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Technical Note

By Leslie Karr and Jeffery C. Heath, P.E.

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Initiation Decision Report: Nonpoint Source Discharge

ABSTRACT Under recent amendments to the Clean Water Act, the Navy must be responsible to State's authority in the control of nonpoint sources (NPS) of water pollution. Nonpoint sources are pollutants that do not originate from a single, well-defined source and are initially transported by the natural hydrological system. The sources are diffuse in nature, ranging from storm water run-off with no single identifiable endpoint, to leachate from abandoned waste sites. The most common Navy nonpoint sources of pollution include storm water run-off from agricultural and rangeland leases, construction areas, industrial areas, residential and commercial areas, impact zones, and training areas.

When a Navy Base takes a shower, what do you do with the dirty water?

NAVAL CIVIL ENGINEERING LABORATORY PORT HUENEME CALIFORNIA 93043

METRIC CONVERSION FACTORS

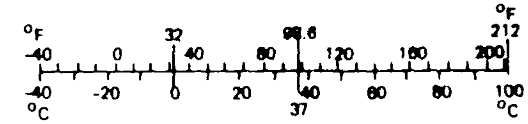
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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Under recent amendments to the Clean Water Act, the Navy must be responsible to State's authority in the control on nonpoint sources (NPS) of water pollution. Nonpoint sources are pollutants that do not originate from a single, well-defined source and are initially transported by the natural hydrological system. The sources are diffuse in nature, ranging from storm water run-off with no single identifiable endpoint, to leachate from abandoned waste sites. The most common Navy nonpoint sources of pollution include storm water run-off from agricultural and rangeland leases, construction areas, industrial areas, residential and commercial areas, impact zones, and training areas.

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EXECUTIVE SUMMARY

Under recent amendments to the Clean Water Act, the Navy must be responsive to State's authority in the control of nonpoint sources (NPS) of water pollution. In anticipation of these new guidelines, this Initiation Decision Report (IDR) outlines the current status of Naval nonpoint sources and control technologies.

Due to funding constraints, this IDR is less encompassing than the IDRs for the Installation Restoration and the Hazardous Waste Minimization programs. It does not assess or prioritize the Navy nonpoint sources of pollution as found in more extensive IDR efforts. It does, however, explain the problem of nonpoint source pollution, specifies regulatory requirements, identifies potential Navy nonpoint sources, describes current Navy mitigation methods, examines current and emerging mitigation technologies, and provides recommendations for research.

Nonpoint sources are pollutants that do not originate from a single, well-defined source and are initially transported by the natural hydrological system. The sources are diffuse in nature, ranging from storm water run-off with no single identifiable endpoint, to leachate from abandoned waste sites. Nonpoint source discharges may be collected and discharged at a single point, such as a storm sewer outfall, and be classified as a point source. States may elect to regulate these discharges under the existing NPDES permit program. As the characteristics of these point discharges are identical to nonpoint discharges, they are included in the discussion of nonpoint source discharges.

The most common Navy nonpoint sources of pollution include storm water run-off from:

- Agricultural and rangeland leases containing sediment, nutrients, pesticides, and bacteria

- Construction areas containing sediment

- Industrial areas containing oil and grease, and other hazardous materials

- Residential and commercial areas containing oil and grease, sediments, nutrients, pesticides, and hazardous materials

- Impact zones and training areas containing sediment, nutrients, and hazardous materials

Contaminated groundwater and surface run-off from past disposal areas may also be a significant nonpoint source of pollution. As discharges from these areas are being addressed under the Installation Restoration Program, it is not intended that they be further investigated under the nonpoint source pollution program. Also, antifouling paints used in the hulls of ships may also be considered a nonpoint source of pollution. As there are currently many Navy sponsored research programs dealing with this source, it will not be further investigated under this program.

The Navy is participating with other Federal and State agencies to abate nonpoint source pollution in the Chesapeake Bay. Concern for the impact of nonpoint source pollution is being shown in the San Francisco Bay and Puget Sound regions. It is expected that the Navy will participate in nonpoint source pollution programs in these and other areas.

Chapter 6 lists eight tasks to identify, characterize, predict, control and eliminate nonpoint sources of pollution which are summarized below:

1. Identification of Nonpoint Sources of Pollution. As stated earlier, this IDR did not assess or prioritize Navy NPS pollution. This task will complete that assessment.

2. Evaluation of Control Technologies. This task will identify candidate sites and install control measures to determine their effectiveness.

3. Evaluation of Soil Bioengineering. This task evaluates state-of-the-art measures to control erosion from surface run-off and bank-shoreline erosion using engineered vegetative systems.

4. Nonpoint Source Monitoring Program Guidelines. This task developes cost-effficient monitoring programs to identify NPS pollution and comply with State requirements.

5. Develop Monitoring Techniques. This task will provide simple and useful tools that can be used to assess the contribution of a Navy NPS discharge on the receiving water quality.

6. Develop Predictive Model. In conjunction with Task 1, computer models will be identified to reduce sampling requirements and simplify the identifying and prioritizing of Navy NPS.

7. Demonstrate Proven Technology on Different Types of Nonpoint Sources. This task will assess the effectiveness of existing technologies to treat Navy NPS.

8. Evaluation of Emerging Technologies. As new methods are identified, this task will develop, test, and evaluate these methods for the applicability for Navy NPS control.

Further information concerning this program may be obtained by contacting Leslie Karr (autovon 551-1618, comm. 982-1618), or Jeff Heath (autovon 551-1657, comm. 982-1657) at NCEL.

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CHAPTER 1

INTRODUCTION

1.1 INITIATION DECISION REPORT APPROACH

The Naval Civil Engineering Laboratory (NCEL) has been tasked to prepare an Initiation Decision Report (IDR) which will evaluate the status of proposed regulations on water nonpoint source discharges, and determine the impact of these regulations on Naval operations. An IDR is prepared at the inception of a project according to guidance in NAVFACINST 3900.7. The IDR is to define the problem, identify pertinent current technology, evaluate alternate courses of action, and specify end products and testing requirements.

Traditionally, under the National Pollutant Discharge Elimination System (NPDES), Naval activities have been monitored for point source pollutants, or those which arise from identifiable sources. Under 1987 amendments to the Clean Water Act, States are being instructed to develop detailed plans for controlling nonpoint sources of water pollution within the next year.

This IDR will detail the proposed regulations, look at their impact on Navy operations, and provide a technology assessment of sampling and monitoring technology, assessment technology, and control and mitigation methods.

1.2 RATIONALE

In recent years, it has become apparent that the water quality in many waterways and bays is in steady decline or not improving as point source discharges of pollutants are eliminated. This is most evident in areas where the waterway is used for commercial and sport fishing. For example, in the Chesapeake Bay harvests of most of the traditional commercial species have declined over the years and recent restrictions have been placed on the taking of some freshwater spawning finfish. Also steady declines in oyster harvests have been noted in the bay for the last 100 years (Ref. 1.1).

The cause of the decline in water quality and ecosystem health is due to both point source discharges regulated under NPDES permits and nonpoint source discharges. Recent data indicates that the magnitude of the impact nonpoint source discharges is great enough that the control of point source discharges through NPDES permits alone may not be sufficient to halt the decline or improve many waterways and bays.

A nonpoint source discharge is defined as a discharge that does not originate from a single point, such as a pipe, but from a larger area. Examples of nonpoint source discharges are the overland flow of rainwater into a waterway and the discharge of a groundwater plume into a waterway.

Nonpoint source discharges may collect at a single point such as a storm drain inlet and then be discharged into a waterway or bay at a single point, such as a storm sewer outfall. Because these nonpoint source discharges are collected and discharged at a single point, States may elect to regulate these nonpoint source discharges under existing point discharge programs such as the NPDES permit programs. For the purpose of this IDR, these point discharges will be included in the discussion of nonpoint source discharges.

Typically, nonpoint source discharges carry a large quantity of pollutants. Rainwater run-off from agricultural lands and timber harvesting areas can be high in turbidity, suspended solids, and nutrients such as nitrogen and phosphorus. The terms "storm water discharge " and "storm water management" are most often used to describe rainwater run-off from urban, industrial, and residential areas and its management. Storm water discharges can contain significant levels of oil and grease and high levels of toxic metals, PCB's, and pathogenic bacteria. Also, as rainwater runs off faster from pavement than native soil, nonpoint source discharges can greatly increase the flow in waterways causing an increase in bank erosion and an increase of turbidity and suspended solids. Most Navy activities have potentially significant storm water discharges. Nonpoint discharges from strip mining, industrial areas, and disposal areas can contain toxic chemicals which are harmful to certain ecosystems.

1 2.1 <u>EPA Philosophy</u>

The Clean Water Act was originally passed to control the discharge of pollutants into the navigatable waterways of the United States. Discharges of pollutants are regulated through the issuance of National Pollutant Discharge Elimination System Permits. These permits are issued for point discharges of pollutants.

In 1987 the Clean Water Act was amended to require the EPA to issue guidelines for the control of nonpoint source discharges. These guidelines are not binding like regulations. In addition, the Clean Water Act amendments require the EPA to adopt regulations concerning the sampling of storm drain discharges, and where applicable, the issuance of NPDES permits.

The EPA is primarily concerned with discharges containing sediment and nutrients such as nitrogen and phosphorus. It is estimated that over three billion tons of top soil are lost each year due to erosion. These pollutants are responsible for eutrophication and ecological decline of many bays and lakes. Also, there are concerns in certain areas over run-off containing oil and grease from paved areas and run-off containing toxic metals from mining operations.

The EPA realizes that nonpoint source discharges create problems only in certain areas. For example, it may be necessary for a State to require certain measures be taken at construction sites to prevent heavy sediment run-off during rain storms from causing turbidity problems in a certain bay or lake. The State could limit the total number of acres that are cleared of vegetation at one time or require that all run-off be collected and treated in a sedimentation and flow equalization pond or tank system. This same requirement may not be appropriate in an arid region where run-off control would be necessary only during the rainy season. Further, in other areas where dams on rivers have impeded the natural sediment flow to the ocean and beaches, it may be desirable to have no controls on nonpoint discharges.

1.2.2 Current DOD Activity

Other activity has been seen in the area of nonpoint source discharges. In September 1984 the DOD entered into a Joint Resolution with the Environmental Protection Agency, other Federal agencies, and several States to abate pollution in the Chesapeake Bay.

As part of the Joint Resolution the DOD has undertaken a study to determine which installations in the Chesapeake Bay area have a significant potential impact on the water quality of the Bay and its tributaries (Ref. 1.1). The study identified three areas of ongoing concerns that are difficult to control or regulate. They include:

1. Storm water run-off.

2. Intermittent discharges of industrial(toxic) pollutants to sewage treatment plants and storm sewers.

3. Leachate from abandoned hazardous waste disposal sites.

Other problems identified in this study include:

1. There is a lack of data to adequately quantify nonpoint source discharge characteristics, levels of impacts and required controls on such discharges.

2. There is insufficient data available to determine whether toxic discharges from installations pose a threat to water quality.

3. While a number of installations in the Chesapeake Bay area have begun actions to address these problems, their effectiveness in controlling nonpoint source discharges is uncertain.

The study recommends that DOD should consider offering certain installation environmental projects as demonstration or pilot projects for the EPA and State programs. Such programs could involve testing of storm water run-off control devices and plans, shoreline erosion control devices, agricultural practices on outlease areas, and effluent toxics monitoring programs.

Further discussion and evaluation of these concerns with nonpoint source discharges will be presented in this IDR with recommendations for future Navy activity in this area.

REFERENCES

1.1 Tetra Tech, Incorporated. Water quality assessment of DOD installations/facilities in the Chesapeake Bay Region - Draft, Phase III Report, vol 1, Summe , Arlington, VA, Jul 1987.

CHAPTER 2

PROBLEM DEFINITION

2.1 NONPOINT SOURCE DISCHARGE REGULATIONS (WATER)

2.1.1 Background

The concern with water nonpoint source (NPS) pollution is not new. State and Federal governments have been separately and jointly addressing nonpoint source pollution problems for quite some time. In a 1985 study by the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), it was pointed out that the States have reported 354 State and local programs that manage NPS pollution (Ref. 2.1). Of these programs, 259 have been rated to be either fully effective (27%), partially effective (71%), or ineffective (2%). However, not all of these programs have water quality management implications.

The current concern with NPS discharge is specifically targeted at the maintenance and improvement of water quality. Past efforts and resources spent for water quality improvement have been directed at point source pollution control and are achieving positive results. The GAO has reported there is strong evidence that the discharge of conventional water pollutants from point sources has been reduced. Point source pollution control effort has had an effect (Ref. 2.2). The same GAO report, however, states that pollution from nonpoint sources may degrade more stream miles than point source pollution.

In an earlier study by a special Federal, State, and local Nonpoint Source Task Force, it was reported that both a 1983 survey by the North American Lake Management Society and a 1982 National Fisheries Survey by the EPA and U.S. Fish and Wildlife Service, concluded that NPS pollution has significant effects on water quality of the studied areas (Ref. 2.3). The same Task Force reported that in the 1983 Environmental Management Reports from the EPA regional offices, NPS pollucion was the principal cause of water quality problems in 6 of the 10 EPA Regions. The significance of controlling NPS pollution in the efforts to achieve the Nation's water quality goals is beyond doubt.

In view of these facts concerning NPS discharges and the Nation's water quality goals, Congress has reauthorized the Water Quality Act (WQA, formerly known as the Clean Water Act) in 1987 to include provisions for controlling NPS pollution. The 1987 legislation places the responsibilities on the control of NPS pollution at the State level rather than at the Federal level.

2.1.2 Nonpoint Source Pollution Defined

Before any further discussions on nonpoint source pollution, it is appropriate to define what is considered nonpoint source pollution. In the draft document, EPA has provided a rather detailed and self-explanatory definition. EPA states that, for the purpose of implementation, NPS pollution is defined as follows:

> "NPS pollution is caused by diffuse sources that are not regulated as point sources and normally is associated with agricultural, silvicultural and urban run-off, run-off from construction activities, etc. Such pollution results in the human-made or human-induced alteration of the chemical, physical, biological, and radiological integrity of water. In practical terms, nonpoint source does not result from a discharge at a specific, single location (such as a single pipe) but generally results from land run-off, precipitation, atmospheric deposition, or percolation. Pollution from nonpoint sources occurs when the rate at which pollutant materials entering waterbodies or ground water exceeds natural levels." (Ref. 2.4)

Point sources regulated under the NPDES permit program are not nonpoint sources.

2.1.3 The 1987 Water Quality Act

As discussed earlier, there are already numerous State programs regulating NPS discharge. The enactment of Section 319 of the Water Quality Act in 1987, however, created specific provisions for the control of NPS pollution. With this Act, the States now have additional support and direction for comprehensive implementation of NPS controls. The Act gives the States the responsibility, as well as the flexibility, to design and implement NPS programs as a part of an overall State water clean-up strategy. As mandated by the Act, the States were required, as a procedure of NPS program implementation, to submit to EPA (the EPA Regional NPS Coordinator) a State Assessment Report (SAR), and a State Management Program (SMP), within 18 months of the enactment of this Act. EPA distributed a guidance document (Ref. 2.4) to assist the States in meeting the requirements mandated by the Act. A brief discussion of these requirements based on EPA's interpretation in the guidance document may generate some foresight on how the States are implementing the NPS programs and formulated NPS regulations.

2.1.3.1 The State Assessment Report (SAR)

As interpreted by EPA, the SAR contains four categories of information:

1. Identification, by a process open to the public and all interested parties, of all the State's navigable waters which cannot attain water quality goal without additional NPS control action or those waters having NPS problem areas (each State is required to indicate the total sizes of the waters in the State by waterbody type and the total size of the waters not assessed).

2. Identification of categories and subcategories of NPS pollution for each waterbody identified in (1) above, and the lands which are the source of the pollution.

3. Description of the process for identifying best management practices to control the NPS sources, especially those sources identified in (2).

4. Identification and description of State and local NPS programs to be used in the implementation of State NPS management programs.

The SAR had a due date of April 1, 1988. However, as of July 1989, many of the States have not complied. EPA pointed out the State shall provide a public notice on the availability of the report for public review as well as opportunity for comments prior to report submission. EPA encouraged the submittal of draft reports prior to formal submission.

2.1.3.2 <u>The State Management Programs (SMP)</u>

EPA states that SMPs provide an overview of a State's NPS programs as well as a summary of what the State intends to accomplish in the next 4 fiscal years beginning after the date of program submission. The SMP is submitted by the Governor of each State, for that State alone or in combination with adjacent States, after notice and opportunity for public comment.

EPA encourages the States to identify their NPS water quality problems based on a comparative assessment of risks and evaluation of the following questions (Ref. 2.5):

1. What are the most valuable waters for aquatic habitat and other designated uses (e.g., public water supply)?

2. In which watersheds do NPSs cause the greatest environmental and public health risks or pose the greatest potential threat?

3. In what areas do NPS controls offer the greatest benefits (e.g., controllability, cost-effectiveness) relative to the evaluation of valuable aquatic areas?

4. In which watersheds are there capable and cooperative groups and agencies willing to proceed with NPS implementation?

The SMP contains six basic items of information as follows:

1. A description of the best management practices (BMPs) that will be used to reduce pollution from the NPSs listed in the SAR, taking into account their impact on groundwater quality.

2. A description of all regulatory and nonregulatory programs to be used to implement the BMPs identified in (1) with the lead agency for implementation of each BMP identified.

3. A schedule with annual milestones for the initiation of the programs listed in (2) and the BMPs listed in (1). Implementation of the BMPs shall be at the earliest practicable date.

4. A certificate by the attorney general of the State or group of States indicating there is adequate authority to implement the SMP. If there is inadequate authority, then the attorney general must identify the additional authority needed along with a schedule to seek the authority.

5. Identification of Federal and other aid and funding available for implementation of BMPs.

6. Identification of Federal financial assistance programs and development projects which may assist in the achievement of the purposes and objectives stated in the SMP.

The SMP had to be formally submitted to the EPA by August 4, 1988. Like the SAR, the SMP was also opened for public comment and EPA gave public notice that they received the SMP within 10 days of the receipt of the SMP.

The WQA of 1987 also requires that each State submit annual reports to the EPA starting November 1, 1987 on the progress made in meeting milestones detailed in its SMP and data available on NPS pollution reduction or water quality improvements in waters listed in the SAR. On January 1, 1990, the Administrator of EPA will submit to Congress a 'Final Report' on NPS pollution control activities carried out under Section 319 of the Act.

2.1.4 State and Local Level NPS Regulations and Programs

Historically, storm water and drainage management have been implemented at the county and local governmental levels, taking the form of drainage ordinances that addressed run-off quantity. In recent years, statewide storm water management programs for both quantity and quality have been adopted by a number of States.

At the State level, nonpoint source programs have been implemented for more than half a century (Ref. 2.1). Some of these State and local NPS pollution control programs include stream aeration control, erosion and sediment control, storm water management, groundwater protection, animal waste management, lake protection, and wastewater and sludge application. Other water quality management programs include dredge and fill permitting, forest land management, hazardous waste management, irrigation diversion permitting, pesticide applicator licensing, coastal zone and floodplain management, habitat preservation and fishery management, and surface mining land reclamation. Under current RCRA regulations, treatment, storage, and disposal facilities must have structural controls to prevent hazardous wastes from entering surface and ground waters. While it is recognized that many of these programs were not implemented solely for water quality improvement purposes, all the programs are significant in the management and control of NPS pollution.

According to one study, there are over 500 specific NPS related management projects operated by the States (Ref. 2.1). With the enactment of the 1987 WQA, States are certain to implement new programs and combine all existing NPS programs into a coherent State clean water strategy.

2.2 ANALYSIS OF IMPACT

2.2.1 Potential Naval Impact by WQA

There are several items in the 1987 WQA that may have impact on Navy activities:

1. One of the major requirements of the WQA is that States in preparing their SAR and SMP should seek the cooperative involvement of regional planning agencies, local governments, and other public and private agencies and organizations (Ref. 2.4). Because of the high visibility of Navy organizations with local communities and the Navy's waterfront locations/operations, it is almost certain that States will request Navy involvement at the very beginning of their preparation of the SARs and SMPs. The Navy must be prepared to participate in those programs.

2. Before the submission of the SAR and the SMP to EPA, the SAR and the SMP will be circulated for public review and comment. Again, because of the Navy's high visibility, it is probable that the Navy activities will be identified as nonpoint sources of pollution even if the State or local regulatory agencies failed to include them.

3. The dates of required compliance with the WQA are all clearly stated. States are required to implement NPS programs according to submitted schedules, involved organizations will in turn have to follow those schedules. There is definitely a sense of urgency in terms of implementation of NPS control efforts to support the State's NPS programs.

4. The process of identifying and prioritizing waters for further action under the NPS program will bring renewed public interest in the historical causes of water quality problems such as fish kills and algal blooms in lakes. The Navy should be prepared to defend itself from accusations of being the cause of water quality problems.

2.2.2 Synopsis of State Views in 1987

Groundwater is the main source of drinking water for a significant number of people in this country. Because surface waters and groundwaters can intermingle, the States are bound to implement more NPS management programs to supplement existing programs to protect groundwater quality. NPS management programs for surface water protection such as those designed to prevent run-off to surface waters, can result in percolation of contaminants to the groundwater, requiring cautious implementation of State NPS programs. This point has special meaning for the Navy because many Navy installations rely on groundwater for their water supply.

To acquire current information on State NPS regulations and programs, a series of telephone interviews were conducted in October 1987 with a small sample of States. States selected include California, Florida, Hawaii, North Carolina, Texas, Virginia and Washington. They were selected largely because of their significance to the Navy. The general impression obtained from those telephone conversations was that there are current and ongoing efforts in State NPS programs, but new regulations for enforcing NPS programs in the way specified in the 1987 WQA may be a couple of years away. Because EPA has not formally distributed its NPS program guidance, many States are taking a wait and see attitude and have not taken a formal position on this program. In the discussion that follows, summarized information gathered from the 1987 interviews is presented.

In order to comply with the 1987 WQA, all of the States should have begun to prepare their SAR. At least one State, Hawaii, reported that they began their assessment report, and hoped to have their management program completed by spring 1988. Other States reported they were awaiting the EPA guidelines. Each State was required to submit their assessment and management reports no later than August 4, 1988. Most States felt that laws to enforce the new NPS programs are at least 2 years away.

As of 1987, the States had not formally identified their high priority water basins required for the SAR. Some waters that were casually mentioned to be candidates as high priority water basins include the Galveston Bay and the Houston ship channel in Texas, Puget Sound in Washington, and Chesapeake Bay and the Elizabeth River between Portsmouth and Norfolk in Virginia. The identification of priority water basins will help in identifying Navy installations that will have to first address NPS issues.

States will continue to employ both point and nonpoint strategies in their effort to clean up polluted water basins that began with enactment of the original Clean Water Act. Specific State views obtained during the survey include:

o Florida, for example, indicates that it has required storm water discharge permits for construction projects (including construction on military installations) since 1982.

o The State of Washington reports that as a pilot program in Bellevue, Washington, an NPDES waste load allocation permit was recently issued for nonpoint source discharge. The first of its kind in the State, this permit might become common in highly urbanized areas.

o In Virginia, stream nutrient standards are being established for point/nonpoint source pollution. Under the new plan, a nutrient enriched stream would be identified by in-stream samples collected bimonthly during the growing season (July-Sept and Feb-April) at a depth of 1 meter. A mean concentration of 25 micrograms per liter of chlorophyll A, pheophytan corrected (degradation products extracted), would indicate a nutrient enriched stream. A standard of 2 mg/l total phosphorus monthly average has been proposed. Point source discharges would be identified and controlled by the Water Control Board, and the Soils and Water Division would regulate nonpoint source discharges. Upstream nonpoint sources would be identified (agricultural, urban, etc.) and BMP (Best Management Practice) would be implemented. Compliance would be automatic. This new proposal was to go before a governor appointed board on September 29. Public hearings were to begin in January, and the measure was to be adopted in June of 1988. Virginia was also proposing toxics standards on roughly the same timetable.

o North Carolina has set their chlorophyll A level at 40 micrograms per liter and is watching developments in Virginia closely.

o Texas is adopting criteria for its stream standards that will identify waters with point/nonpoint problems.

o California plans to take a close look at nonpoint source pollution as a 3-year revision of its Coastal (Ocean) Plan gets under way. A bill already proposed in California (AB 637) would restrict the use of tri-butyl tin (TBT) based antifouling paint on ships.

Although the interviews did not clarify how the States are going to specifically address the NPS regulation issue, there is no doubt that regulations to control NPS pollution will be proposed by these States. As Navy activities are typically located on waterways, they are bound to be impacted by those regulations.

The approach that will be taken by the States with NPS regulations and programs is perhaps best presented in a survey report by the Association of State and Interstate Water Pollution Control Administrators (Ref. 2.1). The study indicated that State water quality agencies, in leading the efforts to manage NPS pollution problems, have identified two priorities: the need of interinstitutional coordination and additional assessment.

Most States indicate that coordination is critical for a successful water quality program and have identified several techniques for use to improve the coordination:

- o Obtain clear regulatory priority statements for agencies that have programs that have primary purposes other than water quality.
- o Clarify roles of the State, Federal, and local agencies.
- o Coordinate planning and resource targeting among management programs in the State.
- o Increase public awareness of the importance and benefits of NPS controls.

The States have identified the following additional assessment needs:

- Improvement of information about the extent and intensity of pollution problems.
- Identification of trends in water quality for more subtle pollutions problems.
- Verification of effects of programs and management practices for improving water quality.

In addition, States report the need for more research on NPS pollutants, particularly toxics, nutrients, pesticides, and volatile organic chemicals.

From discussions with various States, it is clear that the States will administer NPS programs and regulations in a clear and systematic manner stressing coordination with all parties involved, and a high degree of visibility through public comment periods. States will also attempt to collect more information on NPS contributed pollution problems as well as that of particular NPS pollutants to verify the effectiveness of the programs.

It is difficult to predict what BMPs the States will identify in implementing NPS regulations. It is certain however, that States will have to comply with the WQA of 1987, and therefore have to implement NPS regulations and programs that will contribute to the State's water quality goals, or for that matter, the Nation's water quality goals.

It must be emphasized that States will have to address the NPS issues in a very open and visible manner involving all parties within a problem water basin. The Navy is large and owns a significant amount of waterfront property, where industrial activities are conducted. There is no doubt that the Navy installations will be involved in the NPS pollution issues. No one in State government is quick to name the DOD or the Navy as a nonpoint source polluter but as one official said, NPS pollution is everyone's problem.

2.3 POTENTIAL NAVY NONPOINT SOURCES

2.3.1 General

In this section, potential Navy nonpoint sources have been identified to assist in determining what type of monitoring and control technologies need to be investigated and developed for Navy use. The nonpoint discharges from Naval installations include all the principal types identified by EPA, plus some other Navy specific sources. These include:

- Storm water run-off
- Construction activities
- Hydrographic modifications

- Land and subsurface disposal of residual waste
- Impact zones
- Training areas
- Antifouling paints
- Outleases

Navy operations that contribute to nonpoint sources are discussed below.

2.3.2 Storm Water Run-off

Storm water run-off from nonpaved areas, such as lawns, gardens, and landscaped areas can contribute to nonpoint source discharges containing conventional pollutants such as nitrogen, phosphorus, and sediment. Storm water run-off from paved areas such as roads, parking lots, motor pool areas, aircraft runways and parking areas contain petroleum products which can increase oil and grease levels in the discharges. Also, pesticides, herbicides, toxic metals, and PCB's may be present in these discharges.

In the San Francisco Bay area, the California Regional Water Quality Control Board is issuing NPDES Permits for storm water discharges. In response to this, WestDiv EFD has drafted a memo to NAVFAC indicating "the need for development of storm drainage management plan for specific types of naval activities such as Naval Air Stations and for general operations such as transportation/equipment yards" (Ref. 2.6). In terms of surface run-off, one Navy installation in North Carolina reported that the State had requested, and they had submitted, a list with maps to indicate the locations of drainage ditches from the industrial areas (Ref. 2.7). Although the State has not responded to the submitted list, it is clear that the State is concerned enough about the run-off from the industrial areas to warrant the request.

2.3.3 Construction Activities

Construction activities, such as building roads and structures, can contribute to increased levels of conventional pollutants and especially sediment through run-off during rainy periods.

One Navy installation in North Carolina reported that the State is requiring the treatment of storm waters under certain conditions from specified project areas (Ref. 2.8). It was reported that they had just been issued a violation citation for erosion control at a construction site (Ref. 2.8). Although the violation was a result of contractor oversight, the citation was issued to the Navy because the violation occurred inside the Navy installation. As a result of this, the Navy personnel interviewed pointed out that, at least at their base, there is a need of assistance in identifying the applicable standards and regulations, as well as a need of methods to ensure compliance with the requirements.

2.3.4 Hydrographic Modifications

Hydrographic modifications (dredging), which are connected with operation and maintenance of Navy port facilities, can contribute to nonpoint source pollution. Conventional pollutants are generated and discharged especially during maintenance dredging activities as a result of such activities. In certain areas, toxic chemicals contained in the sediment may be released and discharged during dredging activities.

2.3.5 Land and Subsurface Disposal of Residual Waste

Land and subsurface disposal of residual waste can contribute to the pollution of groundwater which may enter a waterbody as a nonpoint source discharge. This category can include abandoned disposal sites, old spills of chemicals, and leaks from chemical storage tanks and piping. Even though these sources can contribute conventional pollutants, the primary concerns with these sources are chlorinated hydrocarbons, heavy metals, and other toxic pollutants.

Additionally, underground nonpoint pollution sources include contributions from leaking fuel farms and oil sumps. An example of such nonpoint source underground transport is petroleum fuel leaking from the Naval fuel storage facility at Point Molate, CA, which enters the Bay of San Francisco as an underground stream and then becomes highly visible nonpoint surface oil discharge into navigable waters (Ref. 2.6). Besides conventional pollutants, such nonpoint discharges carry hydrocarbons, including some highly toxic substances - aromatic and polynuclear hydrocarbons.

The IR (Installation Restoration) Program has identified and assessed over 1,000 sites of potential contamination from past disposal of hazardous wastes. The draft IDR for the IR program has categorized over 600 sites recommended for further action into categories to assist in identifying research needs in this program. Two types of sites, disposal areas and landfills, account for over one half of the sites. These sites are potential nonpoint source discharges via groundwater migration to surface waters and erosion of the sites into adjacent surface waters.

Typically, Navy landfills were constructed in low lying and swampy areas adjacent to waterways. This makes the sites especially prone to bank erosion and the resulting discharges of sediment and contaminated material.

2.3.6 Impact Zones

Impact zones exposed to Navy firing or bombing tests may have an increased level of sediment containing nutrients in storm water run-off from these areas. Also, residual levels of unexploded ordnance may elevate levels of nitrogen and toxic compounds in the storm water run-off.

2.3.7 <u>Training Areas</u>

Training areas used for equipment and vehicle training and maneuvers may contribute to increased levels of sediment containing nutrients similar to construction activities through run-off during rainy periods.

2.3.8 <u>Antifouling Paints</u>

Antifouling paints containing toxic compounds, such as tri-butyl tin, used on the hulls of naval vessels may cause increased levels of toxic compounds in the waters and sediments near ship berthing areas.

2.3.9 <u>Outleases</u>

Thousands of acres of naval real estate is outleased year to year for a variety of uses. These include agricultural, rangeland, silvicultural, and mining. These uses may contribute to increased amounts of sediments, nutrients, and chemicals in storm water run-off.

2.4 CURRENT NAVY PROBLEMS

2.4.1 <u>Engineering Field Divisions Views</u>

To gather information on current Navy practices in regard to complying with the requirements of NPS related programs and regulations of State or local agencies, telephone interviews were conducted with a selected sample of PWCs and EFDs. Both Natural Resources and Environmental Engineering personnel were interviewed over the phone. Some of the NPS related programs/regulations the Navy installations have been responding to included sedimentation and erosion control, land/natural resources management, storm drain/run-off, surface run-off, and leaching/migration of toxics from disposal/spill site. Generally, the Navy has been responding to, and in most instances successfully complying with, the requirements of the existing State NPS related programs and regulations.

One problem cited by many EFDs was that insufficient information exists to determine whether or not a NPS problem exists, mostly due to the fact that there is no current regulatory requirement to monitor and sample for NPS. Since there has been little or no regulatory concern in this area, each felt they had no problems with NPS.

One problem uncovered during the discussions with the EFDs is there is no central data base showing how much acreage of land and miles of waterfront the Navy owns. Each EFD knows how many acres it has leased out, but information on waterfront acreage only exists at the activity level. Having no central data base makes it difficult to assess the magnitude of the problem.

2.5 DOD IMPACT ON CHESAPEAKE BAY

Decline in the water quality and the number of many biological species prompted the EPA to commission a series of surveys and studies conducted over a 7-year period to assess and evaluate sources of pollution near the Chesapeake Bay . Many local activities became involved in the study of this estuary's decline, including the Department of Defense. A study undertaken by Tetra Tech for the DoD beginning Oct. 1985 exposed both point and nonpoint pollution problems on DoD installations (Ref. 2.9). Tetra Tech also made recommendations to correct and/or alleviate these problems. The study included 66 installations (37 Navy) in the Chesapeake Bay drainage basin and the conclusions and recommendations hold some significance for future Navy practices as the EPA moves forward with implementation of its nationwide nonpoint source pollution abatement program.

The Tetra Tech study concluded that the six top ranked areas of concern regarding pollution at military installations near Chesapeake Bay related primarily to nonpoint or intermittent pollutant sources. These sources include storm water run-off, surface erosion, leaking underground storage tanks, and abandoned or inactive hazardous waste disposal sites. These waste disposal sites may have the potential for leachate migration to surface waters. Also mentioned were intermittent discharges of toxic industrial pollutants to sewage treatment systems and/or to storm drains.

The study found evidence of nonpoint source contributions such as erosion, sediment run-off, and storm water discharges from the majority of military installations studied although the pollution seemed to be limited to the immediate areas and did not seem to be contributing to the problem in Chesapeake Bay.

Some Navy and Marine Corps installations were mentioned as having significant adverse impact potential in relation to the nonpoint source pollution categories of erosion/sedimentation, impervious area run-off, combined storm drains, and shoreline erosion. Installations identified in the erosion/sedimentation category included the Naval Air Station at Oceana and the USMC base at Quantico. Mentioned as having a significant adverse impact in the impervious area run-off category was the Sewells Pt. Navy Complex. The Naval Ordnance Station, Indian Head, Sewells Pt. Navy Complex, and the USMC base at Quantico were identified in the combined storm drain category. Finally, shoreline erosion was noted at the Naval Ordnance Station, Indian Head.

Recommendations were made for the above mentioned installations, as well as many other Navy, Army, and Air Force installations. The Tetra Tech study noted that these problems are by no means peculiar to the DoD. Many industries, urbanized areas, and agricultural activities have the same type of problems. With the exception of only a few of the military installations studied, the region of influence of a military activity appeared to be limited to the immediate vicinity of that installation. The exceptions were those facilities where ordnance testing over large areas took place. The study noted that the DoD has performed well in responding to environmental regulations, but that these regulations are constantly being upgraded, and some areas of environmental concern are not adequately addressed at present (e.g., nonpoint sources).

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CHAPTER 3

STATE OF NAVY NONPOINT SOURCE ASSESSMENT, MANAGEMENT AND CONTROL TECHNOLOGY

3.1 GENERAL

Guidance Documents issued by EPA (Ref. 3.1, 3.2) and Department of the Interior (Ref. 3.3) describe general approaches to control nonpoint source discharges. Such control measures are normally divided into two phases:

- o Problem definition
- o Mitigation of nonpoint source discharge

3.1.1 Problem Definition

Problem definition consists of a number of specific tasks. The first is a Problem Identification Task, which is a preliminary assessment of the magnitude of the nonpoint source problem using available data. This task is usually accomplished by examination of water quality degradation in receiving waters that cannot be accounted for by waste contributions from known point sources.

The second is the Identification of the Origin of Nonpoint Sources, which involves determination of a material balance for nonpoint sources showing load for each pollutant to the stream and the origin of the load. Such determination can be carried out by either the Generalized Prediction Method or the Monitoring and Sampling Program, or combination of both.

The Generalized Prediction Method is based on general geological and hydrological considerations such as measurable watershed parameters - soil characteristics, vegetable cover, land use, and size of drainage area, relative to existing or potential nonpoint source discharges (Ref. 3.1).

The Monitoring and Sampling Program uses results of site specific monitoring and sampling to identify nonpoint source loadings. This program is used when accurate determinations are needed in order to refine information on nonpoint loading and to serve as a management tool for assessing progress made in mitigation of discharges (Ref. 3.4).

3.1.2 Mitigation of Nonpoint Source Discharges

No single control method is appropriate for all types of nonpoint source discharges, and a thorough knowledge of specific types of nonpoint sources and local conditions is necessary for the design of appropriate and effective controls. Controls for nonpoint source discharges can be classified as either structural or managerial.

Structural control is comprised of two sets of technological options:

- o Collection of nonpoint source discharge
- o Treatment of collected waste

The nonpoint discharge collection methods include installation of interceptor ponds and wells, construction of containment barriers, drainage ditches, and hydrological modifications. Treatment methods for collected discharges involve field use of various physical, chemical, and biological processes, as well as the use of in-situ treatment methodology.

Managerial control involves evaluation of land use practices that contribute to nonpoint source pollution, and the implementation of changes of such practices to reduce or eliminate nonpoint discharges. Managerial controls include providing grassy buffer zones between farmed areas and waterways, locating training areas for heavy equipment operators in relatively flat areas with buffer zones between the areas and waterways, and locating target/bombing ranges in regions of low rainfall and away from waterways.

3.2 CURRENT NAVY MITIGATION METHODS

The control of nonpoint source discharges at Naval facilities is an old problem and has been addressed on numerous occasions, and in many places. Surface run-off contaminated by petroleum pollutants represents one of the more typical examples of such control. Because oil pollution is highly visible in nature, and a number of statutes regarding its control are in force, the Navy has developed concrete engineering means for dealing with it. Such methods are described in the Naval engineering manuals (Ref. 3.5, 3.6) and implemented at all major installations involved in handling fuel and oil. The most common approach to control of such discharges involves retention of run-off water in interceptor ponds or impoundments, followed by treatment in the existing oily waste water treatment facilities.

In addition to intercept ponds, large holding tanks are also used for containment of the surface run-off prior to treatment. In other instances completely separate oily waste water treatment facilities are used for treatment of nonpoint source discharges. For example, the run-off water from the fuel storage facility at Point Molate Naval installation in Richmond, CA, is collected in a 2.1 million gallon capacity tank, which functions as a primary oil/water separator by gravity under quiescent conditions. Partially treated run-off water is then directed either into a second gravity separation tank, which receives all the oily waste water for treatment at this facility, or introduced directly into a coalescing unit for additional treatment. In both cases the contaminated run-off water undergoes complete treatment at the facility -- coalescence, parallel plate separation, biodegradation, multimedia filtration, chlorination and chemical treatment before discharge into San Francisco Bay (Ref. 3.7).

While this technology is readily available and is used routinely for treating run-off water from fuel storage and handling areas, it is rarely, if ever, used for control of other storm water run-off, such as nonpaved and paved areas of Naval installations.

Leaks from underground fuel tanks are prevented by the addition of leak detection systems and the replacement or elimination of existing tanks. Where leaks are found, measures such as removal of contaminated soil and the treatment of contaminated groundwater are pursued to prevent the discharge of nonpoint source pollution.

Erosion control measures are implemented at many Navy activities. These take the form of best management practices on agricultural and forestry outleases and the construction of shoreline and stream bank erosion control structures.

3.2.1 Storm Water Run-Off

The means to control conventional pollutants from unpaved areas and petroleum pollutants from paved areas are available but used little by the Navy. There has been little requirement by regulatory agencies in the past for the Navy to control pollutants from these sources, so little has been done.

3.2.2 Construction Activities

Conventional erosion controls such as hay bales, stone rip-rap, revegetation, and site clearing limits have been used by the Navy periodically at construction sites. Some of engineering techniques developed and used by the Navy (Ref. 3.8) at these sites may be used to control nonpoint source discharges from other types of sites.

3.2.3 Hydrographic Modifications

Controls have been used to control pollution from maintenance dredging of Naval port facilities. Dredge spoil ponds have been constructed to settle out sediment before discharging the water back into the bay. In certain instances the dredge spoil has been disposed of at sea to prevent the sediment from entering the bay. NCEL has done research into construction of underwater structures to prevent sediment from entering berthing areas. Though successful, these structures were found not to remove sediment from the bay, but instead allow the sediment to accumulate faster in other areas of the bay.

3.2.4 Land and Subsurface Disposal of Residual Waste

Old disposal and spill areas are a potential major pollution source and methods for assessing, detecting, characterizing, and treating these sources are not very well developed at this time.

The discharge of hazardous pollutants from these areas is by underground aqueous transport or bank erosion from adjacent waters. Most research and engineering efforts are directed toward underground transport at this time. While a considerable amount of effort has been expended by the Navy on characterization and mitigation of hazardous waste disposal practices, it is not clear at this time how such information can be utilized in addressing nonpoint source discharge as required under the Clean Water Act amendments of 1987.

3.2.5 Outleases/Land Use

Outleases are controlled under the cognizant EFD. Typically, a soil and water conservation plan for each outlease is prepared for each lessee. These plans are often prepared in conjunction with the local Soil Conservation Service (SCS) to ensure that best management practices (BMPs) are being implemented.

A plan used for an agricultural outlease under CHESDIV's jurisdiction specifically incorporates the requirements legislated in the recent Chesapeake Bay Initiative (Ref. 3.9). The government controls which chemical pesticides may be used and must approve all chemical application rates (fertilizers, pesticides, etc.).

Buffer zones, or filter strips (25 feet) are required between planted fields and water bodies. Erosion control practices are mandatory; harvested fields must be protected within 2 weeks.

3.2.6 Impact Zones

The magnitude of nonpoint source discharges from the impact zones exposed to Naval firing and bombing is largely unknown. Since such training practices were carried on by the Navy in some locations for a very long time, the cumulative effect on the receiving environment can be significant. A major pollution assessment effort will be required at the firing/bombing ranges before technological approaches to the control of nonpoint source discharges can be ascertained.

3.2.7 Training Areas

The magnitude of nonpoint source discharges from training areas is largely unknown. Land use management controls may be used in certain areas to protect sensitive habitats. Controls for these types of areas would be similar to those used in construction areas.

3.2.8 Antifouling Paints

There are currently many Navy sponsored research programs dealing with natural antifouling compounds to replace toxic metal compounds currently in use. These programs are carried out at NCEL, NOSC, and universities.

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CHAPTER 4

PROJECTIONS FOR EMERGING TECHNOLOGY

4.1 GENERAL

The emerging technologies for treatment of nonpoint source discharges of pollutants and hazardous substances are evolving along traditional disciplinary lines of biology, chemistry, and physics. In the field of biological sciences, bioengineering offers, at this time, the most promising approaches to control of environmentally dispersed pollutants. Methods based on bioengineering principles are uniquely suited (logistically and operationally) to treat widely dispersed waste matter and hazardous substances in the soil, surface, and ground waters.

With the advent of genetically tailored bacteria it becomes possible to develop and apply in-situ treatment for specific pollutant types. Perhaps the most successful application of bioengineering is in the treatment of nonpoint source discharges of oily waste waters. Specialized bacteria were developed and used successfully to treat in-situ petroleum matter dispersed in soil and water bodies (Ref. 4.1).

4.2 BIOENGINEERING

Biological processes are based on a material transformation during which biodegradable pollutants or hazardous substances are brought into contact with either mixtures of microorganisms or microbial enzymes which decompose the pollutants, or the plants that are capable of accumulating specific toxic substances in their tissue. Water, organic matter, and nutrients are indispensable requisites for degradation by microorganisms.

While the use of biological means for waste treatment is not new, the recent contributions of bioengineering to the development of specialized bacteria have greatly increased horizons for enhanced and more efficient use of such methods, especially in the area of nonpoint source discharges.

Field applications of biological techniques which are used or explored for treatment of nonpoint source discharges include:

1. Suspended and mixed media growth
2. Anaerobic and aerobic digestion
3. Enzyme treatment
4. In-situ assimilation
5. Composting
6. Land treatment

4.2.1 Suspended and Mixed Media Growth

Activated sludge processes utilize a microbial population which has been acclimated to a particular waste stream to increase the rate of degradation. The aeration process is necessary in order to maintain sufficient dissolved oxygen for the microbes and at the same time provide a mixing mechanism to keep the microbes in constant contact with the waste water. Such processes provide inexpensive means for degradation of organic pollutants (Ref. 4.2, 4.3).

On-site (field) biological treatment for nonpoint source discharge streams is feasible using an activated sludge process. Union Carbide Corporation, developer of an activated sludge process using oxygen in place of air (UNOX), has seven mobile plants which utilize this process. The units have a maximum hydraulic capacity of approximately 6,250 gallons/hour, and can be used in the field to treat contaminated run-off and water streams.

4.2.2 Aerobic and Anaerobic Digestion

Digestion is a biological treatment process that is less reliant on an aqueous medium than conventional, secondary treatment, and is typically used to hydrolyze insoluble substances. Organic substances may be digested in either anoxic (metabolic reduction) or an aerobic (metabolic oxidation) environment (Ref. 4.2, 4.4, 4.5).

Aerobic digestion is one of the most widely used methods of composting which degrades organic matter at elevated temperatures. In this process, the waste is placed in a controlled environment where the energy produced by microbial action is contained, resulting in an increase in the temperature. The constant supply of oxygen coupled with high temperatures and moisture result in accelerated decomposition (Ref. 4.6).

Anaerobic digestion utilizes microorganisms to degrade organic wastes in the absence of oxygen. Complete anaerobic digestion results in the production of methane. Reduction, as opposed to oxidation, is the primary driving reaction in anaerobic digestion. Thus, anaerobic digestion will, in general, degrade chlorinated hydrocarbons and pesticides more rapidly through reductive dechlorination (Ref. 4.2). Such methods are appropriate for field use in instances were treatment of nonpoint source pollution in the soil is required.

4.2.3 Enzyme Treatment

Enzyme treatment is classified as biological treatment because enzymes are produced by living cells. Enzymes are simple or combined proteins that act as catalysts for specific decomposition reactions involving only certain hazardous chemicals. Enzymes cannot be adapted or acclimated to varying substrates and are highly sensitive to pH and temperature conditions. For this reason, they are used for treatment of very specific chemicals, and are useful in only very specific ways.

4.2.4 In-Situ Assimilation

In-situ assimilation is one of the most promising biological techniques for the treatment of widely dispersed pollutants or hazardous substances on land, and in surface and groundwaters. Active in-situ assimilation is based on the use of inoculation by selected bacteria of impacted medium. Genetically tailored microbes can be used for decomposition of specified types of pollutants (i.e., petroleum waste) (Ref. 4.1, 4.3, 4.7).

The most successful application of this technique is in the biological renovation of contaminated groundwater, either by injecting microorganisms below the water table or by pumping up the groundwater, inoculating it with microorganisms, and reinjecting the water below ground. Bioreclamation of groundwater is most often combined with aeration and addition of nutrients to enhance decomposition of the hazardous constituents (Ref. 4.7).

4.2.5 Composting

Composting is becoming one of the more favorite methods of field treatment of hazardous wastes because of low cost. Such treatment is usually accomplished by one of three methods - windrows, piles, and mechanical systems. Bulking agents, such as rice hulls, wood chips, or shredded straw, are used to reduce moisture content in the waste to 40-60%. One of the major advantages of composting is that it is the only biological treatment that is relatively insensitive to solvents and heavy metals (Ref. 4.6).

4.2.6 Land Application

Land application, or land farming, involves the use of plants, the soil surface, and the soil matrix to remove hazardous constituents from environmental matrixes. Although the ultimate objective may be biodegradation, a variety of physical and chemical treatment processes come into effect in such renovation of the land (Ref. 4.8).

4.3 CHEMICAL/PHYSICAL PROCESSES

There are a number of emerging technologies for treatment of collected nonpoint discharges under field conditions of operation. Some methods, based on chemical/physical principles, have been reduced to working prototypes and tested under field conditions. Others are being studied theoretically, or in the controlled environment of research laboratories.

4.3.1 Magnetic Separation

Magnetic separation has been applied to the removal of magnetic and nonmagnetic particles from liquid streams. A waste stream is fed into a magnetic field where magnetic particles are collected on filters, usually woven steel fabric or compressed steel wool. The magnetic field is then shut off and collected waste material is washed from the filter bed.

The nonmagnetic contaminants can be removed from a waste stream by first using powdered activated carbon to absorb the contaminants. The carbon suspension is then thickened by the formation of a magnetic floc when the proper amounts of magnetic material are mixed in the presence of a polyelectrolyte flocculating agent such as aluminum sulfate. Magnetite is a commonly used magnetic material (Ref. 4.9).

Magnetic separators designed for field use are available. The Dynactor is a notable example of this advanced waste treatment technology.

4.3.2 Membrane Separation

Membrane separation is a treatment process which utilizes a preferentially permeable membrane to separate components of a solution or suspension. The driving force of membrane separation is pressure differential of concentration gradient. The most widely used processes include dialysis, reverse osmosis, and ultrafiltration. Ultrafiltration is most commonly used in waste treatment applications. It operates at lower pressures than reverse osmosis and is suitable for applications involving larger molecules. This treatment technique was used with waste streams containing solids concentrations up to 46,000 ppm. Hardware for field use is available (Ref. 4.10, 4.11).

4.3.3 In-Situ Radio Frequency Heating For Treatment of Hazardous Substances in Soils and Sediments

In-situ treatment of hazardous wastes dispersed in soils by application of radio frequencies heating was investigated theoretically. The economical study was performed and dealt with two competing systems:

- o In-situ radio frequency heating
- o Excavating and incinerating the material contained in the soil

The study (Ref. 4.12) revealed that radio frequency heating is two to four times cheaper than the incineration process.

4.3.4 Retention and Detention Ponds

Retention ponds prevent run-off from entering a receiving water by collecting the water and allowing it to infiltrate into the ground and/or evaporate. Some of these basins are designed to capture only the run-off from the first inch of rainfall as it is believed that this "first-flush" run-off from paved areas contains the highest level of pollutants.

Detention ponds have been used to reduce peak flows of storm water run-off from paved, developed areas to streams. These ponds are typically designed to hold the volume of run-off from a large storm and have control structures on the outlet from the pond to limit the maximum rate of discharge from the pond.

Both types of ponds have been effective in preventing flooding due to hydraulic overloading of natural waterways. The effectiveness of using these ponds to reduce pollutant loadings is not as well known;

however, they should be effective in reducing sediment loadings. It has been reported that heavy metals can be removed by these ponds, but there are concerns with groundwater contamination in unlined ponds.

4.3.5 Soil Bioengineering

Biotechnical methods for slope protection and erosion control, often referred to as soil boiengineering, is an old technology which has been effectively used in many applications over the past century. The use of plant material and soil microorganisms to stabilize an area subject to erosional forces is a natural and effective method of control. The plant roots, stems, and leaves all lend structural support and stability. The microbial flora prepares the soil for effective root attachment/penetration and provides critical nutrients for plant growth and homeostasis.

Soil bioengineering can be effective in reducing the transport of nonpoint source pollutants such as sediments and surface contaminants to natural waterways. Vegetated swales can provide for infiltration and sedimentation, reducing the amount and improving the quality of run-off. Bank slope stabilization can reduce erosion in the waterway and enhance the removal of sediments transported in the run-off.

4.3.6 Porous Pavements

Porous pavements allow the infiltration of rain water from otherwise impervious areas. These pavements can be used for roads and parking areas. Oil, grease, hydrocarbons, and metals that accumulate in these areas are allowed to soak in and are prevented from entering surface waters. Pollutant accumulation in the soils and groundwater may be a problem as well as long term stability of the pavement itself.

4.4 LAND MANAGEMENT TECHNOLOGIES

Recently, several new land management technologies are available for agricultural areas. These include no till planting, new crop rotation schemes, and reduced fertilizer application. These methods have been studied from the viewpoint on how they affect productivity of a parcel of land. The matter of how much reduction in nonpoint source pollution is achieved by these methods needs further investigation.

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CHAPTER 5

TECHNOLOGY ASSESSMENT

5.1 GENERAL

The principal sources of nonpoint pollution at Naval installations includes:

- o Storm water run-off from nonpaved areas containing conventional pollutants such as nitrogen, phosphorus, and sediment

- o Storm water run-off from paved areas containing oil and grease, heavy metals, other chemicals and pathogenic bacteria

- o Construction activities generating conventional pollutants and sediment during rainy periods

- o Hydrographic modifications producing discharges containing sediment, conventional pollutants, and in certain instances, toxic chemicals

- o Land and subsurface disposal of wastes producing leachate containing conventional pollutants and toxic chemicals

- o Impact zones contributing sediments, nutrients, and toxic chemicals to surface run-off

- o Training areas producing increased sediment and nutrients in run-off during rainy periods

- o Antifouling paints increasing toxic compounds in waters in berthing areas

- o Outlease operations producing increased levels of sediment and conventional pollutants during rainy periods.

5.2 ASSESSMENT, MONITORING, SAMPLING, AND ANALYTICAL TECHNIQUES

Assessment, monitoring, sampling and analytical techniques are used in support of the problem definition phase of nonpoint source pollution control. They are different in a fundamental way from similar techniques used in control of conventional point source discharges.

The assessment of nonpoint source pollution is based on predictive modeling that uses material balance between the sum total of pollution load on a given watershed, and individual contributions from known point and nonpoint source discharges. Geological, hydrological, and mathematical techniques are the principal tools used in such assessments.

Monitoring operations are considerably more difficult to implement, because large areas of land surface and underground must be addressed as part of the monitoring program. While average conditions shed light on the general situation, an analysis based on extreme run-off periods, covering specific climatic events and seasonal periods, is more likely to provide an accurate evaluation of the significance of each nonpoint source discharge. Because of logistic complexities associated with such a monitoring effort, the EPA believes (Ref. 5.1) that nonpoint source estimates cannot be verified in the relatively short time frame of initial 208 plan formulation, and it might be desirable to initiate an ongoing monitoring program to be carried out in the plan implementation phase. Design and execution of such ongoing monitoring programs will be difficult and expensive.

The nature of sampling and analysis operations, which are an integral part of a monitoring effort, are considerably different from those used in conventional point source pollution control. Instead of a single discharge pipe, equipped with a convenient sampling port, one must address a large expanse of both land surface and underground. Additional complications arise from seasonal variations and specific climatic events that will impact the nature and quantities of dispersed nonpoint pollutants.

In order to execute meaningful sampling and analysis of a given nonpoint source discharge, the geological, hydrological, climatic, and chemical aspects of the problem must be considered at the same time. The experimental design based on interaction of such considerations is an integral part of a successful data generation effort.

Because of the increased complexity of sampling and analytical operations, conventional methods of sampling and off-site analysis might be too expensive and generally not appropriate. Development of a new set of field chemical tests, which can be combined with geological, hydrological, and climatic observations and examinations, may be necessary to generate required data on nonpoint source pollution discharges.

There are a number of standard sampling and analytical procedures as well as operational instrumentation that are capable of addressing detection and characterization of nonpoint waste streams generated at Naval installations (Ref. 5.2, 5.3). However, they were never applied in field mode on a scale which will be required during the field monitoring of nonpoint source discharges. Modification of such methods might be required to meet large volume demands of nonpoint source discharge testing.

For example, petroleum wastes and chlorinated hydrocarbons originating at operational areas and waste disposal areas could be detected and quantified by means of gas sparging, combined with colorimetric detection (Ref. 5.4). Such a procedure can be performed in the field.

Use of vapor monitors, portable field gas and liquid analyzers, as well as semiconductor sensors might also be appropriate for such applications (Ref. 5.4, 5.5).

Electrical resistivity devices, ion-specific electrodes, and electroconductivity test equipment can be used for detection of heavy metals and cyanides that constitute major components of inorganic waste generated at Naval installations (Ref. 5.4). None of these procedures and devices, however, are integrated into appropriate field kits suitable for military use.

5.3 MITIGATION TECHNIQUES

Mitigation of nonpoint source discharges consists of either structural controls, or land use/land management practices (BMPs). Structural controls are essentially technological options, while land use is a management tool.

5.3.1 Structural Controls

Structural controls which are used in the management of nonpoint source discharges can be divided into two phases:

- Containment or displacement of nonpoint source discharges
- Treatment or disposal of contained pollutants

Containment or displacement of nonpoint source discharge is the first step of operation, usually followed by the actual treatment or disposal of contained pollutants. Consequently, this discussion of structural controls for nonpoint source discharges will be divided into two parts: containment/displacement and treatment/disposal.

5.3.1.1 Containment of Nonpoint Source Discharges

Conventional mechanical containment methods either stop nonpoint source discharge, or immobilize or hinder its spread. They are designed for and used on the surface, in water, and underground. The path of released substances may be blocked with barriers or diversions which are either preformed or constructed on site. Containment facilitates subsequent handling of discharged pollutants. Candidate containment methods for retention of nonpoint source discharges on surface, in water, and underground include the following:

1. Dikes, berms, and dams
2. Trenches
3. Booms
4. Curtain barriers
5. Soil barriers/sealants
6. Slurry trenches
7. Catch basins
8. Chemically active covers
9. Synthetic membrane cover/liners
10. Foam covers
11. In-situ burial/encapsulation
12. Stream diversion

Each of these methods is briefly discussed below:

DIKES, BERMS, and DAMS -- Retention dikes can be used to contain surface run-off, and collect conventional pollutants, such as suspended solids, as well as petroleum fuels and oil wastes (Ref. 5.6). Also they may collect heavy metals from the surface run-off which may pollute the groundwater beneath these structures. Such dikes consist of earth, sediment, gravel, or coarse sand. Gravel and coarse sand are the preferred construction materials. Earth or sediment dikes or dams can be constructed using existing dredging equipment, or earth moving equipment such as bulldozers. They often have sloped embankments constructed either in water or directly adjacent in bordering low land areas.

TRENCHES -- Trenches or excavations can also be used as a first step to contain surface run-off of pollutants. They are an effective and relatively inexpensive containment measure for liquid wastes and conventional pollutants. Trenches on land require use of large earth moving equipment such as bulldozers, and generally take advantage of natural conditions and slope to aid in containment of run-off (Ref. 5.6).

BOOMS -- Booms are used to contain released pollutants after they reach waterways. Surface booms are used to contain contaminated waters involving insoluble floating substances, including oil and hazardous substances. A primary concern is compatibility between the spilled substance and the boom material (Ref. 5.7).

CURTAIN BARRIERS -- Curtain barriers are also used to contain nonpoint source discharges after they reach surface water bodies. They are used for containment of hazardous materials that are soluble, or sink in the water. They are designed for bottom to surface coverage, and are made of flexible reinforced plastics. Buoyancy is provided by air flotation collars. These have been employed to induce settlement of solids.

SOIL BARRIERS/SEALANTS -- Soil barriers are used for containment of nonpoint source pollutant movement in contaminated soil and underground environments. Several methods are used -- soil sealants applied directly to the surface of soil; soil sealants injected below the surface; slurry trenches; and sheet piling (Ref. 5.6).

Soil surface sealants are generally grouped into three categories: reactive, nonreactive, and surface-chemical. Reactive sealants require two or more components to be mixed and reacted at the site. Included in this class of sealants are epoxy, urea/formaldehyde, and urethane. Such sealants are more likely to form a film under adverse weather, and effectively cover soil containing gravel and stones. Nonreactive sealants have been previously polymerized and are dispersed as aqueous or solvent systems. They include bitumastic, rubber, polystyrene, and PVC. Surface chemical sealants are generally repellent, such as silicon and fluorocarbon systems. Sealants can be injected into the soil, usually under pressure, to fill fractures and voids with stable insoluble materials. This process is known as grouting (Ref. 5.8).

SLURRY TRENCHES -- Slurry trenches provide a safe and relatively inexpensive method of installing groundwater barriers in unconsolidated soil material. Draglines or backhoes are used to excavate a trench which is then filled with a bentonite-based fluid. This fluid develops a filter cake on the walls of the trench and prevents the seepage (Ref. 5.9).

Sheet piling is a commonly used method to establish a groundwater barrier. However, in some respects it is of questionable effectiveness. The interlocking of sheet piling does not give a completely watertight seal and may have a relatively small effect on water retention.

CATCH BASINS -- Conventional catch basins are often used in conjunction with some other type of initial containment method, such as diking, or a lined trench (Ref. 5.6). Portable catch basins include any container or storage unit that can be transported on site of contamination, assembled, and used to hold hazardous substances, contaminated soil, or water for further treatment.

CHEMICALLY ACTIVE COVERS -- A containment material is considered to be chemically active if it will readily react with dispersed pollutants to neutralize or immobilize its movement. Application of chemically active covers must be done on a case-by-case basis, and evaluated by a qualified chemist.

SYNTHETIC MEMBRANE COVER/LINERS -- Synthetic membrane covers are used to cover solid waste heaps to prevent contact with rain water and dispersion into soil and underground water (Ref. 5.10).

FOAM COVERS -- Foam covers are used primarily for containment of volatile contaminants from dispersion through the air (Ref. 5.11).

IN-SITU BURIAL/ENCAPSULATION -- Burial/encapsulation on land has been used as a measure to prevent dispersion of pollutants into the water and air. There are many potential materials that can be used in such applications: clays, sands, diatomaceous earth, asphalt, cement, and synthetic polymeric substances (Ref. 5.12).

STREAM DIVERSION -- Stream diversions involve insulating the contaminated area by diverting the uncontaminated flow around such an area. This is normally accomplished by placing a dam upstream of the impacted area and diverting the stream around it. The isolated area can then be treated by appropriate means (Ref. 5.13).

5.3.1.2 Displacement

Displacement methods are another form of containment of pollutants from nonpoint source discharges. Such methods are mechanical means for collection and relocation of dispersed hazardous substances or pollutants from the contaminated soil, water, or sediment.

The principal displacement techniques in current use are:

1. Hydraulic and mechanical dredging
2. Excavation
3. Skimming
4. Pumping
5. Vacuuming

HYDRAULIC DREDGING -- Hydraulic dredges, including suction, dustpan cutter head, and hopper dredge, remove and transport sediments in liquid slurry containing 10 to 20 percent solids. They are an appropriate means for collection and elimination of pollutants dispersed in sediments (Ref. 5.14, 5.15).

MECHANICAL DREDGING -- Mechanical dredges such as clamshell and dipper, remove bottom sediments through direct application of mechanical force to dislodge, excavate, and bring to the surface materials in almost in-situ densities (Ref. 5.14, 5.15).

EXCAVATION -- Excavation is a mechanical displacement technique for removal of contaminated soil. Contaminated soils and earth materials are excavated using conventional construction equipment such as backhoes, draglines, front-end loaders, and even shovels (Ref. 5.6).

SKIMMERS -- Skimmers are used to remove liquids floating on the water surface. Most skimmers were designed for oil collection, and may have plastic parts which are incompatible with other hazardous substances (Ref. 5.16, 5.17).

PUMPING -- Pumping of dispersed pollutants is most applicable to small surface areas contaminated by liquid pollutants (Ref. 5.18).

VACUUMING -- Vacuuming is used for cleanup of small areas contaminated by dry particulate pollutants.

5.3.1.3 Treatment of Nonpoint Source Discharges

Treatment of nonpoint source discharges is usually undertaken after nonpoint source discharged pollutants are collected, contained, or displaced. At this time in-situ treatment methods, which are primarily biological in nature, are still in the state of infancy, and can be considered only as emerging technology. The state-of-the-art methods for treatment of nonpoint source discharges are based on standard engineering practices and can be divided into physical or chemical processes.

5.3.1.3.1 Physical Processes

Principal physical processes used for treatment of nonpoint source discharges include:

1. Gravity separation -- flotation and sedimentation
2. Evaporation
3. Aeration
4. Steam stripping

GRAVITY SEPARATION -- Gravity separation is probably the most common physical method used for the treatment of the most common form of nonpoint source discharge, surface run-off. It is a physical separation process that takes advantage of the difference in the specific gravity of the various components of a liquid mixture (Ref. 5.19, 5.20, 5.21, 5.22). Typical operations include flotation and sedimentation.

Flotation is used for separation of substances which are less dense than water. It is typically used for separation and removal of petroleum fuel and waste oil from surface run-off collected in interceptor ponds (Ref. 5.21), or from underground stream in the interceptor wells (Ref. 5.20). Oil/water separators are used at numerous Navy fuel storage facilities. Wider Navy application of this technology may be required to meet nonpoint source discharge requirements.

Sedimentation is used for separation and removal of conventional pollutants, such as suspended solids from surface run-off streams (Ref. 5.23). Swirl concentrators have been used to remove up to 50% of the solids and BOD from a storm water discharge. Catch basins on storm sewer inlets are designed to remove larger solids before the run-off enters the storm sewer. Streets and sewers can act as sedimentation devices. A program of street sweeping and sewer flushing can be used to reduce the amount of sediment entering a stream.

EVAPORATION -- This process is used mainly for concentration of nonvolatile hazardous substances and conventional pollutants in the impounded surface run-off. The most economical method of evaporation is solar evaporation. This method offers the benefit of photolytic decomposition of organic wastes that degrade with exposure to ultraviolet light (Ref. 5.24).

AERATION -- Air stripping or aeration removes volatile compounds in aqueous solutions by increasing the air/liquid interface area. The increased contact area is produced by mechanical means such as in-stream aeration with compressed air, spraying the aqueous solution in the air, or agitating the surface. For field situations, surface agitation and in-stream aeration are probably the most viable options. The application of aeration to the removal of volatile components from aqueous solutions is critically dependent on the potential environmental impact of the resulting air emissions. As with evaporation, aeration could produce toxic fumes. Careful consideration of the environmental impact of air emissions should be done before this treatment method is used (Ref. 5.25).

STEAM STRIPPING -- Steam stripping is essentially a fractional distillation process used to remove volatile components from aqueous solutions. The products of this operation are concentrated vapor and dilute treated stream. The concentrated vapor containing the stream stripped volatile can be either recycled or incinerated (Ref. 5.26).

5.3.1.3.2 Chemical Treatment

Chemical treatment processes either separate phases or components of hazardous substances mixtures or chemically transform the hazardous substances by the addition of chemical reagents or catalysts. Such treatment can be performed in the field or at a waste processing facility. In-situ chemical treatment processes must be carefully controlled and contained, as, in some cases, the chemical treatment agent can pose an equal or greater potential hazard to the environment than the original pollutant. Principal chemical process used for treatment of hazardous wastes and pollutants are:

1. Coagulation/flocculation
2. Extraction
3. Solidification/stabilization
4. Chelation
5. Ion exchange
6. Hydrolysis
7. Neutralization
8. Oxidation/reduction
9. Precipitation
10. Polymerization

COAGULATION/FLOCCULATION -- Coagulation/flocculation is a non-destructive separation process that enhances the physical process of sedimentation. Using this process, small particles suspended in a liquid are made to agglomerate into larger, more settleable particles. In this process, the repulsive, electrostatic forces which keep the particles suspended are overcome by admixing chemical coagulants so that gravitational and inertial forces will force sedimentation of the flocculated mass (Ref. 5.23).

EXTRACTION -- Extraction is a separation process for washing a pollutant or hazardous waste from either soil or water with a liquid carrier. The liquid carrier acts as mobile solvent and is typically a dilute acid or base. Elutriation of soil may occur either in place or in a mixing device such as a screw conveyer. Liquid-liquid extraction is feasible as either a batch operation or a continuous counter-current flow contactor (Ref. 5.27, 5.28).

SOLIDIFICATION/STABILIZATION -- Solidification/stabilization processes convert the hazardous substance to a form that is immobile and/or resistant to leaching. Stabilization refers to a chemical reaction that fixes the hazardous substance prior or during the solidification. Solidification creates a relatively stable mass either by physical encapsulation of the hazardous substance or by a combination of stabilization reaction and entrapment in solid matrix. Some solidification processes are used to make hazardous substances easier to transport, while other processes harden as a monolithic block suitable for safe disposal (Ref. 5.29, 5.30, 5.31).

CHELATION -- Chelation is a fixation process in which a pollutant or a hazardous substance is bonded by the chelating agent, making it unable to react chemically and, therefore, making it less toxic. Chelation is used primarily for fixation of heavy metals (Ref. 5.22).

ION EXCHANGE -- Ion exchange is a reversible interchange of ions between an insoluble, solid salt and an electrolyte solution in contact with the solid. In this process less hazardous ions in the resin are exchanged for more hazardous ions in solution. Such exchanges take place on a resin which is usually made of a synthetic material. Most resins are rechargeable. Ion exchange is considered for treatment of water streams where waste matter is pumped through the resin, which can be either in a loose form or contained in a packed column (Ref. 5.32).

HYDROLYSIS -- Hydrolysis is a chemical process which involves a water-induced bond cleavage to produce a double decomposition. Organic hydrolysis includes reactions in which water is not a reactant. Acids, alkalis, and enzymes are used as catalysts in such processes. Hydrolysis may be applied to a wide range of waste types. It is used primarily for destruction of nitriles, amines, esters, and chlorinated hydrocarbons. Familiarity with specific reaction chemistry is necessary before this technique should be used to treat wastes (Ref. 5.22).

NEUTRALIZATION -- Neutralization refers to interaction of an acid and a base. This reaction produces water, salt, and often carbon dioxide gas. Neutralization is applied to discharges of acidic, or alkaline substances and can be used in-situ under proper circumstances (Ref. 5.22).

OXIDATION/REDUCTION -- Oxidation/reduction processes are important methods for treatment of hazardous substances and pollutants. Such processes are based on chemical reactions in which the oxidation state of at least one reactant is raised while that of another is lowered. Detoxification of oxidized or reduced hazardous substances may come as a direct result of the change in valence state of ionic species or it may result from consequent destruction of chemical bond (Ref. 5.33).

Both oxidation and reduction processes are in widespread use in the waste treatment industry. Oxidation is commonly used for treatment of wastes containing cyanides, phenols, and organo-sulfur compounds. Reduction is generally employed to increase removal efficiency of inorganic ions such as heavy metals. For example, reduction reactions are used to remove lead from oil, mercury from effluent, and reduction of chromium to enhance precipitation. Catalysts are often used to speed the reaction rate. Activated carbon is an effective catalyst for nitrile and cyanide oxidation. Catalysts such as zinc, copper, silver, nickel, and palladium are used for destruction or detoxification of chlorinated pesticides.

PRECIPITATION -- Precipitation is a physical-chemical process whereby a substance in solution is transferred into a solid phase and driven out of solution. Current applications of precipitation in treatment of pollutants and hazardous substances include - the removal of heavy metals by lime treatment, the removal of organic colloids, and for treatment of dye manufacturing wastes (Ref. 5.22).

POLYMERIZATION -- Polymerization refers to in-situ catalysis of a released monomer. In-place polymerization serves to make hazardous substances less mobile and facilitates subsequent removal (Ref. 5.34).

5.3.2 Land Management

Current outleases are managed by soil and water conservation plans developed by the cognizant EFD and local SCS offices. These plans consider current legislation regarding water quality standards as well as best management practices for a given land use. Enforcement of these plans usually consists of visual inspection 1 to 4 times a year by Navy natural resource personnel and SCS officials.

However, sampling and monitoring of run-off is not typical, as the historical need has not been established. It is, therefore, difficult to quantitatively ascertain the overall effectiveness of the BMP's being implemented on Navy outleased lands. It is the general belief that since the land use is conservative in most instances, we have no problems to be concerned with.

5.3.2.1 New Agricultural Methods

Several new techniques are being tried to reduce the run-off of sediment, nutrients, and pesticides for agricultural lands. These techniques include periodic soil and crop evaluations, new crop rotation schemes, alternative soil tilling and crop harvesting techniques. These new techniques augment existing techniques such as buffer zones and grass filters.

The University of Pennsylvania has set up a mobile nutrient laboratory to assist farmers in reducing unnecessary fertilizer use. The mobile laboratory periodically visits various farms and obtains soil borings. The borings are tested on site to determine the levels of various nutrients in the soil at various depths. From that test data the University can determine at what rate the fertilizer should be applied. This program has realized a 55% savings in fertilizer use at a typical dairy farm.

The Rodale Research Institute has been investigating ways to regenerate farm land, not to use it as conventional agricultural practices now do. Currently, a farm typically operates a bicultural system of crop rotation of corn and soybeans. The Institute advocates an expanded crop rotation scheme to conserve nutrients in the soil, reduce soil loses from plowing, and encourage natural ecosystems of insects to control undesirable crop pests. For example, soybeans are drilled into a planted field of barley. After the soybeans mature in the fall and are harvested, winter wheat is planted. Clover is planted after the winter wheat is harvested that summer, and corn is planted the following year. They feel this system of crop rotation can be implemented at a conventional farm over a 2- to 3-year period without any economic loss, and greatly reduce erosion and fertilizer and herbicide use.

The University of Arkansas has been researching the use and application of pesticides to determine what practices can be adopted to reduce nonpoint source pollution from this chemical. Typically, farmers apply certain herbicides on a routine schedule throughout the growing season per the manufacturer's directions on the label. Under the University of Arkansas's program, the crops are regularly monitored and inspected for weed infestation. Herbicides are only used when it becomes necessary to eradicate the weeds to protect the crop. When the herbicide is used, it is applied at only 1/4 of the manufacture's recommended dosage. It appears that this strategy is successful when weather conditions allow application at the times recommended by the monitoring program; otherwise, full dosage is necessary. The University has found that the typical farmer can realize over a 50% savings in herbicide use under this monitoring and inspection program.

Research is being performed into different methods of plowing and tilling to reduce erosion of topsoil. Ridge tilling provides weed control and allows for harvesting of the crop by "mowing" techniques. The plant debris is allowed to remain in the field over the winter and only one plowing is needed in the spring to prepare the field for planting. Ridge tilling considerably reduces soil erosion as conventional methods usually leave the field bare over the winter and require plowing several times to prepare the field for planting in the spring. The no-till method of crop planting is another promising method to reduce soil erosion. Seeds are "drilled" into the soil and no conventional plowing or tilling is necessary.

5.3.2.2 Habitat Study Methods

The University of Maryland has been doing various research projects to determine the impacts on Chesapeake Bay from nonpoint source discharges. As part of one project the University has established test plots in the Bay to determine whether the water quality is improving or declining over time. They have found that one reason for the decline of bass in the bay is due to the destruction of their spawning habitat. The bass need areas with bottom grass growing for spawning and to provide cover for the young bass. Algae blooms from the increased fertilizer in the run-off coat the bottom grass and eventually kill it, destroying the bass's spawning habitat. Test plots in the bay are showing that the ecology of the Bay is slowly improving, but continued efforts are needed to restore the ecology of the Bay back to original levels.

5.3.2.3 Soil Bioengineering for Erosion Control

The Navy and SCS are currently studying the use of biotechnical methods to control erosion and improve slope stability. This technology is particularly useful along stream banks, and areas which are prone to rill or gully formation during periods of high precipitation.

In addition to these studies, there are several ongoing projects utilizing soil bioengineering techniques as sediment control measures in the Chesapeake Bay. This work is being carried out by the Soil Bio-engineering Corporation for several cities and counties in both Virginia and Maryland. All of the projects involve stream and river sites. The most common problem is that of stream bank erosion caused by increased storm water run-off from development and highway construction in the area. The increased sediment carried by these streams and rivers is ultimately deposited in the Chesapeake Bay.

Soil bioengineered systems act to reduce the amount of sediment carried by the streams and rivers by protecting and stabilizing the banks. Thesa living systems alter the bank stratigraphy and trap the sediments thereby rebuilding the banks.

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CHAPTER 6

RECOMMENDATIONS

6.1 OVERVIEW

Problems relating to NPS pollution can be dealt with in several different ways. Naturally, the most effective method is to remove, or eliminate the source completely. Since this method is often not practical, the discharge must be controlled, or inhibited from reaching open water. If this solution is not viable, and the discharge is produced and will eventually reach open water, it must be treated prior to its final destination. If this is not feasible, then mitigation measures must be implemented at the impacted site.

The recommendations are, therefore, divided into the following categories:

1. Source reduction/control
2. Assessment/monitoring technology
3. Mitigation measures

6.2 SOURCE REDUCTION/CONTROL TECHNOLOGY

6.2.1 Identification/Elimination of Navy NPSs - Task 1

Background

There are a number of potential surface and subsurface types of NPS discharges at Naval installations. Some are products of current operations, while the others originate from past activities. For example, old landfill sites are potential sources of conventional and toxic pollutants that may be widely dispersed in the soil and groundwater. Escaped wastewaters from industrial and storm sewers may also be sources of NPS pollution. Surface run-off from impervious areas used for industrial operations and maintenance activities is another Navy NPS discharge. There may be inadvertent cross connection between multiple sources complicating the situation.

While general knowledge exists, there is, unfortunately, no hard factual data on the extent and magnitude of NPS pollution at most Naval installations. Such information is needed in order to develop strategic plans for elimination of NPS pollutants and to comply with provisions of WQA/87 .

Objective

The purpose of this task is to identify all Naval operations and activities, past and present, that may be contributing to the pollution of the local waters quality as nonpoint sources.

Approach

To accomplish this task, the Installation Restoration program studies, and other Navy installation studies such as Environmental Engineering Studies and Environmental Assessments prepared by the Naval Facilities Engineering Command Engineering Field Divisions, will be consulted and reviewed in order to identify pollution generating activities and operations that may be or may become NPS pollution sources. Selected and representative Naval installations will be visited to characterize and categorize such sources and develop a Navy-wide definition of the problem. Samples will be collected to characterize and quantify the types and amounts of pollutants in the discharges. Information on site conditions that cause or may lead to NPS discharges will also be collected and evaluated. This will be used for development of mitigation strategies. It is anticipated that the sites to be selected will be located within "problem" water basins.

Product/Results

The information generated under this task will be used to develop strategies for elimination of NPS pollution from identifiable sources and prevention of degradation of the local water quality. The inventory of real estate land uses will also be made. The total number of miles of waterfront that is or may be impacted by Navy NPS discharges will be determined.

6.2.2 Determination of Effectiveness of Control Measures - Task 2

Background

Many measures for the control of nonpoint source pollution have been identified and have been used for a number of years. Recent studies reveal that the effectiveness as well as the design parameters for these measures are unknown. The Navy requires lessors of Navy land to use best management techniques for performing their agricultural operations. The effectiveness of these techniques is not known.

Objective

The purpose of this task is to identify candidate sites for the installation of control measures and to determine their effectiveness through a program of test beds, as conducted by the University of Maryland, or other appropriate monitoring methods.

Approach

This program will be established to determine the effectiveness of commonly used nonpoint source discharges control procedures. It will include a side by side comparison of technologies such as ridge tilling, no till planting, soil fertilizer level monitoring, crop weed monitoring for optimal herbicide use, and alternative crop rotation.

Product/Results

The results of this effort will be used for assessment of usefulness of current practices and measures used for control of nonpoint source pollution on leased Naval lands. Such an assessment will lead to elimination of useless techniques and substitution of more effective methods.

6.2.3 Soil Bioengineering - Task 3

Background

A biotechnical approach to erosion control is being demonstrated at several sites in the Chesapeake Bay region. This technology, along with simpler revegetative methods, may prove to be a simple and environmentally sound practice for the control of sediment and nutrients in the run-off waters. This technology may be used to remove nutrients through plant uptake before run-off waters are transported to open waters and can be used to protect shorelines in open waters from erosion, thereby reducing the sediment loadings.

Objective

The purpose of this effort will be evaluation of state-of-the-art bioengineering methods in control of surface run-off pollution and bank/shoreline erosion and implementation of such methods on Naval lands.

Approach

A desk-top study of bioengineering approaches to control of nonpoint source pollution will be performed, and applicability of such to Naval lands will be determined.

Product/Results

The results of this study will be used for design of cost-effective and technically sound approaches for control of nonpoint source discharges at Naval installations.

6.3 ASSESSMENT/MONITORING TECHNOLOGY

6.3.1 NPS Monitoring Program Requirements - Task 4

Background

Because of the increased complexity of NPS discharge monitoring, conventional methods of sampling and off-site analysis might be too expensive and generally not appropriate for Naval operation. Development of a new set of field chemical tests, which can be combined with geological, hydrological, and climatic observations and examinations, may be necessary to generate required data on nonpoint source pollution discharges.

Objective

The goal of this task is to develop NPS monitoring programs which include protocols/procedures for participation with State NPS programs and criteria/methods for monitoring NPS that are consistent with the States' NPS monitoring programs. This information will be useful to EFDs and installations alike.

Approach

The basic criteria in the development of an adequate monitoring program are that they meet the requirements of the States and the resource capabilities of the installations.

Product/Results

A product of this effort will be a well-developed NPS monitoring program serving the following objectives:

1. Comply with State NPS monitoring program requirements.

2. Identify potential NPS problems early on and allow lead time for implementing mitigation measures.

6.3.2 Develop NPS Monitoring Technique(s) - Task 5

Background

Identification of the origin of NPS pollution is the key element of an abatement program. To perform such a task a material balance for nonpoint sources must be developed, and contribution of each pollutant must be determined. This information will be used to assign responsibilities for remedial action.

Objective

The purpose of developing NPS monitoring techniques is to provide simple and useful tools that can be used to disprove or to confirm the contribution of NPS discharge, located on a Navy installation, to the deterioration in water quality of local waterways.

Approach

Among the techniques to be developed here is the stream flow study method. In this type of method, water quality data as well as stream flow data upstream and downstream of an installation are collected and analyzed. The total deterioration in water quality between those two points, subtracting the known pollution sources between those points, can then be attributed to NPS discharges. Basically, available techniques for monitoring water quality changes and related subject areas will be studied. The most promising techniques (based on Navy use appropriateness) will be selected for development/modification for Navy use.

Product/Results

Developed NPS monitoring techniques will be tested at selected installations to provide a factual data base and prove the magnitude of Naval contributions to the nonpoint source pollution at specific locations.

6.3.3 Develop A Predictive Model To Forecast The Probability Of A Certain Point Source Contributing To NPS Water Quality Deterioration - Task 6

Background

Predictive models are used to forecast the probability of a given nonpoint source contributing to NPS water quality deterioration. Such information is used for determining probabilities of NPS contamination from past operational practices.

Objective

The purpose of developing such a predictive model is to provide a capability to Navy installations to determine whether NPS discharges from an installation can cause a significant impact on a receiving water based on the operations conducted at the installation and the conditions present at the installation that are conducive to NPS discharges.

Approach

The statistical model will be based on regression analysis concepts. To develop the model, a large amount of historical data will have to be collected. The needed data will include site characteristics, waste source records (spills, disposal site wastes, pesticides/fertilizers applications, etc.), migration/channel media data (soil conditions, subsurface characteristics, groundwater formations, ground surface conditions, etc.), and vicinity water quality records, especially those immediately upstream and downstream of the Navy installation/land in question. In tidal areas, tidal effects will need to be addressed and surrounding water quality data will need to be obtained. Special attention will be given to known water quality stress conditions such as fish kills or eutrophication. The model will be validated by testing at selected Navy site(s). The validation phase will include the collection of an adequate amount of new and existing data at the selected site(s) for input to the model.

Product/Results

The model will be used for estimating the probability and magnitude of Naval NPS pollution contributions to the degradation of local water sources. Based on this information corrective actions can be designed and implemented.

6.4 MITIGATION MEASURES

In order to eliminate existing and potential NPS discharges from Naval installations, and to protect local water quality as mandated under WQA/87, pollution mitigation measures will be required. Such measures can be based on emerging technologies, as well as application of existing engineering.

6.4.1 Demonstration of Conventional Engineering - Task 7

Background

The use of conventional and proven technology for control of nonpoint source pollutants at Naval installations is limited primarily to contamination of oil and surface waters by the oil and petroleum products. Such state-of-the-art techniques could be used, however, in many other instances (i.e., to treat run-off from paved areas, golf courses, lawns and other nonpoint sources).

Objective

The purpose of this effort is to evaluate the applicability of existing NPS pollution control technology used at Naval installations for controlling pollution from other sources.

Approach

Technical feasibility and economical soundness of using interceptor ponds and gravity separators that are currently used to treat oily wastewaters will be determined for treatment of nonoily pollutants such as suspended solids, TOC, BOD, COD, and nutrient pollutants typically found in run-off from paved and grassed areas.

Product/Results

Use of well established and familiar methods for control of surface run-off from Naval facilities could lead to design of simple, cost-effective, and practical approach control of such pollution.

6.4.2 Evaluation of Emerging Technologies - Task 8

Background

Due to past practices, remedial action may be required at impacted sites. It is unknown at this time the extent and severity of the problem. Characterization of these sites, including sediments, water, flora and fuana is necessary prior to identifying a course of action for remedial measures. Work in this arena will be initiated at a later date.

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