildland homeowners, and a Web site (http://www.fire.ca.gov/Education/Education.asp).
- The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. This State government program provides technical and financial assistance to influence positive changes to forest land management, assists communities in solving common watershed problems, and helps landowners in a number of ways. For assistance, call the Forest Stewardship Helpline (Telephone: 1-800-PET-TREE; Web site: http://ceres.ca.gov/foreststeward/index.html).

2.2.13.2 Management Practices

Education and training are vital to effective management practice implementation. Educating and training loggers and landowners about the importance and use of management practices is an effective way to reduce water quality effects from forest operations because harvesters and landowners are responsible for forest harvesting and decisions concerning the management of much of the forested land in the nation.

These programs are based on the premise that it is important to teach forest ecology and silviculture to loggers because professional foresters supervise less than a third of all the acres harvested in the United States while loggers are involved in all of the harvests. Before these programs existed, few people employed in logging had training in forestry and silviculture, and the logger education programs are changing that situation. To accomplish its goal, logger training emphasizes five areas—safety and first aid, business management, harvesting operations, professionalism, and forest ecology and silviculture (USEPA, 2002).

2.2.13.3 Information Resources

- **University of California Center for Forestry** (http://www.cnr.berkeley.edu/forestry/information.html): The Center provides leadership in the development of basic scientific understanding of ecosystem processes, human interactions and value systems, and management and silvicultural practices that ensure the sustainability of forest land in California. Location: 145 Mulford Hall #3114, University of California, Berkeley, Berkeley, CA 94720-3114 (Telephone: 510-642-0095; Fax: 510-643-3490).

- **California Forest Stewardship Program** (http://ceres.ca.gov/foreststeward/): The program is designed to encourage good stewardship of private forest land. The program provides technical and financial assistance to influence positive changes to forest land management, assists communities in solving common watershed problems, and helps landowners. It includes a Forest Stewardship Helpline (Telephone: 1-800-PET-TREE), a quarterly newsletter, programs that provide financial and technical assistance, demonstration projects, and a landowner curriculum. A calendar of natural resource events is updated regularly for information on conferences, workshops, and other programs for the public. Its Web site also provides contacts for technical assistance related to forest stewardship issues (http://ceres.ca.gov/foreststeward/html/assistance.html).
- **Forestry Institute for Teachers** (http://www.forestryinstitute.org/): This program educates K-12 teachers about how ecosystems and their management affect the needs of both rural and urban citizens about water, wildlife, recreation, biological diversity, habitat protection, and consumer products derived from forests. Teachers who participate in the program are able to share their understanding of forest ecology and natural resource management principles and concepts with their students.
- **Humboldt State University College of Natural Resources and Sciences, Institute for Forest and Watershed Management** (http://www.cnr.berkeley.edu/forestry/information.html): The Institute is dedicated to the acquisition, compilation, dissemination, and application of knowledge about the sustainable management of ecological systems in Northern California (Telephone: 707-825-7350).
- **Northern California Society of American Foresters** (http://www.humboldt.edu/~norcal/index.shtml): This organization provides forums for professional development and community outreach.
- **Southern California Society of American Foresters** (http://www.ufei.calpoly.edu/socalsaf/): This organization provides forums for professional development and community outreach.
- **Registered Professional Forester Program** (http://www.fire.ca.gov/CDFBOFDB/pdfs/Role%20of%20RPF_2002%20ygeditfinal_.pdf): A registered professional forester (RPF) is a person knowledgeable in a wide range of studies such as biology, ecology, entomology, geology, hydrology, dendrology, silviculture, engineering, business administration, forest economics, and other natural resource subjects. RPFs use their well-rounded education and experience to maintain the sustainability of forest resources like timber, forage, wildlife, water, and outdoor recreation to meet the needs of the people while protecting the biological integrity and quality of the forest environment.

2.2.13.4 Case Study

Stewardship Education for Forest Landowners: The Extension Forestry group of the California Forest Stewardship Program has developed a comprehensive curriculum on forest ecology and management. The target user for this curriculum is the nonindustrial forest landowner who owns parcels of forest land but who is not in the commercial timber production business for a livelihood. The topics covered in the curriculum are organized around the themes of "who, where, what, when, how, why, and how much" and cover virtually all aspects of land ownership and management ranging from mapping through taxation and investment analysis. Existing sources were used and new documentation prepared to round out the information base. In the summer of 2001 some of the materials were used at a 3-day workshop for landowners held in Redding, and the exposure was valuable for improving the presentations. More information about the forest landowner curriculum is available at http://ceres.ca.gov/foreststeward/html/curriculum.html.

2.2.13.5 References

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Forestry*. Pre-Final Draft. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

2.3 Urban Areas

2.3.1 Introduction

With approximately 80 percent of the nation's population living in coastal areas, controlling polluted runoff in urban areas is a challenge. Negative impacts of urbanization on coastal and estuarine waters are well documented in a number of sources, including California's Clean Water Act section 305(b) and section 319 reports and the Nationwide Urban Runoff Program.

Major pollutants found in runoff from urban areas include sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, viruses, trash, and plastics. Suspended sediments constitute the largest mass of pollutant loadings to receiving waters from urban areas. Construction is a major source of sediment erosion. Petroleum hydrocarbons result mostly from automobile sources. Nutrient and bacterial sources include garden fertilizers, leaves, grass clippings, pet wastes, and faulty septic tanks. As population densities increase, a corresponding increase occurs in pollutant loadings generated from human activities. Many of these pollutants enter surface waters via runoff without undergoing treatment.

The control of urban nonpoint source (NPS) pollution requires the use of two primary strategies: the prevention of pollutant loadings and the treatment of unavoidable loadings. California's 15 urban management measures are organized to parallel the land use development process in order to address the prevention and treatment of NPS pollution loadings during all phases of urbanization; this strategy relies primarily on the watershed approach, which focuses on pollution prevention or source reduction practices. Pollution prevention and source reduction practices are favored over treatment practices because conducting education practices and incorporating pollution prevention practices into project planning and design activities are generally more effective, require less maintenance, and are more cost-effective in the long term than treatment strategies. Treatment strategies should be used only to address unavoidable loadings or where they are truly cost-effective.

The major opportunities to control NPS loadings occur during the following three stages of development: (1) the siting and design phase, (2) the construction phase, and (3) the post-development phase. Before development occurs, land in a watershed is available for a number of pollution prevention and treatment options, such as setbacks, buffers, or open space requirements, as well as wet ponds or constructed urban runoff wetlands that can provide treatment of the inevitable runoff and associated pollutants. In addition, siting requirements and restrictions and other land use ordinances, which can be highly effective, are more easily implemented during this period. After development occurs, these options may no longer be practicable or cost-effective. Management Measures 3.1A: Runoff from Developing Areas—Watershed Protection, 3.1B: Runoff from Developing Areas—Site Development, and 3.1C: Runoff from Developing Areas—New Development address the strategies and practices that can be used during the initial phase of the urbanization process.

Urban Category Links:

Runoff from Developing Areas
- ➔ Watershed Protection
- ➔ Site Development
- ➔ New Development

Runoff from Construction Sites
- ➔ Erosion and Sediment Control
- ➔ Chemical Control

Runoff from Existing Development
- ➔ Existing Development

Onsite Disposal Systems (OSDSs)
- ➔ New OSDSs
- ➔ Operating OSDSs

Transportation Development
- ➔ Planning, Siting, and Developing Roads and Highways
- ➔ Bridges
- ➔ Construction Projects
- ➔ Chemical Control
- ➔ Operation and Maintenance
- ➔ Road, Highway, and Bridge Runoff Systems

Education/Outreach
- ➔ Pollution Prevention/Education

The control of construction-related sediment loadings is critical to maintaining water quality. The implementation of proper erosion and sediment control practices during the construction stage can significantly reduce sediment loadings to surface waters. Management Measures 3.2A: Runoff from Construction Sites—Construction Site Erosion and Sediment Control and 3.2B: Runoff from Construction Sites—Construction Site Chemical Control address construction-related practices.

After development has occurred, lack of available land severely limits the implementation of cost-effective treatment options. Management Measure 3.3A: Runoff from Existing Development—Existing Development addresses strategies for reducing NPS pollution in already-developed areas. Managements Measures 3.4A: Onsite Disposal Systems—New OSDSs and 3.4B Onsite Disposal Systems—Operating OSDSs describe practices to properly install innovative wastewater treatment systems and to reduce pollution from improperly designed or maintained septic tanks and treatment systems. Management Measures 3.5A: Transportation Development—Planning, Siting, and Developing Roads and Highways, 3.5B: Transportation Development—Bridges, 3.5C: Transportation Development—Construction Projects, 3.5D: Transportation Development—Chemical Control, 3.5E: Transportation Development—Operation and Maintenance, and 3.5F: Transportation Development—Road, Highway, and Bridge Runoff Systems address runoff from transportation infrastructure, including the activities involved in building and maintaining roads, highways, and bridges.

Finally, Management Measure 3.6A: Education/Outreach—Pollution Prevention/Education can be used to reduce the amount of pollutants generated or allowed to be exposed to runoff.

2.3.1.2 SWRCB and RWQCB's NPDES Stormwater Program

The Urban NPS Program and Storm Water Programs are intricately linked in that both programs address aspects of urban runoff pollution. With respect to programs within the SWRCB and the RWQCBs, urban runoff is addressed primarily through the National Pollution Discharge Elimination System (NPDES) Permitting Program, although the SWRCB NPS Program will apply where the runoff is not regulated as a permitted point source discharge.

This permitted "point source" system of addressing urban runoff pollution is the result of the Water Quality Act of 1987, which amended the federal Clean Water Act to require NPDES permits for certain categories of storm water discharges. These "categories" of storm water discharges are described as follows:

Phase I of the Storm Water Program, defined in federal regulation in 1990, includes storm water discharges associated with "industrial" activities (as defined by the regulations), construction activities that disturb five acres of land or more, and discharges from municipal separate storm sewer systems (MS4s) serving populations of 100,000 people or more. Phase II of the Storm Water Program, defined in federal regulations in 1999, expanded the program to require NPDES permits for discharges from construction sites disturbing between one and five acres, from small MS4s that serve populations of less than 100,000, from some other governmental facilities, and from industrial facilities owned by small municipalities. The expansion of the Storm Water Program through Phase II has therefore expanded the applicability of the NPDES point source program to a greater number of communities, businesses, government facilities, and industries. The result is that most urban runoff in California is now subject to NPDES permits.

The expansion of the storm water NPDES program has resulted in applying NPDES requirements in areas where NPS was previously the sole regulatory program. In is important to understand that the NPDES Program supercedes the SWRCB or RWQCB NPS Program in the areas where there is overlap. NPDES permits require implementation of best management practices, which may or may not be similar to the

management measures and management practices of the NPS Program. However, the SWRCB/RWQCB's NPDES Program does not supercede the planning and land-use activities of other State agencies, such as the California Coastal Commission or the San Francisco Bay Conservation and Development Commission, which they are responsible for implementing under their own regulatory authorities.

The SWRCB/RWQCB NPDES permits are at least as stringent as the NPS Program and will ensure at least the same level of compliance and water quality protection as the NPS Program's management measures provide. Further, the authority of the SWRCB/RWQCB NPS Program will still apply for land use activities not covered by NPDES permits and for municipalities, construction sites, and industries that fall outside of the Phase I and Phase II Storm Water Programs.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.3.2 Management Measure 3.1A Runoff from Developing Areas Watershed Protection

Management Measure

Develop a watershed protection program to

1. Avoid conversion, to the extent practicable, of areas that are particularly susceptible to erosion and sediment loss;

2. Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian and aquatic biota;

3. Protect to the extent practicable the natural integrity of water bodies and natural drainage systems associated with site development—including roads, highways, and bridges;

4. Limit increases of impervious surfaces; and

5. Provide education and outreach to address sources of NPS pollution.

2.3.2.1 Introduction

The intent of this management measure is to encourage land use and development planning on a watershed scale that takes into consideration sensitive areas that, by being protected, will maintain or improve water quality. Each element of the management measure addresses key issues that result in water quality degradation. Progress can be made when these issues are addressed holistically in a watershed-wide plan.

2.3.2.2 Programs

The California Department of Conservation, Division of Land Resource Protection, provides to landowners information on grants and financial assistance, mapping, and technical resources for protecting natural resources (http://www.consrv.ca.gov/DLRP/index.htm).

Through the Clean Water Act (CWA) section 401 certification program, Regional Water Quality Control Boards (RWQCBs) review projects that require a federal permit under CWA section 404 or that involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. The process for applying for Water Quality Certification under CWA section 401 in California is described on the State Water Resources Control Board's (SWRCB) Web site (http://www.swrcb.ca.gov/rwqcb2/certs.htm).

The California Department of Fish and Game (DFG) may regulate a project through the Streambed Alteration Agreement process. DFG issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes (http://www.dfg.ca.gov/1600/index.shtml).

The Watershed Information Technical System (WITS), developed by the California Environmental Resources Evaluation System (CERES), is a program that provides the information and tools to support local watershed planning, restoration, monitoring, and education. CERES and WITS are programs of the California Resources Agency (http://ceres.ca.gov/watershed/).

California Environmental Quality Act: If CEQA compliance is required (if the project is not found to be exempt based on the current CEQA Guidelines), a local or State agency must act as the lead CEQA agency. More information about CEQA can be found at (http://ceres.ca.gov/ceqa/).

2.3.2.3 Management Practices

Part 1 of the management measure states that areas particularly susceptible to erosion and sediment loss, specifically areas with highly erodible soils or steep slopes, should be avoided when siting new developments. Arendt (1996) developed a process by which a development envelope could be defined based on factors such as soil type, slope, ecological significance, floodplain delineations, existing vegetation, and cultural/historical significance. On a larger scale, undeveloped areas can be ranked by overlaying data sets in a geographic information system (GIS) that describes factors such as those listed above to guide decisions regarding zoning classification.

The second part of the management measure deals with protecting areas that provide water quality benefits, including protection of riparian vegetation and wildlife. Wetlands and riparian areas can be protected by local governments through the implementation of buffer ordinances. In addition, landowners can chose to implement buffers and setbacks on their property and to protect wetlands and other ecologically sensitive areas from development. To formalize this process of protecting water resources, a variety of conservation mechanisms can be used, such as easements, deed restrictions, and covenants. Developers should be encouraged to protect water resources as a selling point (aesthetic and ecological amenity).

The third part of the management measure deals with protecting the integrity of water resources from the effects of site development and infrastructure. This can be accomplished by establishing setbacks from natural drainage areas and using vegetated buffers to provide additional protection. In addition, culverts and crossings can be designed to minimize impacts on riparian areas and to enhance natural drainage rather than impede or overwhelm it. Finally, grading plans can be designed to minimize the adverse hydrologic impacts of clearing and the creation of impervious areas by dispersing drainage to multiple outlets so as not to overwhelm a single drainage feature.

The fourth part of the management measure proposes limiting increases of impervious surfaces. Developers can use innovative site and structure designs that reduce building footprints, decrease the amount of paved infrastructure, and provide for dispersed drainage and infiltration of runoff from impervious surfaces to reduce "effective impervious surface," which can be defined as impervious surface that is connected to the storm water drainage system. The concept of effective impervious surface is important, because when runoff from these surfaces is directed to pervious areas rather to an impervious drainage system (i.e., curbs, gutters, street surfaces, storm drain pipes), it can infiltrate, evaporate, or be taken up by vegetation, thereby reducing the total volume of runoff leaving a site.

The fifth part of the management measure deals with education and outreach regarding NPS pollution. There are abundant opportunities to involve the public in NPS pollution management, including distributing educational materials, holding training sessions and workshops, involving the public in water resource-specific activities such as cleanups and festivals, and encouraging stakeholder involvement in water resource-related decisions via public hearings and meetings. These activities can be focused on high-priority water bodies, groups who contribute to pollution (e.g., lawn care professionals, homeowners

with yards, pet owners), or specific demographic groups (e.g., Spanish-speaking populations, school children).

2.3.2.4 Information Resources

Data for Watershed Evaluations and Determination of Site Characteristics

- **Natural Resources Conservation Service Soil Maps** (http://soils.usda.gov/soil_survey/pub_sur/ca.htm): Soil maps and electronic data available from the Natural Resources Conservation Service can be used to identify areas with highly erodible soils, and topographic maps and data can be purchased from the U.S. Geological Survey and used to identify steep slopes. To view a list of available soil surveys and to obtain soil maps, contact the State Conservationist or access the Soil Survey Request Form.
- **U.S. Fish and Wildlife Service, Pacific Region Field Offices** (http://pacific.fws.gov/ecoservices for Ecological Services staff contact information): Critical Habitat Areas for endangered species can be identified with the assistance of the Fish and Wildlife Service Pacific Region Field Offices in Yreka, Arcata, Red Bluff, Sacramento, Barstow, and Ventura.
- **The California Office of Historic Preservation** (http://ohp.parks.ca.gov/): The Office of Historic Preservation can provide guidance on identifying and conserving cultural or historical resources and meeting the requirements of CEQA, the National Environmental Policy Act (NEPA), and the National Historic Preservation Act (NHPA) regulations.

Land and Water Resource Conservation Options

- **Stormwater Manager's Resource Center** (http://www.stormwatercenter.net/): The Stormwater Manager's Resource Center provides resources for those involved in local storm water management. These resources include a monitoring/assessment section that details environmental indicators, methods, factors to consider in an assessment, and assessment tools and models. The Web site also has articles about land conservation, open space ordinances, and a fact sheet on conservation easements.
- **Nonpoint Education for Municipal Officials (NEMO)** (http://nemo.uconn.edu/): NEMO offers guidance, research studies, data, and land use planning tools to help local officials make land use decisions that will protect natural resources.
- ***The National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft*** (http://www.epa.gov/owow/nps/urbanmm): This guidance manual from USEPA has a review of the various options available for land and water resource conservation (pages 4-5) (USEPA, 2002).
- Nonprofit conservation organizations: Information about land and water resource conservation for landowners is available from several nonprofit organizations, including the **Land Trust Alliance** (http://www.lta.org/), **The Conservation Fund** (http://www.conservationfund.org/), and the **Natural Lands Trust** (http://www.natlands.org/).
- ***Wildlife Reserves and Corridors in the Urban Environment: A Guide to Ecological Landscape Planning and Resource Conservation*** (http://users.erols.com/urbanwildlife/bookstor.htm): This book by Lowell Adams and Louise Dove reviews the knowledge base regarding wildlife habitat reserves and corridors in urban and urbanizing areas and provides guidelines and approaches to

ecological landscape planning and wildlife conservation in such areas. It can be purchased from the Urban Wildlife Resources Bookstore at the Web site listed above.

- ***Growing Greener: Putting Conservation into Local Codes*** (http://www.natlands.org/pdffiles/growinggreener.pdf): Growing Greener is a statewide community planning initiative designed to help communities use the development regulation process to their advantage to protect interconnected networks of greenways and permanent open space. The booklet can be downloaded as a PDF file at the Web site listed above.
- **Smart Growth Network** (http://www.smartgrowth.org/): The Smart Growth Network is a nationwide effort coordinated by USEPA's Urban and Economic Development Division. USEPA is working through cooperative partnerships with a diverse network of organizations to encourage development that better serves the economic, environmental, and social needs of communities. The network provides a forum for information-sharing, education, tool development and application, and collaboration on smart growth issues. Smart growth approaches focus on flexible zoning, preventive planning, intelligent management of natural resources and water quality, and implementation of treatment and control technologies at multiple scales from development sites to watershed planning.
- **Northeastern Illinois Planning Commission** (http://www.nipc.cog.il.us/pubslist.htm): The Northeastern Illinois Planning Commission (NIPC) published *Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District: A Guide for Local Officials*. The model ordinance can be ordered from the NIPC publications Web site.
- **Green Infrastructure Web site** (http://www.greeninfrastructure.net/): The concept of creating and maintaining an interconnected network of protected land and water is called Green Infrastructure. Green Infrastructure supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life. This Web site, developed by The Conservation Fund with support from USDA Cooperative Forestry, contains information to aid in implementing a comprehensive conservation program and includes resources such as searchable profiles, training information, events, and references databases.

Buffer Resources

- **Model Ordinances to Protect Local Resources Web site** (http://www.epa.gov/owow/nps/ordinance): USEPA published this Web site to provide model ordinance language and examples of ordinances that have been implemented by municipalities across the country.
- **Ordinance on Riparian Habitat Areas, City of Napa, California** (http://www.stormwatercenter.net/Model Ordinances/napa_buffer_ordinance.htm): The City of Napa has implemented an ordinance to protect riparian areas that can be used as an example by other California municipalities.
- **Buffer Strips: Common Sense Conservation** (http://www.nrcs.usda.gov/feature/buffers/): This USDA NRCS Web site features information on buffers including background information about the USDA NRCS buffer initiative and the benefits of buffers, technical information for implementing buffers, contacts that can provide assistance with buffer establishment, and examples of successful buffer implementation. A list of contacts can be found at this site as well. California-specific information about buffers can be found at http://www.ca.nrcs.usda.gov/programs/buffer.html.

- ***Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*** (http://www.serc.si.edu/SERC_web_html/pub_ripzone.htm): This Web site presents an annotated and indexed bibliography of buffer strip literature.

Impervious Area Reduction/Innovative Site Designs

- **The Center for Watershed Protection** (http://www.cwp.org/): This nonprofit organization has produced several publications and other technical resources to help planners implement better site design techniques to reduce storm water from impervious surfaces. Specifically, the *Rapid Watershed Planning Handbook*, published in 1998, describes techniques that communities can use to more effectively protect and restore water resources.
- **The Low Impact Development Center Web site** (http://www.lowimpactdevelopment.org/): This nonprofit organization's Web site provides technical references for implementing low impact development techniques and has case studies of sites where these practices have been successfully implemented.

2.3.2.5 References

Arendt, R. 1996. *Conservation Design for Subdivisions*. Island Press, Washington, DC.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft.* EPA 842-B-02-003. U.S. Environmental Protection Agency, Washington, DC.

Fact Sheet Links:
➔ Programs
➔ Management Practices
➔ Information Resources
➔ Case Studies
➔ References

2.3.3 Management Measure 3.1B Runoff from Developing Areas Site Development

Management Measure

Plan, design, and develop sites to

1. Protect areas that provide important water quality benefits necessary to main riparian and aquatic biota, and/or are particularly susceptible to erosion and sediment loss;

2. Limit increases of impervious areas;

3. Limit land disturbance activities such as clearing and grading, and cut-and-fill to reduce erosion and sediment loss; and

4. Limit disturbance of natural drainage features and vegetation.

2.3.3.1 Programs

Through the Clean Water Act (CWA) section 401 certification program, RWQCBs review projects that require a federal permit under CWA section 404 or that involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. The process for applying for Water Quality Certification under CWA section 401 in California is described on the SWRCB Web site (http://www.swrcb.ca.gov/rwqcb2/certs.htm).

The California Department of Fish and Game (DFG) may regulate a project through the Streambed Alteration Agreement process. DFG issues Streambed Alteration Agreements when project activities have the potential to impact intermittent and perennial streams, rivers, or lakes. More information about this program can be found at DFG's Web site (http://www.dfg.ca.gov/1600/index.shtml).

California Environmental Quality Act: If CEQA compliance is required (if the project is not found to be exempt based on the current CEQA Guidelines), a local or State agency must act as the lead CEQA agency. More information about CEQA can be found at http://ceres.ca.gov/ceqa/.

2.3.3.2 Management Practices

Development sites should be evaluated to identify areas that are less suitable for development (i.e., steep slopes, erodible soils, wetlands, land within the 100-year floodplain, and historically or culturally significant areas. Building footprints and infrastructure should be located away from these areas where feasible. Local governments can enact ordinances to protect specific resources such as wetlands or riparian areas, and landowners can be encouraged to voluntarily practice conservation of ecologically significant areas.

Traditional post-World War II development patterns dictate wide streets, large setbacks from the street (resulting in long driveways), and sidewalks on both sides of the street. These infrastructure patterns create an excess of impervious surface, which generates more runoff than would undeveloped land, grass,

and other landscaped areas. Exacerbating this problem is the fact that most modern developments have curb and gutter systems to efficiently collect and rapidly convey this runoff to natural drainage systems, which can overwhelm the receiving water body and result in flooding and water quality degradation.

In recent years, techniques have been developed to redesign traditional subdivisions and commercial properties to reduce the amount of land converted to impervious surfaces. These techniques have many names—including cluster development, open space design, better site design, and low impact development—but a common feature of all of them is to reduce the amount of impervious surfaces created on a particular site. This might involve any of the following practices:

- Designing streets to be narrower
- Placing sidewalks on only one side of the street
- Providing pervious areas for on-street parking
- Redesigning the layout of buildings to reduce street length and preserve open space
- Reducing setbacks for houses
- Reducing parking lot sizes to reflect actual usage
- Promoting shared parking among nearby businesses with different peak demands for parking (e.g., churches and retail businesses)
- Disconnecting impervious surfaces through creative grading plans and distributed infiltration areas

These techniques, among others, can be used as appropriate to reduce the impact of an individual development site on receiving waters. Municipalities can require that these types of practices be implemented through an ordinance that provides modified, environmentally friendly standards for infrastructure dimensions and layouts. In addition, these practices can be encouraged through storm water credits or density credits provided as incentives to developers.

To limit land disturbance activities, developers and construction site contractors can practice site fingerprinting, which is a technique that reduces the amount of land disturbed on a development site to that which will be built upon. Site fingerprinting entails flagging off areas where vegetation is to be preserved so that heavy equipment will not be driven over those areas and so that stockpiles will be placed elsewhere. Signage and other training/education materials for construction site workers are essential to ensure that the protected areas remain undisturbed.

2.3.3.3 Information Resources

- ***California New Development and Redevelopment Handbook*** (http://www.cabmphandbooks.org/): Section 2 of this manual contains information about storm water quality planning for new development and redevelopment, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, modifying development layouts, conducting a site evaluation, and selecting management practices. Section 3 discusses how site layouts should be designed to reduce water quality impacts.

- ***National Menu of Best Management Practices for Storm Water Phase II*, Post-Construction Storm Water Management in New Development and Redevelopment Fact Sheets** (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm): USEPA's guidance for small NPDES-regulated municipalities details several site design practices to reduce the amount of storm water generated on a development site and to disconnect impervious surfaces from the municipal separate storm sewer system. Especially useful for this management measure are the fact sheets listed under "On-lot Treatment" and "Better Site Design."
- **Center for Watershed Protection Resources** (http://www.cwp.org/): The *Consensus Agreement on Model Development Principles to Protect Our Streams, Lakes, and Wetlands* outlines the series of 22 nationally endorsed principles developed by the Site Planning Roundtable, a national cross section of diverse planning, environmental, home builder, fire, safety, public works, and local government personnel, and details basic rationale for their implementation. Also, *Better Site Design: A Handbook for Changing Development Rules in Your Community* outlines 22 guidelines for better developments and provides detailed rationale for each principle. *Better Site Design* also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from across the country. The Center also provides technical information about reducing impervious surfaces in new developments.
- ***Growing Greener: Putting Conservation into Local Codes*** (http://www.natlands.org/pdffiles/growinggreener.pdf): In 1997 Randall Arendt of the Natural Lands Trust, Inc., published *Growing Greener*, which is a statewide community planning initiative designed to help communities use the development regulation process to their advantage to protect interconnected networks of greenways and permanent open space.
- **Low Impact Development Center** (http://www.lowimpactdevelopment.org/): This nonprofit organization's Web site has technical resources and case studies that illustrate successful implementation of low impact development techniques.
- ***Low-Impact Development Design Strategies: An Integrated Design Approach*** (EPA-841-B-00-003) and ***Low-Impact Development Hydrologic Analysis*** (EPA-841-B-00-002), both developed by the Prince George's County, Maryland, Department of Environmental Resources, discuss site planning, hydrology, distributed integrated management practice technologies, erosion and sediment control, and public outreach techniques that can reduce storm water runoff from new and existing developments. Both publications can be ordered free of charge through USEPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.
- ***Residential Streets***, prepared by the American Society of Civil Engineers, the National Association of Home Builders, and the Urban Land Institute, discusses design considerations for residential streets based on their function and their place in the neighborhood. The publication presents guidance on street widths, speeds, pavement types, streetscapes, rights-of-way, intersections, and drainage systems. It can be ordered online at http://www.amazon.com/ or other online booksellers.
- ***Traditional Neighborhood Development—Street Design Guidelines*** (http://www.ite.org/bookstore/): The Institute of Transportation Engineers (ITE) published this manual, which details traditional neighborhood designs that foster pedestrian movement in place of automobile traffic are discussed and design concepts such as on-street parking, street width, and sight distances are presented. The publication also includes a practical discussion of the time needed for community acceptance and travel behavior changes. ITE also published ***Guidelines for Residential Subdivision Street Design*** (1993), which presents a discussion of the overall design of a residential subdivision with respect to the adequacy of vehicular and pedestrian

access, minimizing excessive vehicular travel, and reducing reliance on extensive traffic regulations. It also includes design considerations for local and collector streets and intersections, including such topics as terrain classifications, rights-of-way, pavements, curb types, and cul-de-sacs. These publications are available through the ITE's online bookstore.

- ***Street Design Guidelines for Healthy Neighborhoods*** (http://www.lgc.org/bookstore/land_use/publications/healthystreets.html): This is a guidebook intended to help communities implement designs for streets that are safe, efficient, and aesthetically pleasing for both people and cars. This publication can be purchased from the Local Government Commission's Center for Livable Communities Web site.
- **Reduced Width Street Standards Database** (http://www.sonic.net/abcaia/narrow.htm): The Congress for the New Urbanism has compiled a database of jurisdictions across the country that have adopted reduced width street standards. The database also includes resources related to neighborhood design and transportation.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.3.4 Management Measure 3.1C Runoff from Developing Areas New Development

Management Measure

1. By design or performance:

After construction has been completed and the site is permanently stabilized, reduce the average annual total suspended solids (TSS) loadings by 80 percent (for the purposes of this measure, an 80 percent TSS reduction is to be determined on an average annual basis); or

Reduce the post-development loadings of TSS so that the average annual TSS loadings are no greater than pre-development loadings.

2. To the extent practicable, maintain post-development peak runoff rate and average volume at levels that are similar to pre-development levels.

The first part of this management measure addresses increased pollutant loads associated with developed lands. The second part of this management measure addresses the hydrologic alterations resulting from development that affects runoff volume and timing. Developers can use innovative site planning techniques or incorporate runoff management practices to reduce the hydrologic impact of development on receiving waters.

2.3.4.1 Programs

NPDES Storm Water Program. Most urban runoff is regulated under the NPDES permitting program as point source discharges from municipally owned or operated separate storm sewer systems (MS4s). This program has requirements distinct from those of the NPS program, although the same set of management practices is appropriate for controlling pollutants from both storm water and nonpoint sources. The specific requirements for owners and operators of MS4s depend on the municipality's or public entity's population size and water quality concerns. More information about the requirements can be found at California's Storm Water Program Web site (http://www.swrcb.ca.gov/stormwtr/).

2.3.4.2 Management Practices

In urban areas that do not meet the criteria to be covered under the NPDES storm water regulation, the NPS program requires that owners of new developments implement management practices to meet the requirements of the management measure described above. There are two parts to the requirement: first, runoff quality must be addressed by implementing treatment controls that remove at least 80 percent of the average annual TSS loadings in runoff. TSS is used as a measure of pollutant removal effectiveness because it is a common pollutant in urban runoff and is often associated with other pollutants such as nutrients and heavy metals. The second part of the management measure directs developers to implement practices to control the timing and volume of runoff leaving the site such that it mimics the hydrology of the site before development. The adverse impacts of increased hydraulic loadings to urban streams are well documented and include channel widening, instream and riparian habitat loss, increased pollutant loads, temperature impacts, and increased erosion of streambanks and streambeds, to name a few.

The NPS management measures do not specify a single method that should be used to achieve this level of pollutant removal, which allows developers flexibility in meeting both the 80 percent TSS removal and pre-development hydrology criteria. The types of technologies that can be used to achieve both criteria include detention ponds/vaults, retention ponds and wetlands, infiltration practices, filtration practices, open channel practices, and various proprietary practices, as described in the following:

- Temporary *detention ponds or vaults* that hold runoff and release it slowly but completely after a 72-hour or shorter period.
- *Retention pond or wetlands* in which a permanent pool of water is maintained and runoff is slowly released over time. Retention practices, by allowing water to stand for a longer period of time, achieve greater pollutant removal through settling and allow for biological uptake using wetland vegetation.
- *Infiltration practices*, such as basins, trenches, and French drains, collect runoff and convey it through a porous matrix into the ground water.
- *Filtration practices*, such as sand or organic filters and bioretention practices, act similarly to infiltration practices but area designed to achieve greater pollutant removal and have limited hydraulic loading capacities.
- *Open channel practices*, such as grassed swales, are commonly and effectively used to collect, convey, and infiltrate runoff, but they are not intended to drain large areas of impervious surfaces and therefore are typically implemented in combination with other practices.
- *Proprietary practices* that are typically installed underground use mechanisms such as settling, absorption, and microfiltration as well as other mechanisms such as centrifugal force and gross filtration to remove solids and floatable debris.

2.3.4.3 Information Resources

- ***California New Development and Redevelopment Handbook*** (http://www.cabmphandbooks.org/): Section 2 of this manual contains information about storm water quality planning for new development and redevelopment, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, modifying development layouts, conducting a site evaluation, and selecting management practices. Section 3 discusses how site layouts should be designed to reduce water quality impacts.
- ***Model Urban Runoff Program* Appendix 4T: Post-Construction Controls** (http://www.coastal.ca.gov/la/docs/murp/4t.pdf): The appendix to this manual contains a section on treatment controls that describes rooftop treatment systems, vegetated filter strips, vegetated swales, infiltration basins and trenches, detention ponds, retention ponds, constructed wetlands, filtration practices, and oil/grit separators. It also includes a list of additional resources for more information.
- **USEPA, *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*** (http://www.epa.gov/owow/nps/urbanmm/): Management Measure 5 of this manual describes the different types of treatment controls, including design and maintenance considerations, cost, and effectiveness.
- ***National Menu of Best Management Practices for Storm Water Phase II*, Post-Construction Storm Water Management in New Development and Redevelopment Fact Sheets** (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm): USEPA's guidance for small

NPDES-regulated municipalities details numerous runoff treatment practices to reduce the volume of and pollutant concentrations in storm water from new development sites.

- **California Department of Transportation (Caltrans), *Statewide Storm Water Quality Practice Guidelines*** (http://www.dot.ca.gov/hq/env/stormwater/special/swmp_guidelines_5_03/section5.pdf): Section 5 of this manual describes treatment practices that Caltrans has approved (biofiltration swales and strips, infiltration basins, detention devices, traction sand traps, dry weather flow diversion, and linear radial device and inclined screens) and the process by which the practices are selected, sited, sized, designed, and implemented to minimize environmental impact.
- **USEPA, Environmental Technology Verification (ETV) Web site** (http://www.epa.gov/etv): The ETV program Web site, sponsored by USEPA and the National Sanitation Foundation, develops testing protocols and verifies the performance of innovative technologies for environmental controls, including storm water treatment practices. It is a good source for determining the relative performance of new proprietary technologies.
- ***Caltrans New Technology Report*** (http://www.dot.ca.gov/hq/env/stormwater/annual_report/2003/_annual_report/2003_new_technology_report.pdf): This report summarizes and standardizes information on new technologies, including the latest innovations in permanent storm water treatment and control and existing technologies currently in use. The report contains fact sheets describing progress in 121 existing full-scale and small-scale pilot studies for new technologies. The categories of practices being tested include adsorption/ion exchange, chemical treatment, disinfection, drain inlet inserts, detention basin outlet improvements, filters, filtration, infiltration trenches with alternative backfill, litter and debris removal, and sedimentation.
- **City of Los Angeles Stormwater Program, *Reference Guide for Stormwater Best Management Practices*** (http://www.lacity.org/SAN/wpd/index.htm): This document provides background information on various storm water management practices, along with comprehensive selection matrices, cost information, and target pollutants for each management practice.
- **Los Angeles County Department of Public Works, *Standard Urban Storm Water Mitigation Plan (SUSMP)*** (http://www.ladpw.org/wmd/NPDES/SUSMP_MANUAL.pdf): As required by LA County's Development Planning Model Program, the SUSMP was developed to guide builders, land developers, engineers, planners, and others in the selection of post-construction management practices. The document also provides guidance to assist in gaining municipal approval for urban storm water runoff mitigation plans prior to the issuance of building and grading permits.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.3.5 Management Measure 3.2A Runoff from Construction Sites Construction Site Erosion and Sediment Control

Management Measure

1. Reduce erosion and, to the extent practicable, retain sediment on site during and after construction; and

2. Prepare and implement, prior to land disturbance, an effective, approved erosion and sediment control plan or similar administrative document that specifies erosion and sediment control provisions.

2.3.5.1 Programs

Discharges of pollutants from construction activities are for the most part regulated under the NPDES permitting program. Regulated entities include all construction sites with one or more acres of disturbed area. The SWRCB, Division of Water Quality, Storm Water Program Web site (http://www.swrcb.ca.gov/stormwtr/construction.html) provides information to permittees to help them meet the requirements of the NPDES regulations.

Discharges of pollutants from construction sites smaller than 1 acre typically are considered nonpoint sources but might also be regulated at the local level. Construction site operators should contact the municipal department for more information about local requirements, including air quality requirements for dust control.

2.3.5.2 Management Practices

Storm Water Pollution Prevention Plan

A storm water pollution prevention plan (SWPPP) describes in detail how a contractor or developer will reduce soil erosion and contain and treat runoff bearing eroded sediments and construction site chemicals. It normally includes the locations and type of pollutants present, as well as practices used on the site for soil stabilization, perimeter control, and runoff treatment, including vegetation practices, structural and nonstructural practices. It also details spill control measures, response actions, and a monitoring program. The SWPPP entails more than filing written documentation. It requires follow-through on the part of both the developer (for implementation) and regulator or permitting agency (for inspection and enforcement). This follow-through can include reviewing and modifying the SWPPP to account for unexpected events that occur after plans have been approved, and adapting to unforeseen conditions on the site. It must also include inspecting and assessing the effectiveness of implemented management practices on storm water quality. In some cases, practices will require maintenance or alternative or additional management practices.

Erosion Control Practices

Erosion control is the first step in reducing sediment pollution from construction sites. There are several opportunities for erosion control, beginning at the planning stages of construction. Clearing and grading should be scheduled during the dry season when storm water runoff is expected to be minimal. Construction should be undertaken in a phased schedule, in contrast to the traditional practice of grading a site or excavating it all at once. In phased construction, clearing, grading, and building take place at only one part of a site at a time, and new parts of the site are cleared only after the last part is stabilized with permanent erosion controls and revegetated.

Site fingerprinting is a technique that can be used to protect vegetation and reduce erosion. This practice limits clearing to areas that will be used for buildings, roads, and other infrastructure, leaving undisturbed areas that will be vegetated open space in the final plan. Areas that will remain undisturbed need to be marked off and construction equipment and stockpiles must be excluded to protect the existing vegetation and prevent compaction or erosion. The advantages of site fingerprinting are that natural areas are protected and fewer costs for landscaping are incurred. A disadvantage is that equipment will need to be maneuvered around these protected areas, possibly leading to increased labor hours.

The use of chemical additives to stabilize the soil is sometimes recommended to reduce erosion of exposed, unvegetated areas. Polyacrylamide (PAM) is a common polymer for controlling erosion and promoting infiltration on irrigated agricultural lands, and it has been recommended to reduce erosion on urban construction sites and disturbed areas. It decreases soil bulk density, absorbs water, and binds fine-grained soil particles. Caution should be used when applying PAM in ecologically sensitive areas because its toxicity to aquatic life is unknown. For more information about using PAM at construction sites, visit http://www.epa.gov/ORD/WebPubs/nctuw/Roa-Espinosa.pdf (Roa-Espinosa et al., 2000). This paper provides a literature review and experimental results of PAM use at construction sites.

After clearing, grading, and building are complete, temporary and permanent erosion controls should be implemented, including seeding, mulching, sodding, and installing erosion control blankets:

- *Seeding* with native grasses can be used to establish permanent erosion control. There are several seeding techniques that can be used, including broadcast seeding, hydroseeding, and drill seeding. Broadcast seeding is the simplest method and involves scattering seeds by hand or mechanically. Hydroseeding involves spraying a slurry of seeds, fertilizer, tackifier, and water onto exposed soils. This method is more expensive but can be more effective at erosion control because the water and fertilizer additives promote fast growth and the tackifier provides immediate stabilization.

- *Mulching* of disturbed soils can be effective at reducing erosion. Materials used include tacked straw and wood chips and are often covered by erosion control blankets or netting. The mulch typically has a short useful life and is only a temporary measure. Mulching alone should be used when permanent seeding is not feasible, such as in arid or winter conditions when vegetative growth is slow or absent.

- Using *sod* permanently and immediately stabilizes an area with a thick vegetative cover and should be used in sensitive areas or where establishing permanent vegetation by seeding would be difficult.

- *Erosion control blankets* or *turf reinforcement mats* (TRMs) protect the soil from scouring due to runoff and can enhance vegetative growth. TRMs can raise the threshold of natural vegetation to

withstand higher hydraulic forces on slopes and streambanks and in channels. They should be used in combination with seeding to achieve permanent results.

- *Wind erosion controls*, which include bales of hay, solid board fences, and snow fences, can be used to keep soil in place. Sprinkling with water can moisten the soil surface, but watering should be done in moderation to prevent a non-storm water discharge.

- Runoff can be intercepted above disturbed sites and conveyed to a permanent channel or storm drain. Conveyance systems may be *earth dikes*, *perimeter dikes/swales*, or *diversions*. A pipe slope drain or pipe drop structure is a temporary pipe placed from the top of a slope to the bottom of the slope to convey concentrated runoff down the slope without causing erosion.

- On long or steep, disturbed, man-made slopes, *benches*, *terraces*, or *ditches* can be constructed at regular intervals, or retaining walls can be erected, to intercept runoff, slow it down, and prevent it from becoming concentrated flow.

- *Linings* for urban runoff conveyance channels can be installed to prevent scouring. The first choice of lining should be grass or sod because it reduces runoff velocities and provides water quality benefits through filtration/infiltration. Also effective are turf reinforcement mats, riprap, concrete, and gabions.

- *Flow control practices* can be installed in channels to reduce runoff velocity. For example, check dams are small temporary dams constructed across a swale or channel and can be used to reduce the velocity of concentrated flow and, therefore, to reduce erosion in a swale or channel.

Sediment Control Practices

The second step in preventing sediment pollution from construction sites is to install devices that trap or filter sediment from runoff. These can include sediment basins and traps, filter fabric fences, inlet protection devices, and stabilized construction entrances.

- *Sediment traps:* These are typically installed in a drainage way or other point of discharge from a disturbed area. They are small impoundments that allow some sediment to settle out of runoff water before it is drained through a rock dam. Temporary diversions in the form of berms or channels can be used to direct runoff to the sediment trap.

- *Sediment basins:* The use of sediment basins is a popular way to retain sediment generated at the site during construction and can be adapted to serve as runoff control after the site is stabilized. A perforated pipe riser (sometimes wrapped in filter fabric) connected to a drain pipe constricts flow and slowly releases impounded water from the bottom of the basin. A recent modification to the standard sediment basin design is the use of a floating skimmer, which slowly drains relatively clear water from the top of the basin. These structures require regular inspection and maintenance to ensure that they are not clogged with debris or sediment.

- *Filter fabric fence:* Filter fabric or silt fences can be used along the perimeter of the disturbed area to filter out sediment as runoff flows through the fabric. Such fences should be used only where there is sheet flow (no concentrated flow), and the maximum drainage area should be one-half acre or less per 100 feet of fence.

- *Storm drain inlet protection:* Sediment should be excluded from storm drains using inlet protection measures to trap sediment before it enters the storm sewer system. Common inlet protection measures include riprap wrapped in chicken wire, cinder blocks filled with gravel, straw wattles wrapped in filter fabric, drop-inlet bags, and other combinations of materials that filter runoff. Inspection and maintenance of these measures is essential to their effectiveness; failure to remove sediments and debris can result in reduced treatment of runoff and flooding due to clogging.

- *Stabilized construction entrances.* Construction entrances should be clearly designated and reinforced with gravel, corrugated metal sheets, or devices specially designed to clear tires of sediment and hold it for later cleanout. This practice of protecting construction entrances can minimize the loss of sediment associated with the equipment and traffic leaving the site.

2.3.5.3 Information Resources

- **California Storm Water Program Web site** (http://www.swrcb.ca.gov/stormwtr/construction.html): This site provides information to permittees to help them meet the requirements of the NPDES regulations. The site includes frequently asked questions, the construction general permit, forms, and tools for searching State databases of permittees.

- ***Storm Water Best Management Practice Handbook: Construction*** (http://www.cabmphandbooks.org/Construction.asp): *The Construction Handbook* outlines waste management practices in a set of fact sheets that include erosion controls (scheduling, velocity dissipation devices, slope drains, streambank stabilization, polyacrylamide, preservation of existing vegetation, hydraulic mulch, hydroseeding, soil binders, straw mulch, geotextiles and mats, wood mulching, earth dikes, and drainage swales), sediment controls (silt fence, storm drain inlet protection, chemical treatment, sediment basins, sediment traps, check dams, fiber rolls, gravel bag berms, street sweeping and vacuuming, sandbag barriers, straw bale barriers, stabilized construction entrances and exits, stabilized construction roadways, entrance/outlet tire washing), and wind erosion control.

- ***Erosion and Sediment Control Field Manual*** (http://store.abag.ca.gov/construction.asp): This manual from the San Francisco RWQCB describes management practices for construction site planning and management, erosion and sediment control, pollution prevention, and sampling guidelines. Descriptions of practices are concise and include full-color graphics and installation information including guidelines, timing, and limitations. The manual also includes the new Phase II regulations, the SWRCB's sampling and monitoring guidelines, and long-term maintenance information. Also available are several erosion and sediment control videos (in English and Spanish), ***Guidelines for Construction Projects***, and a ***CD Training Kit*** that includes a complete training kit for construction site planning and management for compliance with NPDES requirements, the1999 version of the *Erosion and Sediment Control Field Manual*, and *Guidelines for Construction Projects*.

- ***National Menu of Best Management Practices for Storm Water Phase II*, Construction Site Storm Water Runoff Control Fact Sheets** (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/con_site.cfm): USEPA's guidance for small NPDES-regulated municipalities details numerous erosion and sediment control techniques to reduce the generation and offsite transport of dust, sediment, and construction site chemicals and materials.

2.3.5.4 References

Association of Bay Area Governments. 2003. *Construction Site Planning*. (http://store.abag.ca.gov/construction.asp) Accessed April 22, 2003.

SWRCB. 2003. *Storm Water Program*. (http://www.swrcb.ca.gov/stormwtr/index.html) Accessed April 22, 2003.

Roa-Espinosa, A., G.D. Bubenzer, and E.S. Miyashita. 2000. Sediment and runoff control on construction sites using four application methods of polyacrylamide mix. In *National Conference on Tools for Urban Water Resource Management and Protection: Proceedings*, Chicago, IL, February 7-10, 2000.

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Washington, DC.

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2.3.6 Management Measure 3.2B Runoff from Construction Sites Construction Site Chemical Control

Management Measure

1. Limit application, generation, and migration of toxic substances;

2. Ensure the proper storage and disposal of toxic materials;

3. Apply nutrients at rates necessary to establish and maintain vegetation without causing nutrient runoff to surface waters; and

4. Prepare and implement, prior to the use or storage of toxic materials on site, an effective, approved chemical control plan or similar administrative document that contains chemical control provisions (e.g., minimize use of toxic materials; ensure proper containment if toxic materials are to be used/stored on site).

2.3.6.1 Programs

Discharges of pollutants from construction activities are for the most part regulated under the NPDES permitting program. Regulated entities include all construction sites with 1 or more acres of disturbed area. The SWRCB Division of Water Quality, Storm Water Program Web site (http://www.swrcb.ca.gov/stormwtr/construction.html) provides information to permittees to help them meet the requirements of the NPDES regulations. Discharges of pollutants from construction sites smaller than 1 acre typically are considered nonpoint sources, but may also be regulated at the local level.

The California Department of Pesticide Regulation regulates the storage and use of all pesticides. The Department's Web site (http://www.cdpr.ca.gov/) contains links to information regarding laws and regulations; product use information; licensing and certification programs for applicators, dealers, and advisors; integrated pest management practices (see the School IPM link for health- and environment-conscious pest management practices); and other information related to pesticide use.

2.3.6.2 Management Practices

The practices associated with this management measure focus on properly using chemicals that might be spilled or transported in runoff, which means storing and using chemicals according to the instructions on the label. Users can help to ensure that chemicals will not become pollutants in runoff by providing a covered storage area with primary and secondary containment of chemicals and storage off the ground to prevent accidental spills or leaks. Care should be taken to not use chemicals during wet weather or high wind conditions. Also, less toxic alternatives should be considered.

Pesticides: The following practices should be used to reduce risks associated with pesticides or to reduce the amount of pesticides that come in contact with storm water:

- Follow all federal, State, and local regulations that apply to the use, handling, or disposal of pesticides.

- Do not handle the materials any more than necessary.
- Store pesticides in a dry, covered area.
- Construct curbs or dikes to contain pesticides in case of spillage.
- Follow the recommended application rates and methods.
- Have equipment and absorbent materials available in areas where pesticides are stored and used in order to contain and clean up any spills that occur.

Petroleum products: The following management practices should be followed to reduce the risk of contamination associated with petroleum products:

- Store petroleum products and fuel for vehicles in covered areas with dikes in place to contain any spills.
- Immediately contain and clean up any spills with absorbent materials.
- Have equipment available in fuel storage areas and in vehicles to contain and clean up any spills that occur.

Solid wastes: State or local solid waste regulatory agencies or private firms should be consulted to ensure the proper disposal of contaminated soils that have been exposed to and still contain hazardous substances. Some landfills might accept contaminated soils, but they require laboratory tests first. The following steps should be taken to ensure proper storage and disposal of solid wastes:

- Designate a waste collection area onsite that does not receive a substantial amount of runoff from upland areas and does not drain directly to a water body.
- Ensure that containers have lids so they can be covered before periods of rain, and keep containers in a covered area whenever possible.
- Schedule waste collection to prevent the containers from overfilling.
- Clean up spills immediately. For hazardous materials, follow cleanup instructions on the package. Use an absorbent material such as sawdust or kitty litter to contain the spill.
- During the demolition phase of construction, provide extra containers and schedule more frequent pickups.
- Collect, remove, and dispose of all construction site wastes at authorized disposal areas. A local environmental agency can be contacted to identify these disposal sites.

Hazardous materials: The following steps should be taken to ensure the proper disposal of hazardous materials:

- Local waste management authorities should be consulted about the requirements for disposing of hazardous materials.

- A hazardous waste container should be emptied and cleaned before it is disposed of to prevent leaks.
- The original product label should never be removed from the container. It contains important safety information. Follow the manufacturer's recommended method of disposal, which should be printed on the label.
- If excess products need to be disposed of, they should never be mixed during disposal unless specifically recommended by the manufacturer.
- Paint and dirt are often removed from surfaces by sandblasting or pressure washing. Sandblasting grits and pressure wash water are the byproducts of these procedures and consist of the sand or water used and the paint and dirt particles that are removed from the surface. These materials can be hazardous if they are removed from older structures because they are more likely to contain lead-, cadmium-, or chrome-based paints. To ensure proper disposal of sandblasting grits and pressure wash water, a licensed waste management or transport and disposal firm should be contracted.

Storage and disposal: The following are ways to ensure proper storage and disposal of materials:

- Cover and stabilize topsoil stockpiles to reapply when revegetating the site.
- Locate pollutant sources such as access roads, borrow areas, and material stockpiles away from critical areas such as steep slopes, highly erodible soils and areas that drain directly into sensitive water bodies.

Phosphorus- and nitrogen-containing fertilizers are used on construction sites to provide nutrients necessary for plant growth, and phosphorus- and nitrogen-containing detergents are found in wash water from vehicle cleaning areas. Excesses of these nutrients can be a major source of water pollution. Management practices to reduce risks of nutrient pollution include the following:

- Apply fertilizers at the minimum rate and to the minimum area needed.
- Work the fertilizer deeply into the soil to reduce exposure of nutrients to storm water runoff.
- Apply fertilizer at lower application rates with a higher application frequency.
- Ensure that erosion and sediment controls are in place to prevent fertilizers and sediments from being transported offsite.
- Use detergents only as recommended, and limit their use on the site. Wash water containing detergents should not be dumped into the storm drain system—it should be directed to a sanitary sewer or be otherwise contained so that it can be treated at a wastewater treatment plant.

2.3.6.3 Information Resources

- ***Storm Water Best Management Practice Handbook: Construction*** (starting on page 279 of http://www.cabmphandbooks.org/Construction.asp): This manual, developed for California, deals with construction activities and is specifically geared for construction site operators covered

under the NPDES general permit. It includes fact sheets for many erosion and sediment control and waste/material management practices.

- **The California Department of Pesticide Regulation Web site** (http://www.cdpr.ca.gov/cfdocs/apps/schoolipm/main.cfm): This site contains the School Integrated Pest Management Program page and a series of fact sheets for pesticide use in noncrop settings (published in both English and Spanish), which are accessible at http://www.cdpr.ca.gov/docs/whs/psi2menu. These fact sheets include safety requirements for pesticide handlers, pesticide storage, transportation and disposal, use of engineering controls, first aid and decontamination, respiratory protection, worker safety regulations, laundering pesticide contaminated clothing, hazard communication requirements for employees handling pesticides, and minimal exposure pesticides in noncrop settings. Other pesticide resources that can be helpful include the following:
- **Lawn Care Tips** (http://www.cdpr.ca.gov/docs/factshts/lawn15.pdf)
- **Pesticides and Proposition 65** (http://www.cdpr.ca.gov/docs/factshts/prop65.htm)
- **Consumer Articles Treated with Pesticides** (http://www.epa.gov/pesticides/factsheets/treatart.htm)
- **Pesticide Storage and Disposal** (http://www.cdpr.ca.gov/docs/factshts/storage.pdf) [Spanish (http://www.cdpr.ca.gov/docs/factshts/storage-s.pdf)]

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2.3.7 Management Measure 3.3A Runoff from Existing Development Existing Development

Management Measure

Develop and implement watershed management programs to reduce runoff pollutant concentrations and volumes from existing development:

1. Identify priority local and/or regional watershed pollutant reduction opportunities (e.g., improve existing urban runoff control structures);

2. Specify a schedule for implementing appropriate controls;

3. Limit destruction of natural conveyance systems; and

4. Where appropriate, preserve, enhance, or establish buffers along surface waters and their tributaries.

2.3.7.1 Programs

The California Department of Transportation (Caltrans) is conducting a series of Retrofit Pilot Studies for modifying existing infrastructure such as facilities and highways to address water quality. A number of different management practices are being studied, including biofiltration, infiltration basins and trenches, catch basin inserts, detention basins, and media filters (http://www.dot.ca.gov/hq/env/stormwater/ongoing/pilot_studies/index.htm).

The Model Urban Runoff Program was developed by the City of Monterey, in conjunction with the City of Santa Cruz, Monterey Bay National Marine Sanctuary, California Coastal Commission, Association of Monterey Bay Area Governments (AMBAG), and Woodward-Clyde Consultants. The program provides guidance to small municipalities that need to meet NPDES Phase II requirements (http://www.swrcb.ca.gov/stormwtr/murp.html).

The Watershed Information Technical System (WITS), developed by the California Environmental Resources Evaluation System (CERES), is a program that provides the information and tools to support local watershed planning, restoration, monitoring, and education. CERES and WITS are programs of the California Resources Agency (http://ceres.ca.gov/watershed/).

The Urban Creeks Council of California works to protect and restore waterways in urban areas through shoreline stabilization, the establishment and protection of buffers and riparian zones, and educational programs for the general public (http://www.urbancreeks.org/).

The County of San Diego's Project Clean Water is a watershed-based approach to integrating regional efforts at improving water quality. The project includes the development of technical guidance for watershed-based urban runoff programs, education and outreach, and the development of a repository for water quality information in the region (http://www.projectcleanwater.org/index.html).

2.3.7.2 Management Practices

Watershed management programs facilitate the prioritization of NPS pollutants and the development of implementation strategies for mitigating the effects of those priority pollutants. By addressing NPS pollution on a watershed basis, managers can ensure that retrofit projects are consistent with overall water quality goals. Watershed management programs for existing development can be used to achieve these three objectives:

- Reduction of pollutant loads from storm water runoff
- Reduction of the volume of storm water runoff, particularly to reduce erosion on streambanks and conveyance systems
- Implementation of nonstructural controls such as the preservation and enhancement of natural buffers along water bodies

There are a number of structural practices that address runoff volume and pollutant loads in urban storm water. In developed areas, however, space is often limited, requiring that retrofit opportunities and nonstructural practices be employed. Retrofitting involves modifying existing runoff structures by enlargement, modification of inflow and outflow characteristics, and increasing detention time to remove sediment and other pollutants.

The following are structural practices (including retrofits) suitable for urban areas:

- Devices that fit into the storm water conveyance system, such as sand filters, trash racks, and water quality inlets
- Modification of existing storm water ponds, drainage pipe outfalls, and the upstream end of road culverts
- Infiltration practices in or near parking lots (bioretention, porous pavement, sand filters and underground vaults)

Once applicable management practices are identified, areas within each watershed can be prioritized for implementation based on site characteristics such as location, ownership, drainage area, soils, and other conditions that may be applicable to specific management practices. These site assessments are conducted using existing data, such as aerial photographs, zoning maps and GIS data, and field surveys.

Where possible, modification of natural drainage patterns should be avoided. Increasing impervious areas by paving and curbing contributes to water quality degradation by increasing peak flows and preventing the natural storm water treatment functions performed by vegetated areas. It is beneficial to route storm water over vegetated buffers, infiltration devices, or other pervious areas. Converting channelized storm water to sheet flow thus increasing its flow path allows these natural infiltration techniques to function properly and remove pollutants. Another option is using open vegetated swales in place of conventional conveyance devices.

In addition to identifying, prioritizing, and implementing management practices for controlling runoff volume and pollution, water quality in urban areas can be protected by restoring streams, preserving buffers, and stabilizing streambanks. Steam restoration involves reestablishing instream habitat structure and riparian cover, stabilizing channel morphology, protecting critical stream substrates, and mitigating the cause of degradation, if possible. Buffers along streams should be preserved and restored, and streambank stabilization techniques can help reduce erosion and provide habitat.

Nonstructural practices are also well suited for developed areas, because they help to control pollution at its source. Techniques that disconnect runoff from conveyance systems (e.g., rain barrels) and urban forestry practices can serve as nonstructural retrofits. Other nonstructural practices applicable to existing development include education and outreach programs, the establishment and preservation of buffers along water bodies, and ordinances to preserve pervious areas within developed areas. Green space goals can be set to promote tree plantings and pavement reclamation projects.

2.3.7.3 Information Resources

Structural Practices and Retrofits

- **U.S. Department of Transportation, Federal Highway Administration, *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*** (http://www.fhwa.dot.gov/environment/ultraurb/index.htm): This online manual provides guidance on storm water management in developed urban areas that have limited space for treatment practices. The intent is to promote technology that is cost-effective and low-maintenance for the ultra-urban environment.
- **USEPA, National Menu of Best Management Practices, Post-Construction Storm Water Management Fact Sheets** (http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/post.cfm): These fact sheets provide guidance on a number of management practices applicable to existing development.
- **County of San Diego's Project Clean Water, *Existing Residential Areas Model Program Guidance*** (http://www.projectcleanwater.org/pdf/Model Program - Residential Areas.PDF): This document outlines a number of management practices appropriate for existing residential development, as well as an implementation strategy.

Nonstructural Practices

- **Northern Virginia Regional Commission, *Nonstructural Urban BMP Handbook*** (http://www.novaregion.org/bmp.htm): This manual provides watershed managers, planners, and engineers with guidance on the implementation of nonstructural practices.
- **Low Impact Development Center Web site** (http://www.lowimpactdevelopment.org/): This resource contains technical references for implementing low impact development techniques and has case studies of sites where these practices have been successfully implemented.

Urban Stream Restoration and Buffers

- **California Department of Water Resources, Planning and Local Assistance, Urban Stream Restoration Program** (http://www.watershedrestoration.water.ca.gov/urbanstreams): This program provides funding for projects to assist communities in reducing damages from streambank and watershed instability and floods while restoring the environmental and aesthetic values of streams. The Web site offers an overview of past projects funded by the program as well as guidelines for project proposals.
- **Stormwater Manager's Resource Center** (http://www.stormwatercenter.net/): The Stormwater Manager's Resource Center provides resources for those involved in local storm water management. These resources include several resources pertaining to aquatic buffers and restoration practices.

- **USEPA, Model Ordinance for Aquatic Buffers** (http://www.epa.gov/owow/nps/ordinance/mol1.htm): This model ordinance can serve as a guide for municipalities looking to establish stream buffers.
- **Ann Riley, *Urban Stream Restoration: A Video Tour of Ecological Restoration Techniques*** (http://www.noltemedia.com/nm/urbanstream/): This video, which is 61 minutes long and can be ordered online, is a documentary tour of six urban stream restoration sites. It provides background information on funding, community involvement, and the history and principles of restoration. The demonstration includes examples of stream restoration in very urbanized areas, re-creating stream shapes and meanders, creek daylighting, soil bioengineering, and ecological flood control projects.
- **Ohio Department of Natural Resources, Stream Management Guide Fact Sheets** (http://www.dnr.state.oh.us/water/pubs/fs_st/streamfs.htm): This is a compilation of fact sheets on technical guidance for streambank and instream practices, general stream management, and stream processes.
- **Federal Interagency Stream Restoration Working Group, *Stream Corridor Restoration: Principles, Processes and Practices*** (http://www.usda.gov/stream_restoration/newgra.html): This document provides background information on stream corridors, the development of stream corridor restoration plans, and details on restoration practices.
- **USDA NRCS, Watershed Technology Electronic Catalog** (http://www.wcc.nrcs.usda.gov/wtec/wtec.html): This online catalog is a source of technical guidance on a variety of restoration techniques and management practices, to provide direction for watershed managers and restoration practitioners. The site is focused on providing images and conceptual diagrams.
- **USDA NRCS, *Buffer Strips: Common Sense Conservation*** (http://www.nrcs.usda.gov/feature/buffers/): This Web site provides background information on the benefits of buffers, technical guidance, and examples of successful buffer implementation.

Monitoring Documents

- **California Department of Transportation, *Guidance Manual: Stormwater Monitoring Protocols*, Second Edition** (http://www.dot.ca.gov/hq/env/stormwater/special/guidance_manual/index.htm): This manual covers the entire process of storm water monitoring, with sections that describe the following topics: purpose and objectives; site, constituent, and monitoring method and equipment selection; sampling and analysis plan development; installation and maintenance of equipment; training; logistics; sample collection; quality assurance/quality control (QA/QC); preparation of laboratory samples and analytical methods, QA/QC data evaluation, and data reporting protocols.

2.3.7.4 Case Study

Santa Monica Bay Restoration Project. The purpose of this project was to evaluate the feasibility and effectiveness of catch basin inserts in addressing storm water pollutant loads into Santa Monica Bay. The devices cost less than $1,000 per catch basin and required an average maintenance frequency of once annually. The three components of the project were

- Characterization of local storm water runoff and selecting target pollutants

- Evaluating catch basin retrofits
- Conducting feasibility and cost-benefit analysis for inter-city retrofit scenarios

This project laid the framework for the development of decision frameworks for municipalities looking to develop retrofit programs. The framework, in the form of a decision tree, helps planners select devices based on local conditions, feasibility, effectiveness, cost and maintenance requirements (http://www.epa.gov/owow/estuaries/coastlines/janfeb99/center/insert.html).

BMP House Demonstration Project. The City of Los Angeles and TreePeople conducted a demonstration project that involved retrofitting a single-family home with multiple management practices. This included a Cistern Collection System, Vegetated/ Mulched Swale, Retention Grading, and Driveway Dry Well (http://www.lacity.org/SAN/wpd/index.htm).

2.3.7.5 References

USEPA. 2002. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft.* EPA 842-B-02-003. U.S. Environmental Protection Agency, Washington, DC.

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2.3.8 Management Measure 3.4A Onsite Disposal Systems (OSDSs) New OSDSs

Management Measure

1. Ensure that new OSDSs are located, designed, installed, operated, inspected, and maintained to prevent the discharge of pollutants to the surface of the ground and, to the extent practicable, reduce the discharge of pollutants into ground water. Where necessary to meet these objectives;

a. Discourage the installation of garbage disposals to reduce hydraulic and nutrient loadings;

b. Install low-volume plumbing fixtures in new developments or redevelopments as required by State law; and

c. Encourage installation of low-volume plumbing fixtures in existing developments. Implement OSDS inspection schedules for pre-construction, construction, and post-construction.

2. Direct placement of OSDSs away from unsuitable areas. Where OSDS placement away from unsuitable areas is not practicable, ensure that the OSDS is designed or sited at a density so as not to adversely affect surface waters or ground water. Unsuitable sites include areas

a. With poorly or excessively drained soils;

b. With shallow water tables or high seasonal water tables;

c. Within floodplains; or

d. Where nutrient and/or pathogen concentrations in the effluent cannot be sufficiently treated or reduced before the effluent reaches sensitive water bodies.

3. Establish protective setbacks from surface waters, wetlands, and floodplains for conventional as well as alternative OSDSs. The lateral setbacks should be based on soil type, slope, hydrologic factors, and type of OSDS. Where uniform protective setbacks cannot be achieved, site development with OSDSs so as not to adversely affect water bodies or contribute to a public health nuisance.

4. Establish protective separation distances between OSDS system components and ground water. The separation distances should be based on soil type, distance to ground water, hydrologic factors, and type of OSDS.

5. Where conditions indicate that nitrogen-limited surface waters may be adversely affected by excess nitrogen loadings from ground water, prohibit the installation of OSDSs or require the installation of OSDSs that reduce total nitrogen loadings to meet water quality objectives.

2.3.8.1 Introduction

When new areas are being developed, sometimes housing and businesses outpace municipal services such as sewers, resulting in the need for treatment of sewage in an individual or small-scale manner at a home

or business. These systems are also needed in areas where development density is low, causing sewerage projects to be prohibitively expensive compared with the number of customers served. Systems for storing and treating small residential and commercial waste streams are called onsite sewage disposal systems, or OSDSs. OSDSs typically consist of a septic tank for storage and a subsurface soil absorption field (USEPA, 2002a). Buried in the ground, septic tanks are essentially watertight, single- or multiple-chamber sedimentation and anaerobic digestion tanks. They are designed to receive and pretreat domestic wastewater, mediate peak flows, and keep settleable solids, oils, scum, and other floatable material out of the soil absorption field. Wastewater effluent is discharged from the tank and passes through pipes to a series of underground perforated pipes or perforated pipe wrapped in synthetic material. From there, the partially treated effluent flows onto and through the soil infiltrative surface, and finally into the subsurface wastewater infiltration system medium (i.e., soil). Treatment occurs in the septic tank, on and within the biomat that forms at the soil infiltrative surface, and in the soil (or other medium); it then continues as the effluent moves through the underlying soil profiles. Treated effluent that is not drawn into plant roots, incorporated into microbial biomass, or evaporated ultimately reaches ground water and possibly nearby surface waters.

Alternative or innovative systems such as mound systems, fixed-film contact units, wetlands, aerobic treatment units ("package plants"), low-pressure drip applications, and cluster systems, are used in areas where conventional soil-based systems cannot provide adequate treatment of wastewater effluent (USEPA, 2002a). Areas that might not be suitable for conventional systems are those with nearby nutrient-sensitive waters, high densities of existing conventional systems, highly permeable or shallow soils, shallow water tables, large rocks or confining layers, and poorly drained soils. Alternative or innovative systems feature components and processes designed to promote degradation and/or treatment of wastes through biological processes, oxidation/reduction reactions, filtration, evapotranspiration, and other processes. Cluster systems can be used to collect and treat wastewater from multiple facilities at a common site (e.g., lagoon, wetland, infiltration field). Alternative, innovative, and cluster systems often require individual septic tanks for each facility served to provide primary treatment and minimize fat, oil, grease, and solids loadings to secondary treatment units. (Note: Cluster systems that serve 20 or more people may be regulated by a federal, State, and/or local Underground Injection Control Program for Class V facilities. For more information, see http://www.epa.gov/safewater/uic.html.)

2.3.8.2 Programs

The California Wastewater Training and Research Center (CWTRC) conducts research and provides training and education on management practices for wastewater treatment. The Center's Web site contains technical guidance documents and articles, links to important local, State, and federal programs, and information on training opportunities (http://www.csuchico.edu/cwtrc/).

The California Onsite Wastewater Association (COWA) supports the use of management practices related to onsite wastewater treatment systems. The COWA Web site provides links to relevant information for engineers and government agencies, as well as links to county health departments (http://www.cowa.org/).

County health departments generally regulate OSDSs, but Regional Boards also have the authority to regulate them. Note that OSDSs are prohibited in some areas, such as where receiving waters are nutrient or pathogen sensitive, where there is a high density of existing OSDSs, or where geologic conditions prevent adequate treatment of sewage. Check with your county government to determine what types of systems are allowed in your area.

2.3.8.3 Management Practices

Management practices for new onsite sewage disposal systems are focused on permitting and installation. These practices fall into the following four categories:

- Comprehensive planning by the regulatory authority, including measures to protect sensitive areas, such as nutrient-limited waters and shellfish harvest areas. Measures might include prohibitions, setbacks, or requirements for the use of innovative treatment systems to effect greater treatment of sewage.
- Performance-based requirements for the siting, design, and installation of systems
- Training and certification programs
- Inspection of newly installed systems

The first practice is the development a comprehensive plan that establishes and implements a management entity, develops an internal planning processes, and coordinates with the overall land use planning process. By coordinating wastewater management with land use planning, the plan can address the protection of sensitive areas, basic guidelines as to where conventional or alternative systems will be allowed, maximum densities for disposal systems, and consideration of alternative solutions such as the extension of sewer lines for developing areas (USEPA, 2002a, 2002b).

Specific requirements should be developed for the selection, siting, design, and installation of onsite disposal systems. There are four components to this measure (USEPA, 2002a):

1. Develop performance-based programs with specific goals and criteria that address public health and water quality

2. Model system performance to determine the long-term impacts of OSDSs on water resources

3. Develop criteria for siting OSDSs, such as setback guidelines and official maps showing areas where conditions are suitable for installation. Design criteria should consider the following:

    - Wastewater characterization and expected effluent volumes
    - Site conditions (e.g., soils, geology, ground water, surface waters, topography, structures, property lines)
    - System capacity, based on estimated peak and average daily flows
    - Location of tanks and appurtenances
    - Tank dimensions and construction materials
    - Alternative tank effluent treatment units and configuration
    - Required absorption field dimensions and materials
    - Requirements for alternative soil absorption field areas
    - Sizing and other acceptable features of system piping
    - Separation distances from other site features
    - Operation and maintenance requirements (access risers, safety considerations, inspection points)
    - Accommodations required for monitoring (USEPA, 2002b)

4. Develop site evaluation procedures to assess the suitability of specific technologies. Evaluation techniques are based on soils, hydrogeology, or multiple factors, such as soils, climate, ground water, onsite disposal system densities, and distance to water resources. The following are procedures for site evaluation (USEPA, 2002a; ASTM, 1995; ASTM, 1996):

   - Preliminary documentation (site survey maps, soil surveys, aerial photos, regulations and setbacks, loading rates)
   - Identification of unsuitable areas (water supply separation distances, buffer zones and setbacks, limiting physiographic features)
   - Subsurface investigations (depth to ground water, soil profiles, percolation tests)
   - Identification of recommended OSDS site (data integration, selection of preferred areas, gravity-based flow assessment, final selection)

The third practice involves the implementation of education, training, licensing and/or certifications for site evaluators, installers, designers, and inspectors. Certification and licensing of service providers can help ensure program effectiveness and compliance and reduce administrative burdens. Professional programs are typically the mechanism for certification, and include required coursework or training; an assessment of knowledge, skills, and professional judgment; past experience; and demonstrated competency. Most licensing programs also require attendance at continuing education workshops (USEPA, 2002b).

Finally, the onsite disposal system should be inspected at various stages during and after installation. A post-construction inspection program should ensure that systems were installed properly, design specifications were followed, and soil absorption field areas were not compacted during construction. Inspections can be conducted by management personnel or trained/certified inspectors (USEPA, 2002a, 1993). If necessary, repairs, replacements, or upgrades should be made to septic systems to meet performance requirements.

2.3.8.4 Information Resources

Selection of Treatment Technologies

- **National Small Flows Clearinghouse, Environmental Technology Initiative (ETI) Fact Sheets** (http://www.nesc.wvu.edu/nsfc/nsfc_etifactsheets.htm): The ETI fact sheets describe innovative and alternative onsite wastewater treatment technologies for single families, clusters of homes, subdivisions, and communities. For each technology, general and technical fact sheets are available. The fact sheets were created as part of USEPA's Environmental Technology Initiative.
- **WATERSHEDSS: Water, Soil and Hydro-Environmental Decision Support System, Septic Systems** (http://www.water.ncsu.edu/watershedss/dss/wetland/aqlife/septic.html - mm): This fact sheet describes management practices for onsite wastewater treatment systems, including alternative treatment technologies such as denitrification systems and regulatory practices such as restrictions on garbage disposals and chemical additives.
- **USEPA, Technology Fact Sheets** (http://www.epa.gov/owm/mtb/decent/technology.htm): These fact sheets discuss advantages and disadvantages, design criteria, performance, costs, examples of installations, and references for various onsite treatment technologies.

System Siting, and Design and Management

- **USEPA, *Design Manual: Onsite Wastewater Treatment and Disposal Systems*** (http://www.epa.gov/ORD/NRMRL/Pubs/625180012/625180012.htm): This document, published in 1980, is a technical resource for basic onsite wastewater treatment systems. Recently, USEPA released an update to this document, the *Onsite Wastewater Treatment Systems Manual*, with supplementary information and a discussion of new technologies. USEPA recommends that the documents be used together.
- **USEPA, *Onsite Wastewater Treatment Systems Manual.*** (http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm - links): This document is an update and companion to the 1980 *Design Manual*. It contains supplementary information on management techniques and recent technological developments.
- **Michael T. Hoover, Ph.D. *A Framework for Site Evaluation, Design, and Engineering of On-Site Technologies Within a Management Context*** (http://www.state.ma.us/dep/brp/wwm/files/hoovered.doc): This document was written as part of a statewide effort to incorporate watershed-specific performance standards into the Massachusetts onsite wastewater management program. It outlines options for various technologies, siting and design considerations, cost information, and management techniques for decentralized OSDSs.
- **County of San Diego, *Land Use Program Guidelines*** (http://www.sdcounty.ca.gov/deh/lwq/land_use/guideline.html): This Web site contains a number of guidance documents pertaining to the siting, design, and maintenance of onsite wastewater treatment systems as regulated in San Diego.

Training and Certification Programs

- **California State University Office of Water Programs** (http://www.owp.csus.edu/training.htm): The Office of Water Programs at the California State University, Sacramento, College of Engineering and Computer Science offers training on the operation and maintenance of wastewater facilities. Documentation and videos as well as distance learning courses are available.
- **NSF International, Onsite Wastewater Inspector Accreditation Program** (http://www.nsf.org/owwi/): This accreditation program consists of written and field tests, an ethics statement, and continuing education components.
- **California Wastewater Training and Research Center** (http://www.csuchico.edu/cwtrc/index.html): The Center conducts training and workshops on wastewater treatment, including onsite wastewater treatment systems.

2.3.8.5 Case Study

Hunters Point Shipyard Decentralized Wastewater Treatment. This study, conducted by the San Francisco Public Utilities Commission, examined the applicability, costs, benefits, and limitations of various alternative treatment approaches. Onsite treatment systems investigated included conventional single and clustered systems, as well as a small satellite treatment facility. The project also involved public outreach and the development of technical resources (http://sfwater.org/detail.cfm/MC_ID/7/MSC_ID/60/MTO_ID/112/C_ID/1532/).

University of Rhode Island Onsite Wastewater Training Center. The Center conducts demonstrations of onsite treatment technology, educates and trains both homeowners and wastewater industry personnel, and provides assistance to municipalities in the development of onsite wastewater management programs (http://www.epa.gov/nps/Section319III/inform_ri.htm).

2.3.8.6 References

American Society for Testing and Materials (ASTM). 1995. *Standard Practice for Surface Site Characterization for On-Site Septic Systems.* Practice D5879-95e1. American Society for Testing and Materials, Conshohocken, PA.

American Society for Testing and Materials (ASTM). 1996. *Standard Practice for Subsurface Site Characterization of Test Pits for On-Site Septic Systems.* Practice D5921-96e1. American Society for Testing and Materials, Conshohocken, PA.

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. (http://www.epa.gov/owow/nps/MMGI/index.html)

USEPA. 2002a. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft.* EPA 842-B-02-003. U.S. Environmental Protection Agency, Washington, DC.

USEPA. 2002b. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/links)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
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2.3.9 Management Measure 3.4B Onsite Disposal Systems (OSDSs) Operating OSDSs

Management Measure

Establish and implement policies and systems to ensure that existing OSDSs are operated and maintained to prevent the discharge of pollutants to the surface of the ground and, to the extent practicable, reduce the discharge of pollutants into ground water. Where necessary to meet these objectives, encourage the reduced use of garbage disposals, encourage the use of low-volume plumbing fixtures, and reduce total phosphorus loadings to the OSDS by 15 percent (if the use of low-level phosphate detergents has not been required or widely adopted by OSDS users). Establish and implement policies that require an OSDS to be repaired, replaced, or modified when the OSDS fails or threatens or impairs surface waters.

Inspect OSDSs at a frequency adequate to ascertain whether the OSDSs are failing.

Consider replacing or upgrading OSDSs to treat influent so that total nitrogen loadings in the effluent are reduced to meet water quality objectives. This provision applies only where (a) conditions indicate that nitrogen-limited surface waters may be adversely affected by significant ground water nitrogen loadings from an OSDS, and (b) nitrogen loadings from OSDSs are delivered to ground water.

This management measure deals with the programmatic aspects of OSDS management. The goals are to ensure that systems that are installed as designed are inspected and maintained regularly to prevent failures. Public education about proper sewage disposal system use and maintenance is an important part of this measure, as is development and enforcement of policies to prevent or minimize the impacts of OSDS failures.

2.3.9.1 Programs

County health departments generally regulate OSDSs, but Regional Boards also have the authority to regulate them. Note that OSDSs are prohibited in some areas, such as where receiving waters are nutrient or pathogen sensitive, where there is a high density of existing OSDSs, or where geologic conditions prevent adequate treatment of sewage. Check with your county government to determine what types of systems are allowed in your area. Below are several examples of municipal programs in California.

- The Stinson Beach County Water District's Onsite Wastewater Management Program, established in 1978, manages the permitting and inspection of onsite wastewater treatment systems and conducts water quality monitoring. The County Water District is responsible for the introduction of special treatment systems designed specifically to address problems with water tables and poor percolation rates (http://stinson-beach-cwd.dst.ca.us/guide/hog1.html).

- The Marin County Septic Systems Program evaluates and permits onsite sewage systems, as well as gray water systems and septage haulers. The program's Web site contains procedures for conducting performance inspections, fee schedules, background information on septic systems, links to articles with maintenance information for homeowners, and relevant regulations (http://www.co.marin.ca.us/depts/CD/main/comdev/ehs/septic/septic_systems.cfm).

- The Town of Paradise established the Onsite Wastewater Management Zone (OWMZ) in Butte County, California, in 1992 to issue permits for new septic systems and for repairs of operating systems. Trained service providers conduct inspections and maintenance activities. The program is financed by operating permit fees, which are reported to be under $15 a year and are included in water bills. (http://pasture.ecn.purdue.edu/~epados/septics/septic/manage.htm - Town of Paradise, California).

2.3.9.2 Management Practices

The key to managing existing onsite disposal systems is an effective operation and maintenance program. Operation and maintenance programs should include system inventories; management, operation, and maintenance policies; inspection and monitoring requirements; guidelines for the disposal or reuse of residuals; and public education.

Inventories of existing onsite disposal systems are an important step in developing an operation and maintenance program. To the extent possible, information on the location, type, date of installation, date of last service, and owner contact information should be maintained. This may require cooperative agreements between agencies.

Management programs can be implemented by regulatory agencies, wastewater utilities or districts, or as voluntary programs. The specific approach should reflect the needs and available resources of the community. USEPA's *Voluntary National Guidelines for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (http://www.epa.gov/owm/mtb/decent/download/guidelines.pdf) describes in greater detail the various aspects of a management program, and includes case studies, technology fact sheets, and other resources.

Inspection and maintenance programs ensure that systems are performing properly. They can be administered through a training program for homeowners, contracts with certified operators, or the management entity itself. System performance can be determined by visual, bacteriological, physical, chemical, and remote monitoring assessment techniques. An effective inspection, monitoring, operation, and maintenance program includes the following (USEPA, 2002b):

- Specified intervals for required inspections (e.g., every 3 months, every 2 years, or at the time of property transfer or change of use)
- Legal authority to access system components for inspections, monitoring, and maintenance
- Monitoring of overall operation and performance, including remote sensing and failure reporting for highly mechanical and complex systems
- Monitoring of receiving environments at compliance boundaries to meet performance requirements
- Review of system use or flow records, (e.g., water meter readings)
- Required type and frequency of maintenance for each technology
- Identification, location, and analysis of system failures
- Correction schedules for failed systems through retrofits or upgrades
- Record keeping on systems inspected, results, and recommendations

In addition to ensuring the proper functioning of the system components, the effectiveness of the system as a whole can be improved through water conservation and pollutant reduction practices. This can be

achieved through regulations or public education programs that discourage or prohibit the use of garbage disposals and the disposal of phosphate-containing detergents and household cleaners.

Guidelines for the disposal of residuals are necessary to ensure proper handling and disposal of sludge (septage) removed from septic tanks. Septage is usually managed via land application, treatment at a wastewater treatment plant, or treatment at a special septage treatment plant. State and local septage management programs that incorporate land application or burial of septage must comply with Title 40 of the U.S. Code of Federal Regulations (CFR), Parts 503 and 257. USEPA has published specific guidance on these topics (*Process Design Manual: Land Application of Sewage Sludge and Domestic Septage,* http://www.epa.gov/ORD/WebPubs/landapp.pdf).

Finally, public education and outreach are important to improve homeowner and industry awareness of the importance of operation and maintenance procedures. Databases with septic system inventories can be used to distribute maintenance information to homeowners. Typical public outreach and education programs address the benefits of the onsite management program, water conservation, and household and commercial/industrial hazardous waste discharge prevention (USEPA, 2002b).

2.3.9.3 Information Resources

General Resources

- **Stormwater Manager's Resource Center, Septic System Controls** (http://www.stormwatercenter.net/Pollution_Prevention_Factsheets/SepticSystemControls.htm). This fact sheet describes ways to develop a comprehensive management program to reduce pollution from septic systems using public outreach and education, regulatory techniques, and maintenance programs.

- **USEPA, *Voluntary National Guidelines for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*** (http://www.epa.gov/owm/mtb/decent/download/guidelines.pdf): Released in March 2003, these guidelines are geared toward state, tribal, and local government officials dealing with the management of onsite wastewater treatment systems. They outline the components of a successful management program, including public education, design, site evaluation, operation and maintenance, inspector certification, and funding.

- **USEPA, *Draft Handbook for the Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*** (http://www.epa.gov/owm/mtb/decent/handbook.htm): The draft handbook is designed to supplement the *Voluntary National Guidelines* by providing tools for program implementation. It is a compilation of case studies, detailed discussions, and supplementary material to provide assistance in implementing management programs.

Selection of Treatment Technology

- **National Small Flows Clearinghouse, Environmental Technology Initiative (ETI) Fact Sheets** (http://www.nesc.wvu.edu/nsfc/nsfc_etifactsheets.htm): The ETI fact sheets describe innovative and alternative onsite wastewater treatment technologies for single families, clusters of homes, subdivisions, and communities. For each technology, general and technical fact sheets are available. The fact sheets were created as part of USEPA's Environmental Technology Initiative.

Homeowner Education

- **Stinson Beach County Water District, *Onsite Wastewater Management Program, Homeowner's Guide*** (http://stinson-beach-cwd.dst.ca.us/wastehome.html): This manual provides information for homeowners on septic system function and maintenance, signs of failure, and basic dos and don'ts.

- **USEPA, *Homeowner Education Materials*** (http://www.epa.gov/owm/mtb/decent/homeowner.htm): These educational materials are available free of charge, either as hard copies or in electronic form. They can be customized to reflect local contact information.

System Inspection, Operation, and Maintenance

- **D. Friedman, The Septic Information Web site** (http://www.inspect-ny.com/septbook.htm): This Web site features a compilation of technical resources; links to industry, government, universities and consultants; and information for homeowners.

- **WATERSHEDSS: Water, Soil and Hydro-Environmental Decision Support System, Septic Systems** (http://www.water.ncsu.edu/watershedss/dss/wetland/aqlife/septic.html - mm): This fact sheet describes management practices for onsite wastewater treatment systems, including alternative treatment technologies such as denitrification systems and regulatory practices such as restrictions on garbage disposals and chemical additives.

- **USEPA, Failing Septic Systems Fact Sheet** (http://cfpub2.epa.gov/npdes/stormwater/menuofbmps/illi_1.cfm): This fact sheet describes measures to address failing septic systems, and includes cost and effectiveness information.

- **J. Riordan, *Septic System Checkup: A Rhode Island Handbook for Inspection*** (http://www.state.ri.us/dem/pubs/regs/regs/water/isdsbook.pdf): This is Rhode Island's online inspection guide, published in 2000.

Septage/Residual Disposal

- **USEPA, Decentralized Systems Technology Fact Sheet: Septage Treatment/Disposal** (http://www.epa.gov/owm/mtb/septage.pdf): This fact sheet provides background information on septage from various sources and details on various options for treatment and disposal of septage.

- **USEPA, *Process Design Manual: Land Application of Sewage Sludge and Domestic Septage*** (http://www.epa.gov/ORD/WebPubs/landapp.pdf): This manual provides detailed guidance on the development of a land application program.

2.3.9.4 Case Study

Septic System Management Task Force. The Santa Monica Bay Restoration Commission created a Task Force on Septic System Management that involved multiple state and local regulatory agencies, environmental organizations, and health departments. The goals of the Task Force were to address human health and water quality problems related to septic systems and options for improving septic system management in the northern Santa Monica Bay watersheds. Recommendations were based on programs implemented in other states, water quality data, and the current regulatory framework for septic system management. The Commission continues to cooperate with regulatory agencies to assist in the implementation of these recommendations (http://www.santamonicabay.org/site/programs/layout/task.jsp - 54).

San Lorenzo River Basin, Wastewater Management Program. This project was developed in order to assist in the development of a management program for existing onsite wastewater treatment systems, including inspection, maintenance, and upgrades. Since 1985, the Santa Cruz County Environmental Health Service has been working to develop a program for inspecting all onsite systems, assessing pollutant loads, and making necessary repairs. Studies conducted through this initiative included calculations of nutrient inputs to the river from onsite systems (http://www.co.santa-cruz.ca.us/eh/env_water_quality/san lorenzo wastewater management plan status report 1996-1998.pdf).

2.3.9.5 References

USEPA. 2002a. *National Management Measures to Control Nonpoint Source Pollution from Urban Areas—Draft.* EPA 842-B-02-003. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

USEPA. 2002b. *Onsite Wastewater Treatment Systems Manual*. EPA/625/R-00/008. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm - links)

2.3.10 Management Measure 3.5A Transportation Development Planning, Siting, and Developing Roads and Highways

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Management Measure

Plan, site, and develop roads and highways to:

1. Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss;

2. Limit land disturbance such as clearing and grading and cut and fill to reduce erosion and sediment loss; and

3. Limit disturbance of natural drainage features and vegetation.

2.3.10.1 Programs

California Department of Transportation (Caltrans), Storm Water Management Program. Caltrans is the agency responsible for managing California 's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (http://www.dot.ca.gov/hq/env/stormwater/index.htm).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups in order to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (http://www.transact.org/ca/environment.htm).

2.3.10.2 Management Practices

The type and location of permanent storm water management practices should be considered when planning highways, roads, and bridges, such that rights-of-way are sized to accommodate structural controls.

Highways and roads should be planned to minimize mileage through areas that might adversely affect sensitive areas, such as wetlands or estuaries. Wetlands that are within the right-of-way and cannot be avoided should be protected with the use of mitigation measures. Highway and road construction should be limited in sensitive areas, and highways should be sited so there is a sufficient setback distance between the highway right-of-way and any wetland or riparian areas. Another consideration is tidal flows to wetlands; highways and rights-of-way should not restrict this flow. Mitigation will likely be required if wetlands, riparian areas, or estuaries are affected.

Curbs can be eliminated (when local development codes permit) to allow highway and road runoff to be filtered through vegetated shoulders and medians. Eliminating curbs also increases infiltration to ground water. If eliminating curbs is not possible, curbs can be designed with breaks to direct runoff to vegetated surfaces. Care must be taken to ensure that the curb breaks do not receive so much runoff as to erode the vegetated infiltration area.

Storm water control structures should be designed so that the storm water does not run directly to receiving waters. This practice is often referred to as disconnecting impervious surfaces. Highway runoff should be routed through a combination of treatment practices or over stabilized vegetated areas before it enters receiving waters.

2.3.10.3 Information Resources

- ***Caltrans Environmental Handbook*, Volume 3** (http://www.dot.ca.gov/ser/envhand.htm): This volume provides guidance on the identification and evaluation of biological resources, processing of biological resource documents, and implementation of biologically related construction, maintenance, and encroachment activities. Volume 3 of the *Environmental Handbook* should be used in conjunction with other project planning and development manuals as well as with Volume 1.
- ***Caltrans Environmental Handbook*, Volume 5** (http://www.dot.ca.gov/ser/envhand.htm): This volume, which is still in preparation, will provide guidance on storm water management.
- **Caltrans, Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/index.htm). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (http://www.dot.ca.gov/hq/env/stormwater/index.htm): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **California Wetland Information System** (http://ceres.ca.gov/wetlands/): The California Wetland Information System is designed to provide wetland information to the public, educational community, and government agencies. It includes information on wetland mitigation and the mitigation role and responsibility for the California Department of Transportation (http://ceres.ca.gov/wetlands/agencies/caltrans.html).
- **Washington Department of Transportation, *Roadside Manual*** (http://www.wsdot.wa.gov/eesc/design/roadside/default.htm#rm): The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.10.4 Case Study

Folsom, California, Dual Drainage System. In Folsom, an arterial street was outfitted with a dual drainage system, which has separate systems to treat runoff for water quality during smaller storms and runoff quantity and timing during larger storms (Richman et al., 1998). The system consists of grassy swales that use a conventional curb-and-gutter system. Two catch basins are included in the design. The

first basin collects the first flush of rainfall from a 2-year storm and discharges the effluent into a grassy swale for treatment. The treated runoff is then directed into the main storm drainage system. The second catch basin, located downstream, collects flows beyond the 2-year storm (up to a 10-year storm) that are not handled by the first system, and discharges this flow directly to the storm drainage system.

2.3.10.5 References

Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/ic/87703.html)

Richman, T., K.H. Lichten, J. Worth, and B.K. Ferguson. 1998. *Landscape Architecture Technical Information Series: Vegetated Swales*. American Society of Landscape Architects, Washington, DC. (http://www.asla.org/latis/Latis2.pdf)

U.S. Department of Transportation. 1995. *Best Management Practices for Erosion and Sediment Control*. Eastern Federal Lands Highway Design, Federal Highway Administration, Sterling, VA. (http://199.79.179.19/OLPFiles/FHWA/009340.pdf)

USEPA. 2002. *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

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2.3.11 Management Measure 3.5B Transportation Development Bridges

Management Measure

Site, design, and maintain bridge structures so that sensitive and valuable aquatic ecosystems and areas providing important benefits are protected from adverse effects.

Bridges by their nature are built in riparian areas and can have pronounced habitat and water quality impacts if care is not taken to protect sensitive areas from both construction and post-construction impacts. Practices to meet these goals include designing bridges to minimize damage to riparian or wetland habitats and treating runoff from bridge decks before it is allowed to enter watercourses. Bridge maintenance activities should be conducted using containment practices to prevent pollutants, such as paint, rust, hazardous chemicals, and building materials, from entering the water or riparian habitat below. Restoration of damaged riparian or instream habitats should be done after bridge construction, maintenance, and demolition.

2.3.11.1 Programs

California Department of Transportation (Caltrans) Storm Water Management Program. Caltrans is the agency responsible for managing California 's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (http://www.dot.ca.gov/hq/env/stormwater/index.htm).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups in order to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (http://www.transact.org/ca/environment.htm).

Through the Clean Water Act section 401 certification program, RWQCBs review projects that require a federal permit under CWA section 404 or involve dredge or fill activities that may result in a discharge to waters of the United States. This is to ensure that the State's interests are protected on any federally permitted activity occurring in or adjacent to waters of the State. The process for applying for Water Quality Certification under CWA section 401 in California is described on the SWRCB's Web site (http://www.swrcb.ca.gov/rwqcb2/certs.htm).

2.3.11.2 Management Practices

Bridges should be planned to minimize mileage and protect sensitive areas such as wetlands or estuaries. Setbacks should be used for river crossings during construction to minimize disturbance to the riparian area. Bridge construction can adversely impact water circulation in wetland areas, so allowances should be made for these impacts when designing bridges. Areas requiring excessive cut and fill and those that may be subject to subsidence, sink holes, landsides, rock outcropping, and highly erodible soils should be avoided when siting bridge locations.

Runoff should be directed away from bridge decks and watercourses by diverting it toward land for treatment. This can be accomplished using drains that pipe water along the bridge edge to either side of the shore. Recommended practices for treating bridge deck runoff include ponds, wetlands, infiltration basins and trenches, media filters, bioretention areas, vegetated swales, filter strips, and hydrodynamic devices. The use of scupper drains should be restricted on bridges less than 400 feet long and on bridges crossing sensitive areas.

2.3.11.3 Information Resources

- ***Caltrans Environmental Handbook*, Volume 3** (http://www.dot.ca.gov/ser/envhand.htm): This volume provides guidance on the identification and evaluation of biological resources, processing of biological resource documents, and implementation of biologically related construction, maintenance, and encroachment activities. Volume 3 of the *Environmental Handbook* should be used in conjunction with other project planning and development manuals and with Volume 1.
- ***Caltrans Environmental Handbook*, Volume 5** (http://www.dot.ca.gov/ser/envhand.htm): This volume, which is currently in preparation, will provide guidance on storm water management.
- **Caltrans, Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/index.htm). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (http://www.dot.ca.gov/hq/env/stormwater/index.htm): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **Washington Department of Transportation, *Roadside Manual*** (http://www.wsdot.wa.gov/eesc/design/roadside/default.htm - rm): The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.11.4 Case Study

North Coast River Loading Study. This study will look at how storm water runoff from bridges affects water quality, fish, and aquatic life. Sediment, nutrients, and temperature changes will be studied to determine how these pollutants may adversely affect coho salmon and steelhead trout. Information about water quality gathered from this watershed will be valuable for future TMDL (total maximum daily load) studies along the North Coast. It will also provide a basis for future cooperative efforts between Caltrans and watershed landowners working together to reduce stream pollutants (http://www.dot.ca.gov/hq/env/stormwater/index.htm).

Road Crossings on Small Streams. Bridge crossings over streams can affect aquatic habitat in several ways. Sediment from eroded banks during and after construction and storm water runoff from bridges can affect water quality and organisms in the streams (http://www.dot.ca.gov/hq/env/stormwater/index.htm).

This study, which is being conducted in the Navarro watershed, will

- Identify the sources of pollution to the major streams in the watershed
- Identify different types of aquatic life within the stream community
- Determine the availability of habitat for salmon and steelhead
- Compare the condition of the riparian area to the health of stream communities
- Investigate the movement of sediment within the stream
- Analyze storm water runoff using standard toxicology tests to determine the effects on living organisms

2.3.11.5 References

Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/ic/87703.html)

U.S. Department of Transportation 1995. *Best Management Practices for Erosion and Sediment Control*. Eastern Federal Lands Highway Design, Federal Highway Administration, Sterling, VA. (http://199.79.179.19/OLPFiles/FHWA/009340.pdf)

USEPA. 2002. *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

2.3.12 Management Measure 3.5C Transportation Development Construction Projects

Management Measure

1. Reduce erosion and, to the extent practicable, retain sediment on site during and after construction; and

2. Prior to land disturbance, prepare and implement an approved erosion control plan or similar administrative document that contains erosion and sediment control provisions.

See Management Measure 3.2A for programs, practices, and information resources relating to erosion and sediment control at construction sites. The same practices apply to transportation projects.

2.3.13 Management Measure 3.5D Transportation Development Chemical Control

Management Measure

1. Limit application, generation, and migration of toxic substances;

2. Ensure the proper storage and disposal of toxic materials;

3. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

See Management Measure 3.2B for programs, practices, and information resources relating to chemical control at construction sites. The same practices apply to transportation projects.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.3.14 Management Measure 3.5E Transportation Development Operation and Maintenance

Management Measure

Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.

Road and bridge maintenance activities can generate pollutants when runoff carries road surfacing materials, sealants, road salt, sand, and deicing chemicals into receiving waters. In addition, soil can erode when rights-of-way are cleared or disturbed. Practices to prevent such pollution include erosion and sediment controls for exposed soils, covering, and surrounding with berms or other secondary containment materials that are stockpiled for maintenance activities. For winter deicing activities, materials to be used should be carefully selected to avoid causing or exacerbating specific water quality problems. For example, where salinity might be a problem in receiving waters, road salt should be avoided and sand used instead.

Motor vehicles generate runoff pollutants through the emission and deposition of automobile exhaust and through discharges of both fluids and solid particles during travel and while braking (USEPA, 2002). These pollutants include hydrocarbons and heavy metals. In a study of traffic-generated particulates in Cincinnati (where the average daily traffic is 150,000 vehicles), Sansalone and Buchberger (1997) found that 15 percent of the 13,500 milligrams (mg) of particulates per square meter of road surface generated per day originated from engine and brake pad wear. The study also found that 6 percent of particulates were deposited from settleable exhaust. The other proportions originated from pavement wear (44 percent to 49 percent), tire wear (28 percent to 31 percent), and atmospheric deposition (3 percent).

2.3.14.1 Programs

California Department of Transportation, Division of Maintenance, Roadside Maintenance Program. This program is responsible for vegetative control and the Adopt-a-Highway Program. (http://www.dot.ca.gov/hq/maint/roadside.htm).

California Department of Transportation, Division of Maintenance, Roadway Maintenance Program. This program manages rehabilitation and maintenance of pavement and snow and ice control (http://www.dot.ca.gov/hq/maint/roadway.htm).

California Department of Transportation (Caltrans) Adopt-A-Highway Program. The Caltrans Adopt-A-Highway Program provides an avenue for individuals, organizations, or businesses to help maintain sections of roadside within California's State Highway System (http://adopt-a-highway.dot.ca.gov/).

California Department of Pesticide Regulation's (DPR) Surface Water Protection Program. This program protects human health and the environment by preventing pesticides from adversely affecting surface waters, by addressing both agricultural and nonagricultural sources of pesticide residues in surface waters. It has preventive and response components that reduce the presence of pesticides in surface waters (http://www.cdpr.ca.gov/docs/sw/).

2.3.14.2 Management Practices

Road Repairs

Potholes and cracks in road surfaces and retaining walls should be repaired promptly to prevent further degradation of the road surface. When these activities, along with road expansion and repaving, disturb vegetated areas, the exposed soils should be protected from erosion using erosion and sediment controls (see Management Measure 3.2A) and denuded areas should be revegetated using seed, mulch, or sod immediately after road work has been completed.

When performing bridge maintenance activities, use enclosures, and containment and collection systems to collect pollutants. Recommended enclosures include free hanging enclosures, total structure enclosures, and negative pressure systems, and recommended containment and collection systems include: cofferdams, barges, containment booms, and vacuum sanders. A runoff control plan should be in place for each large project, and smaller projects should be governed by standard operating procedures to prevent contamination of storm flows and to control spills.

Winter Maintenance

Chemicals and abrasives used to prevent ice on road surfaces in winter should be stored on an impervious pad and covered to prevent runoff from carrying away any of the materials. Not only does this prevent runoff pollution, but it also preserves the materials for their intended use. Stockpiled deicing materials should not be stored in floodplains.

Deicing materials should be selected and applied to cause minimal harm to the environment. Where areas might be sensitive to salinization, alternatives to road salt, such as sand or any number of organic products that are currently on the market, can be used. Organic products should be avoided in areas that have low biochemical oxygen demand. Sand should not be used in areas with sediment problems such as excessive streambank scour or embedded gravels.

When applying materials, care should be taken to apply only the amount of material that is required to provide a safe road surface. Local studies can be undertaken to determine the appropriate amount of deicing materials to be used for different road surfaces in different conditions and locations.

Snow that is plowed from road surfaces should never be stockpiled on or near frozen surface waters or retention ponds. Once the snow and ice has melted, road surfaces should be swept or vacuumed to remove and reclaim sand, salt, or other deicing chemicals. This material can be recycled or disposed of in a locally approved manner.

Trash and Debris Removal

Streets and parking lots should be periodically swept or vacuumed to remove trash and debris. The frequency with which each area or road is swept should depend on the quantity of trash that is seen over time. Areas that are heavily traveled or tend to attract litter should be swept more frequently. Also, areas that drain to sensitive receiving waters or areas that have known trash and debris problems should be swept more frequently.

Anti-litter signage should be posted throughout the community, especially in places with known trash/debris problems. Litter and dumping laws should be strictly enforced, and the municipality should provide a hotline or other medium for citizens to report littering or dumping.

2.3.14.3 Information Resources

- **Federal Highway Administration, *Manual of Practices for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel*** (http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm): The manual was written to guide maintenance managers in developing a systematic and efficient practice for maintaining roads in the best conditions possible during a winter storm. It describes the significant factors that should be understood and must be addressed in an anti-icing program, with the recognition that the development of the program must be based on the specific needs of the site or region within its reach. It focuses on the weather information, materials, and methods that will best address site conditions such as level of service, highway agency resources, climatological conditions, and traffic.
- **Transportation Research Board publications** (http://www4.trb.org/trb/onlinepubs.nsf): The Transportation Research Board has prepared several studies that investigate the environmental impacts of activities related to transportation infrastructure, including such titles as *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters*, *Mitigating Highway Runoff Constituents Via a Wetland*, *Characteristics of Storm-Water Runoff from Highway Construction Sites in California*, and others.
- **Pacific Northwest Snowfighters Association** (http://www.wsdot.wa.gov/partners/pns/): This site provides resources on deicing and anti-icing products and practices.
- **California Department of Transportation (Caltrans), Storm Water Management Program** (http://www.dot.ca.gov/hq/env/stormwater/index.htm). Caltrans is the agency responsible for managing California 's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California.
- **Washington Department of Transportation, *Roadside Manual*** (http://www.wsdot.wa.gov/eesc/design/roadside/default.htm#rm). The purpose of this manual is to provide guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.14.4 References

California Department of Transportation. 1998. *Maintenance Manual: Volume 1*. California Department of Transportation, Sacramento, CA. (http://www.dot.ca.gov/hq/maint/manual/maintman.htm)

Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/ic/87703.html)

National Research Council, Transportation Research Board. 2000. *Primer: Study of the Environmental Impact of Construction and Repair Materials on Surface and Ground Waters*. National Academy Press, Washington, DC. (http://gulliver.trb.org/publications/nchrp/nchrp_rpt_443.pdf)

San Francisco RWQCB. 1998. *Erosion and Sediment Control Field Manual*. San Francisco Regional Water Quality Control Board, San Francisco, CA.

Sansalone, J.J., and S.G. Buchberger. 1997. Partitioning and First Flush of Metals in Urban Roadway Storm Water. *Journal of Environmental Engineering* 123(2): 134–143.

U.S. Department of Transportation 1995. *Best Management Practices for Erosion and Sediment Control*. Eastern Federal Lands Highway Design, Federal Highway Administration, Sterling, VA. (http://199.79.179.19/OLPFiles/FHWA/009340.pdf)

USEPA. 2002. *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

Fact Sheet Links:
➔ Programs
➔ Management Practices
➔ Information Resources
➔ Case Studies
➔ References

2.3.15 Management Measure 3.5F Transportation Development Road, Highway, and Bridge Runoff Systems

Management Measure

Develop and implement runoff management systems for existing roads, highways, and bridges to reduce runoff pollutant concentrations and volumes entering surface waters.

1. Identify priority watershed pollutant reduction opportunities (e.g., improvements to existing urban runoff control structures); and

2. Establish schedules for implementing appropriate controls.

This management measure acknowledges the fact that roads built in the past may not have the same level of runoff control and treatment that is expected today. These older roads may be contributing to pollution problems in receiving waters. Municipalities responsible for road and bridge rights-of-way should undertake an assessment of the roads' and bridges' contribution to surface waters and identify opportunities for installing new treatment practices. Based on water quality priorities and the availability of staff and funding resources, a schedule should be devised to implement these practices.

2.3.15.1 Programs

Caltrans Storm Water Management Program. Caltrans is the agency responsible for managing California's highway system. With its statewide Storm Water Management Program, Caltrans is helping to prevent the adverse effects of storm water runoff from Caltrans roadways and facilities. This program provides a comprehensive effort to preserve and improve water quality in California (http://www.dot.ca.gov/hq/env/stormwater/index.htm).

Surface Transportation Policy Project (STPP). STPP's California field offices provide assistance to local transportation agencies, elected officials, and citizen groups in order to help stakeholders take advantage of the new opportunities available under the federal transportation bill to link transportation to land use, housing, social equity, livable communities, and smart growth (http://www.transact.org/ca/environment.htm).

2.3.15.2 Management Practices

Runoff treatment facilities can be located within existing rights-of-way, medians, or interchange loops, or on adjacent lands (e.g., golf courses and parks). Where no additional land is available, underground runoff storage and treatment (e.g., sand filters) can be used. Vegetative filter strips along roadsides and in medians can be effective at slowing runoff velocities and increasing storm water infiltration. Curbs should be eliminated to allow highway and road runoff to be filtered through vegetated shoulders and medians. Eliminating curbs also increases infiltration to ground water. If eliminating curbs is not possible, curbs can be designed with breaks and energy dissipaters to direct sheet flow to vegetated surfaces. These infiltration areas will require periodic inspection for damage, rilling, ponding, and trash accumulation, and will also require mowing or cropping of vegetation to prevent nuisance conditions.

Soil bioengineering techniques can be used in lieu of retaining walls for slope stabilization practices where sloped roadsides are deteriorating. Practices such as live stakes, fascines, brush layers, branchpacking, live gully repair, live cribwalls, vegetated rock gabions, vegetated rock walls, and joint planting are recommended for relatively moderate slopes where vegetation can be established.

2.3.15.3 Information Resources

- **Caltrans *Environmental Handbook*, Volume 5** (http://www.dot.ca.gov/ser/envhand.htm): This volume, which is still in preparation, will provide guidance on storm water management.
- **Caltrans, Storm Water Management Plan** (http://www.dot.ca.gov/hq/env/stormwater/special/index.htm). The plan, approved by the SWRCB in March 2003, describes procedures and practices Caltrans uses to manage pollutants discharged from storm water drainage systems.
- **Caltrans Internet Water Quality Planning Tool** (http://www.dot.ca.gov/hq/env/stormwater/index.htm): Available only on the Internet, the Water Quality Planning Tool is a database of water quality standards and possible pollutants from Caltrans facilities. This unique tool is another valuable resource being used by Caltrans in its continuing commitment to prevent storm water pollution.
- **Washington State Department of Transportation (WSDOT), Soil Bioengineering** (http://www.wsdot.wa.gov/eesc/cae/design/roadside/SBWebsite/mainpage/BackgroundInfo/background.html): WSDOT has a Web page that provides information on soil bioengineering, from designing projects to costs, funding, contractors, and native plant supplies. The site also showcases past projects and provides links to several online information sources.
- **WSDOT, Roadside and Site Development Unit** (http://www.wsdot.wa.gov/eesc/design/roadside/default.htm): The Roadside and Site Development Unit has a roadside technology transfer center that shares information with the public on technologies such as soil bioengineering, revegetation, soils, and permanent erosion control. The ***Roadside Manual*** (http://www.wsdot.wa.gov/eesc/design/roadside/default.htm - rm) provides guidance on roadside maintenance, including planning, design, construction, and maintenance. The manual has information on sustainable roadsides, environmental functions, wetlands, water quality, parking area design, erosion control, contour grading, soil bioengineering, and vegetative restoration concepts.

2.3.15.4 References

Metropolitan Washington Council of Governments. 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, Washington, DC. (http://www.mwcog.org/ic/87703.html)

San Francisco RWQCB. 1998. *Erosion and Sediment Control Field Manual*. San Francisco Regional Water Quality Control Board, San Francisco, CA.

U.S. Department of Transportation 1995. *Best Management Practices for Erosion and Sediment Control*. Eastern Federal Lands Highway Design, Federal Highway Administration, Sterling, VA. (http://199.79.179.19/OLPFiles/FHWA/009340.pdf)

U.S. Environmental Protection Agency. 2002. *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.3.16 Management Measure 3.6A Education/Outreach Pollution Prevention/Education

Management Measure

Implement educational programs to provide greater understanding of watersheds and to raise awareness and increase the use of applicable urban management measures and practices where needed to control and prevent adverse impacts on surface and ground waters. Public education, outreach, and training programs should involve applicable user groups and the community. Implementation of urban pollution prevention and education programs includes the following subjects, where applicable:

1. Households: Improper storage, use, and disposal of household hazardous chemicals, including automobile fluids, pesticides, paints, and solvents; lawn and garden activities, including the application and disposal of lawn and garden care products, and improper disposal of leaves and yard trimmings; improper operation and maintenance of onsite disposal systems; and improper disposal of pet excrement.

2. Landscaping: Turf management on golf courses and in parks and recreational areas.

3. Commercial: Commercial activities, including parking lots, restaurants, vehicle service facilities, and other entities.

4. Other General Sources: Discharge of pollutants (including floatables, waste oil, and litter) into storm drains; roads, highways, and bridges.

2.3.16.1 Programs

California Integrated Waste Management Board (CIWMB). The CIWMB provides assistance with solid waste minimization and pollution prevention. Material-specific guidance, educational materials, and information on financial assistance are provided for industry and the general public (http://www.ciwmb.ca.gov/).

California Department of Toxic Substance Control (DTSC) Pollution Prevention (P2) Program. The P2 Program provides resources for industry, local government, and other environmental agencies to promote source reduction and pollution prevention. This includes technology transfer, inspection/enforcement program support, and public outreach (http://www.dtsc.ca.gov/PollutionPrevention/index.html).

California Department of Pesticide Regulation, Home2Ocean Program. The Home2Ocean Web site provides information for residential users of pesticides on their proper use and disposal. The Home2Ocean workbook is a capacity-building resource for launching or conducting a public education program for preventing water pollution from household pesticides (http://www.home2ocean.org/index.html).

City of San Diego's Storm Water Pollution Prevention Program. The program aims to reduce pollution in urban runoff through a variety of programs. These include public education, training programs, monitoring for water quality, watershed management, and the development and implementation of management practices (http://www.sannet.gov/stormwater/index.shtml).

Alameda Countywide Clean Water Program (ACCWP). The ACCWP is a consortium of local agencies in Alameda County dedicated to preventing urban storm water pollution. The program grew out of a need to meet NPDES requirements and participate in the development of the Water Quality Control Plan for the San Francisco Bay region. The program engages in efforts to educate the general public, contractors, and government employees through the distribution of literature, information fairs, training workshops, and television ads. In addition, the consortium works to identify and correct illicit discharges into the storm water system (http://www.ci.berkeley.ca.us/PW/Storm/stormala.html).

San Mateo Countywide Stormwater Pollution Prevention Program (STOPPP). STOPPP serves as a community resource for pollution prevention, focusing on educating residential and business communities via publications on management practices, commercials, and training programs (http://www.flowstobay.org/index.html).

California Environmental Protection Agency, Permit Assistance Centers. In addition to helping businesses to comply with permit requirements, this program provides referrals for pollution prevention assistance and other business assistance programs. The Web site lists pollution prevention resources relevant to California businesses (http://www.calgold.ca.gov/P2/).

2.3.16.2 Management Practices

Pollution prevention practices are those that seek to educate the public on the potential for everyday activities to create NPS pollution. Pollution is generated by everyday household activities, commercial and residential lawn and garden care, commercial activities, pet waste, and trash.

Everyday household chemicals can be considered pollutants if they are improperly handled, stored, or disposed of. Automotive substances, household cleaners, fertilizers, pesticides, and home improvement materials must all be carefully managed to prevent contamination of runoff or ground water. Car washing can flush nutrients, metals and hydrocarbons into storm drains. Watershed managers can address these problems through public outreach and education efforts such as pamphlet distribution, training on proper lawn care practices, and storm drain stenciling. Municipalities should also provide facilities for the disposal of household chemicals.

In residential neighborhoods, pet waste can also be a major contributor to NPS pollution. Pet owners can be informed about proper disposal of waste, and municipalities can install “pet waste stations,” pass and enforce “pooper scooper” ordinances, and post signs.

Outreach campaigns should also inform both commercial lawn care specialists and residents of the importance of proper application of fertilizers and pesticides. In particular, techniques such as Integrated Pest Management and timing of fertilizer application should be emphasized to provide citizens with the tools to use these substances efficiently and reduce overall pesticide and fertilizer use.

One way commercial activities can generate NPS pollution is through the release of wastewater into a storm sewer system without a permit (this is known as an illicit discharge). Municipalities must develop programs to help detect and eliminate these illicit discharges, as well as educate businesses and their employees. Commercial and industrial establishments should also implement good housekeeping practices, employee education and training programs and spill prevention plans. Measures should be taken to reduce the possibility of spills or leaks during general operation, maintenance, washing, construction, or repairs and to limit the exposure of pollutants to areas where they might come in contact with storm water.

Finally, municipalities should implement good housekeeping practices, including programs to control trash, debris collected from street sweeping, stockpiled material, and corporation yard pollutant sources, and reduce pollutants from activities such as park and road maintenance. Programs that reduce the amount of trash on the streets include public education, increased waste disposal facilities and cleanup campaigns. Municipalities can also clean streets and prevent trash from entering storm water with street sweeping and trash collection devices for storm drain inlets.

2.3.16.3 Information Resources

General Pollution Prevention Web sites

- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** (http://www.stormwatercenter.net/Assorted Fact Sheets/Tool8-Stewardship/municipal.htm): These fact sheets describe various residential storm water pollution prevention practices.
- **USEPA, Pollution Prevention Information Clearinghouse (PPIC)** (http://www.epa.gov/opptintr/library/ppicindex.htm): The PPIC houses USEPA documents, pamphlets, and fact sheets on pollution prevention. It also answer questions about pollution prevention and provides referrals for technical assistance and additional information.
- **California Consortium of Pollution Prevention Committees** (http://www.westp2net.org/c2p2c/c2p2c_main.htm): The consortium's Web site provides links to various pollution prevention organizations in California. The consortium is part of the Western Region Pollution Prevention Network.
- **California Coastal Commission, *Model Urban Runoff Program (MURP)*** (http://www.coastal.ca.gov/la/murp.html): MURP is a step-by-step guide designed for small municipalities to help them manage NPS pollution from urban runoff in California.

Educational Resources

- **American Oceans Campaign, *Stormwater Resources*** (http://www.americanoceans.org/runoff/epa.htm): This Web site is a compilation of educational resources on storm water pollution specific to California. Fact sheets, brochures, videos and curriculum are available.
- **Orange County Stormwater Program** (http://www.ocwatersheds.com/PublicEducation/pe_brochures.asp): The public education program Web site includes a number of brochures on pollution prevention for residents and businesses. The brochures can be downloaded and printed copies can be ordered.
- **Pierce County, Washington Public Utilities Commission, *Stormwater Pollution Prevention Manual*** (http://www.co.pierce.wa.us/PC/services/home/environ/water/swm/sppman/): This online manual is designed to provide homeowners and businesses with information on pollution prevention.

Residential Pollution Prevention (Household hazardous waste, lawn and garden care, pet waste, car washing)

- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** (http://www.stormwatercenter.net/Assorted Fact Sheets/Tool8-Stewardship/residential.htm):

These fact sheets describe various residential storm water pollution prevention practices, such as pet waste collection, car washing, lawn care, car maintenance, and rain barrels.

- **Natural Resources Conservation Service, Backyard Conservation Tip Sheets** (http://www.nrcs.usda.gov/feature/backyard/): These fact sheets provide information for homeowners on ways to reduce erosion and manage fertilizer and pesticide application for water quality protection.

Municipal/Commercial Pollution Prevention

- ***California Municipal Handbook*** (http://www.cabmphandbooks.org/): This manual contains information about storm water quality planning for municipal operations, including permit requirements, planning principles, techniques for reducing runoff and managing impervious areas, source controls, runoff treatment controls, staff training, and inspections and maintenance.
- **California Department of Transportation, *Maintenance Storm Water Pollution Prevention Bulletin*** (http://svhqsgi4.dot.ca.gov/hq/env/stormwater/publicat/maintain/acrobat.htm): This is a monthly bulletin that provides technical information on management practices for municipal maintenance activities.
- **USEPA, *Phase II Pollution Prevention/Good Housekeeping Fact Sheet*** (http://www.epa.gov/npdes/pubs/fact2-8.pdf): This fact sheet describes general requirements and provides guidance for the Phase II Pollution Prevention/Good Housekeeping minimum control measures.
- **Stormwater Manager's Resource Center, Fact Sheets on Pollution Prevention Practices** (http://www.stormwatercenter.net/Assorted Fact Sheets/Tool8-Stewardship/municipal.htm): These fact sheets describe various municipal storm water pollution prevention practices for pest control, bridge and roadway maintenance, controlling illegal dumping, catch basin maintenance, and parking lot and street cleaning.
- **CalGold, *Pollution Prevention Resources*** (http://www.calgold.ca.gov/P2/default.asp): CalGold was established by the California Environmental Protection Agency to help businesses comply with environmental regulations. The Pollution Prevention Resources include a number of industry-specific fact sheets.
- **USEPA, *National Menu of Best Management Practices for Storm Water Phase II*, Pollution Prevention/Good Housekeeping for Municipal Operations Fact Sheets** (http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm): USEPA's guidance for small NPDES-regulated municipalities describes practices appropriate for municipal crews to reduce pollutants in storm water at their source, including safe material storage and handling practices, vehicle washing, street sweeping, and landscape maintenance. These practices can apply to residents and business owners and operators, as well.

2.3.16.4 Case Study

Pet Pollution Prevention Pledge, Los Angeles County, California. The Los Angeles County Department of Public Works developed this program to educate residents on the importance of proper disposal of pet waste. The outreach campaign relied on multimedia communication efforts, the distribution of cleanup kits, and the installation of plastic bag dispensers in parks. Local pet and pet supply stores helped with the effort (Lehner et al., 1999) (http://www.epa.gov/owow/info/NewsNotes/issue53/education53.html - canines).

2.3.16.5 References

Lehner, P.H., G.P. Aponte Clarke, D.M. Cameron, and A.G. Frank. 1999. *Stormwater Strategies: Community Responses to Runoff Pollution*. Natural Resources Defense Council, New York, NY.

USEPA. 2002. *National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas—Draft*. U.S. Environmental Protection Agency, Office of Water, Washington, DC. (http://www.epa.gov/owow/nps/urbanmm/)

2.4 Marinas and Recreational Boating

2.4.1 Introduction

The California *Management Measures for Polluted Runoff* defines 16 management measures to control pollution from marinas and recreational boating. Because marinas are located at the water's edge, pollutants generated by marinas and boats are less likely to be buffered or filtered by natural processes. When boating and related activities (e.g., marinas and boat maintenance areas) are poorly planned or managed, they may threaten the health of aquatic systems and pose other environmental hazards. USEPA (1993) identifies several sources of pollution associated with marinas and boating activities:

- Poorly flushed waterways
- Pollutants discharged from boats (recreational boats, commercial boats, and "live-aboards")
- Pollutants carried in storm water runoff
- Physical alteration of wetlands and of shellfish and other benthic communities during construction of marinas, ramps, and related facilities
- Pollutants generated from boat maintenance activities on land and in the water

Marinas and Recreational Boating Category Links:

Assessment, Siting, and Design
- ➔ Marina Flushing
- ➔ Habitat Assessment
- ➔ Water Quality Assessment
- ➔ Shoreline Stabilization
- ➔ Storm Water Runoff
- ➔ Fueling Station Design
- ➔ Sewage Facilities
- ➔ Waste Management Facilities

Operation and Maintenance
- ➔ Solid Waste Control
- ➔ Fish Waste Control
- ➔ Liquid Material Control
- ➔ Petroleum Control
- ➔ Boat Cleaning and Maintenance
- ➔ Maintenance of Sewage Facilities
- ➔ Boat Operation

Education/Outreach
- ➔ Public Education/Outreach

California's management measures are intended to be applied to control impacts on water quality and habitat from marina siting and construction (new and expanding marinas), and marina and boat operation and maintenance. The measures are designed to reduce nonpoint source (NPS) pollution by requiring the best possible siting for marinas and maintenance areas, providing for the best available design and construction practices and appropriate operation and maintenance practices, and encouraging the development and use of effective pollution control and education efforts. The management measures cover the following operations and facilities (USEPA, 1993):

- 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
- Any residential or planned community marina with 10 or more slips
- Any mooring field where 10 or more boats are moored
- Public or commercial boat ramps
- Boat maintenance or repair yards that are adjacent to the water, and any federal, State, or local facility that involves recreational boat maintenance or repair on or adjacent to the water

The eight assessment, siting, and design management measures for marinas and recreational boating are as follows:

- 4.1A. Assessment, Siting, and Design—Marina Flushing, which provides for maximum flushing and circulation of surface waters through marina siting and designs. These practices can reduce the potential for water stagnation, maintain biological productivity, and reduce the potential for toxic accumulation in bottom sediment.

- 4.1B. Assessment, Siting, and Design—Habitat Assessment, which involves siting and designing marinas to protect against adverse impacts on fish and shellfish, aquatic vegetation, and important local-, State-, or federal-designated habitat areas.

- 4.1C. Assessment, Siting, and Design—Water Quality Assessment, which considers impacts on water quality in siting and designing new and expanding marinas

- 4.1D. Assessment, Siting, and Design—Shoreline Stabilization, where shoreline erosion is a pollution problem.

- 4.1E. Assessment, Siting, and Design—Storm Water Runoff, which involves implementing runoff control strategies to remove at least 80 percent of suspended solids from storm water runoff coming from boat maintenance areas (some boat yards may conform to this provision through NPDES permits).

- 4.1F. Assessment, Siting, and Design—Fueling Station Design, which requires that fueling stations be located and designed to contain accidental fuel spills in a limited area, and that fuel containment equipment and spill contingency plans be provided to ensure quick spill response.

- 4.1G. Assessment, Siting, and Design—Sewage Facilities, which requires that pumpout, pump station, and restroom facilities be installed at new and expanding marinas where needed to prevent sewage discharges directly to State waters.

- 4.1H. Assessment, Siting, and Design—Waste Management Facilities, which requires that facilities be installed at new and expanding marinas where needed for the proper recycling or disposal of solid wastes (e.g., oil filters, lead acid batteries, used absorbent pads, spent zinc anodes, and fish waste as applicable) and liquid materials (e.g., fuel, oil, solvents, antifreeze, and paints).

The seven operation and maintenance management measures for marinas and recreational boating are as follows:

- 4.2A. Operation and Maintenance—Solid Waste Control, which involves properly disposing of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of these wastes to surface waters.

- 4.2B. Operation and Maintenance—Fish Waste Control, which promotes sound fish waste management, where fish waste is a NPS problem, through a combination of fish cleaning restrictions, education, and proper disposal.

- 4.2C. Operation and Maintenance—Liquid Material Control requires provision and maintenance of the appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, as well as encouraging the recycling of these materials.

- 4.2D. Operation and Maintenance—Petroleum Control is aimed at reducing the amount of fuel and oil that leaks from fuel tanks and tank air vents during the refueling and operation of boats.

- 4.2E. Operation and Maintenance—Boat Cleaning and Maintenance, which requires minimization of the use of potentially harmful hull cleaners and bottom paints and prohibiting discharges of these substances to State waters.

- 4.2F. Operation and Maintenance—Maintenance of Sewage Facilities, which involves maintaining pumpout facilities in operational condition and encouraging their use so as to prevent and control untreated sewage discharges to surface waters.

- 4.2G. Operation and Maintenance—Boat Operation, which involves prevention of turbidity and physical destruction of shallow-water habitat resulting from boat wakes and propwash.

The education/outreach management measure for marinas and recreational boating, 4.3A Education/Outreach—Public Education, requires that public education, outreach, and training programs be instituted to prevent and control improper disposal of pollutants into State waters.

2.4.1.1 Background

The following fact sheets provide information on management measures that can be used to reduce NPS 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 NPS pollution of surface waters from marinas and recreational boating.

The guidance can assist marina managers in identifying possible sources of NPS pollution and it offers potential solutions. Finding a solution to NPS pollution problems at a marina requires taking into account the site-specific factors that together compose the setting of a marina. The management practices presented in the following fact sheets are recommended based on their successful application at many marinas. Their applicability to any particular marina or situation, however, must be determined based on site-specific factors. The applicability of the individual management practices and combinations of management practices 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 management practices in this guidance or others would be most effective for controlling NPS pollution.

2.4.1.2 General Marina-Related Programs and Information Sources

- **Boating Clean and Green Campaign** (http://www.coastal.ca.gov/ccbn/ccbndx.html): This program provides education and outreach to promote environmentally sound boating practices for marine businesses and boaters in California. The Web site includes tips on clean boating, information on California water quality programs, listings of oil disposal sites, and links to other boating sites.

- **California Clean Boating Network** (http://www.coastal.ca.gov/ccbn/ccbnhomenew.html): The California Clean Boating Network is collaboration of government, environmental, business, boating, and academic organizations working toward clean boating education in California. The Web site contains information on the organization's publication, *Changing Tides*, and a variety of projects geared toward public education and the promotion of green boating practices.

- **California Department of Boating and Waterways** (DBW) (http://dbw.ca.gov/): DBW provides information to boaters on boating safety, boating law, boating guides, boating-related pollution and pollution prevention, marine sanitation device (MSD) laws, and many other topics of interest to the boating public.
- **National Clean Boating Campaign** (http://www.cleanboating.org/): This Web site provides tips on clean boating, information on the campaign's National Clean Boating Celebration, and a comprehensive, searchable bibliography of clean boating documents and Web sites.
- **U.S. Coast Guard Sea Partners** (http://www.uscg.mil/hq/g-m/nmc/seapart.htm): This site has information on marine environmental protection laws, links related to marine debris, small spills, clean boating practices, and educational resources.
- **USEPA, Office of Wetlands, Oceans, and Watersheds, Nonpoint Source Branch** (http://www.epa.gov/owow/nps/marinas.html): These are federal documents on clean boating, clean marinas, and engine maintenance.
- **University of California Cooperative Extension, *Marina Pollution Prevention Manual*** (http://nsgd.gso.uri.edu/cuimr/cuimrh95002.pdf): This manual describes important components of pollution prevention at recreational boating facilities. It covers pollution sources, hazardous waste management, spill response, marina staff procedures and training, San Diego County agency and service contacts, and publications for distribution among marina staff, contractors, and boaters.
- **Florida Department of Environmental Protection, *Best Management Practices for Boatyards: Clean Boatyards Manual*** (http://www.dep.state.fl.us/law/Grants/CMP/BestMangPrac.htm): This manual includes sections dealing with boat cleaning, boatyard storm water management, fire safety, hazardous waste management, hurricane information, hurricane preparation, liquid waste storage management, petroleum, planning for emergencies, sewage pumpouts and waste dump receptacles, and solid waste management.

2.4.1.3 Information on Watersheds

- **Orange County, Watersheds and Coastal Resources Division** (http://www.ocwatersheds.com/): This Web site provides detailed information on the watersheds of Orange County.
- **The South Coast Watershed Environmental Education Center, Orange County,** showcases and demonstrates management practices for watershed management and water conservation (Telephone: 949-643-1600).

2.4.1.4 References

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. (http://www.epa.gov/owow/nps/MMGI/index.html)

Fact Sheet Links:
- ➔ Programs
- ➔ Management Practices
- ➔ Information Resources
- ➔ Case Studies
- ➔ References

2.4.2 Management Measure 4.1A Assessment, Siting, and Design Marina Flushing

Management Measure

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

2.4.2.1 Management Practices

New or expanding marinas should be designed such that the natural circulation of water from tidal action is not restricted. Ensure that the bottom of the marina and entrance channels are not deeper than adjacent navigable channels to help keep the bottom of the marina basin from becoming a pollutant trap, leading to low dissolved oxygen levels.

Consider alternatives to a single-entrance design in poorly flushed water bodies to enhance flushing, for example:

- An open design instead of a semi-enclosed design in a naturally protected location
- Wave attenuators instead of fixed breakwaters where they will provide sufficient protection

New marinas should be designed with as few enclosed water sections or separated basins as possible to promote circulation within the entire basin. Small side basins off the main basin may not flush nearly as well as a large single basin. Consider the value of entrance channels in promoting flushing when designing or reconfiguring a marina. Two entrances at opposite ends of a marina can promote flow-through currents.

Use mechanical aerators to improve flushing and water quality where basin and entrance channel configuration cannot provide adequate flushing. Place them in basin corners or other poorly flushed areas.

2.4.2.2 Information Resource

California Department of Boating and Waterways, *Layout, Design and Construction Handbook for Small Craft Boat Launching Facilities* (http://dbw.ca.gov/PDF/Lramps.pdf): This document describes both mandatory and recommended design criteria for boat launching facilities.

2.4.2.3 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
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2.4.3 Management Measure 4.1B Assessment, Siting, and Design Habitat Assessment

Management Measure

Site and design new and expanding 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.

2.4.3.1 Programs

The Marine Region, part of the California Department of Fish and Game, is responsible for protecting and managing California's marine resources. It was created to improve marine resource management through law enforcement, fisheries and habitat programs, environmental review, and water quality monitoring. The Marine Region has adopted an ecosystem approach that incorporates the values of biological communities and habitats as well as the public, while protecting the health of the marine environment. http://www.dfg.ca.gov/mrd/aboutus.html.

The California Ocean and Coastal Environmental Access Network (CalOCEAN) is a Web-based ocean resource information system for the State of California. It is designed to provide access to ocean and coastal data and information from a wide variety of sources on biological, physical, and legal information for resource managers, educators, students, and the general public. The data includes, or will include, an inventory of water quality monitoring projects, coastal habitat types and locations, marine managed areas, and wetlands and fisheries information. http://ceres.ca.gov/ocean/.

The Marine Life Inventory, by the California Coastal Commission, Department of Fish and Game, is a program for high school students and teachers to participate in ocean sampling while monitoring water quality (Telephone: 949-640-9956).

2.4.3.2 Management Practices

This management measure involves conducting habitat surveys and characterizing the marina site prior to construction. Critical and unique areas should be inventoried, such as shellfish beds and submerged aquatic vegetation. Areas that provide critical habitat functions, such as riparian areas, spawning areas, nursery areas and feeding areas should be identified so that appropriate measures can be taken to minimize their disturbance. Rapid bioassessment techniques provide a cost-effective way to inventory aquatic resources. Established bioassessment protocols use sampled invertebrate and fish communities as indicators of ecosystem health.

If possible, alternative sites should be considered that could minimize disturbance to sensitive areas. For example, waterfront areas that are already developed could be used for new marinas, or existing marinas could be expanded. If this is not a viable alternative, consider dry stack storage, in which boats are stored on vertical stands, minimizing disturbance, leakage, and pollution from maintenance operations. In addition, a good way to compensate for potential habitat loss is to create or expand habitats within the marina. Rough surfaces such as docks, piers, piles, and floats provide a good substrate for attachment of bivalves and other aquatic organisms.

2.4.3.3 Information Resources

USEPA, *Estuaries and Near Coastal Areas Bioassessment and Biocriteria Guidance* (http://www.epa.gov/ost/biocriteria/States/estuaries/estuaries1.html): This technical guidance document describes protocols for conducting bioassessments in estuarine and coastal marine waters. Case studies illustrate the bioassessment process and biocriteria derivation procedures. The document discusses sampling methods and candidate metrics for benthic macroinvertebrates, fish, aquatic macrophytes, and phytoplankton.

2.4.3.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- Programs
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- References

2.4.4 Management Measure 4.1C Assessment, Siting, and Design Water Quality Assessment

Management Measure

1. Assess water quality as a part of the siting and design of new and expanding marinas to establish baseline water quality conditions or trends.

2. Assess water quality at existing marinas to establish baseline water quality conditions.

2.4.4.1 Programs

The San Diego BayKeeper Citizen Monitoring Program trains the public to monitor local waters. BayKeeper works with regulatory agencies, municipalities, academic institutions, businesses and volunteer groups (http://www.sdbaykeeper.org/programs/ctznwater.htm).

The Orange County CoastKeeper Citizen Water Monitoring Program organizes local citizens for volunteer monitoring of county streams and rivers (Telephone: 949-723-5424; Web site: http://www.cacoastkeeper.org/cacoast/current-programs.html#Water%20Monitoring).

The Marine Life Inventory, by the California Coastal Commission, is a program for high school students and teachers to participate in ocean sampling while monitoring water quality (Telephone: 949-640-9956).

The Orange County Marine Life Refuge Project is a community watch volunteer program and a water quality monitoring program to determine the effects of urban runoff. Volunteers of at least high school age are trained in data collection and interpretation (http://www.ocparks.com/tidepools/MLRproject.htm).

The Los Angeles County Ocean Water Monitoring Program provides Web-based beach and rain advisories for Los Angeles County (http://www.lapublichealth.org/beach/).

The State Water Resources Control Board (SWRCB) sponsors the Clean Water Team Citizen Monitoring Program as part of California's NPS Program http://www.swrcb.ca.gov/nps/)

The City of Santa Barbara Clean Water Program conducts storm water sampling, and ocean and creek monitoring, and supplies information on opportunities for citizen involvement (http://www.countyofsb.org/project_cleanwater/).

The Morro Bay Volunteer Monitoring Program provides citizen monitoring opportunities in Morro Bay estuary waters (http://www.mbnep.org/volunt.htm).

The Monterey Bay Sanctuary Citizen Watershed Monitoring Network is a network of citizens who comprehensively monitor the health of the sanctuary (http://www.mbnms.nos.noaa.gov/monitoringnetwork/welcome.html).

The Southern California Marine Institute's Environmental Monitoring Program educates students in grades 5–12 on marine environmental issues and water quality monitoring in southern California. The

goal of the program is to educate young people about natural resources and to allow them to become directly involved in monitoring their environment (http://www-bcf.usc.edu/~scmi/Sites/genbroch.html).

The Land Conservancy of San Luis Obispo is implementing a volunteer water quality monitoring program in the county (Telephone: 805-544-9096).

The Coastal Water Quality Monitoring Inventory is a database with information on California's Coastal Water Quality Monitoring Programs. Major water quality monitoring programs along the California coast and its bays are listed, along with details such as the water quality measurements made, locations, frequency, quality assurance information, and contact information (http://www.sfei.org/camp/).

2.4.4.2 Management Practices

Water quality assessments can be conducted through a water quality monitoring program that includes pre-development, construction, and post-development phases to assess the water quality impacts of a marina. Effective assessments can also be accomplished through numerical modeling that includes pre-development and post-construction model applications.

Prior to construction, the current water quality conditions should be assessed. Acceptable water quality data may already have been collected by the U.S. Geological Survey, the U.S. Army Corps of Engineers, State and local agencies or local universities. If new data are required, there are a few ways to collect information when resources are limited:

- Visual inspections of water quality might suffice. Keeping an eye out for oil sheens, trash, and sediment buildup on aquatic plants can be a simple way to track water quality.
- Use rapid bioassessment techniques to monitor water quality. Aquatic insects and grasses can be surveyed quickly and give a good visual idea of how clean the water is.
- Establish a volunteer monitoring program. Enlist the help and environmental enthusiasm of slip renters and their kids. Its good for the marina and the volunteers learn a lot!

As an alternative to a comprehensive monitoring program, water dynamics in a marina basin can be modeled. It is important to keep in mind that all modeling applications require some field data for calibration, and a cost-effective approach would be a combination of both water quality monitoring and numerical modeling. These models can be used to investigate alternative designs and their predicted impact on water quality.

2.4.4.3 Information Resources

Water Quality Monitoring

USEPA, *Monitoring and Assessing Water Quality* (http://www.epa.gov/owow/monitoring/): This Web site is a repository of technical guidance and information on various water quality assessment techniques. Guidance documents on biological assessment and volunteer monitoring are included.

Watershed Planning

California Coastal Commission, *California's Critical Coastal Areas (CCA) Program* (http://www.coastal.ca.gov/nps/cca-nps.html)*:* The CCA Program encourages collaboration among local

stakeholders and government agencies to better identify coastal-zone watershed areas in critical need of protection from polluted runoff.

Bioassessment

USEPA, *Estuaries and Near Coastal Areas Bioassessment and Biocriteria Guidance* (http://www.epa.gov/ost/biocriteria/States/estuaries/estuaries1.html): This technical guidance document describes protocols for conducting bioassessments in estuarine and coastal marine waters. Case studies illustrate the bioassessment process and biocriteria derivation procedures. The document discusses sampling methods and candidate metrics for benthic macroinvertebrates, fish, aquatic macrophytes, and phytoplankton.

2.4.4.4 Case Study

Clean Water Team. The Clean Water Team (CWT) is the citizen monitoring program of the California SWRCB. Regional CWT Citizen Monitoring Coordinators provide technical assistance, training, data management consultation, outreach, and education to citizen monitoring organizations. Citizen monitoring activities include collecting water quality data, evaluating fish habitat, counting birds, or making visual observations of water health. Monitoring activities are available for school children, youth groups, landowners, and community organizations (http://www.swrcb.ca.gov/nps/mission.html).

2.4.4.5 References

USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002. (http://www.epa.gov/owow/nps/MMGI/index.html)

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

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2.4.5 Management Measure 4.1D Assessment, Siting, and Design Shoreline Stabilization

Management Measure

Where streambank or shoreline erosion is a NPS pollution problem, streambanks/shorelines should be stabilized (when determining whether streambank/shoreline erosion is a NPS problem, assess natural erosion rates and the dynamic equilibrium of the streambank/shoreline). The use of vegetative stabilization methods is preferred over the use of structural stabilization methods, if appropriate considering the climate, severity of erosion, offshore bathymetry, and/or the potential adverse impact on other streambanks or shorelines and offshore areas.

2.4.5.1 Programs

Through its Beach Erosion Control Program, the California Department of Boating and Waterways acts as shore protection advisor and plans, designs, and constructs erosion control structures when funds are available. The goals of the program are cosponsoring beach erosion control projects with local and federal agencies, improving present knowledge of oceanic forces, beach erosion and shoreline conditions, and preventing future erosion (http://www.dbw.ca.gov/beach.htm).

2.4.5.2 Management Practices

Shoreline stabilization can be accomplished using either vegetative or structural stabilization techniques. When possible, vegetative stabilization is preferable and often more aesthetically pleasing. Use vegetative plantings, wetlands, beaches, and natural shorelines where space allows.

If structural stabilization is required, riprap revetment is preferable to a solid vertical bulkhead. This is because riprap allows for colonies of aquatic animals and plants and absorbs wave energy better than bulkheads.

Shorelines can be protected from wave energy with structural features such as vertical bulkheads in areas where reflected waves will not endanger shorelines or habitats.

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

2.4.5.3 Information Resources

City of Newport News, *Shoreline Erosion Control Informational Brochure* (http://www.newport-news.va.us/plan/shoreline.pdf): This four-page brochure provides an overview of various structural and non-structural shoreline stabilization and erosion control practices, complete with photographs, a discussion of environmental impacts, and cost information.

U.S. Army Corps of Engineers, *Low-Cost Shore Protection: A Guide for Engineers and Contractors* (http://limpet.wes.army.mil/sec227/Downloads/sect54eng.pdf): This document caters to individuals with

some prior experience with civil engineering. It outlines various affordable shoreline stabilization techniques.

National Shoreline Erosion Control Development and Demonstration Program, *Coastal Shore Protection Structures and Techniques* (http://limpet.wes.army.mil/sec227/Structures/structures.htm): This Web site is a compilation of user-friendly fact sheets that describe and illustrate a number of structural and nonstructural shoreline stabilization practices. The site also links to technical documents, case studies, and useful databases.

2.4.5.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
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2.4.6 Management Measure 4.1E Assessment, Siting, and Design Storm Water Runoff

Management Measure

Implement effective runoff control strategies, which include the use of pollution prevention activities and the proper design of marinas and boat maintenance areas (including parking areas). Reduce the average annual loadings of total suspended solids (TSS) in runoff from these areas to meet water quality objectives.

2.4.6.1 Programs

The Marin County Storm Water Pollution Prevention Program produces publications and Web-based information about used oil, hazardous waste, recycling, storm water, and other water quality issues (http://www.mcstoppp.org/).

The LA County Department of Public Works runs a Storm Water Program that provides Web-based information on used oil, solid waste, storm water runoff, recycling, storm drain stenciling and hazardous waste (http://www.ladpw.org/epd/).

The Orange County Watersheds and Coastal Resources Division publishes information on storm water programs and prevention. The Web site for their water pollution hotline provides instructions on reporting a storm drain or water pollution problem, and on the disposal of hazardous wastes (http://www.ocwatersheds.com/WQHotline/wqh_introduction.asp).

Santa Monica Bay's Storm Water Program provides storm water tips, a contact number for reporting illegal discharges into storm drains, and links for volunteer opportunities (http://www.ci.santa-monica.ca.us/environment/baytips.htm).

The City of Dana Point, Clean Beaches, Clean Oceans provides a public awareness program on the causes of pollution and solutions. It is expanding a catch basin filter installation and maintenance program, as well as educating owners on runoff, recycling, household waste, and grease prevention in sewers (Telephone: 949-248-3588).

The Clean Marina and In-Water Hull Cleaner Programs were created by the Santa Monica Bay Restoration Foundation. They consist of an in-water hull cleaning certification program and a clean marina pilot program. The goals of the programs are to raise awareness regarding the effects that certain boating activities have on water quality, promote management practices and less-toxic products, and promote "green" businesses. Contact Joel Hanson at the Santa Monica Bay Restoration Foundation (Telephone: 213-576-6648).

The Santa Clara Valley Urban Runoff Pollution Prevention Program provides a toll-free phone number where callers can obtain information about urban runoff issues (Telephone: 1-800-794-2482; Web site: http://www.scvurppp-w2k.com/default.htm).

Kids for Clean Water in Orange County provides education on the prevention of urban runoff (Telephone: 949-497-7128).

2.4.6.2 Management Practices

Structural Practices

Increasing vegetation is an easy way to slow runoff and naturally remove pollutants from storm water. Crushed stone paving, sand filters, wet ponds, grassy swales, and traps can be used to catch solids from runoff, and should be installed in particular between impervious areas and the marina basin. Install lawn and garden buffers along the bulkhead to act as natural filters and add beauty to the facility. Where possible, minimize paved surfaces next to the bulkhead to allow rain to soak into the ground instead of running into the water. Finally, construct or restore wetlands where feasible and practical. Wetlands are great storm water filters they provide wildlife habitat and add a natural character to the marina.

Pollutants can also be captured and filtered out of runoff water with permeable tarps, screens, and filter cloths. Install simple oil traps with absorption pillows and debris filters between the work areas and the bulkhead to protect the water quality. Absorbent pillows and filters collect what sweeping misses, like oils and solvents. Install oil/grit separators to capture petroleum spills and coarse sediment. Finally, use catch basins where storm water flows to the marina basin in large pulses (these should be designed by an engineer).

Good Housekeeping

Do as much maintenance work as possible indoors away from rain and runoff. For outdoor work, provide clearly designated land areas away from the water and insist on their use. Also, perform abrasive blasting and sanding in spray booths or tarp enclosures to prevent the wind from taking debris to the water. Restrict the type and 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. Debris left behind is exposed to storm water runoff and wind. Sweep or vacuum around hull maintenance areas, roads, parking lots, and driveways frequently. Use vacuum sanders to remove paint from hulls and to collect paint dust and chips. Vacuum sanders can collect as much as 99 percent of the dust.

2.4.6.3 Information Resources

- **New York Sea Grant Extension Program, Cornell Cooperative Extension, *Stormwater Runoff Best Management Practices for Marinas: A Guide for Operators*** (http://www.seagrant.sunysb.edu/pages/BMPsForMarinas.htm): This 1998 bulletin describes hull maintenance practices and storm water treatment devices suitable for marinas. Cost estimates, planning and technical considerations, photographs, and drawings are included. The document is available online or can be ordered for $2.00.
- **Florida Department of Environmental Protection (DEP), Boatyard Stormwater Management** (http://www.dep.state.fl.us/law/Grants/CMP/pdf/BoatyardStormwaterManagementBMP.pdf): This six-page fact sheet, part of the Florida DEP's *Clean Boatyard Manual*, describes management practices for controlling storm water at marinas.

2.4.6.4 Case Study

Ski Run Marina Stormwater Filtration System. Ski Run Marina is located directly on Lake Tahoe and directly discharged its storm water into the lake. In order to prevent NPS pollution from entering the lake, the marina installed a state-of-the-art storm water filtration system, The Stormwater Management StormFilter®, developed by Stormwater Management, Inc. The Ski Run Marina project used a combination of perlite and zeolite filtration media, which allows the StormFilter® to effectively remove the storm water pollutants that have an adverse impact on Lake Tahoe. (http://www.stormwatermgt.com/news/press_releases/ski_run_marina.pdf).

2.4.6.5 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

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2.4.7 Management Measure 4.1F Assessment, Siting, and Design Fueling Station Design

Management Measure

Design existing and proposed fueling stations to allow for spill prevention and for ease in cleanup of spills that may occur.

2.4.7.1 Programs

The Marina Fueling Facilities Project is a component of the California SWRCB's Underground Storage Tank Program. The program administers guidelines and performs inspections for the design and construction of fuel storage, piping, and dispensing systems in marinas (http://www.swrcb.ca.gov/ust/leak_prevention/marina/).

The California Office of Spill Prevention and Response (OSPR) includes a Marine Safety Branch, which works to protect marine resources by developing and maintaining spill prevention measures and response plans. The OSPR requires that all marine facilities and tank vessels carrying petroleum product as cargo, as well as all nontank vessels over 300 gross tons, have California-approved oil spill contingency plans (http://www.dfg.ca.gov/ospr/organizational/msb/msb.htm).

2.4.7.2 Management Practices

For Boaters

Boaters should keep engines properly tuned for efficient fuel consumption and clean exhaust. Avoid overfilling gas tanks, and listen for splashbacks just in case the shutoff nozzle does not work in time. Always keep an absorbent pad ready in case of spills.

For Marina Owners and Operators

Education and Training: Train employees to give information and direction to customers before they begin fueling. Don't take it for granted that boaters know the correct fueling procedures. Install easy-to-read signs on the fuel dock that explain proper fueling, spill prevention, and spill reporting procedures, especially at self-serve facilities.

Site Design

Locate and design boat fueling stations so that spills can be contained, such as with a floating boom, and cleaned up easily. This usually means locating them away from clutter in areas where spill cleanup will not cause traffic problems.

Spill Prevention

Remove old-style fuel nozzle triggers that are used to hold the nozzle open. Install automatic shutoff systems on fuel nozzles. They help keep spills small and prevent tanks from overfilling. In addition, use a spill monitoring system that will shut off the main line when a leak is sensed.

Install personal watercraft floats at fuel docks to help drivers stabilize their boats and refuel without spilling.

Regularly inspect, maintain, and replace fuel hoses, pipes, and tanks. A small leak can mean a big spill, so check your system often.

Spill Response

Create an emergency spill response plan for containment and cleanup. Make sure to post readable directions for spill response, because in an emergency situation it is important to know exactly what to do. Have spill containment equipment storage, such as a locker attached to the fuel dock, easily accessible and clearly marked. Be prepared for over-spill and excess fuels—keep absorbent pads on hand. If there is an oil spill, call the Coast Guard (Telephone: 1-800-424-8802).

2.4.7.3 Information Resources

- **Virginia Clean Marina Guidebook, *Emergency Planning*** (http://www.vims.edu/adv/vamarina/emergencyplanning.pdf): This chapter outlines important emergency planning procedures applicable to marinas.
- **California Department of Fish and Game, Office of Spill Prevention and Response, *Oil Spill Reporting Procedures*** (http://www.dfg.ca.gov/ospr/misc/reportaspill.html): This Web site provides basic reporting and contact information.

2.4.7.4 Case Study

Elliot Bay Marina Fueling Station. Elliott Bay Marina in Seattle, Washington, has implemented a number of management procedures, including fueling station design and petroleum control. The marina fuel dock is equipped with double-walled tanks and fuel lines, as well as monitors, sensors, and automatic shutoff in case a leak is detected. The marina keeps oil booms, spill containment kits, and an aluminum pontoon boat on hand for spill response. Boaters are also asked to sign a slip agreement in which they promise to follow the marina's environmental rules (http://www.elliottbaymarina.net/history.htm).

2.4.7.5 References

National Clean Boating Campaign. *Fuelage and Bilge Care Fact Sheet*. (http://cleanboating.org/research/boat3a.html)

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.4.8 Management Measure 4.1G Assessment, Siting, and Design Sewage Facilities

Management Measure

Install pumpout, dump station, and restroom facilities where needed at new and expanding and existing 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.

2.4.8.1 Programs

The Clean Vessel Act of 1992 Pumpout Grant Program, established by Congress, is administered by the California Department of Boating and Waterways. The Clean Vessel Act grant funds are available the public and private sector. Grant recipients receive reimbursement for up to 75 percent of the cost of installing or renovating equipment for sewage pumpout facilities (http://dbw.ca.gov/pumpout.htm).

The California Department of Boating and Waterways provides educational resources and guidance on vessel pumpout facilities, California law governing the discharge of sewage and management practices (http://dbw.ca.gov/PubsAndReports.htm).

2.4.8.2 Management Practices

For Marina Owners and Operators

Restroom Facilities: Marina owners or operators should ensure that there are clean, conveniently located restroom facilities available for those who use the marina, and should encourage their use by customers before casting off.

Onshore Sewage Collection Systems: Onshore sewage collections systems should be installed for slip renters and visiting boats, and a clearly marked sign should indicate their presence to all visitors. Pumpout services should be provided at convenient times and for a reasonable cost, and stations should be kept clean. Collection systems include the following:

- Fixed-Point Systems: Pumpout facilities located at one or more central locations
- Dump Stations for Portable Toilets
- Portable/Mobile Systems: Pumpout facilities that can be moved to the location where a boat is docked

No Discharge Zones: Consider declaring the marina a No Discharge Zone if it is not already in a federal or State-designated No Discharge Zone. The following site provides a list of federal No Discharge Zones: http://www.epa.gov/owow/oceans/regulatory/vessel_sewage/vsdnozone.html.

For Boaters

Boaters should always use onshore restrooms when their boats are docked, particularly if the boat does not have a toilet. If planning a boat trip for three or more hours, plan for onshore restroom stops while buying fuel or eating at waterfront restaurants. A portable toilet can be taken onboard, and dumped at a shoreside station or at home. It is illegal to dump any untreated sewage into any inland lake, river, or coastal water inside the 3-mile limit. Fats, solvents, oil, emulsifiers, paints, poisons, phosphates, disposable diapers, and sanitary napkins should be kept out of toilets. In addition, pets should be taken to a marina's posted pet walk area and waste disposed of properly.

If the boat has a Marine Sanitation Device (MSD) type 1 or 2, which pretreats sewage before it is discharged overboard, by law it must be certified by the U.S. Coast Guard. To keep the MSD working properly, follow the manufacturer's suggested maintenance program. Clearly post MSD use instructions near the toilet. If your MSD uses a biodegradable disinfectant, keep the liquid container full. For sanitation systems that require pretreatment chemicals, use chlorine- and formaldehyde-free products. To help prevent clogging, use fast-dissolving marine toilet tissue made for MSD use. When in "no discharge" waters, lock or secure the toilet closed so it cannot discharge overboard.

If your boat has an MSD type 3 with a holding tank, use a pumpout facility at the end of each boating day. They are fast, clean, easy to use, and inexpensive. Consider contracting with a mobile pumpout service to empty your tank while in the slip. If your boat has a y-valve and through hull, always keep them locked closed when inside coastal waters, in bays, in any inland river or lake where dumping untreated sewage is illegal. Opening a y-valve and through-hull is legal only in ocean waters 3 miles or further from shore. The best solution is to remove y-valves and through-hulls so no sewage can go overboard. Use only environmentally compatible holding tank deodorants. To help prevent clogging, use fast dissolving marine toilet tissue made for MSD use.

To find the nearest pumpout service, consult National Oceanic and Atmospheric Administration (NOAA) charts, cruising guides, boating almanacs, or local pumpout maps, or call the National Hotline (Telephone: 1-800-ASK-FISH). When cruising, look for the national pumpout logo at boating facilities to find a pumpout service. If pumping out is self-service, ask a marina staff member for instructions on how to operate the pumpout equipment. Be sure to turn the machine off before leaving and wash your hands after each use.

Encourage the installation of more onshore pumpouts and dump stations by letting marina owners know of the need for local facilities. Report any malfunctioning pumpouts or dump stations by calling the National Hotline (Telephone: 1-800-ASK-FISH).

2.4.8.3 Information Resources

- **U.S. Coast Guard, *Marine Sanitation Devices (MSDs)*** (http://www.uscg.mil/hq/gm/mse/msd.htm): This fact sheet provides answers to frequently asked questions about MSDs.
- **USEPA, *Vessel Sewage Discharge Program*** (http://www.epa.gov/owow/oceans/regulatory/vessel_sewage/): This Web site contains regulatory and technical resources on vessel sewage discharge and marine sanitation devices.
- **California Coastal Commission, *Used Oil and Sewage Related Services*** (http://www.coastal.ca.gov/ccbn/ccbndx.html): This Web site provides information on marina-based services by county and mobile environmental services for boaters.

- **San Francisco Estuary Project, *MSDs and Pumpout Stations*** (http://www.abag.ca.gov/bayarea/sfep/programs/boated/msds.html): This fact sheets describes the importance of properly disposing of sewage and tips for following management practices.
- **California Department of Boating and Waterways, *Vessel Pumpout Locations*** (http://dbw.ca.gov/pump24/html/index.htm): This Web site provides the names and phone numbers of marinas with vessel pumpout facilities, which can be sorted by name, city, or region. Regional maps are also available online.
- **California Department of Boating and Waterways, *Shipshape Sanitation*** (http://dbw.ca.gov/Pubs/Sanitation/index.htm): This fact sheet explains the California laws regarding vessel sewage discharge, and the importance of proper disposal.
- **California Department of Boating and Waterways, *Sewage Holding Tank Systems for Recreational Boats*** (http://dbw.ca.gov/PUMP.HTM): This fact sheet describes California law on sewage holding tanks, and includes information on system design, equipment selection, installation and maintenance.
- **U.S. Coast Guard, *Federal Marine Sanitation Device Regulations*** (http://dbw.ca.gov/Pubs/FedMSD/index.htm): This fact sheet describes federal regulations and includes a list of no discharge areas in California.

2.4.8.4 Case Study

Oak Harbor Marina Floating Restroom and Barge. Oak Harbor Marina in Washington is a city-owned, recreational boating facility. The marina complies with the marina management measures for sewage facility and maintenance of sewage facilities, as well as a number of other management measures. The facility purchased a floating restroom barge, which has both a pumpout and a dump station, to service the guest docking area. In 1995, a combined total of 1,700 pumpouts were done. An estimated total of 40,000 gallons of boat sewage was collected from the barge and fuel dock, an average of 23.5 gallons per boat. (http://www.p2pays.org/ref/04/03708/text/ch18.html).

2.4.8.5 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
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2.4.9 Management Measure 4.1H Assessment, Siting, and Design Waste Management Facilities

Management Measure

Install facilities where needed for the proper recycling or disposal of solid wastes (such as oil filters, lead acid batteries, used absorbent pads, spent zinc anodes, and fish waste as applicable) and liquid materials (such as fuel, oil, solvents, antifreeze, and paints) generated by users of marinas and boat maintenance areas. Design these facilities to allow ease of access, post signage to promote use by the boating public, and encourage recycling to the fullest extent possible.

2.4.9.1 Programs

The California Integrated Waste Management Board is responsible for managing California's solid waste stream. The Board develops waste reduction programs, provides public education and outreach, assists local governments and businesses, and fosters market development for recyclable materials. You can obtain information on used oil recycling, including the location of local recycling centers, and other waste management topics on the Board's Web site: http://www.ciwmb.ca.gov/.

2.4.9.2 Management Practices

Good housekeeping at marinas is a key practice for keeping waste materials out of the water. The following practices can be used by marina operators to improve and encourage the use of waste disposal facilities:

- Encourage marina patrons to avoid doing any hull maintenance while their boats are in the water. Scraped-off paint and debris can be harmful to aquatic life.
- Place trash and recycling receptacles in convenient locations for marina patrons. Let customers know they are there and encourage their use. In addition, provide information on fishing line collection and recycling or disposal. Provide boaters with trash bags so they can collect waste onboard and bring it back to be disposed of properly.
- Require patrons to clean up pet wastes. Provide a specific dog walking area at the marina. Plastic bags provided near the walking area will help keep the marina clean and help customers comply with the rule.
- Install fish cleaning stations at the marina and at boat launch sites. Cleaning stations help keep waters from becoming dumping grounds. In addition, compost fish waste where appropriate and encourage catch and release fishing, which does not kill the fish and produces no fish waste. Encourage boaters to clean fish offshore where the fish are caught and return the waste to the sea (if allowed by the State).

2.4.9.3 Information Resources

- **California Department of Fish and Game, *Fishing Line Recycling*** (http://www.dfg.ca.gov/fishing/html/Publications/recycle.html): This Web page provides instructions for recycling fishing lines in California.

- **Maryland Clean Marina Initiative, *Waste Containment and Disposal*** (http://dnrweb.dnr.state.md.us/download/cleanmarina/8TipShee-ps.pdf): This fact sheet describes waste management practices for trash, fish waste, and liquid waste.

2.4.9.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

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2.4.10 Management Measure 4.2A Operation and Maintenance Solid Waste Control

Management Measure

Properly dispose of solid wastes produced by the operation, cleaning, maintenance, and repair of boats and operation of marinas—and encourage recycling of recyclable materials to the fullest extent possible—to limit entry of solid wastes to surface waters.

2.4.10.1 Programs

The California Coastal Commission's Boating Clean and Green Program publishes information on oil and sewage-related services (http://www.coastal.ca.gov/ccbn/ccbndx.html).

San Diego BayKeeper works to detect and report illicit discharges and pollution from boating activities with boat patrols, monitoring, and a pollution hotline (http://www.sdbaykeeper.org/programs/beachcln.htm).

The Los Angeles County Department of Public Works runs a Storm Water Program that provides Web-based information on used oil, solid waste, storm water runoff, recycling, and hazardous waste (http://www.ladpw.org/epd/).

The Ocean Conservation Society conducts Kayak Cleanups of Marina Del Rey in Los Angeles County. These trash and debris cleanups are sponsored by the Ocean Conservation Society in collaboration with COBRA Kayaks and Patagonia Santa Monica, an ongoing series of cleanups of Marina del Rey Harbor (http://www.oceanconservation.org/mdrcleanuptxt.html).

The California Coastal Commission holds the California Coastal Cleanup Day in order to help reduce marine debris along the coast, as well as educate the public on the dangers of dumping marine debris and the potential for environmental damage. The Web site provides information on the annual event, as well as on marine debris and its effects (http://www.coastal.ca.gov/publiced/ccd/ccd.html).

The Marin County Storm Water Pollution Prevention Program produces publications and Web-based information about used oil, hazardous waste, recycling, storm water, and other water quality issues (http://www.mcstoppp.org/).

The City of Dana Point, Clean Beaches, Clean Oceans provides a public awareness program on the causes of pollution and solutions. It is expanding a catch basin filter installation and maintenance program, as well as educating owners on runoff, recycling, household waste, and grease prevention in sewers (Telephone: 949-248-3588).

Heal The Bay provides Santa Monica Bay's environmental events calendar, citizen involvement, and beach report (http://www.healthebay.org/).

Generation Earth in Los Angeles County provides Web-based information about the solid waste problem in Los Angeles and citizen involvement opportunities (http://www.generationearth.com/).

2.4.10.2 Management Practices

For Marina Owners and Operators

Provide easily accessible recycling facilities for glass, newspapers, aluminum, plastics, batteries, and numerous, well-marked trash receptacles. Recycling can reduce the amount of dumpster trash, which lowers waste hauling fees. Train staff to inform patrons of trash disposal practices and to pick up any trash they see lying about. Provide boaters with trash bags imprinted with the marina's logo to demonstrate a commitment to pollution prevention.

Encourage staff and boaters to follow these principles for cleaning activities:

- Use less-toxic or less-caustic materials and use less of them.
- Purchase frequently used materials in bulk to minimize waste.
- Buy products that come in reusable containers and have minimal packaging.
- Advise customers to buy only what is needed for immediate use to avoid throwing away what is left over.
- Share leftover products with others who need them.
- Avoid the use or sale of anything described as being "disposable" and encourage the use of long-life products.

For Boaters

Conduct hull work indoors or under cover where possible, and discourage dockside sanding and painting over the water. At the very least, stretch a tarp between the side of the boat and the dock to catch any falling debris. Use drop cloths or filter cloths beneath the hull to collect sanding dust and paint drops. Empty the cloths into a trash container frequently, and do not leave them dirty overnight. Use only non-abrasive underwater hull cleaning techniques to prevent excessive paint discharge. Dry storage reduces the need for antifouling paints and saves money.

Dispose of paints, batteries, antifreeze, cleaning products, oil, oil filters, and other hazardous wastes at a hazardous waste collection facility. Call Earth's 911 to find a location nearby (1-800-CLEAN-UP). Recycle paints, batteries, oil, oil filters, and antifreeze.

Keep all trash on board. Never throw cigarette butts, fishing line, or any other garbage into the ocean. Take advantage of shoreside facilities to recycle plastic, glass, metal, and paper. Reduce the potential for litter by removing unnecessary packages and wrappings, and bringing reusable containers to the boat. Have several litter bags onboard and discard full ones at the marina dumpster or at home. When trash accidentally falls overboard, go back and get it.

2.4.10.3 Information Resources

- **Florida Department of Environmental Protection, Solid Waste Management** (http://www.dep.state.fl.us/law/Grants/CMP/pdf/SolidWasteManagementBMP.pdf): This fact sheet, part of the Florida Department of Environmental Protection's *Clean Boatyard Manual*, describes ways to prevent pollution from solid waste.

- **U.S. Coast Guard, *Marine Debris: Garbage Dumping Restrictions in U.S. Waters*** (http://www.uscg.mil/hq/g-m/nmc/mardeb.htm): This fact sheet explains federal regulations on dumping in territorial waters.
- **University of California Cooperative Extension, *Marina Pollution Prevention Manual*** (http://nsgd.gso.uri.edu/cuimr/cuimrh95002.pdf): This manual describes important components of pollution prevention at recreational boating facilities. It covers pollution sources, hazardous waste management, spill response, marina staff procedures and training, San Diego County agency and service contacts, and publications for distribution among marina staff, contractors, and boaters.
- **California Department of Fish and Game, *Fishing Line Recycling*** (http://www.dfg.ca.gov/fishing/html/Publications/recycle.html): This Web page provides instructions for recycling fishing lines in California.
- **Maryland Clean Marina Initiative, *Waste Containment and Disposal*** (http://dnrweb.dnr.state.md.us/download/cleanmarina/8TipShee-ps.pdf): This fact sheet describes waste management practices for trash, fish waste, and liquid waste.

2.4.10.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

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2.4.11 Management Measure 4.2B Operation and Maintenance Fish Waste Control

Management Measure

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

2.4.11.1 Management Practices

Use a fish cleaning station, which usually has a waste grinder, running water, and a large surface to work on. Alternatively, clean fish as they are caught offshore and toss fish waste only in open unrestricted water or at sea (where the State allows it), rather than in the marina basin where circulation and flushing are more limited and the fish waste could create a water quality and odor problem.

Recycle fish parts by composting them with peat moss, or burying them in a garden to be used as fertilizer. Fish parts can also be frozen and re-used as bait or chum on another next fishing trip. When no other option exists, bag the fish parts and place the bag in the trash.

Finally, avoid releasing bait either dead or alive into the water. This can introduce foreign species to fresh water lakes. You might not be releasing just the bait, but something that it is infected with.

2.4.11.2 Information Resources

Maryland Clean Marina Initiative, *Waste Containment and Disposal* (http://dnrweb.dnr.state.md.us/download/cleanmarina/8TipShee-ps.pdf): This fact sheet describes waste management practices for trash, fish waste, and liquid waste.

2.4.11.3 Case Study

Marin County–Petaluma River Black Point Boat Launching Facility. In 2003, the Department of Boating and Waterways awarded the County of Marin $80,000 for a proposed $782,000 project to replace the boat launching facility at Black Point in Novato, on the Petaluma River. The new boat launching facility will include a fish cleaning station. Additional measures incorporated into the plan include new restrooms and a boat wash-down area (http://www.dbw.ca.gov/bwcm3-13-03.htm).

2.4.11.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- Programs
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2.4.12 Management Measure 4.2C Operation and Maintenance Liquid Material Control

Management Measure

Provide and maintain appropriate storage, transfer, containment, and disposal facilities for liquid materials—such as fuel, oil, solvents, antifreeze, and paints—and encourage recycling of these materials to the fullest extent possible.

2.4.12.1 Programs

The Marin County Storm Water Pollution Prevention Program produces publications and Web-based information about used oil, hazardous waste, recycling, storm water, and other water quality issues (http://www.mcstoppp.org/).

The Los Angeles County Department of Public Works runs a Storm Water Program that provides Web-based information on used oil, solid waste, storm water runoff, recycling, and hazardous waste (http://www.ladpw.org/epd/).

The California Department of Fish and Game, Office of Spill Prevention and Response maintains CalTIP, a spill response hotline: (Telephone: 1-888-DFG-CALTIP; Web site: http://www.dfg.ca.gov/Ospr/index.html).

The California Coastal Commission's Boating Clean and Green Program publishes information on oil and sewage-related services (http://www.coastal.ca.gov/ccbn/ccbndx.html).

The California Integrated Waste Management Board's Used Oil Recycling Program develops and promotes alternatives to the illegal disposal of used oil by establishing a statewide network of collection opportunities and undertaking outreach efforts to inform and motivate the public to recycle used oil (http://www.ciwmb.ca.gov/UsedOil/). The Board's Household Hazardous Waste Program aims to provide the public with convenient collection locations for used oil and other types of household hazardous waste, increase the demand for new products made from oil and household hazardous waste, and provide grants to local governments, nonprofit organizations, and for research and demonstration projects (http://www.ciwmb.ca.gov/HHW/).

2.4.12.2 Management Practices

For Marina Owners and Operators

Storage: Store minimal quantities of hazardous materials. Reduce waste by buying only as much as is needed. Liquid materials should be carefully stored under cover and on an impervious surface. Locate storage and disposal areas for liquid materials in or near repair and maintenance areas for ease of access but away from flood areas and fire hazards, and protect them from rain with a cover and berms or secondary containment.

Disposal: Provide clearly labeled, separate containers for the disposal of waste oils, fuels, and other liquid wastes. Keeping them separate minimizes the chance of combining dangerous chemicals and makes them easier to recycle.

Spill prevention: Prepare a hazardous material spill recovery plan and update it as new types of materials are acquired or other changes are necessary. Keep adequate spill response equipment where liquid materials are stored and used. Change engine oil using non-spill vacuum-type systems, and use the same equipment to suction oily water from bilges.

For Boaters

Recycle liquid materials where possible, and ask your marina to provide recycling if it does not already do so. Use antifreeze and coolants that are less toxic to the environment. Propylene-glycol-based antifreeze (with a pink color) is less toxic than the blue-green antifreeze. Recycle the blue-green antifreeze if it is used.

Use alternative, less-toxic liquid materials where practical. Minimize the use of solvents or switch to water-soluble choices. Before discarding paint cans, remove the top and let any paint residue dry and harden.

2.4.12.3 Information Resources

- **Florida Department of Environmental Protection (DEP), Liquid Waste Storage Management** (http://www.dep.state.fl.us/law/Grants/CMP/pdf/LiquidWasteStorageManagementBMP.pdf): This fact sheet, part of the Florida DEP's *Clean Boatyard Manual*, describes ways to store liquid waste to prevent pollution.
- **University of California Cooperative Extension, *Marina Pollution Prevention Manual*** (http://nsgd.gso.uri.edu/cuimr/cuimrh95002.pdf): This manual describes important components of pollution prevention at recreational boating facilities. It covers pollution sources, hazardous waste management, spill response, marina staff procedures and training, San Diego County agency and service contacts, and publications for distribution among marina staff, contractors, and boaters.

2.4.12.4 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

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2.4.13 Management Measure 4.2D Operation and Maintenance Petroleum Control

Management Measure

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

2.4.13.1 Programs

The Los Angeles County Department of Public Works runs a Storm Water Program that provides Web-based information on used oil, solid waste, storm water runoff, recycling, and hazardous waste (http://www.ladpw.org/epd/).

The Santa Monica BayKeeper Program in LA County is conducting a "Fill It, Don't Spill It" campaign to address the accidental discharge of petroleum at fuel docks (http://www.smbaykeeper.org/smbay/programs/).

The Marin County Storm Water Pollution Prevention Program produces publications and Web-based information about used oil, hazardous waste, recycling, storm water, and other water quality issues (http://www.mcstoppp.org/).

The California Department of Fish and Game, Office of Spill Prevention and Response maintains the CalTIP hotline (Telephone: 1-888-DFG-CALTIP; Web site: http://www.dfg.ca.gov/Ospr/index.html).

The Lake Tahoe Pollution Prevention Marina Program is focused on promoting environmentally responsible and cost-effective management of used oil. The emphasis is on increasing boater awareness of the impacts of illegally disposed oil, poorly maintained watercraft, bilge water pumped overboard, and on the availability of used oil collection centers (http://www.co.el-dorado.ca.us/emd/solidwaste/marina.html).

The California Coastal Commission's Boating Clean and Green Campaign administers the Shop Clean and Green Program. Shopping Clean and Green Displays, designed for marina supply shops, provide consumers with free plastic wallet-sized information cards. These cards contain product information and tips for recycling used oil and reducing oil and fuel discharges from boats as well as toll-free numbers for boater information about waste disposal and reporting spills (http://www.coastal.ca.gov/ccbn/ccbndx.html).

The California Coastal Commission's Boating Clean and Green Program publishes information on oil and sewage-related services (http://www.coastal.ca.gov/ccbn/ccbndx.html).

2.4.13.2 Management Practices

To prevent fuel and oil leaks, keep your engine well tuned. Place an oil absorbent pad or pillow under your engine where drips may occur and in the bilge. Check the pads often and dispose of them as hazardous waste at a marina or nearby collection center. Spill-proof your oil changes by using an oil

change pump to transfer oil to a spill-proof container. Wrap a plastic bag or absorbent pad around the oil filter to prevent oil from spilling into the bilge. Fill fuel tanks slowly and carefully and use absorbent pads or rags to catch drips and spills. Do not top off or overflow the fuel tank, and leave it 5 percent empty to allow fuel to expand as it warms. If there is a spill, do not use soap or emulsifiers to disperse it. That is harmful to the environment, as well as illegal. Rather, notify the marina and the proper authorities.

If the boat has an outboard motor, fill tanks carefully to avoid spilling fuel into the boat and wasting fuel. Mix oil in the fuel according to manufacturer recommendations. Clean any drops off the deck by wiping with an oil absorption pad. Close portable tank fuel vents when the boat is not in use to save fuel from vapor loss, and store fuel only in approved marine containers.

If the boat has a built-in fuel tank on board, install a fuel/air separator in the air vent line from the tank to prevent vent spills. Routinely check for and fix fuel leaks. Use a drip pan under the engine. Use a bilge-oil absorbent pillow and dispose of it before it is fully saturated by recycling it with used oil, or use a bilge-maintenance bioremediation pad with natural oil-eating bacteria, which can last much longer than absorbent pads. If the boat is 26 feet or more in length, it is a legal requirement to display a U.S. Coast Guard oil discharge placard on the boat.

All boaters should avoid pumping any bilge water that is oily or has a sheen. A drip pan should be used under the engine and routine checks performed for oil or fuel leaks. In addition, avoid the use of bilge cleaners that are detergents or emulsifiers. These chemicals dissolve the oil and fuel in the water so both can be pumped overboard into the water. The bilge may be clean, but the water won't be.

If there is a spill, immediately stop the source, notify the marina for assistance, and call the U.S. Coast Guard (Telephone: 1-800-424-8802). Contain the spill with absorbent pads or booms, and do not apply any detergent or emulsifier to the oil slick. Dispose of absorbent pads with recyclable oil, or wrap them in newspaper and tie them inside a plastic bag for disposal with your home trash.

2.4.13.3 Information Resources

- **Rhode Island Sea Grant, Bilges, Fueling and Spill Response** (http://seagrant.gso.uri.edu/factsheets/boaterfs/bilge.html): This is a brief fact sheet with information on bilge pumping, fueling, and spill response.
- **El Dorado County, Lake Tahoe Pollution Prevention Marina Program** (http://www.co.el-dorado.ca.us/emd/solidwaste/marina.html): This Web site provides information about a Lake Tahoe program to reduce oil pollution.
- **California Coastal Commission, Used Oil and Sewage Related Services** (http://www.coastal.ca.gov/ccbn/ccbndx.html): This Web site provides information on marina-based services by county, mobile environmental services for boaters, and used oil collection centers in California.
- **El Dorado Environmental Management Department, Oil Absorbent Pads and Pillow Disposal Sites** (http://www.co.el-dorado.ca.us/emd/solidwaste/pillow_sites.html): This is a list of marinas participating in Lake Tahoe's Pollution Prevention Marina Program by collecting absorbent pads and pillows.
- **Florida Department of Environmental Protection (DEP), Used Oil and Petroleum Management** (http://www.dep.state.fl.us/law/Grants/CMP/pdf/PetroleumBMP.pdf): This 14-page fact sheet, part of the Florida DEP's *Clean Boatyard Manual*, provides guidance for marina owners on proper storage, disposal, spill prevention, and fueling procedures.

- **California Coastal Commission, *Oil Pollution Solutions for Boaters: Designing and Implementing Programs to Reduce Hydrocarbon Discharges***. This is a manual for government, businesses and individual owners that provides guidance on reducing oil pollution and developing education and outreach programs. It presents an overview of marine pollution and boating in California, information on services marina operators can provide to reduce pollution, guidance on various types of boats and their operation/maintenance needs, and information on the development of outreach programs. Order from the Boating Clean and Green Campaign (Telephone: 415-904-5200).
- **University of California Cooperative Extension, *Marina Pollution Prevention Manual*** (http://nsgd.gso.uri.edu/cuimr/cuimrh95002.pdf): This manual describes important components of pollution prevention at recreational boating facilities. It covers pollution sources, hazardous waste management, spill response, marina staff procedures and training, San Diego County agency and service contacts, and publications for distribution among marina staff, contractors, and boaters.
- **California Department of Fish and Game, Office of Spill Prevention and Response (OSPR), *The Office of Spill Prevention and Response's Guide to Clean, Green Boating***. This is a 4-inch by 6-inch flip guide to oil spill prevention. It includes information about OSPR, the impacts of oil spills, and pollution prevention tips. It also includes rules of the road, navigation tips, information about boating courses, and a space to write notes. Contact California Boating Clean and Green Campaign (Telephone: 415-904-5200).

2.4.13.4 Case Study

Lake Tahoe Pollution Prevention Marina Program. The Lake Tahoe Pollution Prevention Marina Program was motivated by a general concern for the ecosystem health in the lake. It promotes responsible management of used oil and increased public and boater awareness. The program focuses on lake ecosystems, the environmental impacts of oil pollution, boater education, and improving the availability of oil collection centers (http://www.co.el-dorado.ca.us/emd/solidwaste/marina.html).

- **California Coastal Commission, *Oil Pollution Solutions for Boaters: Designing and Implementing Programs to Reduce Hydrocarbon Discharges*.** This is a manual for government, businesses and individual owners that provides guidance on reducing oil pollution and developing education and outreach programs. It presents an overview of marine pollution and boating in California, information on services marina operators can provide to reduce pollution, guidance on various types of boats and their operation/maintenance needs, and information on the development of outreach programs. Order from the Boating Clean and Green Campaign (Telephone: 415-904-5200).
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- **California Department of Fish and Game, Office of Spill Prevention and Response (OSPR), *The Office of Spill Prevention and Response's Guide to Clean, Green Boating*.** This is a 4-inch by 6-inch flip guide to oil spill prevention. It includes information about OSPR, the impacts of oil spills, and pollution prevention tips. It also includes rules of the road, navigation tips, information about boating courses, and a space to write notes. Contact California Boating Clean and Green Campaign (Telephone: 415-904-5200).

2.4.13.4 Case Study

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Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.4.14 Management Measure 4.2E Operation and Maintenance Boat Cleaning and Maintenance

Management Measure

For boats that are in the water, perform (1) topside cleaning and maintenance operations to minimize, to the extent practicable, the release to surface waters of (a) harmful products such as cleaners and solvents and (b) paint; and (2) underwater hull cleaning and maintenance operations to minimize, to the extent practicable, the release of paint and anodes.

2.4.14.1 Programs

The Nontoxic Bottom Paint Demonstration Project by the University of California, Davis, Sea Grant Extension Program in San Diego County provides educational resources and conducts field demonstrations of nontoxic boat bottom paints (http://commserv.ucdavis.edu/cesandiego/seagrant/nontoxicdemo.htm).

The Clean Marina and In-Water Hull Cleaner Programs were created by the Santa Monica Bay Restoration Foundation. They consist of an in-water hull cleaning certification program and a clean marina pilot program. The goals of the programs are to raise awareness regarding the effects that certain boating activities have on water quality, promote management practices and less-toxic products, and promote "green" businesses. Contact Joel Hanson at the Santa Monica Bay Restoration Foundation (Telephone: 213-576-6648).

The California Professional Divers' Association has established a Professional Divers Training and Certification Program to educate divers on pollution prevention from underwater hull cleaning and other management practices (http://www.prodivers.org/bmpprogram.htm).

2.4.14.2 Management Practices

Boat Cleaning

One way to reduce the potential for pollution is to buy "nontoxic" and "phosphate-free" products. While "biodegradable" products are desirable, they are not necessarily nontoxic. If possible, avoid those that warn "do not get in the eyes" or "always wear gloves," such bleach, ammonia, lye, or petroleum distillates.

Buy only as much cleaner as you need to avoid having to dispose of leftover cleaning supplies. If you do have leftovers, give them to another boater or start an exchange program at the marina for cleaners, paints, varnishes, and other materials. Always keep caps on bottles while cleaning to prevent spills.

Wash decks and hulls frequently with fresh water, because this will reduce the need for cleaning products. When cleaners are necessary, use them sparingly. While washing, try to avoid washing dirt, paint chips, and solvents into the water by washing boat hulls above the waterline by hand. Clean boat bottoms

ashore, over hard surfaces or over a tarp to contain debris. Whenever feasible, remove boats from the water and clean them where debris can be collected and disposed of in the trash.

Finally, thoroughly wash off your boat if taking it from one body of water to another. This will help minimize the spread of exotic and invasive species.

Boat Maintenance

Whenever possible, hull work should be done inside or under cover where rain cannot wash dust, dirt, paint chips, oil, and solvents into the water.

Prevent pollution from engine maintenance by tuning your engine regularly per the manufacturer's recommendation. This helps your engine operate cleanly and more efficiently. Frequently inspect fuel lines for leaks or potential leaks such as cracks and loose connections, and repair them immediately. Frequently wipe the engine to keep it clean. Engine parts should be cleaned on land over a leak-free container, not over the water, with minimal amounts of engine-cleaning solvents.

Change oil and transmission fluid with a spill-proof pump or vacuum tank. Slip a plastic bag over the oil filter before removing it. Wipe up oil drops immediately with an absorbent pad. Keep used oil separate from other wastes and recycle it. Use antifreeze and coolants that are less toxic to the environment. Propylene-glycol-based antifreeze (with a pink color) is less toxic than the blue-green antifreeze. Recycle the blue-green antifreeze if it is used.

Prevent pollution from sanding and painting by doing all hull scraping, sanding, and chemical stripping onshore over a drop cloth to catch all debris. Prepare the surface with dustless sanders to keep you, the air, the ground, and other boats clean. Be sure to use only legal bottom paints, and depending on boat use, consider a hard non-ablative paint that might last longer. If possible, switch to long-lasting and low-toxicity or nontoxic antifouling paints. New environmentally friendly alternative paints are being developed, so ask around for the latest and best. Leave paint cans open to thoroughly dry out before throwing them away.

2.4.14.3 Information Resources

- **California Coastal Commission, *Clean Green Boat Maintenance*** (http://www.coastal.ca.gov/ccbn/checklist.pdf): This is a pollution prevention boat maintenance checklist for contractors and the general public.
- **University of California Cooperative Extension, *Selecting Underwater and Topside Maintenance Services for Your Boat*** (http://commserv.ucdavis.edu/cesandiego/seagrant/topside.htm): This fact sheet provides guidance on the selection of a professional maintenance service that will follow environmentally sound procedures.
- **University of California Cooperative Extension, *Underwater Hull Cleaner's Best Management Practices*** (http://commserv.ucdavis.edu/cesandiego/seagrant/hullclean.htm): This fact sheet is for professionals and describes ways to lower costs as well as to help the environment with management practices that reduce pollution and extend the life of hull paints.
- **University of California Cooperative Extension, *Selecting a Hull Paint for Your Boat*** (http://commserv.ucdavis.edu/cesandiego/seagrant/selpaint.htm): This fact provides tips on the most environmentally sound practices related to antifouling.

- **Florida Department of Environmental Protection (DEP), Boat Cleaning** (http://www.dep.state.fl.us/law/Grants/CMP/pdf/BoatCleaningBMP.pdf): This 8-page fact sheet, part of the Florida DEP's *Clean Boatyard Manual*, describes management practices for cleaning in the water, saltwater rinsing, and pressure cleaning.
- **California Department of Boating and Waterways, *Boater Alert: Hydrilla*** (http://dbw.ca.gov/Pubs/Hydrilla/Hydrilla.pdf): This fact sheet provides background information on hydrilla, an invasive species, and gives tips on how to avoid spreading this aquatic pest from one waterway to another.

2.4.14.4 Case Study

Innovative Boat Maintenance Facility. Summerfield Boat Works, Inc., in Broward County, Florida, installed a water recycling system for boat maintenance activities that does not discharge any wastewater. Water used for cleaning is cleaned with ultraviolet technology and reused. The marina reports conservation of 24,000 gallons of water every year (http://www.umich.edu/~nppcpub/resources/compendia/CSTLpdfs/CSTLmarina.pdf).

2.4.14.5 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.4.15 Management Measure 4.2F Operation and Maintenance Maintenance of Sewage Facilities

Management Measure

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

2.4.15.1 Programs

The Clean Vessel Act of 1992, Pumpout Grant Program, established by Congress, is administered by the California Department of Boating and Waterways. Clean Vessel Act grant funds are available for the public and private sectors. Grant recipients receive reimbursement for up to 75 percent of the cost of installing or renovating equipment for sewage pumpout facilities (http://dbw.ca.gov/pumpout.htm).

2.4.15.2 Management Practices

Regularly inspect and maintain sewage facilities. Small leaks can cause big pollution problems, and non-functioning facilities increase the chance that boaters will discharge into the water. Consider having a contractor regularly repair and maintain the pumpout and dump station if it takes up too much staff time.

Disinfect the suction connection of a pumpout station (stationary or portable) by dipping or spraying it with disinfectant after each use. This practice is primarily for the protection of public health. Ensure that the disinfectant is safely stored such that it is not at risk of being spilled into the water.

Provide dump stations for boaters who use portable toilets to dispose of their waste.

Keep restroom facilities in the marina clean, dry, and pleasant, and locate them where they are convenient to use.

2.4.15.3 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- ➔ Programs
- ➔ Management Practices
- ➔ Information Resources
- ➔ Case Studies
- ➔ References

2.4.16 Management Measure 4.2G Operation and Maintenance Boat Operation

Management Measure

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

2.4.16.1 Management Practices

For Marina Owners and Operators

Restrict boater traffic in shallow-water areas. Put signs up near sensitive areas of your marina or give boaters maps that indicate where boats should be operated with caution to avoid environmental harm.

Mark seagrass beds and other sensitive areas with signs. Survey these areas annually (since they can grow and expand) to ensure you have them marked correctly.

For Boaters

Respect no-wake zones and speed limits. They are posted to protect the environment and other boaters.

Familiarize yourself with the underwater environment where you will be boating so you can anticipate and avoid sensitive environmental areas, like seagrass beds and coral reefs. Ask the marina or a local conservation organization for maps that show these areas.

Ask marina operators and local authorities to post signs in the water that indicate where boaters should not go to avoid damaging the environment.

2.4.16.2 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.4.17 Management Measure 4.3A Education/Outreach Public Education/Outreach

Management Measure

Implement educational programs to provide greater understanding of watersheds, and to raise awareness and increase the use of applicable marina and boating management measures and practices where needed to control and prevent adverse impacts on ground and surface waters. Public education, outreach, and training programs should involve applicable user groups and the community (e.g., boaters, boating groups, marina owners and operators, boat maintenance facility operators, waterfront agencies, service providers, live-aboards, environmental groups, and other related groups).

2.4.17.1 Programs

The Save Our Shores Sanctuary Steward Certification Program is a training program for presenting beach cleanup and sanctuary slide programs on the Monterey Bay National Marine Sanctuary (http://www.mbnms.nos.noaa.gov/educate/sospgm.html).

The Santa Clara Valley Urban Runoff Pollution Prevention Program has a hotline for callers to obtain information about urban runoff issues (Telephone: 1-800-794-2482; Web site: http://www.scvurppp-w2k.com/default.htm).

The San Francisco Estuary Project's Boater Education Program publishes fact sheets, flyers, and guidance documents on clean boating practices (http://www.abag.ca.gov/bayarea/sfep/programs/boated/).

The Boating Clean and Green Campaign Dockwalkers Program trains boaters and other volunteers to conduct face-to-face boater education on environmentally sound boating practices (http://www.coastal.ca.gov/ccbn/ccbndx.html).

The Santa Monica Bay Restoration Program's Boater Education Program works to reduce pollution from recreational boating activities through technical assistance and outreach efforts. The program was awarded California Environmental Protection Agency's Program Excellence Award in May 2001 (http://www.santamonicabay.org/site/programs/layout/boater.jsp).

2.4.17.2 Management Practices

Communicate with Boaters

Ensure that management practices are clearly communicated to boaters. Use signs to inform marina patrons of appropriate clean boating practices and establish bulletin boards for environmental messages and forums for sharing leftover paints and varnishes. Hand out pamphlets or flyers, send newsletters, and add inserts to bill mailings with information about how recreational boaters can protect the environment and keep marina waters clean. Organize environmental education meetings, presentations, and demonstrations. For instance, hold clinics on safe fueling and bilge maintenance. Paint signs on storm drains so patrons know that what they toss on the ground is tossed into the water. Place signs in the water

and label charts to alert boaters about sensitive habitat areas they should avoid. Finally, insert language into facility contracts that promotes the use of clean boating and maintenance practices. Using a contract increases the likelihood that tenants will comply with the marina's management practices.

Training and Education of Marina Staff

Educate and train marina staff to do their jobs in an environmentally conscious manner and to be good role models for marina patrons. Have a clearly written environmental management practices agreement for outside contractors to sign as a precondition to their working on any boat in the marina.

Promote recycling and trash reduction programs. Tell your patrons what they can recycle and where to put recyclables. Provide information on local waste collection and recycling programs.

Provide Pollution Prevention Resources

MARPOL is the protocol resulting from the International Convention for the Prevention of Pollution from Ships, initially adopted in 1973 and revised in 1978 (for more information, visit http://www.londonconvention.org/marpol_73.htm). One of the provisions of the MARPOL protocol requires that boats carrying oil, noxious liquids, and harmful substances in packaged form display pollution prevention placards. These placards should be provided and phosphate-free, nontoxic cleaners and other environmentally friendly products stocked in the marina store.

2.4.17.3 Information Resources

- **Marin County Storm Water Pollution Prevention Program, *Boating Clean and Green*** (http://www.mcstoppp.org/consumers.htm): This is Marin County's guide to environmentally sound boating practices, available by calling the county (Telephone: 415-499-6528).
- **Boating Clean and Green Campaign, *An Annotated Catalog of Marina and Recreational Boater Pollution Education Materials*** (http://www.coastal.ca.gov/ccbn/catalognew.html): This is a comprehensive annotated bibliography, available online. It includes audiovisual materials, handbooks and manuals, fact sheets, brochures, posters, stickers, and mailers.
- **Boating Clean and Green Campaign, *Materials for Educators*** (http://www.coastal.ca.gov/ccbn/ccbndx.html): A compilation of fact sheets, reports, signs, and brochures for use by anyone conducting an outreach or education effort.
- **Boating Clean and Green Campaign, *The Dockwalkers Handbook: A Manual for Participants in Dockwalkers' Training*.** This manual is used as training for the Dockwalkers program. It addresses pollutants and management practices related to oil and fuel, sewage, boat cleaning and maintenance, hazardous and solid waste, marine debris, and gray water. Contact the California Coastal Commission, Boating Clean and Green Campaign (Telephone: 415-904-5200).
- **Maryland Clean Marina Initiative, *Clean Boating Lesson Plan*** (http://dnrweb.dnr.state.md.us/download/lessonplan6.pdf): This lesson plan includes a speaking plan, overheads, and handouts on petroleum control, vessel sewage, waste containment and disposal, and vessel cleaning and maintenance.
- **California Clean Boating Network, *Changing Tide Newsletter*** (http://www.santamonicabay.org/site/library/layout/index.jsp): The newsletter provides

information on clean boating practices in California, focusing on new trends in clean boating practices and environmental services for boaters.

2.4.17.4 Case Study

Southern California Boater's Guide. The Santa Monica Bay Restoration Project published the *Southern California Boater's Guide* as an educational product for the boating community. It serves as a recreational cruising guide and contains important information on clean boating practices. The guide covers Santa Barbara, Ventura, Los Angeles, Orange, and San Diego County harbors. It promotes clean boating in a fun, attractive, and user-friendly format; focuses on the importance of maintaining a boat in the most environmentally friendly manner possible; and explains the potentially adverse impacts that a poorly maintained boat can have on coastal waters.

The guide has three primary sections: General Boating, Harbors, and Boating Clean and Green. The General Boating section addresses boating safety, communications, navigation, rules and regulations, and vessel equipment requirements, registration, and operation. The Harbors section provides information about each of the region's 15 harbors, including overviews; what to do upon arrival; maps; the locations of waste disposal facilities for used motor oil, sewage, hazardous waste, and trash; and finally, a host of recreational opportunities (e.g., boardwalks, restaurants, shopping districts, fun-zones, beach rentals). The Boating Clean and Green section discusses the types of boating-related activities that could pollute marina and coastal waters, and how to prevent such pollution. Contact Stephanie McDonald of the Santa Monica Bay Restoration Project (Telephone: 323-266-7667; E-mail: smbrp@earthlink.net; Web site: http://www.santamonicabay.org/site/library/layout/index.jsp).

2.4.17.5 References

USEPA. 2001. *National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating*. EPA 841-B-01-005. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/mmsp/index.html)

2.5 Hydromodification

2.5.1 Introduction

2.5.1.1 Background

The State Water Resources Control Board (SWRCB), California Coastal Commission, and other State agencies have identified seven management measures to address nonpoint sources of pollution from hydromodification. Hydromodification is the alteration of stream and river channels, installation of dams and water impoundments, and streambank and shoreline erosion. The management measures consist of a suite of plans, practices, technologies, operating methods, or other alternatives that may be used in combination to control nonpoint source (NPS) pollution. Associated with each management measure are management practices that are designed to reduce the quantities of pollutants entering receiving waters. The fact sheet prepared for each management measure informs readers of the programs, resources, and case studies specific to California and the management measure.

Hydromodification Category Links:

Channelization and Channel Modification

- ➔ Physical and Chemical Characteristics of Surface Waters
- ➔ Instream and Riparian Habitat Restoration

Dams

- ➔ Erosion and Sediment Control
- ➔ Chemical and Pollutant Control
- ➔ Protection of Surface Water Quality and Instream and Riparian Habitat

Streambank and Shoreline Erosion

- ➔ Eroding Streambanks and Shorelines

Education/Outreach

- ➔ Educational Programs

The seven hydromodification management measures are separated into four categories: (1) channelization and channel modification; (2) dams, (3) streambank and shoreline erosion, and (4) education and outreach. Channelization and channel modification activities straighten, enlarge, deepen, or relocate the natural channel of rivers and streams. Channelization and channel modification activities diminish the quality of aquatic habitats and streamside habitats. It can alter the instream pattern of water temperature and sediment type, as well as the rate of sediment erosion, transport, and deposition. Hardening the banks of streams and rivers with shoreline stabilization protection or armor can accelerate the movement of surface water and pollutants from upstream, causing decreased water quality.

Dams can adversely impact the hydrology and quality of surface waters and riparian habitat in the rivers and streams where they are located. For the purposes of these management measures, dams are defined as constructed impoundments that are either (1) 25 feet or more in height and greater than 15 acre-feet in capacity, or (2) 6 feet or more in height and greater than 50 acre-feet in capacity. Impacts on surface waters and riparian habitats can result from the siting, construction, and operation of dams. Dams can reduce downstream flows affecting water quality and habitat. Construction of the dam can remove vegetation, cause increased sedimentation and turbidity. Shoreline and streambank erosion can occur after installation of a dam, which results in increased sediment load in the water body, affecting aquatic habitats.

The erosion of streambanks and shorelines is a natural process that can be beneficial and detrimental. Some erosion is necessary to provide sediment for beaches in estuaries and coastal bays, to provide point bars and channel deposits in rivers, and for substrate in tidal flats in wetlands. Excessively high erosion can cause sediment to smother aquatic vegetation, cover shellfish beds and tidal flats, fill in riffle pools, and contribute to increased turbidity and nutrients.

Plan for California's Nonpoint Source Pollution Control Program Volume II: California Management Measures for Polluted Runoff (SWRCB and CCC, 2000) defines the even hydromodification management measures as follows:

- **Channelization and Channel Modification.** California's management measures for channelization and channel modification promote the evaluation of channelization and channel modification projects. Channels should be evaluated as a part of the watershed planning and design processes, including watershed changes from new development in urban areas, agricultural drainage, or forest clearing. The purpose of the evaluation is to determine whether resulting NPS changes to surface water quality (Management Measure 5.1A. Physical and Chemical Characteristics of Surface Waters) or instream and riparian habitat (Management Measure 5.1B. Instream and Riparian Habitat Restoration) can be expected and whether these changes will be good or bad. Existing channelization and channel modification projects can be evaluated to determine the NPS impacts and benefits associated with the projects. Modifications to existing projects, including operation and maintenance or management, can also be evaluated to determine the possibility of improving some or all of the effects without changing the existing benefits or creating additional problems. In both new and existing channelization and channel modification projects, evaluation of benefits and/or problems should be site-specific.
- **Dams.** The second category of management measures addresses NPS pollution associated with dams. Dams are defined as constructed impoundments that are either (1) 25 feet or more in height and greater than 15 acre-feet in capacity, or (2) 6 feet or more in height and greater than 50 acre-feet in capacity. Management Measure 5.2A. Erosion and Sediment Control and Management Measure 5.2B. Chemical and Pollutant Control address two problems associated with dam construction: (1) increases in sediment delivery downstream resulting from construction and operation activities, and (2) spillage of chemicals and other pollutants to the waterway during construction and operation. Management Measure 5.2C. Protection of Surface Water Quality and Instream and Riparian Habitat addresses the impacts of reservoir releases on the quality of surface waters and instream and riparian habitat downstream.
- **Streambank and Shoreline Erosion.** Management Measure 5.3A. Eroding Streambanks and Shorelines addresses the stabilization of eroding streambanks and shorelines in areas where streambank and shoreline erosion creates a polluted runoff problem. Bioengineering methods such as marsh creation and vegetative bank stabilization are preferred. Streambank and shoreline features that have the potential to reduce polluted runoff should be protected from impacts, including erosion and sedimentation resulting from uses of uplands or adjacent surface waters. This management measure does not imply that all shoreline and streambank erosion must be controlled; the measure applies to eroding shorelines and streambanks that constitute a NPS problem in surface waters.
- **Education/Outreach.** Management Measure 5.4A. Educational Programs focuses on the development and implementation of pollution prevention and education programs for agency staffs and the public, as well as the promotion of assistance tools that emphasize restoration and low impact development. Education, technical assistance, incentives, and other means can be used to promote projects that reduce NPS pollutants, which retain or reestablish natural hydrologic functions (e.g., channel restoration projects and low impact development projects), and which prevent and remedy adverse effects of hydromodification activities.

2.5.1.2 General Resources

There are several federal and State agencies and programs that can provide general information to address NPS pollution from hydromodification from entering receiving waters. The agencies and programs listed below can provide assistance and information for all seven management measures. Resources specific to each of the seven hydromodification management measures can be found on the corresponding fact sheet.

- **California Coastal Commission** (http://www.coastal.ca.gov/): The California Coastal Commission's primary mission is to plan for and regulate land and water uses in the coastal zone consistent with the policies of the Coastal Act. Programs include permitting, planning, enforcement, and resource protection.
- **The Coastal NPS Pollution Control Program** (http://www.coastal.ca.gov/nps/npsndx.html): This program addresses nonpoint pollution problems in coastal waters. In its program, a state or territory describes how it will implement NPS pollution controls. This program is administered jointly with the U.S. Environmental Protection Agency (USEPA) and the National Oceanic and Atmospheric Administration (NOAA).
- **U.S. Army Corps of Engineers (USACE)** (http://www.spd.usace.army.mil/): USACE's mission is to provide quality, responsive engineering services to the nation including: planning, designing, building, and operating water resources and other civil works projects; designing and managing the construction of military facilities for the Army and Air Force; and providing design and construction management support for other defense and federal agencies.
- **U.S. Fish and Wildlife Service South Pacific Division** (http://www.fws.gov/): The South Pacific Division's mission is to conserve, protect, and enhance the nation's fish and wildlife and their habitats for the continuing benefit of people.

2.5.1.3 References

SWRCB and CCC. 2000. *Plan for California's Nonpoint Source Pollution Control Program Volume II: California Management Measures for Polluted Runoff*. State Water Resources Control Board and the California Coastal Commission, Sacramento, CA.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.2 Management Measure 5.1A Channelization and Channel Modification Physical and Chemical Characteristics of Surface Waters

Management Measure

1. Evaluate the potential effects of proposed channelization and channel modification on the physical and chemical characteristics of surface waters.

2. Plan and design channelization and channel modification to reduce undesirable impacts.

3. Develop an operation and maintenance program for existing modified channels that includes identification and implementation of opportunities to improve the physical and chemical characteristics of surface waters in those channels.

2.5.2.1 Programs

- California Environmental Resources Evaluation System (CERES) is an information system developed by the California Resources Agency to facilitate access to a variety of electronic data describing California's rich and diverse environments. The goal of CERES is to improve environmental analysis and planning by integrating natural and cultural resource information from multiple contributors and by making it available and useful to a wide variety of users (http://ceres.ca.gov/).
- The CALFED Bay-Delta Program aims to improve the quality and reliability of California's water supplies and revive the San Francisco Bay-Delta ecosystem. Its Web site contains information about water supply, water quality, and ecosystem restoration (http://www.calwater.ca.gov/).
- The California Department of Fish and Game (DFG) has jurisdictional authority over wetland resources associated with rivers, streams, and lakes under California Fish and Game Code sections 1600 to 1607 (City of Palo Alto, 2001). The DFG has the authority to regulate work that will substantially divert, obstruct, or change the natural flow of a river, stream, or lake; substantially change the bed, channel, or bank of a river, stream, or lake; or use material from a streambed. Typical activities regulated by DFG under sections 1600–1607 authority include rechanneling and diverting streams, stabilizing banks, implementing flood control projects, river and stream crossings, diverting water, damming streams, gravel mining, and logging operations. The DFG encourages completion of a Streambed Alteration Agreement, which is a mutual agreement between the DFG and the project proponent (http://www.dfg.ca.gov/1600/).

2.5.2.2 Management Practices

This management measure applies to any proposed channelization or channel modification project to evaluate potential changes in surface water characteristics, as well as to existing modified channels that can be targeted for opportunities to improve the surface water characteristics necessary to support desired fish and wildlife.

Changes created by channelization and channel modification activities are problematic if they unexpectedly alter environmental parameters to levels outside normal or desired ranges. The physical and chemical characteristics of surface waters that may be influenced by channelization and channel modification include sedimentation, turbidity, salinity, temperature, nutrients, dissolved oxygen, oxygen demand, and contaminants. Changes in natural sediment supplies, reduced freshwater availability, and accelerated delivery of pollutants are examples of the types of changes that can be associated with channelization and channel modification.

In cases where existing channelization or channel modification projects can be changed to enhance instream or streamside characteristics, several practices can be included as a part of regular operation and maintenance programs. New channelization and channel modification projects that cause unavoidable physical or chemical changes in surface waters can also use one or more practices to mitigate the undesirable changes. The practices include the following:

- Structural practices to protect or rehabilitate eroded streambanks are usually implemented in combination to provide stability of the stream system, and they can be grouped into direct and indirect methods. Direct methods include stone riprap revetments, erosion control fabrics and mats, revegetation, burlap sacks, cellular concrete blocks, and bulkheads. Indirect methods include the following: dikes, wire or board fences, gabions, and stone longitudinal dikes.
- Levees are embankments or shaped mounds constructed for flood control or hurricane protection.
- Setback levees and floodwalls are longitudinal structures used to reduce flooding and minimize sedimentation problems associated with fluvial systems. They can be constructed without disturbing the natural channel vegetation, cross section, or bottom slope.
- Check dams are small dams constructed across an influent, intermittent stream, or drainageway to reduce channel erosion by restricting flow velocity. They can serve as emergency or temporary measures in small eroding channels that will be filled or permanently stabilized at a later date, such as in a construction setting.
- Grade control structures are hydraulic barriers (weirs) installed across streams to stabilize the channel, control headcuts and scour holes, and prevent upstream degradation. These structures can be built with a variety of materials, including sheet piling, stone, gabions, or concrete.
- Vegetative cover is used to protect or rehabilitate eroded streambanks. Streambank protection using vegetation is probably the most commonly used practice, particularly in small tributaries. Vegetative cover, also used in combination with other structural practices, is relatively easy to establish and maintain, is visually attractive, and is the only streambank stabilization method that can repair itself when damaged. Appropriate native plant species should be used.
- Structural, vegetative, or bioengineered practices are used to control instream sediment load. Streambank protection and channel stabilization practices, including various types of revetments, grade control structures, and flow restrictors, have been effective in controlling sediment production caused by streambank erosion.
- To minimize erosion and prevent sedimentation impacts on nearby water bodies during construction and operation periods, streamside roadway management needs to combine proper design for site-specific conditions with appropriate maintenance practices.

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- To minimize erosion and prevent sedimentation impacts on nearby water bodies during construction and operation periods, streamside roadway management needs to combine proper design for site-specific conditions with appropriate maintenance practices.

2.5.2.3 Information Resources

- **North Delta Improvements Project** (http://ndelta.water.ca.gov/index.html): The (NDIP), which is under the Department of Water Resources, presents unique opportunities for synergy in achieving flood control and ecosystem restoration goals.
- **South Delta Improvement Project** (http://sdelta.water.ca.gov/): The purpose of the South Delta Improvements Program (SDIP) is to incrementally maximize diversion capability into Clifton Court Forebay, while providing an adequate water supply for diverters within the South Delta Water Agency, and reducing the effects of State Water Project exports on both aquatic resources and direct losses of fish in the South Delta
- **Washington State Department of Transportation** (http://www.wsdot.wa.gov/eesc/cae/design/roadside/SBwebsite/mainpage/Index.html): This is a comprehensive Web site, with information on cost, specifications, funding, and case studies.
- **California Forest Stewardship Program.** ***Bioengineering to Control Streambank Erosion*** (http://ceres.ca.gov/foreststeward/html/bioengineering.html): This fact sheet discusses various bioengineering techniques applicable to California streams.
- **WATERSHEDSS: Water, Soil and Hydro-Environmental Decision Support System** (http://www.water.ncsu.edu/watershedss/info/bmps.html): These fact sheets provide information on a variety of techniques for management practices, including soil bioengineering, structural streambank stabilization, and instream practices.
- **Ohio Department of Natural Resources.** ***Stream Management Guide Fact Sheets*** (http://www.dnr.state.oh.us/water/pubs/fs_st/streamfs.htm): This is a compilation of fact sheets on technical guidance for streambank and instream practices, general stream management, and stream processes.

2.5.2.4 Case study

Urban Stream Restoration Program. In 2000, a 900-linear-foot reach of degraded stream flowing through a well-used city park was restored by regrading the channel and increasing its sinuosity. The banks were revegetated using native willow and cottonwood cuttings and close to 100 native trees and shrubs from container stock. The East Bay Conservation Corps, under the supervision of the Urban Creeks Council, provided the labor. The California Department of Water Resources, Urban Stream Restoration Program, California Coastal Conservancy, and the San Francisco Foundation funded this project (http://www.urbancreeks.org/Current_Projects.html).

Hunter Creek Salmon and Steelhead Habitat Restoration Project. This project, implemented in 1998 by the California Conservation Corps with guidance from California Department of Fish and Game and U.S. Fish and Wildlife Service, was designed to improve the physical and chemical characteristics of the creek to provide a more suitable habitat. The specific goals of the project were to improve water quality, instream habitat, and the riparian area along the creek. The project had five components:

- *Cleanup*: Approximately 40 car bodies were removed from the streambank.
- *Instream structures*: Boulders, wood structures, and willow posts were placed in the stream and on the streambank to provide habitat complexity and to stabilize streambanks.
- *Fencing to exclude cattle*: The area along both sides of Hunter Creek was fenced to exclude cattle.

- *Planting native vegetation*: Native trees were planted alongside the stream, including willow, alder, Sitka spruce, western red cedar, Douglas fir, coast redwood, big-leaf maple, and black cottonwood.

- *Monitoring*: Photographs are taken at specific locations twice per year to monitor project effectiveness and habitat changes.

More information about this project can be obtained by contacting Scott Bauer of the California Conservation Corps, Klamath Service District, Phone: 707-482-2941; E-mail: sbauer@ccc.ca.gov.

2.5.2.5 References

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. PB98-158348LUW. Federal Interagency Stream Restoration Working Group, Washington, DC.

City of Palo Alto, California. 2001. San Francisquito Creek Bank Stabilization and Revegetation Master Plan: Section 7. (http://www.city.palo-alto.ca.us/sfcreek/) Accessed January 6, 2004.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.3 Management Measure 5.1B Channelization and Channel Modification Instream and Riparian Habitat Restoration

Management Measure

1. Evaluate the potential effects of proposed channelization and channel modification on instream and riparian habitat.

2. Plan and design channelization and channel modification to reduce undesirable impacts.

3. Develop an operation and maintenance program for existing modified channels that includes identification and implementation of opportunities to restore instream and riparian habitat in those channels.

2.5.3.1 Programs

- CALFED Bay-Delta Program mission is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System (http://calwater.ca.gov/).
- The California Ecological Restoration Projects Inventory (CERPI) is a comprehensive electronic database with details on restoration projects in California. It is searchable on the Internet as part of the Natural Resource Project Inventory (NRPI). The project is the result of collaboration between the California Biodiversity Council and the University of California, Davis, Information Center on the Environment (http://www.ice.ucdavis.edu/nrpi/).
- The Riparian Habitat Joint Venture, started by the California Partners in Flight (CalPIF), is a collaborative effort between 18 federal, state, and private organizations. The focus of the venture is to protect and improve riparian zones bordering streams and lakes (http://www.prbo.org/calpif/htmldocs/rhjv/).
- The Salmon Restoration Project is the result of cooperation between the California Conservation Corps, and California Department of Fish and Game. The agencies have been working in partnership with private and public landowners to restore California's salmon and steelhead habitat by adding instream structures. These structures provide shelter for fish, help reduce water temperatures, and add ecological complexity to the stream channel (http://www.ccc.ca.gov/cccweb/DISTRICT/SHASTAPA/SRP/srp.htm).

2.5.3.2 Management Practices

The purpose of this management measure is to correct and prevent further detrimental changes to instream and riparian habitat caused by channelization and channel modification projects. The management measure generally will be implemented by applying one or more management practices appropriate to the source, location, and climate. Implementation practices for instream and riparian habitat restoration in planned or existing modified channels are consistent with those management practices for physical and chemical characteristics of channelized or modified surface waters. To prevent future impacts on instream or riparian habitat or to remedy current problems caused by channelization or channel modification projects, include one or more of the following practices to mitigate the undesirable changes.

- Structural practices to rehabilitate eroded streambanks are usually implemented in combination to provide stability of the stream system, and they can be grouped into direct and indirect methods. Direct methods include stone riprap revetments, erosion control fabrics and mats, revegetation, burlap sacks, cellular concrete blocks, and bulkheads. Indirect methods include the following: dikes, wire or board fences, gabions, and stone longitudinal dikes.
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- Structural, vegetative, or bioengineered practices are used to control instream sediment load. Streambank and channel stabilization practices, including various types of revetments, grade control structures, and flow restrictors, have been effective in controlling sediment production caused by streambank erosion.
- To minimize erosion and remedy sedimentation impacts on nearby water bodies during construction and operation periods, streamside roadway management needs to combine proper design for site-specific conditions with appropriate maintenance practices.

2.5.3.3 Information Resources

- **Lower American River Corridor River Management Plan** (http://www.safca.com/): The plan has a section on aquatic habitat management goals, which includes restoration to improve aquatic habitat impaired by low flows from channel modification of the Lower American River.

- **Welcome and User's Guide to the San Pablo Bay Watershed Restoration Program** (http://144.3.144.213/program/SanPabloReport.pdf#opportunities): The San Pablo Bay Watershed Restoration Program is an innovative new effort to restore the ecological vitality of the San Pablo Bay watershed. There are many unique opportunities to revitalize streams, rivers, and wetlands in this large, northern San Francisco Bay region, and the Watershed Restoration Program creates a framework to promote its rejuvenation.
- **South Sacramento County Streams Project** (http://www.spk.usace.army.mil/): South Sacramento County Streams Project provides flood damage reduction to the urban areas of the Morrison Creek and Beach Stone Lake drainage basins in the southern area of Sacramento, as well as around the Sacramento Regional Waste Water Treatment Plant. The project will fund stream restoration in southern Sacramento County.
- **Sacramento River Riparian Habitat Program** (http://www.sacramentoriver.ca.gov/): The Sacramento River Riparian Habitat Program is working to ensure that riparian habitat management along the river addresses the dynamics of the riparian ecosystem and the reality of the local agricultural economy.
- **Washington State Department of Transportation, Soil Bioengineering Web site** (http://www.wsdot.wa.gov/eesc/cae/design/roadside/SBwebsite/mainpage/Index.html): This is a comprehensive Web site, with information on cost, specifications, funding, and case studies.
- **California Forest Stewardship Program, *Bioengineering to Control Streambank Erosion*** (http://ceres.ca.gov/foreststeward/html/bioengineering.html): This fact sheet discusses various bioengineering techniques applicable to California streams.
- **WATERSHEDSS:Water, Soil and Hydro-Environmental Decision Support System** (http://www.water.ncsu.edu/watershedss/info/bmps.html): These fact sheets provide information on a variety of techniques for management practices, including soil bioengineering, structural streambank stabilization, and instream practices.
- **Ohio Department of Natural Resources, *Stream Management Guide Fact Sheets*** (http://www.dnr.state.oh.us/water/pubs/fs_st/streamfs.htm): This is a compilation of fact sheets on technical guidance for streambank and instream practices, general stream management, and stream processes.
- **USDA Natural Resources Conservation Service, *Stream Visual Assessment Protocol*** (http://www.nrcs.usda.gov/technical/ECS/aquatic/svapfnl.pdf): This document outlines methods useful for field conservationists and landowners for the evaluation the ecological condition of a stream.
- **Ann Riley, *Urban Stream Restoration: A Video Tour of Ecological Restoration Techniques*** (http://www.noltemedia.com/nm/urbanstream/): This video, which is 61 minutes long and can be ordered online, is a documentary tour of six urban stream restoration sites. It provides background information on funding, community involvement, and the history and principles of restoration. The demonstration includes examples of stream restoration in very urbanized areas, re-creating stream shapes and meanders, creek daylighting, soil bioengineering, and ecological flood control projects. Ann Riley, a nationally known hydrologist, stream restoration professional, and executive director of the Waterways Restoration Institute in Berkley, California, leads the tour.
- **Natural Resources Conservation Service, *Watershed Technology Electronic Catalog*** (http://www.wcc.nrcs.usda.gov/wtec/wtec.html): This online catalog is a source of technical guidance on a variety of restoration techniques and management practices, to provide direction for watershed managers and restoration practitioners. The site is focused on providing images and conceptual diagrams.

2.5.3.4 Case Study

Urban Stream Restoration Program. In 2000, a 350-linear-foot section of degraded stream was restored, and failing concrete banks were stabilized using soil-bioengineering techniques (brush layering). Native riparian trees, willows, and cottonwood cuttings were planted, and a trail was graded along one bank. The East Bay Conservation Corps, under the supervision of the Urban Creeks Council, provided the labor. The California Department of Water Resources, Urban Stream Restoration Program, California Coastal Conservancy, and the San Francisco Foundation funded this project (http://www.urbancreeks.org/Current_Projects.html).

Mill Creek Channel Restoration Project. In 2001, Round Valley Indian Tribes, partnering with the FishAmerica Foundation and the National Oceanic and Atmospheric Administration's Restoration Center, initiated a project to restore this stream, located in Mendocino County, California. The purpose of the restoration was to reestablish and improve salmonid habitat within Mill Creek by creating a single, deeper stream channel and a functional riparian corridor. Restoration techniques included the use of riprap wing deflectors, structural streambank stabilization, boulder weirs, and large woody debris. The local community is participating through an Adopt-A-Watershed program, which provides an opportunity for local schools to monitor the success of the project and track changes in the health of the stream (http://yosemite.epa.gov/water/restorat.nsf/California?OpenView).

2.5.3.5 References

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. PB98-158348LUW. Federal Interagency Stream Restoration Working Group, Washington, DC.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.4 Management Measure 5.2A Dams Erosion and Sediment Control

Management Measure

1. Reduce erosion and, to the extent practicable, retain sediment onsite during and after construction.

2. Prior to land disturbance, prepare and implement an approved erosion and sediment control plan or similar administrative document that contains erosion and sediment control provisions.

2.5.4.1 Programs

- The California Water Code entrusts the regulatory Dam Safety Program to the Department of Water Resources. The principal goal of this program is to avoid dam failure and thus prevent loss of life and destruction of property. Dams under State jurisdiction are an essential element of the California infrastructure that provides constant water supply integrity (http://damsafety.water.ca.gov/).
- The Bureau of Reclamation's Dam Safety Program must ensure that dams are operated and maintained in a safe manner through inspections for safety deficiencies, analyses using current technologies and designs, and corrective actions, if needed, based on current engineering practices. In addition, future evaluations should include assessments of benefits forgone with the loss of a dam. For example, a failed dam can no longer provide needed fish and wildlife benefits (http://www.usbr.gov/ssle/dam_safety/).
- Both Edison Mission Energy and Southern California Edison use hydropower to generate electricity. Using moving water to effectively generate electricity is clean and environmentally safe; however, it affects portions of streams from which water is diverted, and it can create reservoirs that have both positive and negative impacts. Edison International works with local groups and government agencies to increase the benefits of hydroelectric operations and reduce negative impacts. (Southern California Edison's Big Creek hydro facilities re-licensing has an environmental program. Information is not yet available on its Web site: http://www.sce.com/sc3/006_about_sce/006b_generation/006b2_big_creek/default.htm.

2.5.4.2 Management Practices

Two broad performance goals constitute this management measure: minimizing erosion and maximizing the retention of sediment onsite. Preparing and implementing an erosion and sediment control plan for dam construction and operation can accomplish these goals. The goals give states and local governments flexibility in specifying practices appropriate for local conditions. Recommended practices to control erosion and sediment control from dams include the following:

- Develop and implement an erosion and sediment control plan (ESC plan) for the dam. These plans describe how a contractor or developer will reduce soil erosion and contain and treat runoff that is carrying eroded sediments. Plans typically include descriptions and locations of soil stabilization practices, perimeter controls, and runoff treatment facilities that will be installed and maintained before and during construction activities. In addition to special area considerations, the full ESC plan review inventory should include topographic and vicinity maps, a site

development plan, construction schedule, erosion and sedimentation control plan drawings, detailed drawings and specifications for practices, design calculations, and a vegetation plan. Changes to an ESC plan should be made based on regular inspections that determine whether the ESC practices were appropriate or properly installed or maintained.

- Provide education and training opportunities for designers, developers, and contractors. One of the most important factors determining whether erosion and sediment controls will be properly installed and maintained on a construction site is the knowledge and experience of the contractor.
- Schedule projects so clearing and grading are done during the time of minimum erosion potential. Often a project can be scheduled during the time of year when the erosion potential of the site is relatively low. In many parts of the country, there is a certain period of the year when erosion potential is relatively low and construction scheduling could be very effective (in the Pacific region, for example, the 6-month dry season from May 1 to October 31).
- Plan to use construction phasing. Construction site phasing involves disturbing only small portions of a site at a time to prevent erosion from dormant parts. Elements to consider when phasing construction activities include managing runoff separately in each phase, determining whether water and sewer connections and extensions can be accommodated, determining the fate of already completed downhill phases, and providing separate construction and residential accesses to prevent conflicts between residents living in completed stages of the site and construction equipment working on later stages.

2.5.4.3 Information Resources

- **California Storm Water Quality Association, *Construction Handbook***
(http://www.cabmphandbooks.org/Construction.asp): The *Construction Handbook* provides general guidance for selecting and implementing management practices that will eliminate or reduce the discharge of pollutants from construction sites to waters of the State. The practices for erosion and sediment control are included in Section 3 of the handbook.
- **California Coastal Commission, Beach Erosion and Response Document**
The *Beach Erosion and Response Guidance Document*, or BEAR, is now available by request from the California Coastal Commission. This document provides general information about types of shorelines and seawalls, as well as guidance for analyzing shoreline activities. To receive a copy, call the Technical Services Unit in the Headquarters Office (Telephone: 415-904-5240).
- **Resources Agency of California, Draft Policy on Coastal Erosion Planning and Response and Background Material**
The draft policy on coastal erosion planning and response focuses on responding to erosion at the coastline with actions that will cause the least environmental damage, while protecting existing coastal infrastructure. The draft policy outlines a tiered approach that proposes the following broad policy goals: (1) increasing sand supply to the coast; (2) avoiding the construction of new structures in hazardous areas; (3) if structures are threatened, considering the feasibility of re-locating them; (4) using beach nourishment (placing sand on or near eroding beaches) as the first priority for stabilizing beaches, if feasible; (5) using hard protective structures (seawalls, revetments, breakwaters, etc) only if other less environmentally damaging alternatives are deemed infeasible. The draft policy and background material can be found at http://resources.ca.gov/ocean/coastal_erosion_draft.html.
- **Russellville Water Intake Environmental Assessment**
(http://www.tva.gov/environment/reports/russell/ea_text.htm): This environmental assessment was prepared for the addition of a special reservoir drawdown during construction of intake at mile 32.4R on Cedar Creek Reservoir, Franklin County, Alabama.

- **Wyoming Department of Environmental Quality, *Hydrologic Modifications Best Management Practices*** (http://deq.state.wy.us/wqd/watershed/Downloads/NPS Program/92251.pdf): This manual provides information on the management practices recommended by the Wyoming Department of Environmental Quality for protecting streams and riparian areas from hydrologic modifications.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.5 Management Measure 5.2B Dams Chemical and Pollutant Control

Management Measure

1. Limit application, generation, and migration of toxic substances.

2. Ensure the proper storage and disposal of toxic materials.

3. Apply nutrients at rates necessary to establish and maintain vegetation without causing significant nutrient runoff to surface waters.

2.5.5.1 Programs

- The Bureau of Reclamation's Dam Safety Program must ensure that dams are operated and maintained in a safe manner through inspections for safety deficiencies, analyses using current technologies and designs, and corrective actions, if needed, based on current engineering practices. In addition, future evaluations should include assessments of benefits forgone with the loss of a dam. For example, a failed dam can no longer provide needed fish and wildlife benefits (http://www.usbr.gov/ssle/dam_safety/).
- The California Resources Agency, Department of Water Resources, Division of Safety of Dams conducts investigations of selected dams, which include a comprehensive review of all pertinent material contained in the Division's files, a visual project inspection, technical studies when necessary, and preparation of a comprehensive report (http://damsafety.water.ca.gov/about.htm).

2.5.5.2 Management Practices

The purpose of this management measure is to prevent downstream contamination from pollutants associated with dam construction and maintenance activities. Recommended practices used to control chemical pollution from dam construction sites include the following:

- Develop and implement a spill prevention program. Spill procedure information should be posted, and persons trained in spill handling should be onsite or on call at all times. Materials for cleaning up spills should be kept onsite and easily available. Spills should be cleaned up immediately and the contaminated material properly disposed of.
- Control pollutant runoff from equipment. During both construction and maintenance activities at dams, equipment and machinery can be a potential source of pollution to the surface and ground waters.
- Establish fuel and maintenance staging areas. Proper maintenance of equipment and installation of proper stream crossings further reduces pollution of water by these sources. Vehicles need to be inspected for leaks. To prevent runoff, fuel and maintain vehicles onsite only in a bermed area or over a drip pan.
- Store, cover, and isolate construction materials, refuse, garbage, sewage, debris, oil and other petroleum products, mineral salts, industrial chemicals, and topsoil to prevent runoff of pollutants and contamination of ground water.

- Mix, transport, load, and apply pesticides correctly and dispose of their containers properly to prevent potential NPS pollution. Fertilizers should be handled and applied properly.

2.5.5.3 Information Resources

- **USEPA, *Spill Prevention Planning*** (http://www.epa.gov/npdes/pubs/spillprv.pdf): This fact sheet outlines key programmatic components to establishing spill prevention plans.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.6 Management Measure 5.2C Dams Protection of Surface Water Quality and Instream and Riparian Habitat

Management Measure

Develop and implement a program to manage the operation and maintenance of dams that includes an assessment of

1. Surface water quality and instream and riparian habitat and potential for improvement, and

2. Significant NPS pollution problems that result from excessive surface water withdrawals.

2.5.6.1 Programs

- The Department of Fish and Game is responsible for conserving, protecting, and managing California's fish, wildlife, and native plant resources. To meet this responsibility, the law requires any person, State, or local government agency, or public utility proposing a project that may impact a river, stream, or lake to notify the Department before beginning the project. If the Department determines that the project may adversely affect existing fish and wildlife resources, a Lake or Streambed Alteration Agreement is required (http://www.dfg.ca.gov/1600/).
- California Department of Water Resources Fish Passage Improvement Program staff meet with local, State, and federal agencies and stakeholder partners to plan and implement projects to remove barriers that impede migration and spawning of anadromous fish species. This program's Web site has a link to a table of dams removed in California (http://www.isi.water.ca.gov/fish/dams.shtml).
- The goal of the American Rivers campaign, Rivers Unplugged, is to restore rivers critical to fish and wildlife by removing dams that no longer make sense. The primary focus of the Rivers Unplugged California Field Office is to provide technical assistance and other guidance to individual dam removal efforts (http://www.amrivers.org/contactus/california2.htm).

2.5.6.2 Management Practices

The purpose of this management measure is to protect the quality of surface waters and aquatic habitat in reservoirs and in the downstream portions of rivers and streams that are influenced by the quality of water contained in the releases (tailwaters) from reservoir impoundments. Impacts from the operation of dams on surface water quality and aquatic and riparian habitat should be assessed and the potential for improvement evaluated. In addition, potential upstream and downstream impacts on surface water quality and aquatic and riparian habitat that would be caused by the implementation of practices should also be considered in the assessment. The overall program approach is to evaluate a set of practices that can be applied individually or in combination to protect and improve surface water quality and aquatic habitat in reservoirs, as well as in areas downstream of dams. After this evaluation, the most cost-effective operations should be implemented to protect and improve, where economically feasible, surface water quality and aquatic and riparian habitat.

Recommended practices for aeration of reservoir waters and releases include the following:

- Pumping and injection systems. Water pumps have been used to move surface water containing higher concentrations of dissolved oxygen downward to mix with deeper waters as the two strata are entering the turbine. Oxygen injection systems use pure oxygen to increase levels of dissolved oxygen in reservoirs.
- Turbine venting. This is the practice of injecting air into water as it passes through a turbine.

Recommended practices to improve oxygen levels in tailwaters include the following:

- Gated conduits. These are hydraulic structures that divert the flow of water under the dam. They are designed to create turbulent mixing to enhance the rest of the oxygen transfer.
- Spillways and overflow weirs. These are important structures in improving dissolved oxygen levels.
- Spillway modifications. Spillways can be modified by cutting a notch to prevent water from plunging directly into the stilling basin
- Reregulation weirs. This type of weir has been constructed from stone, wood, and aggregate. In addition to increasing the levels of dissolved oxygen in the tailwaters, reregulation weirs result in a more constant rate of flow farther downstream during periods when turbines are not in operation.
- Labyrinth weirs. This type of weir has extended crest length and is usually W-shaped. These weirs spread the flow out to prevent dangerous undertows in the plunge pool.
- Selective withdrawal. Multilevel intake devices in storage reservoirs allow selective withdrawal of water based on temperature and dissolved oxygen levels.
- Turbine operation. Implementation of changes in the turbine start-up procedures can also enlarge the zone of withdrawal to include more of the epilimnetic waters in the downstream releases.

Recommended watershed protection practices include the following:

- Land use planning. Planning establishes guidelines for permissible uses of land within a watershed and serves as a guide for reservoir management programs addressing NPS pollution.
- NPS screening and identification. The analysis and interpretation of stereoscopic color infrared aerial photographs can be used to find and map specific areas of concern where a high probability of NPS pollution exists from septic tank systems, animal wastes, soil erosion, and other similar types of NPS pollution.
- Soil erosion control. Soil erosion has been determined to be the major source of suspended solids, nutrients, organic wastes, pesticides, and sediment that, when combined, form the most problematic form of NPS pollution.
- Ground water protection. Proper protection and management of ground water resources primarily depends on the effective control of NPS pollution, particularly in ground water recharge areas.
- Mine reclamation. Old mines need to be located and reclaimed to reduce the NPS pollutants emanating from them. Revegetation is a cost-effective method of reclaiming denuded strip-mined lands.
- Animal waste control. A major contributor to reservoir pollution in some watersheds is wastes from confined animal facilities.

- Failing septic system control. Septic systems should be sited, designed, and installed so that impacts on water bodies will be reduced to the extent practicable.

Practices to restore or maintain aquatic and riparian habitat include the following:

- Flow augmentation. A flushing flow is a high-magnitude, short-duration release for the purpose of maintaining channel capacity and the quality of instream habitat by scouring the accumulation of fine-grained sediments from the streambed.
- Riparian improvements. These include reducing sediment loading in the watershed, improving riparian vegetation, eliminating barriers to fish migration, and providing greater instream and riparian habitat diversity

Practices to maintain fish passage include the following:

- Behavioral barriers. Such barriers use fish responses to external stimuli to keep fish away from the intakes or to attract them to a bypass.
- Physical barriers. These include barrier nets and stationary screens to prevent the entry of fish and other aquatic organisms into the intakes at a generating facility.
- Collection systems. These are used to capture fish by screening and/or netting, followed by transport by truck or barge to a downstream location.
- Fish diversion systems. These lead or force fish to bypasses that transport them to the natural water body below the dam.
- Spill and water budgets. Spill budgets provide alternative methods for fish passage that are less dangerous than passage through turbines. The water budget is the mechanism for increasing flows through dams during the out-migration of anadromous fish species.
- Fish ladders. These are one type of structure that can be provided to enable the safe upstream and downstream passage of mature fish.
- Transfer of fish runs. Transfer involves inducing anadromous fish species to use different spawning grounds in the vicinity of the impoundment.
- Constructed spawning beds. When the adverse effects of a dam on the aquatic habitat of an anadromous fish species are severe, one option may be to construct suitable replacement spawning beds.

2.5.6.3 Information Resources

- **California Department of Water Resources Fish Passage Improvement Program, *Bibliography*** (http://www.isi.water.ca.gov/fish/bibliography.shtml): This Web site provides several references on fish species biology, dam removal, geomorphology, fish passage structures, riparian and instream restoration, road crossings, and riparian vegetation.
- **California Department of Fish and Game (DFG), Lake or Streambed Alterations Agreements** (http://www.dfg.ca.gov/1600/brochure.pdf): This brochure provides information on the DFG lake or streambed alterations notification and agreement program.
- **California Salmonid Stream Habitat Restoration Manual** (http://www.dfg.ca.gov/nafwb/pubs/manual3.pdf): This manual formally explains and describes the DFG ground level approach to restoration of fishery resources, and standardizes the DFG's descriptive terminology and technical methods. Principal emphasis is on salmon, steelhead, and

trout; therefore, this manual is principally intended to be used to assist in restoration efforts for those species in California.

2.5.6.4 Case Study

Battle Creek Restoration Project. A plan to restore rare Chinook salmon and steelhead by removing five dams, constructing fish ladders, and improving stream flow in 42 miles of Northern California's Battle Creek was announced in 1999. Spring-fed Battle Creek, a major Sacramento River tributary, is the first stream in California to which several species of salmon will be able to return and find their original spawning grounds.

The Battle Creek restoration proposal includes increasing the minimum instream flows from the present amount of 3 to 5 cubic feet per second (cfs) year round to approximately 35-88 cfs adjusted seasonally; decommissioning five diversion dams (Wildcat, Coleman, South, Lower Ripley Creek, and Soap Creek) and transferring their associated water rights to instream uses; screening and enlarging ladders at three diversion dams (Inskip, Eagle Canyon, and North Battle Creek Feeder); and constructing new infrastructure to eliminate mixing of North and South Fork waters. Screening prevents fish from getting pulverized in the dams' turbines.

This restoration is being done under the CALFED Bay-Delta Program, which was formed in 1994. It is a joint federal and State agreement to improve California's water and ecosystem quality as well as the water supply reliability and the vulnerability of Delta functions in and around San Francisco, Sacramento, and Stockton, CA (http://www.usbr.gov/mp/regional/battlecreek/f_overview.html).

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.5.7 Management Measure 5.3A Streambank and Shoreline Erosion Eroding Streambanks and Shorelines

Management Measure

1. Where streambank or shoreline erosion is a NPS problem, streambanks and shorelines should be stabilized. The use of vegetative stabilization methods is strongly preferred over the use of structural stabilization methods, if appropriate considering the climate, severity of wave and wind erosion, offshore bathymetry, and the potential adverse impacts on other streambanks, shorelines, and offshore areas.

2. Protect streambank and shoreline features with the potential to reduce NPS pollution.

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

2.5.7.1 Programs

- The California Coastal Commission's primary mission is to plan for and regulate land and water uses in the coastal zone consistent with the policies of the Coastal Act. Programs include permitting, planning, enforcement, and resource protection (http://www.coastal.ca.gov/).
- The CALFED Bay-Delta Program's mission is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System (http://www.calwater.ca.gov/).
- The California Department of Fish and Game's mission is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public (http://www.dfg.ca.gov/).

2.5.7.2 Management Practices

- Use bioengineering and other vegetative techniques to restore damaged habitat along shorelines and streambanks wherever conditions allow.
    - Live staking involves the insertion and tamping of live, rootable vegetative cuttings into the ground.
    - Live fascines are long bundles of branch cuttings bound together into sausage-like structures. When cut from appropriate species and properly installed, they will root and immediately begin to stabilize slopes.
    - Brush layering consists of placing live branch cuttings in small benches excavated into the slope. The portions of the brush that protrude from the slope face assist in retarding runoff and reducing surface erosion.
    - Brush mattressing involves digging a slight depression on the bank and creating a mat or mattress from woven wire or single strands of wire and live, freshly cut branches from sprouting trees or shrubs.

- Branch packing consists of alternating layers of live branch cuttings and compacted backfill to repair small localized slumps and holes in slopes.
- Joint planting involves tamping live cuttings of rootable plant material into soil between the joints or open spaces in rocks that have previously been placed on a slope.
- Live cribwalls consist of a hollow, box-like interlocking arrangement of untreated log or timber members. The structure is filled with suitable backfill material and layers of live branch cuttings, which root inside the crib structure and extend into the slope.

- Use properly designed and constructed engineering practices for shore erosion control in areas where practices involving marsh creation and soil bioengineering are ineffective.
  - Bulkheads are primarily soil-retaining structures designed also to resist wave attack.
  - Seawalls are principally structures designed to resist wave attack, but they also may retain some soil. Both bulkheads and seawalls may be built of many materials, including steel, timber, or aluminum sheet pile, gabions, or rubble-mound structures.
  - Revetment design contains several layers of randomly shaped and randomly placed stones, protected with several layers of selected armor units or quarry stone. The armor units in the cover layer should be placed in an orderly manner to obtain good wedging and interlocking between individual stones. The cover layer may also be constructed of specially shaped concrete units.
  - Gabions (stone-filled wire baskets) or interlocking blocks of precast concrete are used in the construction of revetments. In addition to the surface layer of armor stone, gabions, or rigid blocks, successful revetment designs also include an underlying layer composed of either geotextile filter fabric and gravel or a crushed stone filter and bedding layer.
  - Groins are structures that are built perpendicular to the shore and extend into the water. Groins are generally constructed in series, referred to as a groin field, along the entire length of shore to be protected. Groins trap sand in littoral drift and halt its longshore movement along beaches. The sand beach trapped by each groin acts as a protective barrier that waves can attack and erode without damaging previously unprotected upland areas.
  - Breakwaters are wave energy barriers designed to protect the land or nearshore area behind them from the direct assault of waves.
- In areas where existing protection methods are being flanked or are failing, implement properly designed and constructed shore erosion control methods.
  - Toe protection usually takes the form of a stone apron installed at the base of the vertical structure to reduce wave reflection and scour of bottom sediments during storms.
  - Return walls should be provided at either end of a vertical protective structure and should extend landward for a horizontal distance consistent with the local erosion rate and the design life of the structure.
  - Maintenance of structures is necessary to repair the damage from storms and winter ice and to address the effects of flanking and offshore profile deepening.
- Plan and design all streambank, shoreline, and navigation structures so that they do not transfer erosion energy or otherwise cause visible loss of surrounding streambanks or shorelines. Many streambank or shoreline protection projects result in a transfer of energy from one area to another, which causes increased erosion in the adjacent area. Property owners should consider the possible effects of erosion control measures on other properties located along the shore.

- No-wake zones should be established and enforced. No-wake zones should be given preference over posted speed limits in shallow coastal waters and inland lakes and streams for reducing the erosion potential of boat wakes on streambanks and shorelines.
- Setbacks should be established to minimize disturbance of land adjacent to streambank and shorelines to reduce other impacts. Setbacks most often take the form of restrictions on the siting and construction of new standing structures along the shoreline.
- Upland drainage from development should be directed away from bluffs and banks so as to avoid accelerating slope erosion.

2.5.7.3 Information Resources

- **Sacramento River Riparian Habitat Program** (http://www.sacramentoriver.ca.gov/): The Sacramento River Riparian Habitat Program is working to ensure that riparian habitat management along the river addresses the dynamics of the riparian ecosystem and the reality of the local agricultural economy.
- **California Forest Stewardship Program, *Bioengineering to Control Stream Bank Erosion*** (http://ceres.ca.gov/foresteward/html/bioengineering.html): This fact sheet includes information on using bioengineering techniques to control streambank erosion.
- **Bioengineering for Hillslope, Streambank, and Lakeshore Erosion Control** (http://www.ianr.unl.edu/pubs/Soil/g1307.htm): This NebGuide (part of a series published by the Cooperative Extension of the University of Nebraska) describes bioengineering techniques for hill slope, streambank, and lakeshore erosion control. Tips for a successful bioengineering installation and demonstration project are described.
- **California Environmental Resources Evaluation System (CERES)** (http://ceres.ca.gov/): CERES is an information system developed by the California Resources Agency to facilitate access to a variety of electronic data describing California's rich and diverse environments. The goal of CERES is to improve environmental analysis and planning by integrating natural and cultural resource information from multiple contributors and by making it available and useful to a wide variety of users.

2.5.7.4 Case Study

Beaches Starved of Sand Because of Dams. Four hundred miles of California's fabulous beaches are starving for sand, but surfers and other beach lovers have the muscle to bring them back. Beaches are disappearing mostly because of dams. Seventy to 90 percent of the sand on California beaches comes from rivers, and millions of tons of sand-laden sediments are now trapped behind the 1,400 dams that were built in California between l850 and l970. Twenty percent of the sand on California's beaches comes from the natural erosion of bluffs (http://www.ecoiq.com/magazine/opinion/opinion61.html).

2.5.7.5 References

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. *Stream Corridor Restoration: Principles, Processes, and Practices*. PB98-158348LUW. Federal Interagency Stream Restoration Working Group, Washington, DC.

Fact Sheet Links:
➔ Programs
➔ Management Practices
➔ Information Resources
➔ Case Studies
➔ References

2.5.8 Management Measure 5.4A Education/Outreach Educational Programs

Management Measure

Implement educational programs to provide greater understanding of watersheds, to raise awareness and increase the use of applicable hydromodification management measures and practices where needed to control and prevent adverse impacts on surface and ground waters, and to promote projects that retain or reestablish natural hydrologic functions (e.g., channel restoration projects). Public education, outreach, and training programs should involve applicable user groups and the community.

2.5.8.1 Programs

- The Clean Water Team Citizen Monitoring Program is part of the SWRCB's NPS Pollution Control Program. Regional coordinators provide technical assistance, training, data management consultation, outreach, and education to citizen monitoring organizations. The program provides an opportunity for the public to participate in stewardship efforts and learn about the issues facing their local watersheds (http://www.swrcb.ca.gov/nps/volunteer.html).

2.5.8.2 Management Practices

- Focus on the development and implementation of pollution prevention and education programs for agency staffs and the public.
- Promote assistance tools that emphasize restoration and low impact development.
- Promote projects that reduce NPS pollutants, retain or reestablish natural hydrologic regimes, and/or prevent or remedy adverse effects of hydromodification activities.

2.5.8.3 Information Resources

- **Adopt-A-Watershed** (http://www.adopt-a-watershed.org/index.html): The Adopt-A-Watershed Program's Web site provides school curricula, as well as information on its consulting services and training programs, and links to local Adopt-A-Watershed groups.
- **Adopt-A-Stream Foundation** (http://www.streamkeeper.org/): The Adopt-A-Stream Foundation, based in Washington, travels to communities around the country to provide education and outreach for students, professionals, and government officials.
- **USEPA, *Volunteer Stream Monitoring: A Methods Manual*** (http://www.epa.gov/volunteer/stream/): This guide discusses volunteer stream monitoring in terms of its role in state monitoring programs, and provides information on how to organize, implement, and maintain volunteer programs. Instream physical, chemical, and biological assessments are covered, as well as land use or watershed assessments.
- **Arroyo Seco Foundation** (http://www.arroyoseco.org): The Arroyo Seco Foundation works to protect and restore the Arroyo Seco watershed, which is part of the Los Angeles River watershed. The foundation also promotes environmental awareness and education.

- ***Riverwatch River and Watershed Conservation Directory*** (http://www.riverwatch.org/library/libnetdirsearch.cfm): The River Network and the Rivers, Trails and Conservation Assistance Program of the National Park Service maintain this comprehensive directory, which lists over 3,600 river and watershed conservation groups, as well as local government agencies. The directory is searchable by city, state, and organization name.
- **The Council of State Governments, *Getting in Step: A Guide to Effective Outreach in Your Watershed*** (http://www.epa.gov/watertrain/gettinginstep/): This Web site is an online training module that provides guidance on the development of an outreach program. Downloadable worksheets are provided for use in the planning process.
- **California Regional Environmental Education Community** (http://www.creec.org/): This online network is a source of environmental education resources, with links to curriculum and a statewide searchable research directory.

2.5.8.4 Case Study

Urban Creeks Council Environmental Education Program. In conjunction with hands-on projects, the Urban Creeks Council (UCC) of California works with schools and community groups to try to build a sense of stewardship for the creeks. UCC works with elementary school teachers, taking students on field trips to local creeks to learn about creek ecology, and with high school teachers, teaching students to understand how streams and rivers function, how to survey and graph creek cross sections and profiles, to conduct pebble counts, and to identify native riparian trees, shrubs, and other plants (http://www.urbancreeks.org/Current_Programs.html).

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2.6 Wetlands, Riparian Areas, and Vegetated Treatment Systems

Wetlands, Riparian Areas, and Vegetated Treatment Systems Category Links:

- ➔ Protection of Wetlands and Riparian Areas
- ➔ Restoration of Wetlands and Riparian Areas
- ➔ Vegetated Treatment Systems
- ➔ Education/Outreach

2.6.1 Introduction

2.6.1.1 Background

The State Water Resources Control Board (SWRCB) and California Coastal Commission (CCC) have identified four management measures to protect and restore wetlands and riparian areas, and encourage the use of vegetated treatment systems as a means to control nonpoint sources of pollution. The purposes of these management measures are to promote and maintain the water quality benefits of wetland and riparian areas and to ensure that degradation does not result in nonpoint source (NPS) pollution. Associated with each management measure are management practices that are designed to promote conservation and restoration of wetlands, and reduce the quantities of pollutants entering receiving waters. The fact sheet prepared for each management measure informs readers of the programs, information resources, and case studies specific to California and the management measure.

Wetlands are vital to the survival of aquatic and terrestrial wildlife and plants. They play an important role in filtering out pollutants, preventing soil erosion, providing flow control, surface and ground water storage, aquatic and semiaquatic habitat, biological diversity, and recreation (California Resources Agency, 1998). In California, only 10 percent of the wetlands that existed prior to European settlement remain intact and only 5 percent of the coastal wetlands remain intact (California Resources Agency, 1998). Changes in hydrology, geochemistry, substrate, or species composition can impair wetland and riparian areas and reduce their ability to filter out pollutants in runoff, which can result in poor water quality in the receiving waters. Activities such as highway construction, deposition of dredged material, draining wetlands for development or cropland, hydromodification, and excavation of ports and marinas can all cause impairment of wetlands and riparian areas (USEPA, 2001).

The *Plan for California's Nonpoint Source Pollution Control Program, Volume II: California's Management Measures for Polluted Runoff* (SWRCB and CCC, 2000) defines the four management measures for wetlands, riparian areas, and vegetated treatment systems as follows:

- **6A. Protection of Wetlands and Riparian Areas**. Implementation of this management measure is intended to protect the existing water quality improvement functions of wetlands and riparian areas as a component of NPS programs.

- **6B. Restoration of Wetlands and Riparian Areas**. Restoration of wetlands and riparian areas refers to the recovery of a range of functions that existed previously by reestablishing hydrology, vegetation, and structure characteristics. Damaged or destroyed wetland and riparian areas should be restored where restoration of such systems will significantly abate polluted runoff.

- **6C. Vegetated Treatment Systems**. This management measure promotes the installation of vegetated treatment systems (e.g., artificial or constructed wetlands) in areas where these systems will serve a polluted runoff-abatement function. Vegetated filter strips and engineered wetlands remove sediment and other pollutants from runoff and wastewater, and prevent pollutants from entering adjacent water bodies. Removal typically occurs through filtration, deposition, infiltration, absorption, adsorption, decomposition, and volatilization.

- **6D. Education and Outreach**. This management measure promotes the establishment of programs to develop and disseminate scientific information on wetlands and riparian areas and to develop greater public and agency staff understanding of natural hydrologic systems—including their functions and values, how they are lost, and the choices associated with their protection and restoration.

2.6.1.2 General Resources

There are several federal programs that can provide general information to promote the protection and restoration of wetlands and riparian areas and assist with the implementation of the four management measures. The agencies and programs listed below can provide assistance and information for each wetland, riparian, and vegetated treatment system management measure. Resources specific to each of the four management measures can be found on the corresponding fact sheet.

- **California Coastal Commission's Local Assistance Program, Links to Wetlands Sites Web page** (http://www.coastal.ca.gov/la/wetland_links.html): This is a page of Web links related to wetlands management in California and nationally.

- **California Resources Agency, California Wetlands Information System** (http://ceres.ca.gov/wetlands/): This system is a compilation of public and private sector information, including maps, environmental documents, agency roles in wetlands management, restoration and mitigation activities, regulatory permitting, and wetland policies. It is designed to provide comprehensive wetlands information to the general public, the educational community, and government agencies.

- **Coastal Conservancy and California Coastal Commission, Southern California Coastal Wetlands Inventory** (http://www.ceres.ca.gov/wetlands/geo_info/so_cal.html): The inventory consists of a database of existing information on 41 coastal wetlands that lie between Mexico and Point Conception in northern Santa Barbara County. It provides three types of information for each site: (1) a map of the wetland's historical extent, (2) a map of recent habitat distributions, and (3) a "profile" that briefly describes ecological conditions and land use and enhancement histories.

- **California Resources Agency, California Wetlands** (http://ceres.ca.gov/ceres/calweb/wetlands.html): This site contains excerpts from the Water Plan Update and a series of links to wetlands- and water resource-related Web pages.

- **Pacific Estuary Research Laboratory** (http://www.sci.sdsu.edu/PERL): The Pacific Estuary Research Laboratory was created in 1984 with funding from NOAA's Office of Coastal Zone Management, the California State Resources Agency, California State Coastal Conservancy, and San Diego State University. The site offers such resources as water quality-related reports and data, A Manual for Assessing Restored and Natural Coastal Wetlands, and other tools related to wetlands management.

- **Natural Resource Projects Inventory (NRPI)** (http://endeavor.des.ucdavis.edu/nrpi/): NRPI is a searchable comprehensive electronic database with information on thousands of conservation, mitigation and restoration projects being developed and implemented throughout California. It was developed as a collaborative effort between the California Biodiversity Council and the University of California at Davis Information Center for the Environment.

- **Water Resources Center Archives, Internet Resources** (http://www.lib.berkeley.edu/WRCA/internet.html): This Web page is a clearinghouse for links related to water resource management and historical water resource data in California. The links are organized by topic and include Topic: "Coastal, Estuarine, Ocean," "Restoration," "Rivers, Lakes, Creeks," and others.

- **San Francisco Bay Area Wetland Project Tracker** (http://www.wrmp.org/projectsintro.html): The Wetland Project Tracker provides free public access to information about the location, size, sponsors, habitats, contact persons, and status of wetland restoration, mitigation, creation, and enhancement projects in the San Francisco Bay Area.

- **Watershed Institute** (http://watershed.csumb.edu/): The Watershed Institute consists of a direct action community-based coalition of researchers, restoration ecologist, educators, planners, students, and volunteers. The Web site offers links to watershed-related publications, courses, watershed studies, the Return of the Natives Restoration Education Project, and the Bureau of Land Management's Watershed and Riparian Assessment Report.

- **USEPA Wetlands Program** (http://www.epa.gov/owow/wetlands/): This program encourages and enables others to act effectively in protecting and restoring the nation's wetlands and associated ecosystems, including shallow open waters and free-flowing streams. In doing so, the program engages in two principal categories of activities—establishing national standards and assisting others to meet them.

- **U.S. Army Corps of Engineers (USACE) Regulatory Program** (http://www.usace.army.mil/inet/functions/cw/cecwo/reg/): This Web site acts as a starting point for information about USACE's wetlands regulatory program and offers policy and guidance related to wetland management. The site provides links to laws and regulations governing activities that can impact wetlands, policy documents, jurisdictional information, and technical guidance for delineation, management, and mitigation.

- **U.S. Geological Survey National Wetlands Research Center (NWRC)** (http://www.nwrc.usgs.gov/): The Center develops and disseminates scientific information needed for understanding the ecology and values of wetlands and for managing and restoring wetland habitats and associated plant and animal communities.

- **U.S. Department of Agriculture Natural Resources Conservation Service, Wetlands Science Institute** (http://www.pwrc.usgs.gov/WLI/): The Institute develops, adapts, and disseminates science and technology needed to protect and restore wetlands. The "Oxford Site Home Page" link provides information on and photos of constructed wetlands, along with hydrology tools, restoration information, and links to papers, fact sheets, and posters.

2.6.1.3 References

California Resources Agency. 1998. *California Wetlands Information System: California's Valuable Wetlands*. (http://ceres.ca.gov/wetlands/introduction/values.html) Last updated August 13, 1998. Accessed July 15, 2003.

SWRCB and CCC. 2000. *Volume II: California's Management Measures for Polluted Runoff (CAMMPR)*. State Water Resources Control Board and the California Coastal Commission, Sacramento, CA.

USEPA. 2001. Chapter 4: Management Measure for Protection of Wetlands and Riparian Areas. In *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (Draft)*. EPA 841-B-01-001. U.S. Environmental Protection Agency, Washington, DC.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.6.2 Management Measure 6A Protection of Wetlands and Riparian Areas

Management Measure

Protect from adverse effects wetlands and riparian areas that serve to reduce NPS pollution; maintain this function while protecting the other existing functions of these wetlands and riparian areas as measured by characteristics such as vegetative species composition, diversity, and cover; hydrology and quality of surface water and ground water; geochemistry of the substrate; and fauna species composition, diversity, and abundance.

2.6.2.1 Programs

The California Resources Agency is responsible for the implementation of the State Wetlands Conservation Policy. The policy has three main goals: (1) no net loss of wetlands and a net gain of wetlands, (2) reduction in the complexity of wetland conservation laws and regulations, and (3) implementation of landowner incentive programs and cooperative planning programs. The program is divided into three geographic areas: Central Valley, San Francisco Bay, and Southern California. For more information contact Chris Potter, Coastal Grants and Wetlands Coordinator (Telephone: 916-653-5656).

Central Valley Habitat Joint Venture (CVHJV) was established in 1988 to "protect, maintain, and restore habitat to increase waterfowl populations to desired levels in the Central Valley of California consistent with other objectives of the North American Waterfowl Management Plan." An Implementation Board of representatives from the California Waterfowl Association, Defenders of Wildlife, Ducks Unlimited, National Audubon Society, Waterfowl Habitat Owners Alliance, and The Nature Conservancy guides the CVHJV. The U.S. Fish and Wildlife Service, California Department of Fish and Game, California Department of Food and Agriculture, and other organizations and agencies provide technical assistance and advice to the Board (http://www.usbr.gov/mp/cvhjv, http://ceres.ca.gov/wetlands/introduction/policies_and_programs.html).

San Francisco Bay Conservation and Development Commission is charged with the protection and enhancement of San Francisco Bay. Protecting the Suisun Marsh and other wetlands around the bay is one of the responsibilities of the Commission (http://www.bcdc.ca.gov/index.html).

Inland Wetlands Conservation Program carries out some of the Central Valley Habitat Joint Venture objectives by administering a $2-million-per-year program to acquire, improve, buy, sell, or lease wetland habitat (http://www.dfg.ca.gov/wcb/inland_wetlands_conservation_program.htm).

CALFED Bay-Delta Program develops and implements a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta System (http://www.calwater.ca.gov/).

Riparian Habitat Joint Venture (RHJV) has as its goal to conserve, increase, and improve riparian habitat in order to protect and enhance California's native resident birds and neotropical migratory birds. California Partners in Flight initiated the RHJV project in 1994. To date, 18 federal, state, and private organizations have signed the landmark Cooperative Agreement to protect and enhance habitats for native land birds throughout California (http://www.prbo.org/calpif/htmldocs/rhjv/).

2.6.2.2 Management Practices

The purpose of this management measure is to protect the water quality improvement and NPS pollution reduction benefits derived from wetlands and riparian areas. Wetlands are characterized by a combination of standing water at the surface or root zone, unique soil conditions, and vegetation adapted to wet conditions (Mitsch and Gosselink, 1993). This management measure should combine structural and programmatic measures to protect wetland and riparian areas so that they maintain their existing functions. Recommended measures and practices include the following:

- Consider wetlands and riparian areas and their NPS control potential on a watershed or landscape and maintain their function as part of a continuum of filters along rivers, streams, and coastal waters.
- Identify existing functions of those wetlands and riparian areas with significant NPS control potential when implementing NPS management practices. Do not alter wetlands or riparian areas to improve their water quality function at the expense of their other functions.
- Do not place surface water runoff ponds or sediment retention basins in healthy wetland systems.
- Conduct permitting, licensing, certification, and nonregulatory NPS pollution abatement activities in a manner that protects wetland functions.
- Obtain easements or full acquisition rights for wetlands and riparian areas along streams, bays, and estuaries.
- Use zoning and protective ordinances to control activities that have an adverse impact on these targeted areas through special area zoning and transferable development rights.
- Ensure that State water quality standards apply to wetlands.
- Establish, maintain, and strengthen regulatory and enforcement programs.
- Encourage the use of programs that restore wetlands and riparian areas.
- Educate landowners and agencies on the role of wetlands and riparian areas in protecting water quality and on management practices for restoring stream edges.
- Provide a mechanism for private landowners and agencies in mixed ownership watersheds to develop, by consensus, goals, management plans, and appropriate practices and to obtain assistance from federal and State agencies.
- Use appropriate pretreatment practices such as vegetated treatment systems or detention or retention basins to prevent adverse impacts on wetland functions that affect the abatement of NPS pollution from hydrologic changes, sedimentation, or contaminants.
- Reduce erosion and, to the extent practicable, retain sediment onsite during and after construction.

2.6.2.3 Information Resources

Options for Wetland Conservation: A Guide for California Land Owners (http://www.ceres.ca.gov/wetlands/introduction/opt_guide.html): This guide describes a wide variety of approaches that have been devised to assist landowners in protecting wetlands according to their different needs, within the context of broader conservation goals. The array of options includes technical information and advice, and financial contributions for projects or practices that provide long-term improvements for wetland values. To obtain a copy, contact the California State Coastal Conservancy, 1330 Broadway Street, Suite 1100, Oakland, CA 94612 (Telephone: 510-286-1015; Fax: 510-286-0470).

The Oregon Wetlands Conservation Guide: Voluntary Wetlands Stewardship Options for Oregon's Private Landowners: To obtain a copy of this guide, contact the Oregon Department of Agriculture, Natural Resources Division (Telephone: 503-292-9451).

California Wetlands Information System (http://ceres.ca.gov/wetlands/): This Wetlands Information System is designed to provide comprehensive wetlands information to the general public, the educational community, and government agencies. It is a compilation of public and private sector information, including maps, environmental documents, agency roles in wetland management, restoration and mitigation activities, regulatory permitting, and wetland policies. It also includes a wetland database and inventory.

Izaak Walton League, *Handbook for Wetland Conservation and Sustainability* (http://www.iwla.org/sos/handbook/): The Izaak Walton League put together this handbook to assist communities with planning and implementing a wetland project. The book features guidelines and tips for an effective project, monitoring techniques, case studies of other restoration projects, and extensive lists of contacts and resources.

Managing Wetlands to Control Nonpoint Source Pollution (http://www.epa.gov/owow/nps/facts/point11.htm): This USEPA fact sheet, Nonpoint Pointer Number 11, includes information on the use of wetlands to control NPS pollution.

California Resources Agency, Department of Fish and Game, *Report to Legislature, California Wetland Mitigation Banking* (http://www.dfg.ca.gov/hcpb/conplan/mitbank/Wetlands Bank Leg Report Final.pdf): This is a report to California State Congress on the progress of wetland mitigation banking in California.

Save San Francisco Bay Association, Save The Bay Web Site (http://www.savesfbay.org/): Save The Bay (Save San Francisco Bay Association) seeks to preserve, restore, and protect the San Francisco Bay and Sacramento/San Joaquin Delta Estuary as healthy and biologically diverse ecosystems essential to the well-being of the human and natural communities they sustain.

2.6.2.4 Case Studies

The Los Osos Creek Wetland Reserve. This 144-acre site is located on Los Osos Creek, just upstream of the Morro Bay estuary. The USDA Natural Resources Conservation Service and the Coastal San Luis Resource Conservation District (CSLRCD) have purchased permanent wetland reserve easements on the property. The State Coastal Conservancy provided funding for the CSLRCD easement. The easements were acquired in order to return 111 acres to floodplain and riparian habitat, which will serve as a sediment deposition area, trapping sediment before it enters Morro Bay. Thirty-three acres are permanently protected in an agricultural easement. Because this is still private property, there is no public access to the site (http://www.coastalrcd.org/).

California's Big River Becomes a State Park. A 50-mile stretch of California's Big River, along with 1,500 acres of the State's remaining coastal wetlands became a State park in August 2002. For years, the swath of redwoods belonged to timber companies. Now, the wildlife habitat will be protected, as will an 8.3-mile estuary—the longest undeveloped estuary in Northern California. The deal encompasses 12 miles of prime coho and steelhead salmon spawning grounds. More than 130 species of birds live there. The Big River, which gets its name from the towering trees along its banks, is also home to river otters, beavers, and harbor seals (http://www.amrivers.org/rivercurrents/080902.htm).

2.6.2.5 References

USEPA. 2001. Chapter 4: Management Measure for Protection of Wetlands and Riparian Areas. In *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (Draft)*. EPA 841-B-01-001. U.S. Environmental Protection Agency, Washington, DC.

California Resources Agency. 1998. *California Wetlands Information System: California's Valuable Wetlands*. (http://ceres.ca.gov/wetlands/introduction/values.html) Last updated August 13, 1998. Accessed July 15, 2003.

Mitsch, W., and J. Gosselink. 1993. *Wetlands.* Second Edition. Van Nostrand Reinhold, New York, NY.

Fact Sheet Links:
- Programs
- Management Practices
- Information Resources
- Case Studies
- References

2.6.3 Management Measure 6B Restoration of Wetlands and Riparian Areas

Management Measure

Promote the restoration of the preexisting functions in damaged and destroyed wetlands and riparian systems in areas where the systems will serve to reduce NPS pollution.

2.6.3.1 Programs

Southern California Wetlands Recovery Project is a partnership of public agencies working cooperatively to acquire, restore, and enhance coastal wetlands and watersheds between Point Conception and the international border with Mexico (http://www.coastalconservancy.ca.gov/scwrp/). The Southern California Wetlands Recovery Project is also building a dynamic information system to help collect and distribute data, resources, and other information on Southern California's coastal wetlands and coastal watersheds (http://eureka.regis.berkeley.edu/wrpinfo/).

The San Francisco Bay Joint Venture (SFBJV) is a partnership that brings together public and private agencies, conservation groups, development interests, and others seeking to collaborate in restoring wetlands and wildlife habitat specifically within the San Francisco Bay watersheds and along the San Mateo Coast (http://www.sfbayjv.org/).

CALFED Bay-Delta Program ecosystem restoration actions under the CALFED Bay-Delta Program help restore and improve the health of the Bay-Delta system for all native species while reducing its water management constraints (http://www.calwater.ca.gov/Programs/EcosystemRestoration/Ecosystem.shtml).

U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS), California Wetlands Reserve Program has focused on the restoration of a variety of wetland types throughout the State, including seasonal wetlands, semi-permanent marsh, vernal pools along the perimeter of the Central Valley, riparian corridors, and tidally influenced wetlands (http://www.nrcs.usda.gov/programs/wrp/states/ca.html).

California Department of Transportation (Caltrans) abides by the no-net loss requirement for California wetlands and is responsible for creating, restoring, or enhancing wetlands or riparian areas damaged or destroyed by highway projects (http://www.dot.ca.gov/hq/env/bio/index.htm).

Ballona Wetlands Foundation was created by a court action to preserve and protect the remaining Ballona Wetlands on California's coast near Los Angeles. The foundation is responsible for implementing and managing a comprehensive restoration plan for the wetlands (http://www.ballona-wetlands.org/).

2.6.3.2 Management Practices

The purpose of this management measure is to promote the restoration of degraded or destroyed wetlands in areas where they can reduce NPS pollution. Restoration of a wetland and a riparian area means reestablishing the existing vegetation, hydrology, and structure characteristics. This management measure should be used in conjunction with other measures addressing the adjacent land use activities, like agriculture, urban areas, marinas, and forestry. Recommended practices and measures for promoting the restoration of riparian areas and wetlands include the following:

- Provide a hydrologic regime similar to that of the type of wetland or riparian area being restored.
- Identify important information such as site history, topography, tides, existing water control structures, hydrology, sediment budgets, soil, plants, salinity, timing of the restoration project, and potential impacts from adjacent human activities, before beginning a restoration project.
- Restore native plant species through either natural succession or selected planting.
- Plant a diversity of species or manage the natural succession of diverse plant species rather than planting monocultures.
- Plan restoration as part of naturally occurring aquatic ecosystems.
- Factor in ecological principles when selecting sites and designing restoration. Consider type and quantity of pollutant, slope, and vegetated area.

2.6.3.3 Information Resources

Stream Corridor Restoration (http://www.usda.gov/stream_restoration/): This document was produced by the collective experience, skills, and technology of 15 federal agencies. It is a benchmark document that is being used by these agencies, as well as many others who are interested in restoring the functions and values of the nation's stream corridors.

Caltrans, *Standard Environmental Reference*, Chapter 5: Mitigation and Monitoring (http://www.dot.ca.gov/ser/vol3/chap5.htm): This chapter provides guidance on mitigation activities used to compensate for the loss of wetlands due to transportation activities.

Tennessee Hollow Restoration Project (http://www.shadesofgreen.bizland.com/tennhollow01.chtml): This site offers a detailed look at the proposed plan to restore Tennessee Hollow Creek, one of two streams in San Francisco that have not been completely buried and built over with tall structures. The site offers a detailed report that describes the efforts of the Urban Watershed Project to restore the watershed.

Orange County Coastkeeper (http://www.coastkeeper.org/): The mission of the Orange County Coastkeeper, a nonprofit environmental activist organization, is to protect and preserve Orange County's marine habitat and watershed through education, restoration, and enforcement.

USDA Forest Service, Sierra Nevada Research Center (http://www.psw.fs.fed.us/snrc/research_emphasis_areas/aquatic/aquatic.html): The Aquatic, Riparian and Wetland Ecology Group focuses on the response of populations and communities of aquatic and riparian-associated species to natural and anthropogenic influences, such as introduced exotic species, natural and regulated stream flow regimes, livestock grazing, natural and prescribed fire, and vegetation management.

USEPA, River Corridor and Wetland Restoration (http://www.epa.gov/owow/wetlands/restore/): This Web site features information on restoration techniques, the benefits of restoration, information resources, and links.

2.6.3.4 Case Studies

Wetland Reserve Program Success Story. In 1989, Yolo County realtor Jeff Dyer purchased 98 acres of marginal farmland east of Zamora, California. The land had previously been used to grow rice, tomatoes, and other crops, but the heavy alkaline clay soil made farming conditions less than ideal. Dyer farmed part of the land, but he had other plans for a large portion of the property. He wanted to restore a wetland. In 1999, with assistance provided under USDA's Wetland Reserve Program (WRP), Dyer successfully restored 34 acres of seasonal marsh through a 30-year WRP easement. USDA NRCS assisted Dyer with the excavation work necessary to restore the natural hydrology of the property and improve habitat for wetland-dependent wildlife. The work included construction of shallow water areas, levees, and water-control structures. Excavation spoil was used to build levees and create islands in two of the ponds. Dyer established and maintains a variety of wetland plants and perennial vegetation that reduce soil erosion and sedimentation, improve water quality, and provide habitat for wildlife. He also installed a pump to control the water level for brood pond areas and resident waterfowl (http://www.nrcs.usda.gov/programs/wrp/states/success_ca.html).

Palomares Creek Streambank Restoration Project. The Palomares Stream Restoration Project is a joint effort by the Conservation Partnership and Alameda County Flood Control and Water Conservation District to illustrate alternative (soft) stream restoration practices. The project consists of 300 linear feet of bank protection and restoration along Palomares Creek at Palomares Elementary School near Castro Valley, California. The project demonstrates four different techniques in riparian restoration. At the most downstream reach, a live (vegetated) crib wall has been constructed. At a large curve in the creek, toe rock has been installed. The toe rock extends into the middle reach of the root wad revetment. Lastly, at an extreme bend in an upper reach of the creek, rock riprap with joint plantings has been installed. Native vegetation will be replanted in and around the bank protection structures (http://www.baysavers.org/projects/SanLorenzo/Palomares/palstreambank.html).

2.6.3.5 References

USEPA. 2001. Chapter 5: Management Measure for Restoring Wetland and Riparian Areas. In *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (Draft)*. EPA 841-B-01-001. U.S. Environmental Protection Agency, Washington, DC.

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2.6.4 Management Measure 6C Vegetated Treatment Systems

Management Measure

Promote the use of engineered vegetated treatment systems such as constructed wetlands or vegetated filter strips where these systems will serve to reduce NPS pollution.

2.6.4.1 Programs

The Sacramento Constructed Wetlands Demonstration Project is a 5-year project of the Sacramento Regional County Sanitation District that was conducted from January 1994 to December 1998. The emphasis of the project was on describing how treatment wetlands remove trace metals (http://www.srcsd.com/cw.html).

California Buffer Initiative is an effort to encourage farmers, ranchers, and other landowners to use conservation buffers more extensively for a variety of conservation purposes (http://www.ca.nrcs.usda.gov/programs/buffer.html).

2.6.4.2 Management Practices

The practices listed below should be used where engineered systems of wetlands or vegetated treatment systems can treat NPS pollution. Vegetated treatment systems can be placed in upland regions and protect wetlands and aquatic resources from NPS pollution. For the purposes of this management measure, vegetated treatment systems are vegetated filter strips and constructed wetlands. Recommendations for installing and using vegetated treatment systems are as follows:

- Install vegetated filter strips to remove sediment and other pollutants from runoff and wastewater.
- Construct vegetated filter strips in areas adjacent to water bodies that may be subject to suspended solids and/or nutrient runoff. Key elements to be considered in the design of such areas include the type and quantity of pollutant, slope, native/non-native species, length, detention time, monitoring performance, and maintenance.
- Use vegetated filter strips to improve urban environments by increasing wildlife habitat and adding beauty to an area.
- Construct properly engineered systems of wetlands for NPS pollution control. Several factors to consider in the design and construction of an artificial wetland include hydrology, soils, vegetation, influent water quality, geometry, pretreatment, and maintenance.
- Manage constructed wetland systems to avoid negative impacts on surrounding ecosystems or ground water.

2.6.4.3 Information Resources

Sustainable Conservation, Wastewater to Wetlands: Opportunities for California Agriculture (http://www.suscon.org/wetlands/pdfs/feasibility.pdf): This guidebook describes the use of wetlands to control pollutants in wastewater from agriculture.

Broome, S.W., *Constructed Wetlands for the Treatment of Storm Water Runoff* (http://www.soil.ncsu.edu/lockers/Broome_S/vmmiller/stormwater.html): This article provides information on using wetlands to treat storm water runoff.

USEPA, *Guiding Principles for Constructed Treatment Wetlands: Providing for Water Quality and Wildlife Habitat* (http://www.epa.gov/owow/wetlands/constructed/guide.html): This guidebook presents guiding principles for siting, design, construction, operation, maintenance, and monitoring of constructed treatment wetlands.

USEPA, *Handbook of Constructed Wetlands* (http://www.epa.gov/owow/wetlands/pdf/hand.pdf): This is a guide to creating wetlands for agricultural wastewater, domestic wastewater, coal mine drainage, and storm water in the Mid-Atlantic Region.

USDA, *Constructed Wetlands Bibliography* (http://www.nal.usda.gov/wqic/Constructed_Wetlands_all/index.html): This constructed wetlands bibliography, compiled by the Natural Resources Conservation Service and the Water Quality Information Center at the National Agricultural Library, consists of more than 600 citations.

USDA NRCS, Conservation Buffers Initiative (http://www.nrcs.usda.gov/feature/buffers/): This Web site provides information on buffers, their use, and technology specifications. It describes success stories and provides links for more information.

2.6.4.4 Case Study

The Orange County Water District Constructed Wetlands Project. The Orange County Water District owns 2,150 acres behind Prado Dam in Riverside County, California. Within this area lie nearly 465 acres of constructed wetlands, which have effectively demonstrated the ability to reduce nitrogen levels in Santa Ana River. The Santa Ana River is the main source of recharge for the vast Orange County ground water basin, and consists primarily of tertiary treated wastewater from upstream dischargers. The river also receives storm flows, natural runoff, and rising ground water, especially during winter months.

The wetland consists of a system of 50 shallow ponds that have been used to remove nitrogen in river water since July 1992. The wetland system removes approximately 20 tons of nitrate a month, and during summer months reduces nitrate concentrations from 10 milligrams per liter to less than 1 milligram per liter. Several modifications have been made to increase the hydraulic capacity of the Prado wetland pond system, in order to handle a potential increase in future baseflows from the Santa Ana River, and to improve the operational flexibility of the system.

Prado Dam is a key component for increasing local water supplies in Orange County. Historically, storm flows from the Santa Ana River have been lost to the ocean because flood control took precedence over water conservation. However, a series of agreements between Orange County Water District, the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service have allowed the District to conserve water behind the dam in a seasonal storage pool. (http://www.ocwd.com/_html/prado.htm)

2.6.4.5 Reference

USEPA. 2001. Chapter 6: Management Measure for Vegetated Treatment Systems. In *National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution (Draft)*. EPA 841-B-01-001. U.S. Environmental Protection Agency, Washington, DC.

Fact Sheet Links:
- Programs
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- Information Resources
- Case Studies
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2.6.5 Management Measure 6D Education/Outreach

Management Measure

Implement educational programs to provide greater understanding of watersheds, to raise awareness and increase the use of applicable management measures and practices for wetlands and riparian areas, and to promote projects that retain or reestablish natural hydrologic functions. Public education, outreach, and training programs should involve user groups and the community.

2.6.5.1 Programs

Lake Tahoe Environmental Education Coalition (LTEEC) provides assistance to many different groups and educational organizations with educating the public about how to prevent pollution of Lake Tahoe. The University of Nevada Cooperative Extension and the University of California Cooperative Extension sponsor LTEEC (http://www.lteec.org/working_groups.php?groupID=2).

Orange County Watershed and Coastal Resources Division is progressively developing materials to better inform the public about the services that are provided. It also offers and encourages ways for the public to get involved (http://www.ocwatersheds.com/PublicEducation/pe_introduction.asp).

Adopt-A-Watershed is a K-12 school-community learning experience. Adopt-A-Watershed uses a local watershed as a living laboratory in which students engage in hands-on activities, making science applicable and relevant to their lives. It develops collaborative partnerships and reinforces learning through community service (http://www.adopt-a-watershed.org/index.html).

2.6.5.2 Management Practices

The purpose of this management measure is to promote the establishment of programs to develop and disseminate scientific information on wetlands and riparian areas. Recommended practices include the following:

- Develop fact sheets, brochures, and flyers on the importance of wetlands and riparian areas.
- Develop greater public and agency staff understanding of natural hydrologic systems—including their functions and values, how they are lost, and the choices associated with their protection and restoration.
- Work with private landowners to encourage the preservation of wetland and riparian areas.
- Develop education programs for grade school children.
- Promote restoration of degraded wetland and riparian areas by volunteer and community groups.

2.6.5.3 Information Resources

Association of Wetland Managers, *Wetlands Outreach: Getting the Message Out—New Techniques and New Partners for the Millennium* (http://www.aswm.org/propub/pubs/pdf/outreach.pdf): The report is a synthesis of two days of discussion on wetland outreach among 45 wetland outreach professionals from around the country. Participants included representatives from state, federal, and local governments as well as not-for-profit organizations.

The California Coastal Commission's New Science Activity Guide: Waves, Wetlands, and Watersheds (http://www.coastal.ca.gov/publiced/pendx.html): This is a classroom and community activity guide that addresses issues such as endangered species, marine debris, coastal geology, water use, and much more. It is carefully aligned to the California State Science Content Standards for grades 3 through 8, and includes "Community Action" lessons adaptable to all ages up to and beyond grade 12. The guide is available for free from the California Coastal Commission.

Watershed Institute (http://watershed.csumb.edu/index.html): The Watershed Institute consists of a direct action community-based coalition of researchers, restoration ecologists, educators, planners, students, and volunteers. These participants all work to promote and employ a systems approach to the management of watersheds around the world.

The Return of the Natives Restoration Education Project (http://watershed.csumb.edu/ron/): The Return of the Natives (RON) Restoration Education Project is a project of Creative Environmental Conservation, a 501(c)3 nonprofit. It is the education and outreach branch of the Watershed Institute of the California State University Monterey Bay. RON is a community- and school-based environmental education project dedicated to involving students (kindergarten through university) in native plant and habitat restoration projects in the schoolyard and the community

2.6.5.4 Case Study

Upper Newport Bay Project, Community-Based Restoration and Wetland Education Program. The California Coastal Commission's Upper Newport Bay (UNB) Community-Based Restoration Education Program is working to enlist community support for habitat restoration by engaging the public in hands-on restoration work and teaching them why this work is important. The program grew out of the Coastal Commission's successful public involvement efforts. The Commission's programs use a tried and true formula: collaborate with local organizations working in ecology, education, and conservation, and provide the leadership, planning, and funding to help connect volunteers and neighborhood groups with the affected ecosystem. The UNB program will serve as a model for developing coastal restoration education programs throughout California (http://www.coastal.ca.gov/publiced/restore.html).

Yolo Basin Foundation, Discover the Flyway Program. The Discover the Flyway (DTF) program for schools serves more than 2,500 students annually. The purpose of this program is to introduce Central Valley area teachers to wetland ecosystems and encourage class visits to the Vic Fazio Yolo Wildlife Area so they may participate in educational and interactive field studies. The DTF program includes teacher workshops, the Wild About Wetlands classroom resource kit, a lending library, classroom field trips, native grass/sedge restoration, Nature Bowl, Marsh Madness, and the Yolo Demonstration Wetlands (http://www.yolobasin.org/education.html).

3. FUNDING RESOURCES

The following are Web sites that can be helpful in tracking down information about funds available to implement NPS pollution projects and programs:

- **SWRCB, Financial Assistance** (http://www.swrcb.ca.gov/funding/): This Web site provides links to numerous funding resources for projects and programs related to water quality protection and improvement. Topics include Propositions 13, 40, and 50; Clean Water Act Section 319 funding; the Clean Water State Revolving Fund; and local and subject-specific programs.

- **USEPA, Funding for Nonpoint Source Pollution** (http://www.epa.gov/owow/nps/funding.html): This site contains numerous links to resources that are specifically geared toward addressing NPS pollution problems. Both USEPA and non-USEPA sites are included.

- **USEPA, Catalog of Federal Funding Sources for Watershed Protection** (http://cfpub.epa.gov/fedfund/): This Web site provides a comprehensive summary of federal grant and loan programs that be used at the local level to support watershed projects. Also contains references to other publications as well as web sites on funding assistance.

- **USEPA, A State and Local Government Guide to Environmental Program Funding Alternatives** (http://www.epa.gov/owow/nps/MMGI/funding.html): This document provides an overview of traditional (nongovernmental) funding mechanisms and innovative approaches for funding environmental programs.

- **USEPA, Clean Water Financing** (http://www.epa.gov/OWM/cwfinance/index.htm): This Web site provides links with more information about the Clean Water State Revolving Fund, the Construction Grants Program, Water Pollution Control Program Grants, Water Quality Cooperative Agreements, Clean Water Indian Program Grants, and assistance with privatization of wastewater facilities.

- **USEPA, Environmental Finance Program** (http://www.epa.gov/efinpage/): The goal of this program is to assist communities in their search for creative approaches to funding their environmental projects. The program provides financial technical assistance to the regulated community and solicits advice and recommendations to the Agency on environmental finance issues, trends, and options. The Environmental Financial Tools Web page (http://www.epa.gov/efinpage/efptools.htm) provides continuously updated links to sources of financing from the Environmental Finance Program, USEPA programs and offices, and organizations outside the agency.

- **USDA Water Quality Information Center, Funding Sources for Water Quality** (http://www.nal.usda.gov/wqic/funding.html): For information on water quality funding sources beyond EPA's programs including funding from USDA, the U.S. Department of Interior, NOAA, the Federal Highway Administration, and USGS.

- **U.S. General Services Administration, The Catalog of Federal Domestic Assistance** (http://12.46.245.173/cfda/cfda.html): Click "Search for Assistance Programs" and browse "By Functional Area" to select "Environmental Quality," which yields the following choices relevant to NPS pollution: water pollution control; solid waste management; pesticides control; and research, education, and training.

- **USEPA, Drinking Water State Revolving Fund** (http://www.epa.gov/safewater/dwsrf.html): This Web site provides guidance, fact sheets and reports, program data, and information about programs related to the Drinking Water State Revolving Fund. Funds from this program are to be used to finance drinking water infrastructure improvements. Emphasis is placed on funds to small and disadvantaged communities and to programs that encourage pollution prevention.

4. LIST OF ACRONYMS

A

ACCWP	Alameda Countywide Clean Water Program
AMBAG	Association of Monterey Bay Area Governments

B

BAER	Burned Area Emergency Rehabilitation
BEAR	Beach Erosion and Response
BIFS	Biologically Integrated Farming Systems
BLM	Bureau of Land Management
BMP	Best Management Practice

C

CALFED	California Bay-Delta Authority
CalOCEAN	California Ocean and Coastal Environmental Access Network
CalPIF	California Partners in Flight
CAMMPR	California's Management Measures for Polluted Runoff
CCA	Certified Crop Advisors
CCC	California Coastal Commission
CCVT	Central Coast Vineyard Team
CDF	California Department of Forestry and Fire Protection
CDP	Coastal Development Permits
CDQA	California Dairy Quality Assurance
CEQA	California Environmental Quality Act
CERES	California Environmental Resources Evaluation System
CERPI	California Ecological Restoration Projects Inventory
CFIP	California Forest Improvement Program
CFR	Code of Federal Regulations
CIMIS	California Irrigation Management Information System
CIWMB	California Integrated Waste Management Board
CMS	Conservation Management System
CNMP	Comprehensive Nutrient Management Plan
COWA	California Onsite Wastewater Association
CSLRCD	Coastal San Luis Resource Conservation District
CURES	Coalition for Urban/Rural Environmental Stewardship
CVHJV	Central Valley Habitat Joint Venture
CWA	Clean Water Act
CWE	Cumulative Watershed Effects
CWT	Clean Water Team
CWTRC	California Wastewater Training and Research Center

CZARA	Coastal Zone Act Reauthorization Amendments
CZMA	Coastal Zone Management Act

D

DBW	Department of Boating and Waterways
DEP	Department of Environmental Protection
DFG	Department of Fish and Game
DPR	Department of Pesticide Regulation
DTF	Discover the Flyway
DTSC	Department of Toxic Substance Control

E

EAO	Environmental Assistance Office
EISIP	Expanded Irrigation System Improvement Program
ELZ	Equipment Limitation Zone
ESC	Erosion and Sediment Control
ESHA	Environmentally Sensitive habitat Area
ETI	Environmental Technology Initiative
ETV	Environmental Technology Verification

F

FHP	Forest Health Protection
FIP	Forestry Incentives Program
FOTG	Field Office Technical Guides
FRAP	Fire and Resource Assessment Program
FSCBG	Forest Service Cramer-Barry-Grim

G

GIS	Geographic Information System
GLCI	Grazing Land Conservation Initiative

I

IPM	Integrated Pest Management
ITE	Institute of Transportation Engineers

L

LCP	Institute of Transportation Engineers
LTEEC	Lake Tahoe Environmental Education Coalition
LWWL	Lake Tahoe Environmental Education Coalition

M

MARPOL	Protocol from the International Convention for the Prevention of Pollution from Ships
MPA	McAteer-Petris Act
MS4	Municipal Separate Storm Sewer System
MSD	Marine Sanitation Device
MURP	Model Urban Runoff Program

N

NDIP	North Delta Improvements Project
NEMO	Nonpoint Education for Municipal Officials
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NIPC	Northeastern Illinois Planning Commission
NIPMN	National Integrated Pest Management Network
NIWQP	National Irrigation Water Quality Program
NMP	Nutrient Management Plan
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRPI	Natural Resource Project Inventory
NWRC	National Wetlands Research Center

P

P2	Pollution Prevention
PAM	Polyacrylamide
PCA	Pest Control Advisors
PPIC	Pollution Prevention Information Clearinghouse
PPS	Positive Points System
PRC	Public Resources Code

Q

QA	Quality Assurance
QC	Quality Control

R

RCD	Resource Conservation Districts
RHJV	Riparian Habitat Joint Venture
RMS	Resource Management Systems
RON	Return of the Natives
RPF	Registered Professional Forester
RWQCB	Regional Water Quality Control Board

S

SbMA	Subdivision Map Act
SDIP	South Delta Improvements Program
SFBJV	San Francisco Bay Joint Venture
SMA	Streamside Management Areas
SMZ	Streamside Management Zones
SRF	State Revolving Fund
STOPPP	San Mateo Countywide Stormwater Pollution Prevention Program
STPP	Surface Transportation Policy Project
SUSMP	Standard Urban Storm Water Mitigation Plan
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board

T

THP	Timber Harvest Plan
TMDL	Total Maximum Daily Load
TRM	Turf Reinforcement Mat
TSS	Total Suspended Solids

U

UCC	Urban Creeks Council
UNB	Upper Newport Bay
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency

V

VMP	Vegetation Management Program

W

WDR	Waste Discharge Requirements
WITS	Watershed Information Technical System
WLPZ	Watercourse and Lake Protection Zones
WRP	Wetland Reserve Program
WSDOT	Washington State Department of Transportation

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