

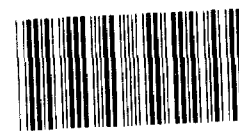
GAO

Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

July 1987

WILDLIFE  
MANAGEMENT

National Refuge  
Contamination Is  
Difficult to Confirm  
and Clean Up



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United States  
General Accounting Office  
Washington, D.C. 20548

**Resources, Community, and  
Economic Development Division**

B-148898

July 17, 1987

The Honorable John D. Dingell  
Chairman, Subcommittee on  
Oversight and Investigations  
Committee on Energy and Commerce  
House of Representatives

Dear Mr. Chairman:

This report responds to your January 6, 1986, letter and subsequent discussions with your office asking us to review the status of cleanup activities at the Kesterson National Wildlife Refuge, located in California. You also asked us to determine whether the Department of the Interior has assessed the extent to which contamination exists at other national wildlife refuges nationwide and whether it has developed programs to deal with actual or potential contamination, and whether the Environmental Protection Agency is enforcing laws to prevent damage to the refuges.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Director, Office of Management and Budget; the Secretary of the Interior; the Administrator, Environmental Protection Agency; and other interested parties.

This work was performed under the direction of James Duffus III, Associate Director. Other major contributors are listed in appendix III.

Sincerely yours,



J. Dexter Peach  
Assistant Comptroller General

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# Executive Summary

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## Purpose

Between 1983 and 1985 an estimated 1,000 ducks at the Kesterson National Wildlife Refuge in California died from contaminated water drained from a nearby irrigation district. National attention then focused on possible contamination problems at the other 429 wildlife refuges nationwide.

At the request of the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, GAO reviewed the status of cleanup activities at the Kesterson Refuge and federal efforts to

- assess the extent of contamination at refuges nationwide,
- develop water quality criteria to protect wildlife and refuge habitat from contamination, and
- deal with actual or potential contamination from agricultural drainage water or other sources.

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## Background

The Department of the Interior is responsible for national wildlife refuges. Such refuges are generally located in wetlands, and thus tend to collect pollutants discharged into the water from surrounding developments. Some refuges have been established on or near military, private, or municipal dump sites and landfills that are leaching pollutants into the surrounding water and soil. Others receive the drainage water from irrigated farmlands, which is contaminated by agricultural chemicals and elements occurring naturally in the soil.

The Kesterson refuge, an example of the latter type, receives its water from a leading California agricultural region. The water was transported there by the San Luis Drain, a project built by Interior's Bureau of Reclamation to relieve excess salinity in the region.

The Clean Water Act requires the Environmental Protection Agency (EPA) to set regulatory criteria to protect fish and wildlife from the effects of water pollution. The Comprehensive Environmental Response, Compensation, and Liability Act requires cleanup of the nation's uncontrolled hazardous waste sites and establishes the Superfund, administered by EPA. Cleanup costs are to be borne first by private responsible parties. Superfund is used if it is not possible to get them to pay, and only for the worst cases.

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## Results in Brief

Contaminated water no longer flows into the Kesterson refuge, and cleanup efforts are underway. Interior has intensified efforts to identify other refuges with the potential for similar problems. An Interior survey indicated that 85 of the 430 refuges are or may be contaminated by agricultural drainwater or by municipal, industrial, or military activities. GAO found that the survey techniques used did not ensure that all contaminated refuges have been identified. Interior is continuing to study the extent of refuge contamination. However, progress in identifying and cleaning up contaminated sites is likely to be slow. Obstacles to identifying and cleaning up sites include

- the lack of water quality criteria to determine when wildlife and refuge habitat are threatened;
- the lack of federal regulatory authority over agricultural drainage water; and
- for municipal and industrial contamination, the lengthy process of identifying the party responsible for cleanup, deciding on a cleanup plan, and obtaining cleanup funds.

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## GAO's Analysis

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### Kesterson's Status

The Bureau of Reclamation has stopped the flow of contaminated water to the Kesterson refuge and prepared a phased cleanup plan to initially treat contamination in place rather than dispose of it. In March 1987 the California Water Resources Control Board, responsible for protecting the state's water resources, rejected the phased plan and approved the concept of on-site disposal. The Bureau will follow the Board's approved concept. Cleanup is required by August 1988 and will cost an estimated \$27 million. (See ch. 2.)

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### Identification Efforts

The problems at Kesterson sparked Interior's Fish and Wildlife Service to survey its 430 refuges for potential contamination. GAO interviewed officials at 26 of the 85 refuges that had identified indications of contamination, and 50 of the 345 refuges without such indications. For both groups, GAO found that about 70 percent of the refuges had not conducted sampling or other studies to identify contamination, but had relied on observation, record searches, or refuge personnel's knowledge. As a result, the Service still does not know with certainty how many

refuges are contaminated. The Service is developing a long-term monitoring and sampling program for all refuges as directed by the Congress. (See ch. 3.)

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**Criteria Lacking to Protect Wildlife and Refuge Habitat**

Determining when and what cleanup actions at refuges are necessary is complicated by the lack of criteria establishing what levels of contaminants are hazardous to wildlife and refuge habitat. EPA has concentrated on establishing criteria to protect human health and aquatic life; these criteria are not applicable to wildlife or the refuge habitat. Without the criteria, the Fish and Wildlife Service has difficulty gauging the impact of the contamination. (See ch. 3.)

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**Cleanup Progress Will Be Slow**

Once a problem is confirmed, the process of determining the party responsible for cleanup and deciding on and carrying out a cleanup plan can consume many years. Court action may be necessary to get responsible parties to accept responsibility. Refuges selected for Superfund cleanup must go through a five-step process that may take 2 to 3 years before cleanup actions begin.

Funding of refuge cleanup is also uncertain. Refuges eligible for Superfund cleanup must compete for funding with other hazardous waste sites, and are likely to be low on EPA's priority list. The Department of Defense has a similar program to deal with the cleanup of its hazardous waste sites. If the executive agencies are responsible, they must obtain funds for cleanup through the annual budget process. (See ch. 4.)

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**No Regulation of Agricultural Drainage Water**

The Fish and Wildlife Service identified 40 of the 85 refuges that are or might be contaminated with agricultural drainage water. The Clean Water Act of 1977, however, exempts agricultural drainage from federal regulation, classifying it as "nonpoint source" pollution (not traceable to a specific point). In the case of Kesterson, however, the contamination can be traced to a specific point source—agricultural drainage collected from farmland through surface and subsurface drains and transported by the San Luis Drain. Interior is studying these 40 refuges to confirm the existence, source, and extent of contamination. (See ch. 5.)

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## Recommendations

GAO recommends that the Administrator, EPA, in close coordination with the Secretary of the Interior, develop water quality criteria for protecting wildlife and refuge habitat.

GAO also recommends that the Secretary of the Interior evaluate the results of the ongoing studies to determine if agricultural drainage traceable to a single source is occurring elsewhere. If it is, GAO recommends that the Secretary work with the Administrator, EPA, in preparing a legislative proposal to amend the Clean Water Act to require that agricultural drainage traceable to a single source be subject to discharge permit requirements.

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## Agency Comments

GAO discussed this information with Department of the Interior and EPA program officials and has included their comments where appropriate. However, as requested, GAO did not obtain official agency comments on a draft of this report.

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**Abbreviations**

EPA	Environmental Protection Agency
NWR	National Wildlife Refuge
USGS	United States Geological Survey
WMA	Wildlife Management Area



# Introduction

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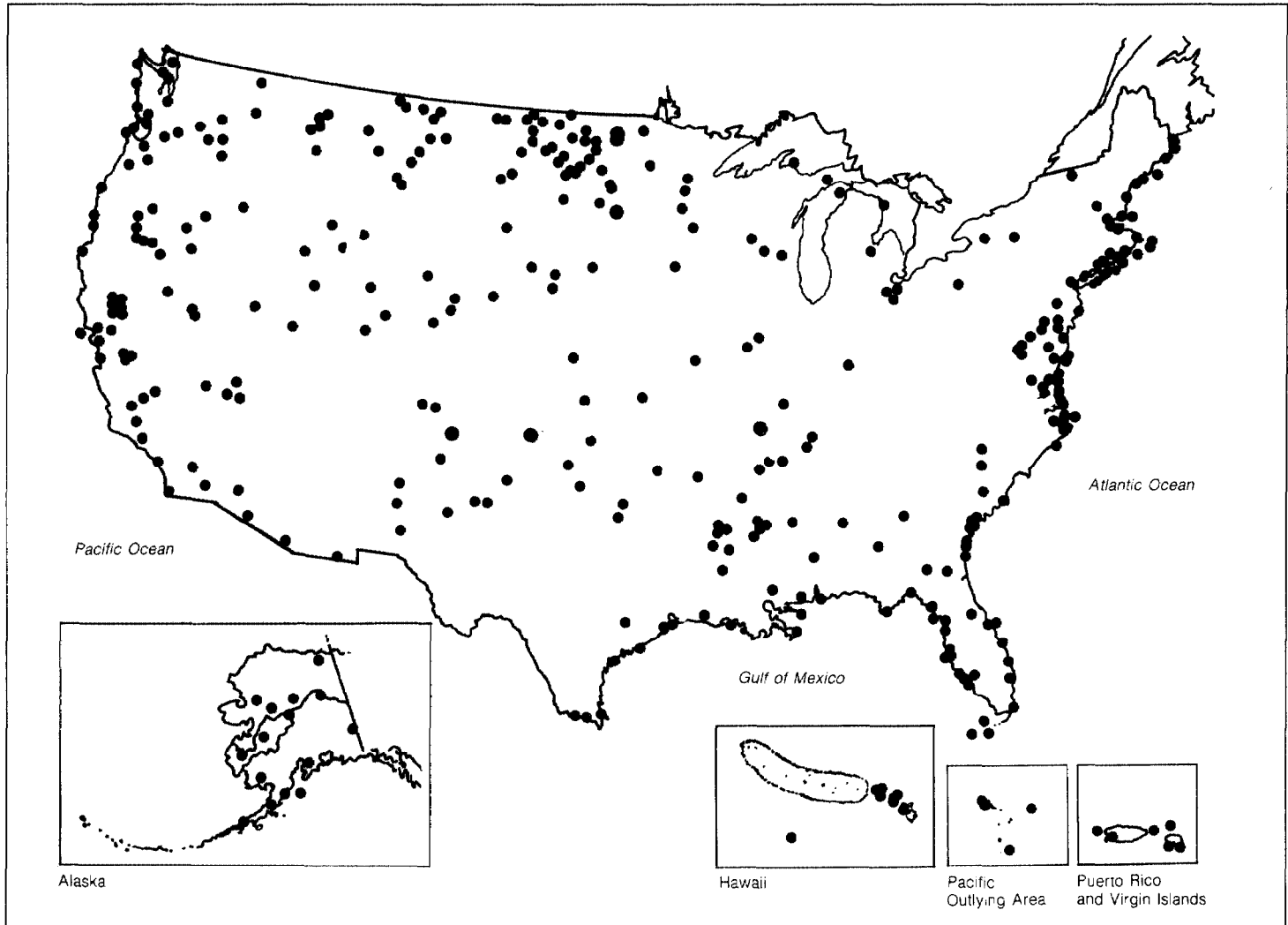
The National Wildlife Refuge (NWR) System is the world's largest collection of lands managed specifically for wildlife. It is managed by the Department of the Interior (Interior) through the Fish and Wildlife Service (Service). Although the refuges have become increasingly important to wildlife conservation, they have also become more susceptible to contamination from pollutants. Public awareness of refuge contamination heightened in 1984 when the news media started covering the contamination problems at the Kesterson refuge in California's San Joaquin Valley. In a letter dated January 6, 1986, the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, asked us to determine the extent to which contamination exists at refuges nationwide, the status of cleanup activities at Kesterson, and the extent to which Interior and the Environmental Protection Agency (EPA) are dealing with actual or potential contamination at selected wildlife refuges.

The refuge system began in 1903 when President Theodore Roosevelt designated Florida's 3-acre Pelican Island as a bird sanctuary. As of April 30, 1987, the 439 refuges encompass about 90 million acres in 49 states and 5 trust territories. The largest newer additions have occurred on federal lands in Alaska, where the Yukon Delta refuge comprises almost 20 million acres. Most of the lands added to the system in the contiguous United States since 1961, however, have been acquired through purchases, donations, or as replacements for lands lost from water development projects.

Like Pelican Island, many of the early refuges were created for water birds. Others were set aside for large mammals like elk and bison. But by far, most are wetlands that have been created to protect migratory waterfowl. This is the result of migratory bird treaties, which require the United States and several other nations to conserve ducks, geese, and other migratory birds. Consequently, refuges dot the map along the four major "flyways" that waterfowl follow from their northern nesting grounds to resting places enroute and finally to winter feeding areas further south. Figure 1.1 shows the location of the national wildlife refuges.

Refuges play a vital role in preserving threatened and endangered species, which are protected under the Endangered Species Act. For many of these rare creatures, secure habitat can mean the difference between extinction and survival. Refuges also conserve habitat for native plants and many species of resident mammals, fish, insects, amphibians, and reptiles.

Figure 1.1: National Wildlife Refuge System



Source: U.S. Fish and Wildlife Service.

Although the refuges have become increasingly important to wildlife conservation, they have also become more susceptible to contamination from pollutants. As historical wildlife habitats have diminished through agricultural, industrial, and municipal development, wildlife have become more dependent on refuges. Many refuges are located in areas where such development has occurred. Since refuges are generally located in wetlands, they tend to serve as sumps, or collection points, for pollutants discharged into the water from these adjacent developments.

Some refuges have been established on or near old dump sites and landfills, which are leaching pollutants into the surrounding water and soils. Unfortunately, little is known about the toxic effects of these pollutants on wildlife or the refuge habitat.

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## Contamination Fatal to Wildlife at Kesterson Refuge

Public awareness of refuge contamination heightened in 1984 when the news media started covering the contamination problems at the Kesterson refuge in California's San Joaquin Valley. Selenium, a trace element that occurs naturally in soil and is needed in small amounts to sustain life, was being leached out of the soil and carried in agricultural drainwater to a part of the Kesterson refuge—the Kesterson Reservoir—where it accumulated at dangerously high levels. The Kesterson Reservoir, in addition to being an integral part of the refuge, is part of the Central Valley Project, a major federal water project constructed by the Department of the Interior's Bureau of Reclamation (Bureau). Dead and deformed ducks were found at the Reservoir, and the Service linked these deaths and deformation to selenium toxicosis. A Service biologist estimated that between 1983 and 1985, at least 1,000 migratory birds died as a result of exposure to selenium at Kesterson.

The news media later suggested that similar problems could be occurring elsewhere in the West, where the federal government had constructed water projects. The Sacramento Bee newspaper ran a series of investigative articles in September 1985 concerning possible selenium contamination at 23 such sites. In December 1985, in the wake of this media attention and congressional inquiries, the Secretary of the Interior initiated an interagency task group to determine whether selenium problems were occurring elsewhere in the West. In addition, the Service initiated a survey to determine the extent of contamination problems at refuges nationwide.

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## Legislation

The problems associated with toxic pollutants in the nation's water supplies and environment have been recognized for many years. Throughout the 1970s and 1980s, the Congress has passed and amended numerous laws aimed at monitoring and cleaning up the environment. With respect to contamination problems at refuges, two laws are critical. The Clean Water Act is directed at restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. The Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as "Superfund," provides for cleanup of the nation's uncontrolled hazardous waste sites. Both acts are administered by EPA.

The Clean Water Act requires EPA to review and publish periodically water quality criteria for pollutants that accurately reflect the latest scientific knowledge. Under the act, each state is authorized to set water quality standards for lakes, wetlands, and rivers and their tributaries within its borders. State water quality standards, which are based on EPA's criteria but may be more stringent, are supposed to represent the goals that pollution controls are meant to achieve. To set these standards, a state specifies the uses of each body of water and determines the maximum pollution levels that can be tolerated without impairing those uses.

States set effluent limitations defining the amount and kinds of pollutants that may be discharged into waterways, and then issue National Pollutant Discharge Elimination System permits to parties making such discharges. Such parties generally include municipal sewage systems and industries operating their own waste water treatment facilities.

Superfund gives EPA money and authority to direct and oversee cleanup of old and abandoned waste sites that pose a threat to the public health or the environment. Once potential sites are identified, site assessments and investigations are undertaken to determine whether problems actually exist. If problems are documented, waste removal or cleanup actions are to be taken to protect the environment and/or public health. Through agreements and other judicial procedures called for by the act, owners of abandoned sites are encouraged or directed to clean up sites themselves or reimburse the government for cleaning up the sites. To the extent that responsible parties cannot be identified or are not able to pay, Superfund will finance these cleanups.

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## **Objectives, Scope, and Methodology**

In a letter to us dated January 6, 1986, the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, expressed his concern about increasing reports of actual or potential damage to National Wildlife Refuge areas from toxic, saline, pesticide, and other wastes resulting from farm and other activities that are supported by federally constructed projects, such as the San Luis Drain in California. He was concerned that the laws administered by EPA to prevent and control wastes were not being enforced by EPA to prevent actual or threatened damage to these refuges, and that Interior was not adequately using its authorities to prevent such wastes and enforce laws, regulations, and contract provisions that could prevent such wastes. The Chairman asked us to focus on the activities at the Kesterson refuge in California, and raised a series of questions about the waste

problem at Kesterson and its impact on fish and wildlife and on refuge operations. In addition, he asked us to address what Interior is doing to resolve the agricultural drainage problems in the San Joaquin Valley. In subsequent discussions with the Chairman's office, we were asked to expand our review to all national wildlife refuges in order to look at contamination problems caused by wastes from industrial, agricultural, municipal, and military sources.

To address these broad issues, our specific objectives were to determine

- the status of cleanup activities at the Kesterson refuge, including impacts on fish and wildlife and refuge operations, federal enforcement responsibilities and actions taken, and the timetable and costs of proposed cleanup plans, including agreements reached among responsible entities (ch. 2);
- whether Interior has assessed the extent to which contamination exists at its refuges nationwide and developed programs to deal with actual or potential contamination, and if such contamination is found, whether EPA or Interior has developed water quality criteria that can be used to protect the fish and wildlife from contamination (ch. 3); and
- the extent to which Interior and EPA are dealing with actual or potential contamination at selected wildlife refuges. (Chapter 4 discusses municipal, industrial, and military contamination issues, and the Superfund process. Chapter 5 discusses agricultural drainage issues including the San Joaquin Valley activities, applicable Clean Water Act provisions, and whether Bureau contracts for water supply contain provisions to control agricultural drainage pollution.)

To address the first objective, we interviewed Service, Bureau, U.S. Geological Survey (USGS), EPA, state of California, Westlands Water District, and environmentalist group officials and obtained documents, including environmental impact statements, regarding the Kesterson refuge contamination problem. We also attended public hearings to determine public opinion on Kesterson cleanup issues.

To address the second objective, we interviewed Service and Interior officials and obtained documents describing their efforts to (1) determine the extent to which contamination existed at refuges nationwide and (2) develop programs to deal with actual or potential contamination. We evaluated the Service's April 1986 report, Preliminary Survey of Contaminant Issues of Concern on National Wildlife Refuges, which was based on a 1985 questionnaire completed by the 430 refuges that existed as of May 1985. To determine the methodology and evidence used by



refuge personnel to develop the data for the report, we conducted telephone interviews in November 1986 with Service officials at 76 refuges. Specifically, we contacted 26 refuges in the Service report—9 refuges where contamination existed and corrective action was needed and 17 refuges where contamination was suspected or needed to be confirmed. We also contacted 50 refuges that were not in the report or considered to have contamination issues at the time of the survey. We did not design the sample to project the results to the 430 refuges nationwide, but rather to identify possible problems in the survey report. The 76 refuges we contacted are listed in appendix I.

Regarding the water quality criteria issue in the second objective, we interviewed EPA, Interior, and state officials and obtained documents to determine what criteria have been established to protect fish, wildlife, and refuge habitat. We also reviewed applicable federal laws and regulations that require the development of such criteria, and determined the extent to which the responsible agencies have established criteria.

To address the third objective, we judgmentally selected and visited eight refuges in order to interview refuge officials, obtain information, observe refuge conditions, and determine the status of contamination identification, confirmation, and cleanup activities. We selected the refuges we visited on the basis of the following criteria: they were identified by the Service as having direct evidence of contaminant problems that need either corrective actions or in-depth monitoring and analysis of impacts; they contained contamination from agricultural, municipal, industrial, or military sources; and they were located in seven states that included four out of seven Service regions. Appendix II provides the locations of the refuges within each state and a general description and background on the refuge and its contamination issues. Table 1.1 identifies the eight refuges and their locations.

**Table 1.1: National Wildlife Refuges and Service Regions Included in GAO's Review**

<b>Refuges</b>	<b>Regions</b>
Seal Beach, California Stillwater, Nevada	Region 1, Portland, Oregon
Cibola, Arizona and California Imperial, Arizona and California	Region 2, Albuquerque, New Mexico
Wheeler, Alabama	Region 4, Atlanta, Georgia
Great Meadows, Mass. Great Swamp, New Jersey Tinicum, Pennsylvania	Region 5, Boston, Mass.

Also regarding the third objective, we interviewed Interior and EPA officials and obtained and reviewed program status and technical reports and pertinent environmental laws, including the Clean Water Act and Superfund. We reviewed Bureau water supply contracts and interviewed Bureau contracting officials to determine whether such contracts contain provisions to control agricultural drainage pollution.

Our work was conducted from March 1986 through March 1987 and was performed in accordance with generally accepted government auditing standards. The views of Interior and other federal officials responsible for the programs discussed in this report were sought during this review and are incorporated into the report where appropriate. In accordance with the requester's wishes, we did not request Interior or the other agencies included in our review to comment officially on a draft of the report.

# Contamination at the Kesterson Refuge and Cleanup Status

In 1984, after high levels of selenium were discovered in the waters of the Kesterson refuge and many dead or deformed newborn waterfowl were found, the Fish and Wildlife Service closed the evaporation pond area of the refuge to all public use and began a hazing program to frighten waterfowl away. The selenium was traced to agricultural drainage water coming from farms in the Westlands Water District<sup>1</sup> via the San Luis Drain. In June 1986, under orders from the Secretary of the Interior and the state of California, Westlands and the Bureau of Reclamation stopped all drainage flows into the drain and the refuge.

Pursuant to the California Water Resources Control Board's cleanup and abatement order, the Bureau of Reclamation submitted a plan to the state in December 1986 for cleaning up Kesterson by March 1992. The plan recommended a phased approach to treat in place, rather than dispose of, contaminated material, in which each phase involves more intensive efforts should the previous phase fail. The state rejected the Bureau's plan in March 1987 and approved on-site disposal. On April 7, 1987, the Secretary of the Interior decided to follow the state-approved, on-site disposal concept.

## Kesterson Originally Seen as a Temporary Solution to Valley Drainage Problems

The Kesterson refuge traces its origins to an agricultural problem in the San Joaquin Valley. The valley is located in a semi-arid portion of California, and much of its west side contains naturally saline soil. Because the water used in irrigation also contains natural salts, upon evaporation it adds to the already saline soil of the region. If the soil is left untreated, the salt accumulates until only those crops that are very salt-tolerant, such as cotton, can be grown.

Where there is adequate underground drainage, the salt can be flushed out of the soil by irrigating with more water than is needed to grow crops. However, much of the valley's west side lies above a relatively impermeable layer of clay that impedes the movement of water downward through the soil into the deep water table. As a result, salty water stays on top of the underlying clay, eventually building up and saturating the root zone of crops until crop growth is no longer possible.

## San Luis Unit Constructed

To relieve the salt buildup as well as supply water to the valley's west side, the Congress authorized the Bureau in 1960 to construct the San

<sup>1</sup>Westlands is a special governmental entity chartered under the laws of California that is eligible to receive water from federal projects in the San Joaquin Valley.

Luis Unit as part of the Central Valley Project.<sup>2</sup> The unit, a joint project with the state of California, was designed to transport and store surplus water from Northern California and deliver it to a federal service area in Central California for agricultural purposes and to a state service area in Southern California for agricultural, municipal, and industrial purposes. Among the facilities to be developed was an adequate agricultural drain for the federal San Luis water service area that would carry away the salt-laden water used to cleanse the soil.

In 1968 the Bureau started construction of the San Luis Drain. The drain was to begin southwest of Fresno and deposit water some 200 miles north into the San Joaquin-Sacramento Delta, which runs into the Pacific Ocean through the San Francisco Bay. The drain would primarily serve the Westlands Water District, which contains over 600,000 acres of land. (See fig. 2.1.) The San Luis Drain was to be completed in sections, with the final section—northward to the point of discharge into the delta—to be undertaken after further environmental studies. Recognizing that these studies might delay discharge into the delta for several years, the Bureau planned to construct a reservoir at about the halfway point of the drain to provide temporary drainwater discharge and storage until the drain's northern section could be completed. Eventually, funding constraints and environmental concerns blocked the completion of the northern section, and this reservoir became the terminus of the San Luis Drain.

The Kesterson Reservoir, as it was named, was not a reservoir in the usual sense, but a series of evaporation ponds created with low dikes. (See fig. 2.2.) To facilitate construction of the evaporation ponds, in 1968 the Bureau purchased 5,900 acres of native grasslands and wetlands in Merced County, near Gustine, California, which now comprise the Kesterson NWR.

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## Refuge Established

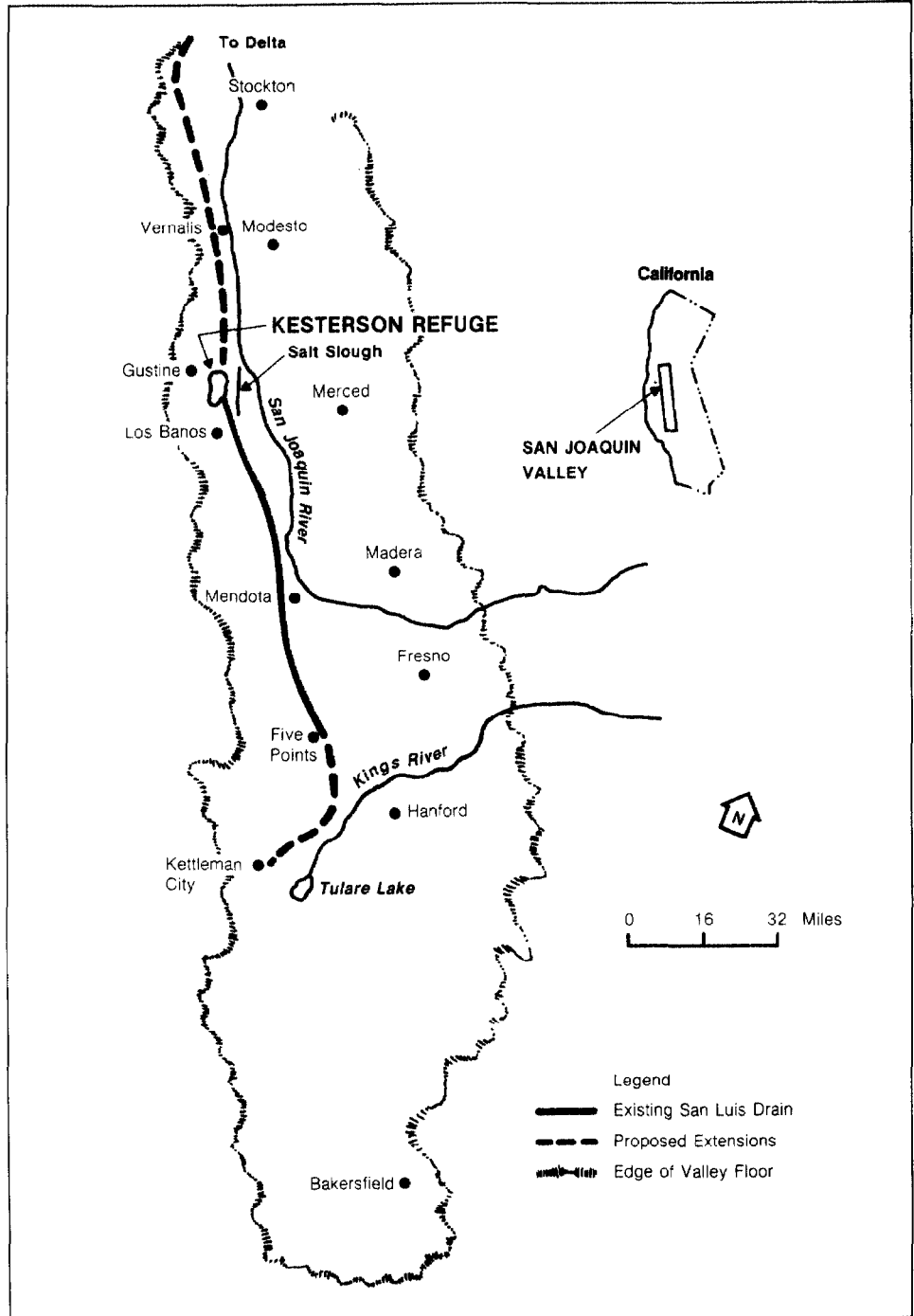
Following this land acquisition, the Service asked the Secretary of the Interior, under provisions of the Fish and Wildlife Coordination Act, to designate the area as a unit of the NWR System. Because it was concerned about the diminishing waterfowl habitat in the San Joaquin Valley, the Service had previously endorsed the use of drain water for waterfowl and fishery production within evaporation ponds as part of the drainage system in the San Luis Unit.

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<sup>2</sup>An integrated network of dams and reservoirs designed primarily to provide flood control, water for irrigation and municipal and industrial use, and power generation.

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Cleanup Status**

**Figure 2.1: Location of the San Joaquin Valley, San Luis Drain, and Kesterson Refuge**

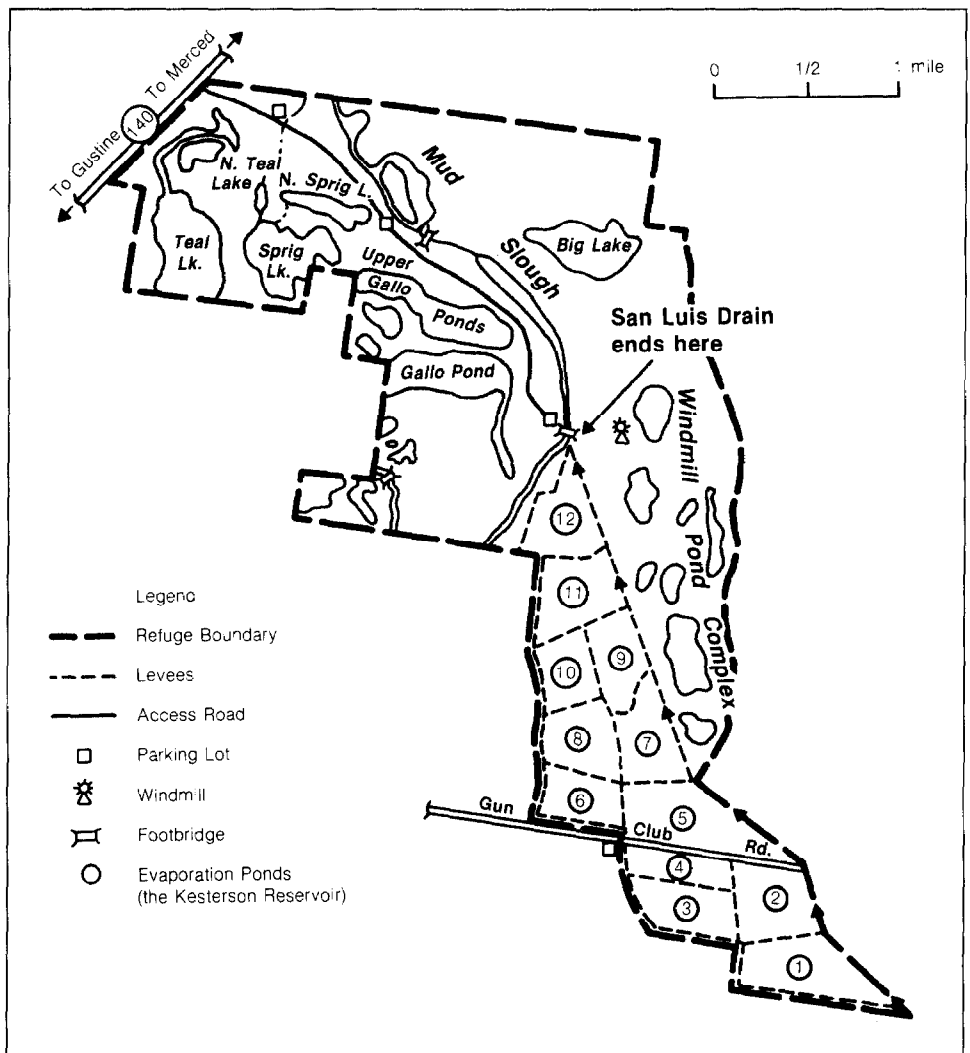


Source: U.S. Bureau of Reclamation.

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In 1969 the Secretary approved a general plan to make these federal lands available to the Service for the conservation and management of wildlife resources, subject to the primary purpose of the reservoir for the regulation of drain water. In July 1970 a cooperative management agreement between the Service and the Bureau was reached and the area became known as the Kesterson NWR. By 1972 the Bureau had constructed 85 miles of the drain and 12 evaporation ponds totaling 1,280 acres.

**Figure 2.2: Kesterson National Wildlife Refuge**



Source: U.S. Bureau of Reclamation.

## Selenium Contamination Recognized

From 1972 to 1978, before Westlands' collection drains were completed, irrigation-quality water was delivered to the ponds. This water created a very attractive habitat for migratory waterfowl that use the San Joaquin Valley for their wintering grounds. Subsurface drain water began to flow into the Kesterson ponds during 1978, and by 1981 it constituted the refuge's total water supply. The subsurface drain water came from a collection system that effectively drained a 42,000-acre area within Westlands.

As part of the environmental studies for extending the drain to the delta, Bureau personnel began testing water quality within the drain in May 1981. Initial test results for selenium, one of several elements being monitored, showed elevated levels, but Bureau personnel did not consider them meaningful at that time. Also in 1981, the Kesterson refuge manager noticed dead or dying vegetation and the absence of small mammals and aquatic life forms at the Kesterson ponds. He speculated that this was due to high levels of salts in the drain water and suggested that the Service initiate a study of the situation.

In 1982 Service research biologists toured Kesterson and collected samples of mosquito fish for contaminant analysis and comparison with a wildlife area not receiving drain water. Toxic test results on the mosquito fish sampled showed selenium levels 100 times greater than those found in samples from the control area. Although Service biologists were unsure what these selenium concentrations meant, they were convinced that the drain and the ponds should be further studied for probable contamination. During the spring of 1983, Service biologists conducted on-site studies of nesting waterfowl at the refuge. They observed dead and deformed embryos in several kinds of waterfowl and attributed these abnormalities to the effects of selenium.

According to one of the biologists, the Bureau challenged the Service's findings and questioned its ability to detect and test for selenium. While the dispute continued, the Service asked USGS for assistance in validating the data. In February 1984 USGS agreed with the selenium concentrations identified by the Service.

During 1984, research studies at the refuge further documented the presence of selenium in waterfowl. Various abnormalities were identified: embryo deformities and mortality, a trend of weight loss in adult birds, deaths of adult birds, a trend of increasing selenium concentrations in bird samples, elevated levels of selenium in the food chain, and nesting failures.

In late 1984 USGS reported the following information:

- It had detected selenium in 76 percent of 130 sampling sites within the San Luis Drain service area.
- Concentrations were highest in the central and southern parts, which included lands within Westlands Water District.
- Concentrations were much higher in the sediments of the drain than in the drain water itself.
- The greatest selenium concentrations were found near where Westlands' collector drains discharge into the drain.

This information positively linked the source of the selenium contamination in the Kesterson ponds to drain water from farms in the Westlands Water District.

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## Ponds Closed, Drains Plugged

In 1984 the Bureau and the Service closed the ponds to all public use and initiated a waterfowl protection program comprising three parts: operation of the ponds to make them unattractive to waterfowl, a hazing program to frighten birds away from the ponds, and the improvement of nearby habitat to attract waterfowl away from Kesterson.

In February 1985 the California Water Resources Control Board, which is responsible for protecting the state's water resources, reviewed the Kesterson situation. Acting on a petition from a citizen who owned property adjacent to the ponds, the Board adopted an order (1) stating that the wastewater in the ponds was hazardous, was threatening state waters, and was a threat to public health because of the potential for consumption of contaminated waterfowl and (2) directing the Bureau to alleviate nuisance conditions at the ponds within 3 years.

In March 1985 the Secretary of the Interior instructed the Bureau and the Service to begin shutting down Kesterson, plugging the San Luis Drain, withholding irrigation waters from lands that were being drained, and cleaning up the contaminated water and soil. In his statement, he cited concerns about public health, compliance with state and federal law, the insufficiency of the hazing program, and prohibitions contained in the Migratory Bird Treaty Act. Regarding the Migratory Bird Treaty Act, the Secretary was advised by Interior's solicitor that Interior personnel could be subject to criminal prosecution if migratory waterfowl died from ingesting selenium at Kesterson.



Westlands objected to the Secretary's instruction to stop delivering water to lands that drain into the ponds, citing the economic hardships it would bring to the farmers and their communities. Interior and Westlands reached an agreement that the Bureau would continue irrigation water deliveries while Westlands, at its own cost, would take action to eliminate the flow of drain water into the San Luis Drain and the Kesterson ponds by June 30, 1986. The Department of Justice, upon request, advised Interior that no enforcement action under the Migratory Bird Treaty Act was contemplated against its personnel. As agreed, Westlands plugged collector drains and in June 1986 stopped all drain water flows into the Kesterson ponds. Drainage then flowed into the valley soil, as it had before construction of the San Luis Drain.

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### Impact on Westlands' Farming Operations

According to Westlands' public information officer, plugging the drains created no negative impact on any of the farms located in the affected 42,000 acre area. As of December 15, 1986, there had been no rise in the water table since last season, and none of the reported crop yields were lower than the previous year's. Westlands was encouraged by this situation but considers it temporary, and is concerned that over time the affected area, as well as additional acreage in the district, will require drainage.

To offset and delay some of the need for drainage, Westlands has initiated two water management programs in the affected area: (1) a recycling program, which consists of reusing drainwater diluted with fresh water and (2) an irrigation scheduling program to improve the application and timing of periodic crop irrigations. During the last irrigation season, the recycling and irrigation scheduling programs were used on about 33 percent and 96 percent, respectively, of the affected 42,000 acres.

Concerned that solutions to San Joaquin Valley drainage problems will not be forthcoming in the near term (see ch. 5), Westlands is also testing two experimental drainage disposal techniques: (1) a biological process to remove selenium and other potential toxicants from drainwater and (2) a deep-well injection process to place the drainwater underground below usable aquifers. In October 1986 Westlands executed contracts with two consulting firms to develop 1-million-gallon-per-day prototypes of these techniques. The biological process and deep-well injection prototypes are expected to be completed and available for testing in the fall of 1987 and the spring of 1988, respectively. Estimated costs of the two

prototypes are \$4.9 million for the biological process and \$1.7 million for the deep-well injection process.

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## Plans for Cleaning Up Kesterson

Three types of proposals were considered as the Bureau developed its plan for cleaning up the ponds at the Kesterson refuge: (1) disposal of contaminated soil and vegetation off-site, (2) two versions of on-site disposal, and (3) a phased approach beginning with less costly measures to treat in place, rather than dispose of, contaminated materials and proceeding with on-site disposal if treatment techniques failed. The Bureau's final environmental impact statement recommended the phased approach.

Originally, the Service, environmentalist groups, and the several individuals commenting on the draft impact statement favored off-site disposal as providing the greatest assurance of reducing the risk to wildlife and meeting the state's time frame for cleanup. They felt the phased approach was based on incomplete information and posed unacceptable risks to wildlife. However, the off-site disposal plan was omitted from the final environmental impact statement on the grounds that no available off-site landfills existed with sufficient capacity, and it would likely involve substantial costs for acquisition of a landfill site and disposal operations.

One version of on-site disposal suggested by the Service involved (1) establishing an on-site landfill that would contain up to 1 million cubic yards of contaminated soils, sediments, and vegetation, (2) removing the Kesterson Reservoir (the 12 evaporation ponds) from the Kesterson NWR, (3) immediately establishing a wetland habitat elsewhere to compensate for the loss of the ponds, (4) taking steps to protect endangered and potentially endangered species located at the Kesterson refuge, and (5) continuing nuisance abatement actions, such as hazing and provision of alternative habitat to draw birds away from the ponds. This proposal was discussed in the summary of the final environmental impact statement.

A second, less intensive, on-site disposal alternative involved removing an estimated 450,000 cubic yards of materials containing contaminated soils and sediments and placing them in a lined and capped containment area.

Eventually, however, the Service's director and the Bureau's commissioner agreed on the phased approach suggested by the Bureau. This

approach had as its goal to achieve safe selenium levels in the refuge's water and food chain within 5 years. In the meantime, the nuisance abatement actions would continue. The first phase, flexible response, involved flooding the southern ponds with low-selenium groundwater and keeping the northern ponds dry while controlling the vegetation there by plowing it under. These procedures, based in part on the results of scientific work conducted at the pond site over the past year by the University of California, were designed to lock up selenium biologically or chemically in the pond sediments.

If cleanup goals are not met in the first phase, a second phase, immobilization, would be implemented. This phase would involve increasing water depths in the southern ponds and harvesting vegetation there. If both phases fail to meet cleanup goals, the third phase—the on-site disposal option—would be implemented.

The phased approach was chosen because it had the potential to save substantial costs and to add to scientific knowledge about selenium contamination. The assistant secretaries who approved the decision noted the lack of standards or widely accepted criteria to determine acceptable levels of selenium for a healthy wildlife environment and reasoned that research under the phased approach would assist in determining acceptable levels. The financial and scientific benefits would make the increased short-term risks to human and wildlife populations reasonably acceptable.

Table 2.1 compares the costs of these alternatives as estimated by the Bureau.

**Chapter 2**  
**Contamination at the Kesterson Refuge and**  
**Cleanup Status**

**Table 2.1: Kesterson Cleanup Proposals—Cost Estimate Summary**

Dollars in thousands	
<b>Cleanup proposals</b>	<b>5-year cost</b>
1. Phased approach:	
Flexible response:	
Capital costs	\$300
Monitoring and operations	6,600
<b>Total</b>	<b>6,900</b>
Immobilization:	
Capital costs	4,200
Monitoring and operations	6,600
<b>Total</b>	<b>10,800</b>
2. On-site disposal:	
450,000 cubic yards:	
Capital costs	16,150
Monitoring and operations	4,550
<b>Total</b>	<b>20,700</b>
1 million cubic yards:	
Capital costs	40,000
Monitoring and operations	4,550
<b>Total</b>	<b>44,550</b>
3. Off-site disposal:	
Capital costs	62,500 <sup>a</sup>
Monitoring and operations	2,200
<b>Total</b>	<b>\$64,700</b>

<sup>a</sup>Assumes a disposal facility is available and is within 100 miles. The Bureau has not identified a facility that will accept the materials for disposal.

Note: Costs do not include expenditures through February 1987 (estimated at \$5.6 million) for preparing an environmental impact statement and related documents, and developing and testing proposals prior to implementation. Costs also do not include long-term replacement of the habitat lost because of the contamination, which would require an estimated capital investment of \$6 million to \$10 million.

According to the Bureau, the Kesterson cleanup and possible replacement would require additional congressional appropriations. Under current repayment policies, the costs would be charged to the San Luis Unit and repaid by Central Valley Project water users.

**Plans to Restore a Safe Wildlife Habitat**

Apart from the cleanup efforts, the Kesterson refuge faces certain immediate and longer term operational problems. These include protection of wildlife still using the refuge while cleanup efforts get underway,

the need for a clean water supply, and the need for an alternative habitat should the cleanup efforts fail to provide a safe refuge.

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## Continued Danger to Wildlife

Since 1984 the Kesterson pond area, the major wildlife attraction in the Kesterson refuge, has been closed to public use. The hazing program established that year has been successful in scaring away visiting waterfowl, but has had little success in scaring away resident birds and animals. As a result, resident birds and animals, including the endangered San Joaquin kit fox, still live in or near the pond area and continue to be susceptible to selenium poisoning.

For example, in the spring of 1986, the Service noted a breeding problem among tricolored blackbirds. Over 250 dead chicks were collected from the levee roads and around two ponds. By early May the Service estimated that the tricolored blackbird population at the Kesterson ponds had suffered an almost total nesting failure. At that time the colony consisted of approximately 47,000 breeding adults—up to one-third of the world's population of these birds. Subsequent tests indicated that the dead chicks contained high levels of selenium, which is thought, but not proven, to be the cause of death.

To reduce risks of harm to wildlife during the phased cleanup approach, the Bureau and Service recommended

- hazing of wildlife at the ponds until the ponds are environmentally safe for wildlife;
- harvesting of vegetation, if necessary, to enhance hazing effectiveness or control availability of contaminated wildlife food;
- providing alternative habitat for tricolored blackbirds now using the ponds; and
- conducting field studies to determine the hazards of contamination to the endangered San Joaquin kit fox.

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## Need for a New Water Source

According to the Kesterson refuge manager, the major operating problem at the refuge since the discovery of selenium in local drain water is the lack of "quality water" (noncontaminated) and a system to deliver the water to other parts of the refuge.

To help with water supply and distribution during the cleanup, the Bureau and Service recommended

- providing groundwater pumping facilities, dikes, and water control structures to improve the habitat on Kesterson refuge and
- providing a water supply to the Service for use on lands elsewhere, to offset the loss of habitat at the ponds by increasing the attractiveness of alternative habitat to wildlife.

### Potential Need for a New Habitat

Long-term replacement of the habitat lost because of contamination is another concern the Bureau and Service may have to deal with. Staff within the Service including the refuge manager are concerned that the Kesterson pond area may never be suitable for wildlife and have recommended that the ponds be replaced with wetlands of similar size. The Service has estimated the capital cost of the replacement to be from \$6 million to \$10 million. The Bureau's commissioner and Service's director recommended deferring decisions on purchasing private lands surrounding Kesterson or acquiring lands elsewhere, pending further evaluation and the outcome of litigation between the United States and the owners of two adjacent properties.

### California State Water Board Decision and Interior's Response

As required by the state Board's cleanup and abatement order, the Bureau submitted its proposed cleanup plan in December 1986 for the Board's review and approval.<sup>3</sup> The Board held hearings to obtain public comments on the Bureau's plan. Environmentalists and a Service biological expert reiterated their concerns about the continued risks posed to wildlife and the likelihood that the state's cleanup milestone of February 1988 would not be met, and the staff of the Board echoed these concerns.

In March 1987, after reviewing the available evidence, the state Board rejected the phased approach and approved the concept of on-site disposal. The state Board concluded that the flexible response and immobilization proposals (1) lacked sufficient information to assess their technical feasibility, (2) continued to subject wildlife to significant risks, (3) did not afford adequate water quality protection equivalent to on-site disposal, and (4) provided little cost benefit over on-site disposal in terms of present value. The state Board order requested the Bureau to submit waste discharge information regarding the on-site proposal within 60 days and ordered its regional water quality control board to

<sup>3</sup>When the Bureau submitted its cleanup plan to the state Board, it presented only one on-site disposal option, consisting of 600,000 cubic yards of material and an estimated 5-year cost of about \$27 million. (This on-site disposal option differs from the two on-site versions the Bureau considered when developing its plan.)

adopt waste discharge requirements 90 days thereafter. This action effectively extends the state's cleanup milestone to August 1988. In addition, the state Board ordered the Bureau to submit a report within 60 days addressing the need to compensate for the loss of wetland habitat at Kesterson.

On April 7, 1987, the Secretary of the Interior announced that he had decided to cooperate with the state to implement on-site disposal. However, he suggested that before cleanup could begin, several important issues needed to be resolved.

- California's Department of Health Services must classify the Kesterson waste for its level of toxicity before engineering decisions relative to the final design of the on-site storage facility can be made.
- California's Central Valley Regional Board must issue a permit for the cleanup process and adopt waste discharge requirements before the size of the on-site facility can be determined.
- Interior will have to seek and obtain additional appropriations from the Congress in order to fund the construction of the state-approved cleanup facility.

In May 1987 the Bureau submitted a report concerning waste discharge information to the Regional Board as required. As of June 1, 1987, the Regional Board was reviewing this information and was expected to adopt waste discharge requirements by mid-August 1987. However, the California Department of Health Services had not yet classified the level of waste at Kesterson.

According to the Bureau's Kesterson program manager, the additional time needed to resolve the above issues means that final cleanup specifications, which are necessary for implementation, probably will not be completed until September 1987. Consequently, even if adequate funding is obtained, she suggested that work at the site should be postponed until spring 1988, after the winter rainy season is over and the pond area is dry enough to accommodate earth moving equipment.

The Bureau submitted its report concerning the need to compensate for the loss of wetland habitat to the Regional Board in May 1987, as required. The report, while addressing the subject of long-term habitat replacement, did not recommend a specific course of action. Instead it reiterated that Interior is evaluating long-term actions in accordance with its responsibilities and authorities. No specific date was provided as to when this evaluation would be completed; however, the report

stated that completion would depend in large part on the habitat conditions that can be expected at the Kesterson Reservoir area following approved cleanup actions.

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## Conclusions

The Bureau of Reclamation and the Fish and Wildlife Service have taken steps to arrest the unforeseen effects of selenium contamination at the Kesterson refuge. The Department of the Interior hoped that its plan to cleanup the contamination would achieve safe selenium levels in the refuge's water and food chain within 5 years. Interior identified cleanup options with costs ranging from \$6.9 million to \$44.5 million, which would be covered initially by federal appropriations, but would eventually be repaid by Central Valley water users. Interior's preferred phased cleanup approach was challenged by environmentalist groups and was rejected by the California State Water Board.

In April 1987 Interior decided to adopt the state's suggested on-site disposal option, and cooperate with the state to carry out the disposal, which is estimated at \$27 million.



# Extent and Effect of Refuge Contamination Nationwide Remains Largely Unknown

Following the disclosure of contamination at the Kesterson refuge, the Service completed a nationwide survey in 1985 to identify potential contamination at its 430 refuges. The survey was based on refuge personnel reviews of site records and visual observations of the refuge site rather than on periodic sampling of fish, wildlife, or the refuge habitat. In short, the survey represented a limited indication of potential contamination, not a thorough evaluation of the problems. As a result of congressional direction, the Service has begun to put in place a long-term monitoring and sampling program for all refuges.

Once suspected contamination problems are confirmed, the Service needs to know the impact of the contamination on fish, wildlife, and the refuge habitat so it can determine what action is necessary to protect the refuge. However, the Service does not always know whether contamination is harmful because the potential toxic effects of many elements are unknown, and EPA has not established levels at which contamination might be harmful to wildlife or its habitat.

## Limitations of the Contaminant Issues Survey

In 1985 the Service attempted to determine the extent of contamination at refuges nationwide. Its April 1986 report, Preliminary Survey of Contaminant Issues of Concern on National Wildlife Refuges, was based on a questionnaire completed by refuge personnel. We found that most of these personnel judged the potential for contamination on the basis of records review and visual observations rather than on on-site testing or analysis of fish, wildlife, and refuge habitat samples.

## Survey Approach

In May 1985 the Service requested that each of the 430 refuges complete a questionnaire for each contaminant issue or problem perceived to either (1) have a persistent adverse impact on refuge habitats, animal populations, or human health and safety or (2) potentially violate federal or state laws, local ordinances, or international treaties. The questionnaire provided no criteria for determining whether a particular substance in the environment might be harmful.

After the questionnaires had been reviewed by the regional offices, they were tabulated in July 1985, and in September a report was drafted. The final report was issued in April 1986, following a Service-wide review of each contamination issue cited in the September draft. The report identified contaminant problems at 85, or about 20 percent, of the 430 refuges. Although 87 other refuges identified possible contamination problems, the Service determined that these problems had been solved

or did not meet its definition of a contamination issue or problem. The Service noted that it would continue monitoring or other follow-up action to ensure that benign situations would not become future issues of concern. After a review of regional and refuge file information and discussions with field and regional personnel, the Division of Refuge Management placed the contamination problems in categories. (See table 3.1.) Contamination stemmed from four major sources, as shown in table 3.2.

**Table 3.1: Number of Refuges With Contaminant Problems, by Category**

<b>Category</b>	<b>Number of refuges</b>
A. Evidence indicates the need for corrective action.	9
B. On-site, direct evidence indicates the need for in-depth monitoring and analysis of impacts.	28
C. On- or off-site, circumstantial evidence indicates a priority need for additional reconnaissance monitoring.	48
<b>Total</b>	<b>85</b>

**Table 3.2: Number of Refuges With Contaminant Problems, by Contaminant Source**

<b>Contaminant source<sup>a</sup></b>	<b>Number of refuges</b>
Agricultural drainage	40
Industrial waste	21
Municipal waste	12
Military activities	8
Other (asbestos, cattle waste, mosquito spraying)	4
<b>Total</b>	<b>85</b>

<sup>a</sup>Some refuges were contaminated by several sources (e.g., industrial/municipal). The source identified in the table represents the first source shown in the Service report, which we used as the basis to categorize sources, and may not necessarily signify importance.

## Our Evaluation of the Survey

To evaluate the Service's survey methodology and results, we interviewed Service personnel in November 1986 by telephone at 76 selected refuges. Twenty-six of these refuges had been identified in the survey as having actual or suspected contamination. These 26 included the 9 listed in category A, plus 17 randomly selected from refuges listed in categories B and C of the Service's report. We selected randomly the other 50 refuges from 345 that were considered not to have contamination at the time of the survey. Our results cannot be projected to the 430 refuges nationwide, but they can be used to indicate shortcomings in the survey results.

The 26 Refuges Listed in the Survey

At the 26 refuges listed in the survey as potentially contaminated, we contacted 23 refuge managers, 1 assistant refuge manager, and 2 refuge biologists. These officials completed the questionnaire and were familiar with refuge contamination problems. The questionnaires completed by the 26 refuges identified 49 actual or suspected contamination problems.

We asked the refuge officials how they judged that contamination might be present. They told us that 14 (29 percent) of the reported problems were identified through a sampling or contamination study. The remaining 35 problems at 18 refuges were identified through on-site visual inspection or observation, searches through refuge records, citizen complaints, news media, or the knowledge and past experience of refuge personnel.

The contamination problems generally were known to the refuge personnel far in advance of the 1985 survey. The refuge personnel told us they knew about or suspected 25 of the 49 contamination issues for at least 5 years. For example, personnel from the Wheeler refuge in Alabama suspected DDT contamination for over 10 years prior to the survey.

Since the survey, 38 of the 49 actual or suspected contaminant issues have received some form of additional investigative attention. These actions were performed primarily by service staff as well as other governmental and private entities that were involved in discovering contamination problems prior to the survey. However, personnel from only 7 of the 26 refuges told us that the refuges have received what they would consider a complete contamination review, including samples of fish, wildlife, sediments, and water.

Of the 19 refuges that have not received complete, refuge-wide contamination reviews, 5 are planning intensive sampling or contamination studies, while 14 are not planning additional investigations. The reasons Service officials gave for not performing additional sampling or studies were that (1) no evidence existed to support contaminant problems on other parts of the refuge (9 refuges), (2) contamination studies already had been performed or were underway at the refuge (4 refuges), or (3) funds were not available (1 refuge). When asked if periodic, systematic studies should be performed to identify developing contaminant problems, officials at 16 of the 26 refuges believed they should. The other 10 refuge officials did not believe such routine monitoring efforts are necessary.

The 50 Refuges Not Listed in the Survey

At the 50 refuges that were not considered to have contamination, we contacted 39 refuge managers, 6 assistant refuge managers, and 5 other refuge personnel. All but two of these officials were working at the refuges when the questionnaires were completed.

Refuge officials at 14 of the 50 refuges (28 percent) told us that questionnaire responses were based on investigative action, including sampling or special studies, to identify refuge contaminant problems. At the remaining 36 refuges, no formal sampling or contamination study was performed; instead, the questionnaire responses were based primarily on the personal knowledge of refuge officials.

Refuge officials from 5 of the 50 refuges said that they had become aware of potential contamination since the questionnaire was completed in 1985. For example,

- Ash Meadows refuge in Nevada suspected water contamination because of nearby underground nuclear testing.
- Becharof refuge in Alaska suspected contamination after discovering that oil exploration had been conducted on refuge lands during the 1930s through the 1950s.
- Chassahowitzka refuge in Florida suspected sulfur dioxide, air and water quality, and sewage treatment contaminant problems.
- Fallon refuge in Nevada suspected selenium, mercury, and arsenic contamination in refuge water and fish.
- Ottawa refuge in Ohio suspected the presence on refuge lands of buried drums containing herbicides.

Officials from 11 of the 50 refuges told us that since the questionnaire was completed, they or other entities have performed sampling, contamination studies, or other investigative work to identify refuge contamination. The other entities included USGS, the Bureau, the Nuclear Defense Agency, the military, local power companies, and universities.

Regarding future contaminant studies, officials at 15 of the 50 refuges plan to conduct sampling or contaminant studies, 33 have no such plans, and 2 were not aware of such plans. The most frequent reason for not planning contaminant studies was the belief that contamination problems did not exist.

When we asked officials of the 50 refuges if periodic, systematic contaminant studies should be performed, 25 said yes. Twenty-four officials disagreed that such studies were necessary because (1) they have no

contamination on their refuges, (2) such studies are not cost-effective, or (3) a study was already being performed. One official was undecided.

Three refuge officials told us they had submitted survey questionnaires to the regional office reporting actual or suspected contamination, but the survey did not list those refuges as potentially contaminated. The Desecheo refuge in Puerto Rico reported unexploded munitions on the refuge. The J. Clark Salyer refuge in North Dakota reported botulism assumed to be caused by sewage flowing into the refuge from upriver.<sup>1</sup> The Upper Ouachita refuge in Louisiana reported high saline levels as a contaminant problem. The officials at these three refuges believed their refuge contaminant issues were significant and should have been included in the Service's 1986 report.

We asked a habitat specialist in the Service's Refuge Management Division the reasons why the three refuges were not included. She told us the Service's regional offices had omitted

- Desecheo refuge because it had been included in a Department of Defense master plan to address contamination issues in the Caribbean area,<sup>2</sup>
- the J. Clark Salyer refuge because the region could not establish a definite link between the botulism problem and the sewage flow (an August 1985 memo from the regional director to the Service director indicated that the problem was being studied by the state health department), and
- the Upper Ouachita refuge because the region believed that the saline problem was under adequate regulatory control.

## Increased Attention to Identifying and Confirming Refuge Contamination

Prompted by congressional oversight, the Service has provided increased attention and support to the refuge contamination issue since mid-1986. The Congress increased fiscal year 1987 funding for refuge contamination issues beyond the Service's request and encouraged the Service to move faster to resolve the issues.

For fiscal year 1987, the Department of the Interior was appropriated an additional \$4.5 million beyond the Service's contaminant program

<sup>1</sup>Botulism is bacteria-caused food poisoning, which was afflicting wildlife.

<sup>2</sup>This refuge appears on the July 1986 Defense Environmental Restoration Account Program inventory list, which represents sites that have been reviewed, are to be reviewed, or that are being reviewed by the Department of Defense to determine if a hazardous situation exists and if the Department of Defense is the party responsible for cleanup.

funding request. Of this amount, \$2.5 million was earmarked for research and development activities and studies. The appropriation conference report recommended that the Service use \$1.5 million to initiate necessary studies, accelerate analysis of refuge contaminant samples, and develop and implement strategies to clean up affected refuges.

The remaining \$500,000 was to be used to develop and implement a plan for long-term contaminant monitoring of refuge habitats and wildlife, designed to detect the presence of contaminants throughout the National Wildlife Refuge System through repetitive sampling, resulting in early detection and correction of future contamination. The Service was directed to work with the Department of Energy's Idaho National Engineering Laboratory to design the monitoring system, develop sampling and analytical procedures, and train refuge employees to collect samples.

In response to the congressional directive, in April 1987 the Service entered into an interagency agreement with the Idaho laboratory to begin a program to monitor the presence of toxic and potentially hazardous chemicals in fish, wildlife, and their habitats, including those lands for which the Service has trust responsibility. The project's goals are to (1) develop plans and protocols that will set standards for Service monitoring efforts, (2) coordinate with other federal agencies so that Service programs are compatible with their programs to monitor contamination in the environment, and (3) provide training to Service personnel conducting the monitoring activities.

In November 1986 guidance, the Service director established the refuge contamination issue as one of his priorities for fiscal year 1987. This guidance stated that the Service should accelerate the identification and evaluation of how environmental contaminants affect fish and wildlife resources. The director noted that evaluating contamination's impact was both an immediate and a long-term need. He added that the Service would continue to pursue the identification and evaluation of contamination in 1988 and 1989 and would aggressively implement action plans and cleanup.

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## **Organizational Structure**

In 1986 the Service director reorganized headquarters operations and removed direct-line responsibilities from the headquarters staff. The regional offices are now under the director's immediate control. Two headquarters units have staff responsibilities for activities relating to environmental contaminants. The assistant director for Refuges and

Wildlife is responsible for contaminants on refuges, while the assistant director for Fish and Wildlife Enhancement is responsible for other, generally broader, contaminant issues.

In theory, the Fish and Wildlife Enhancement personnel provide technical support to refuge personnel at the Service headquarters in Washington, D.C., and the regions. In practice, the effectiveness and coordination of this technical support function varies widely at all levels of the Service. Roles and responsibilities are not clearly defined, nor are priorities among contaminant-related activities.

Because of the continuing high level of public and congressional interest in refuge contamination, Service officials believe that substantive headquarters involvement in planning, tracking, and reporting will necessarily continue. In February 1987 the director was presented with organizational options for realignment of refuge contamination responsibilities within the headquarters office. In March 1987 the director decided that Fish and Wildlife Enhancement will be responsible for coordinating, monitoring, and reporting on all Service operational contaminant-related activities. Further, Refuges and Wildlife will track and report, in close coordination with Fish and Wildlife Enhancement, contaminant activities on refuges. In addition, current contaminant activity planning is attempting to better define the appropriate allocation of responsibilities. The director also determined that the identification and resolution of contaminant problems on refuges is of the highest priority.

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## Criteria to Protect Wildlife and Refuge Habitat Have Not Been Established

Despite evidence of potential contamination, the question remains as to whether the contamination is harmful to the fish and wildlife using the refuge and to the refuge habitat, which includes vegetation and sediments. The Service has no authority to set enforceable water quality standards for fish, wildlife, or the refuge habitat, and has relied on EPA to develop criteria and the states to set standards. EPA is responsible under the Clean Water Act for setting water quality criteria to protect fish and wildlife and has established criteria for a few pollutants to protect aquatic life.<sup>3</sup> But EPA has not set criteria that could be used to specifically protect wildlife or the refuge habitat. Without such criteria, the Service cannot readily determine what harm the contamination found in a refuge or in its fish or wildlife could cause or whether action is needed to protect the refuges.

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<sup>3</sup>Aquatic life includes fish, shellfish, and other invertebrates.

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**EPA Responsibilities and Actions**

A goal of the Clean Water Act is that water quality should, wherever attainable, be sufficient for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water. Section 304 of the act requires EPA to periodically review and publish criteria for water quality that accurately reflect the latest scientific knowledge (1) on the kinds and extent of all identifiable effects on health and welfare, including plankton, fish, shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation, from the presence of pollutants in any body of water, (2) on the concentration and dispersal of pollutants through biological, physical, and chemical processes, and (3) on the effects of pollutants on biological diversity, productivity, and stability.

EPA water quality officials told us that over the years, EPA's primary concern has been to develop water quality criteria to protect human health. It has, however, developed water quality criteria to protect aquatic life from 25 pollutants. These criteria have no direct regulatory impact. Rather, they represent scientific data and guidance on the environmental effects of pollutants. States can use them to establish regulatory requirements. Generally, the states use the EPA-developed water quality criteria for the various pollutants to set water quality standards. Under EPA's National Pollutant Discharge Elimination System, permits are issued to municipal and industrial dischargers to ensure that total pollutant discharges do not violate the water quality standards.

EPA has also published information on the so-called "lowest observed effect level" for 65 other pollutants. These levels apply to 49 priority pollutants and 16 nonpriority pollutants. These levels differ from the water quality criteria in that EPA determined that not enough data was available to develop national water criteria. But they represent levels above which harmful effects have been noted in certain aquatic life, and can be used by refuge managers to indicate possible effects of these 65 pollutants on aquatic life at their particular refuge.

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**EPA Water Quality Criteria-Setting Has Been Limited to Protecting Human Health and Aquatic Life**

The water quality criteria EPA has developed are not specifically applicable to the protection of wildlife or the refuge habitat. The deputy director of EPA's Office of Water Regulations and Standards told us that over the years, EPA has been involved in developing, publishing, and updating water quality criteria for priority pollutants. EPA expects to publish about 10 new or revised final criteria documents each year. The deputy director told us that EPA uses studies that involve impacts on wildlife in developing water quality criteria for various pollutants, but it has not set criteria that would protect wildlife or the refuge habitat



from water pollution. The aquatic life and human health criteria cannot be applied to wildlife because of the many differences between the species. According to the deputy director, the development of water quality criteria for the protection of wildlife and refuge habitat would be feasible but would require substantial costs.

According to the deputy director, EPA has embarked on a new approach to the development of water quality criteria: water quality advisories. An advisory for a pollutant will be based on a review of existing data on the pollutant to provide information as to an acceptable level. The advisories will not be subjected to the Federal Register review process, which criteria are subject to, but will undergo review within EPA. EPA expects to issue 40 advisories in 1987. The advisories will set limits based on protecting human health and aquatic life but which cannot be applied to wildlife or the refuge habitat. Neither advisories or water quality criteria are enforceable until adopted by the states as water quality standards. The deputy director told us that EPA will continue to give priority to developing water criteria for human health and aquatic life and does not plan to expand criteria development to include wildlife and other refuge habitat.

We discussed the lack of protective criteria with Service officials. The chief of the Division of Environmental Contaminants—the division that has responsibility for the technical assessments of refuge contamination—told us that it would be desirable to have criteria to determine when contaminants are adversely affecting fish, wildlife, and wildlife habitat, and that without criteria, it was difficult for the Service to interpret sample results. He said the Service must now rely on whatever data are available from existing contaminant study efforts to determine possible effects, although in his view, not enough was known about most contaminants to develop criteria. The chief of the Resource Management Branch told us that the Service's ongoing efforts on suspected refuge contamination is focusing on obtaining data on the cause-and-effect relationships of contaminants with the fish and wildlife, and that once such data are obtained, EPA could use it to develop water quality criteria.

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### The Service Has No Authority to Set Enforceable Water Quality Standards for Fish and Wildlife Protection

The Service has general authority and responsibility to operate wildlife refuges to conserve, protect, and enhance fish and wildlife and their habitats, but has no specific legislative authority to set enforceable water quality standards for fish and wildlife protection. The Fish and Wildlife Coordination Act authorizes the Secretary of the Interior, through the Service and the Bureau of Mines, to make investigations to

determine the effects of domestic sewage, mine and petroleum and industrial wastes, erosion silt, and other pollutants on wildlife. The act also authorizes the Secretary to report to the Congress concerning these investigations and recommend how to alleviate dangerous and undesirable effects of pollutants. The investigations shall include (1) determining standards of water quality for the maintenance of wildlife, (2) studying methods of abating and preventing pollution, and (3) distributing study data for the use of federal, state, municipal and private agencies, individuals, organizations, or enterprises. Service officials told us they have not considered making such investigations.

The Service recently began to issue syntheses of the research available on certain pollutants. As of February 1987, the Service's Patuxent Wildlife Research Center in Laurel, Maryland, had issued nine "contaminant hazard reviews" of various contaminants. The first of these reviews, issued in March 1985, dealt with mirex. Subsequent reviews have dealt with cadmium, carbofuran, toxaphene, selenium, chromium, polychlorinated biphenyl, dioxin, and diazinon. Two reviews were in draft form as of May 1987.

No new research is performed in developing these reviews. Instead, the reviews synthesize the research available on the pollutants and include data on the pollutants' background concentrations and toxic and sublethal effects. The reviews also contain a recommended level to protect sensitive species of wildlife and aquatic organisms. For example, the report on dioxin states that no criteria or standards have been promulgated for any of the 75 dioxin isomers (composition variations) by any regulatory agency for the protection of sensitive species of wildlife and aquatic organisms. Data are scarce or missing on the distribution and upper limits of dioxins in natural resources, the identification of fish and wildlife resources potentially at risk, the relative importance of dioxin sources, and on the comparative toxicities of various dioxins to fish and wildlife, especially reproductive and immunosuppressive toxicities.<sup>4</sup>

The report states that in 1982 one of the dioxin isomers—2, 3, 7, 8-TCDD—was found in such heavy concentrations in soils in Times Beach, Missouri, that the town was permanently evacuated. An extensive amount of research has been completed on this isomer and according to the report, various laboratory studies with birds, mammals, aquatic

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<sup>4</sup>Suppression of natural immune responses.

organisms, and other species have conclusively demonstrated that exposure to 2, 3, 7, 8-TCDD can be associated with carcinogenic, reproductive, mutagenic, or other effects, and/or death. The report concluded that the limited data available strongly suggest that 2, 3, 7, 8-TCDD concentrations should not exceed a certain numeric level in water for the protection of aquatic life, or in the foods of birds and other wildlife.

The researcher from the Patuxent Wildlife Research Center who prepared these studies told us that Service regional contaminant specialists requested research on the effects of contaminants on fish and wildlife, and since 1983 he has been preparing the reports. He considers the recommended levels to be guidance since they have no regulatory effect. The reports are provided to the regional resource contaminant specialists and the Service refuge managers who request them.

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## Conclusions

The Service's 1985 attempt to determine whether its refuges were contaminated was a step in the right direction. The Service identified 85 refuges with actual or suspected contamination problems. However, the study had its limitations. The refuge personnel who responded to the questionnaire generally had limited knowledge of actual or suspected problems because the refuges had not been subjected to contamination studies, including samples of fish, wildlife, sediments, and water. Furthermore, five refuge managers told us they had identified potential contamination problems after responding to the Service's questionnaire. This suggests that contamination problems may exist at other refuges.

The Congress is concerned about the potential contamination problem at refuges, and for fiscal year 1987 it appropriated \$4.5 million more than the Service requested to begin long-term monitoring at all refuges to detect the presence of contaminants. The Service has made refuge contamination one of its highest priorities. It is too early to determine the effectiveness or impact of these initiatives on the refuge contamination problem, but the proper direction has been established.

The Service needs some measure to use in determining whether the contamination found in a wildlife refuge is harmful to the fish, the wildlife, and the refuge habitat. Unfortunately, criteria have not yet been developed for many water pollutants and few studies of the impact of contaminants on wildlife or refuge habitat have been done. EPA's primary concern has been to develop water quality criteria to protect human

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health rather than wildlife or refuge habitat. The Service has undertaken to synthesize past studies of contaminant effects on fish and wildlife, and the resulting nine research reports issued as of February 1987 provide guidance to protect fish and wildlife.

The Service will be unable to determine the effect of contaminants on fish, wildlife, and the refuge habitat without criteria developed by its own researchers or EPA's. Moreover, unless EPA sets regulatory criteria, as it is required to do by the Clean Water Act, to protect wildlife, the Service will have no leverage to compel responsible parties to abate pollution when damage to the refuge is detected.

With the current emphasis on reducing government expenditures, we recognize that it may be difficult to obtain the additional staff and funding to develop the criteria. However, we believe that potentially widespread refuge contamination demonstrates the need for water quality criteria to protect wildlife.

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## **Recommendation**

We recommend that the Administrator, EPA, in close coordination with the Secretary of the Interior, develop water quality criteria for protecting wildlife and refuge habitat. If current resources and funding levels are insufficient for this program, we recommend that the Secretary and the Administrator submit estimates of the additional needs to the Congress for consideration.

# Cleanup of Industrial, Municipal, and Military Contamination May Be Costly and Take Many Years

Of the 85 refuges identified in the Fish and Wildlife Service's 1986 survey, 41 were suspected of contamination by industrial, municipal, and military sources. A Service official told us that as of February 1987, cleanup action was completed on 2 and underway on 2 of the 41 refuges. At most refuges, the suspected problems still have to be confirmed.

Once a problem is confirmed, the party responsible for cleanup must be identified. In some cases, identified responsible parties may undertake cleanup. Otherwise, industrial or municipal contamination will be studied under the lengthy process of EPA's Superfund program, while cleanup of military contamination will be the responsibility of the Department of Defense, which has a similar process. If the cleanup is not funded by Defense, Superfund, or parties responsible for the contamination, the Department of the Interior will ultimately be financially responsible for the cleanup, which is likely to involve large federal expenditures.

## Refuges Contaminated by Industrial or Municipal Activities

In its 1986 survey, the Service identified 33 refuges with direct or suspected evidence of contamination from industrial or municipal landfills or discharges. Superfund legislation requires that such potential hazardous waste sites be reported to EPA, suspected contamination be confirmed, cleanup plans be developed, and parties responsible for cleanup be identified. Parties responsible for site cleanup under Superfund may include individuals, corporations, or other entities that are (1) past or present owners or operators of sites or (2) generators or transporters that have contributed hazardous substances to sites. If the responsible party cannot be identified or cannot pay for cleanup, Superfund can be used to finance cleanup. Sites eligible for Superfund cleanup are placed on a National Priorities List for funding.

We selected 4 of the 33 refuges—Wheeler in Alabama, Tinicum in Pennsylvania, Great Meadows in Massachusetts, and Great Swamp in New Jersey—for case study review. (See app. II for a description of the problems.) To document the problems on these four refuges, the Service and others sampled items such as water, soil, sediments, and fish to detect the presence of suspected contaminants. The sample analyses have identified the presence and levels of various contaminants. Relative to one or more of these refuges, the Service (1) has notified the potentially responsible party who subsequently initiated actions to deal with the problem, (2) has initiated or will initiate a field study to obtain more detailed data on the source, extent, and contaminants involved, (3) has notified EPA of potential hazardous waste sites, and (4) is working with

EPA to fund and initiate a comprehensive study that would develop additional data and recommend the necessary cleanup action. At Wheeler refuge, the responsible party has begun cleanup action. At the other three refuges, more data is needed before cleanup action can be recommended and pursued.

Following are two case studies, one on the Wheeler refuge, where industrial discharges are being cleaned up, and one on the Tinicum refuge, where industrial and municipal landfills are suspected of causing contamination.

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## **Wheeler Refuge**

The Wheeler NWR covers 34,000 acres near the cities of Decatur and Huntsville, in north central Alabama. It is adjacent to the U.S. Army's Redstone Arsenal.

### **Problem Description**

A plant manufacturing the insecticide DDT on the arsenal was leased from the Army by the Olin Corporation and its predecessors from 1947 to 1971. The plant discharged several hundred tons of DDT residue into a ditch running into the Huntsville Spring Branch of Indian Creek that flows through the arsenal, into the refuge, and eventually into the Tennessee River. A 1964 Service analysis of wildlife specimens indicated that the refuge was being subjected to serious DDT contamination.

Because it could not meet the federal standard for effluent that could be discharged into the Huntsville Spring Branch, Olin decided to discontinue manufacturing DDT and terminated its lease. When the plant closed, settling ponds and refuse dumps were filled with crushed lime and sealed with clay in accordance with federal guidelines of that time. In 1972 the plant was dismantled.

In June 1977 the Army reported severe ecological stress in the branch due to a wide variety of pollutants. A high concentration of DDT in fish and bird tissue was traced to the arsenal. The DDT concentration in the edible portions of fish exceeded the Food and Drug Administration's maximum of 5 parts per million for fish sold in interstate commerce. Levels as high as 412 parts per million were found in fish from the Tennessee River, and as high as 2,818 parts per million in fish from the Huntsville Spring Branch.

Although the extent of the contamination was unknown, the report concluded that the soil in and around the former plant contained high concentrations of DDT sufficient to contaminate the Tennessee River during storm periods and that the DDT migration from the former disposal site showed that past control measures were inadequate and corrective measures were needed.

#### Responsible Party Identified

In 1978 the Army decided to take several actions over a 3-year period within the arsenal: installing a water treatment plant to remove DDT from drainage water that had come in contact with contaminated soil, excavating sediments from the ditch that carried drainage from the old plant site, stabilizing disposal sites containing buried DDT, and establishing a program to detect DDT migration into surface and groundwater.

In December 1978 EPA determined that the Army was responsible for corrective action and ordered it to clean up the problem both on and off the refuge. The Army replied that it would not clean up the DDT off the arsenal because it did not cause the problem, had effectively abated the discharge from Army property, and did not have jurisdiction to comply with EPA-ordered actions outside Army property. The Army suggested an EPA-led coordinated approach by interested agencies to develop an acceptable solution. In March 1979 the Army, the Service, and the Tennessee Valley Authority agreed that an environmental impact study should be conducted to fully address all available alternatives, and that Olin Corporation should not be overlooked as a party potentially responsible for the problem.

In January 1980 the Public Health Service's Center for Disease Control studied nearby Triana, Alabama, and found that the DDT level of the 499 persons living downstream from the former plant was several times the national mean (76.2 parts per billion vs. 16.7 parts per billion). The study showed that these DDT levels were associated with high levels of serum cholesterol and triglycerides,<sup>1</sup> but not with specific illness or ill health.

Later in 1980 the Department of Justice brought a lawsuit in the U.S. District Court for the Northern District of Alabama, on behalf of the Army and EPA, against the Olin Corporation. The federal government

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<sup>1</sup>A triglyceride is a form of glycerol containing three compound groups involving up to three acids. High levels increase the risk of human heart disease.

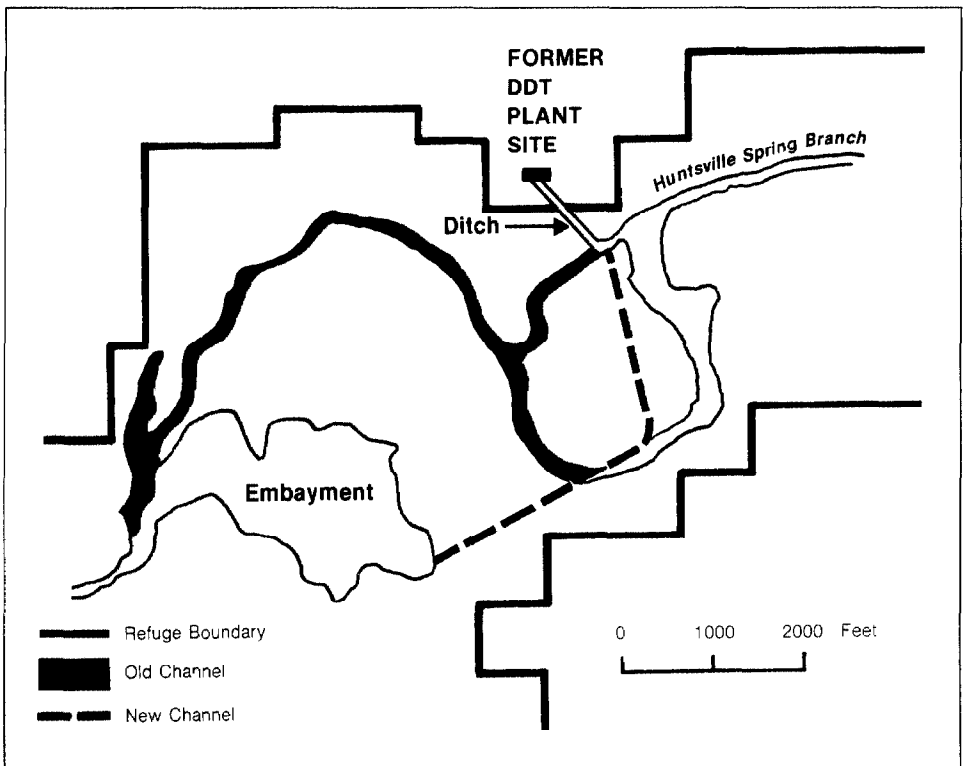
sought the cleanup of the contaminated area and reimbursement of funds expended by various agencies to investigate and abate the DDT problem. In 1983 a consent decree was entered into under which Olin agreed to undertake and pay for remedial action on the contamination site.

### Actions Taken and Planned and Costs Projected

In April 1986 Olin began a major construction effort to reroute the section of the Huntsville Spring Branch on the refuge that contains the highest percentage of DDT sediments. About 3 miles of stream will be closed and a new stream bed is being constructed around the contaminated section. (See fig. 4.1.)

Olin is also burying 300 to 400 tons of sediments in the former stream bed where the DDT residues are located. Olin will cover the stream bed with a plastic liner, then with stone and dirt, and plant grasses and vegetation over the dirt.

Figure 4.1: Location of Rerouting of the Huntsville Spring Branch, Wheeler NWR



Source: Norwood, 1986.



Olin expects to spend an estimated \$30 million on the project. Although the project is scheduled for completion in 1989, the refuge manager told us in February 1987 that the construction was expected to be completed by August 1987, or 20 months ahead of the scheduled completion date. The consent decree gives Olin 10 years from the date construction is completed to meet the Food and Drug Administration's maximum of 5 parts per million for certain fish in the branch. Meanwhile, the Service is collecting and analyzing blackbird fledglings and wood duck eggs for DDT residues, and future monitoring of DDT in waterfowl, primarily mallards, is planned.

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## **Tinicum Refuge**

Tinicum refuge (established by Public Law 92-326, 1972) covers nearly 900 acres located a mile north of the Philadelphia International Airport and includes 200 acres of tidal marsh and 145 acres of nontidal wetlands. It contains one landfill site (Folcroft), and a second is nearby (Clearview). (See fig. 4.2.) Recognizing that the refuge would include an active landfill, the legislation was amended in 1980 to direct EPA and the Service to investigate potential health hazards and recommend ways to protect the refuge and the general public.

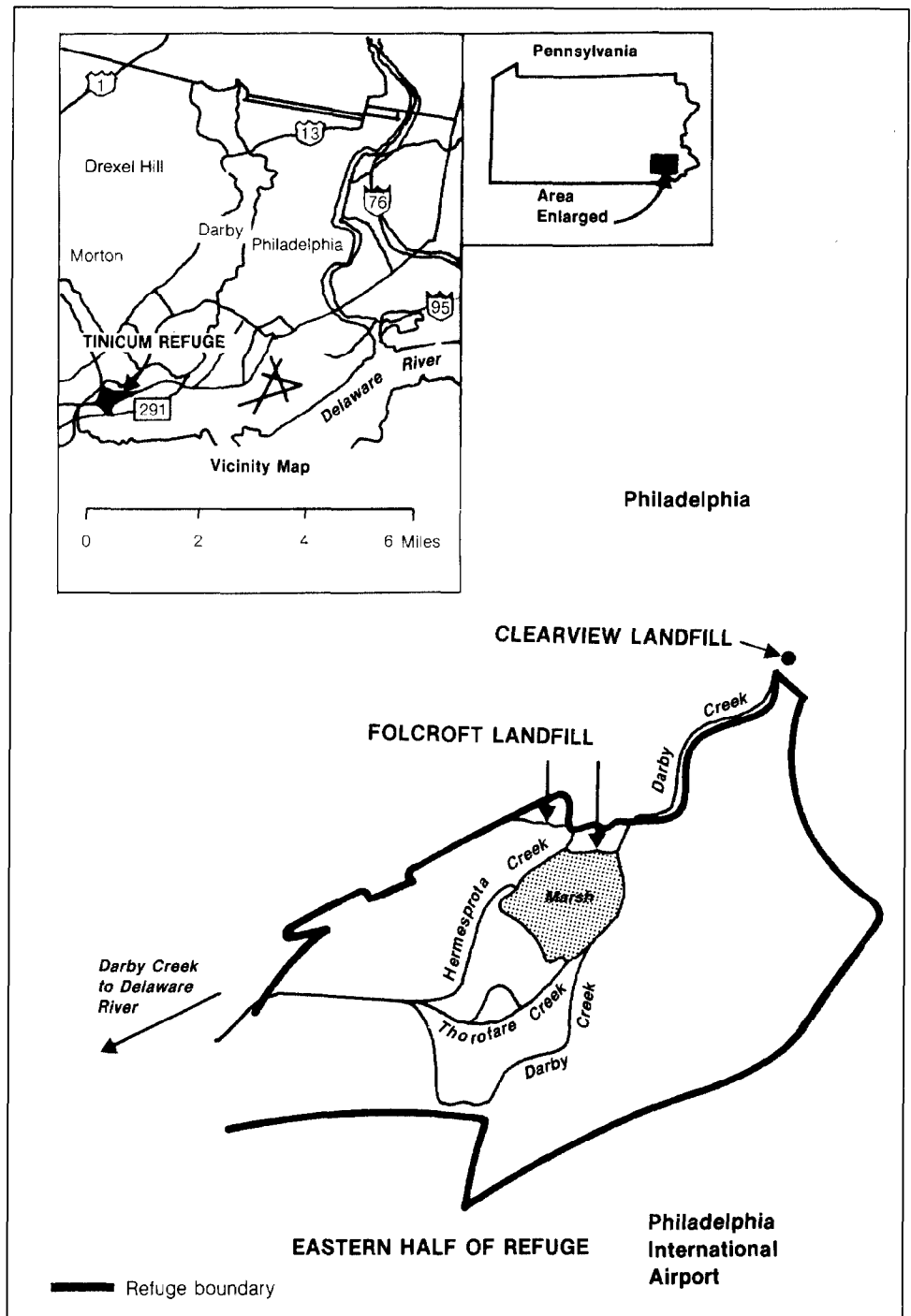
Folcroft landfill was closed in 1974 by a Pennsylvania court order and covered with fill material. The landfill comprises 62 acres, most of which were purchased by the Service and added to the refuge in 1980. Clearview landfill, located adjacent to and upstream of Tinicum refuge, was closed in 1973, but the Service suspects it is a potential source of refuge contamination. The 16.5-acre Clearview site is surrounded by residential areas to the south and east, industrial and commercial areas to the west, and woods to the north.

## **Confirmation Process**

In October 1980 EPA contracted for a site inspection of Folcroft landfill. The inspectors noted smoke from an underground fire and a major leachate flow with brown residue along the three creeks that border the landfill. Their analysis indicated high levels of numerous metals, such as iron, vanadium, lead, and chromium, in ponded water and sediment and several organic compounds in the leachate. However, an EPA review found the contractors' work to have been compromised by a lack of supporting documentation, discrepancies in paperwork, and excessive sample holding time.

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**Military Contamination May Be Costly and**  
**Take Many Years**

**Figure 4.2: Location of Folcroft and Clearview Landfills, Tinicum Refuge**



Source: U.S. Fish and Wildlife Service.

In July 1983 a fire at the Folcroft landfill burned for several days. After the fire was extinguished, the Service had the site covered with ash and clean fill, and seeded with grasses and other vegetation.

Since 1983 the Service and EPA have analyzed numerous samples of water, sediment, fish, turtles, and air in and around the refuge with the following results:

- Pesticides and PCBs (toxic industrial chemicals) were found in sediment, fish, and turtle samples.
- Silver, cadmium, copper, and lead were found to exceed EPA water quality criteria for aquatic life.
- Pennsylvania issued a warning about the consumption of aquatic life and creek water in the area.
- EPA toxicologists warned that the waters of Darby Creek might be more toxic than sensitive species could tolerate, assuming the additive effects of contaminating metals.

Both landfills were investigated for possible Superfund cleanup. In 1984 and 1985 EPA inspected Clearview and found no evidence of an immediate or imminent public health threat. In June 1986 EPA took air samples at Folcroft. According to a Service resource contaminant assessment specialist, EPA did not find any releases harmful to humans. An EPA environmental engineer told us that because EPA found no direct threat to human health from either the Clearview or Folcroft sites, EPA considers neither site as a potential Superfund site.

In September 1986 a joint EPA-Service report recommended the following actions:<sup>2</sup>

- EPA and Interior should conduct a full-scale assessment of the contamination at Tinicum and use the data gathered to develop and analyze alternatives for reducing contamination from Folcroft.
- EPA and the state of Pennsylvania should increase their efforts to reduce pollution from upstream sources in Darby Creek, including Clearview landfill.
- Interior, with EPA assistance, should investigate potential enforcement measures against the parties responsible for dumping hazardous wastes at Folcroft and pursue efforts to obtain funds necessary for investigation and corrective action.

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<sup>2</sup>An Investigation of Potential Environmental Hazards at Tinicum National Environmental Center.

The full-scale site assessment is underway. As for the second and third recommendations, a Service specialist told us that EPA, the state of Pennsylvania, and the Service are awaiting the results of a full-scale Environmental Impact Statement before taking further action.

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## The Superfund Process

The Service, as required by the Superfund legislation, reports sites to EPA. In all, the Service has reported to EPA 14 refuges identified in its 1986 survey report as potential Superfund sites. This is the first step in a detailed and lengthy process, which sometimes results in EPA's determination that the site should be placed on its National Priorities List for cleanup funding.

We have been evaluating the Superfund program for several years, and we summarized the results of these efforts in a March 29, 1985, report, Cleaning Up Hazardous Wastes: An Overview of Superfund Reauthorization Issues (GAO/RCED-85-69). We noted that Superfund cleanup is a lengthy, complex process that is complicated by the absence of cleanup standards. Several time-consuming steps are necessary before cleanup actions actually begin. Together, these steps may take 2 to 3 years:

- In a preliminary assessment EPA obtains all available background information from USGS maps and EPA, state, and local files, attempting to determine the size of the site, the identity of the parties most likely to have disposed of wastes there, the types and quantities of wastes most likely to have been disposed of, local hydrological and meteorological conditions, and the impact of wastes on the environment. If EPA determines that the site may be a hazard, an inspection is conducted.
- During a site inspection, inspectors collect sufficient information to rank the hazard of the site. They look for dead or discolored vegetation and other evidence of hazardous wastes. Samples of the soil or nearby water may be taken. The inspectors determine the ways hazardous materials could be contaminating the nearby environment, for example by runoff into nearby streams.
- Sites are ranked on the basis of type, quantity, and toxicity of wastes; the number of people potentially exposed; the likely pathways for exposure; the importance and vulnerability of the underlying aquifers; and other factors. The sites with the highest hazard ratings are put on EPA's National Priorities List.
- The feasibility study identifies alternative cleanup approaches and determines their relative effectiveness and cost. Remedial actions may include taking the waste to another site, "capping" the original site with

waterproof clay, installing drains or liners to prevent groundwater contamination, or providing alternative sources of water.

- A cleanup action for the site is selected and implemented.

If no responsible party can be compelled to pay for cleanup and the waste site does not qualify as a Superfund site but cleanup is necessary, Interior has the responsibility and will have to obtain funds through its annual budget process. The cleanup costs will be significant. In 1984 EPA estimated that the average federal cleanup cost of an individual site ranges from \$6 million to \$12 million. As discussed in the Wheeler case study, Olin Corporation expects to pay an estimated \$30 million to clean up the Wheeler refuge contamination problem.

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## Refuges Contaminated by Military Activities

Some refuge lands were once used as military installations or to conduct military activities, while others are still being used for military purposes. The Service has identified past and present military activities as potential sources of contamination at eight refuges. We selected for a case study review the Seal Beach refuge in California.

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### Seal Beach Refuge

The 977-acre Seal Beach refuge lies within the U.S. Naval Weapons Station in Seal Beach, California, south of Los Angeles. The refuge is managed jointly by the Navy and the Service under a May 1974 joint cooperative management plan.

In February 1985 the Navy issued a report, Initial Assessment of Naval Weapons Station, Seal Beach, California. The study was part of a Navy-wide effort to identify, confirm, and clean up potentially harmful contamination problems at Navy and Marine Corps facilities. The effort includes three phases: initial assessment, confirmation, and cleanup of sites determined to be potentially hazardous. This study is part of the Department of Defense's Installation Restoration Program—the military's counterpart to Superfund.

The February 1985 report presented the results of the initial assessment. It cited potential contamination problems stemming from 25 disposal and spill sites located on the weapons station. The suspected sites contained solvents, battery acid, munitions, and oil products. The Navy assessment team identified the potentially contaminated sites by reviewing historical records, aerial photographs, field inspections, and personal interviews. No samples were taken or analyzed during this phase. The initial assessment concluded that 9 of the 25 sites—5 on and

4 off the refuge—posed a sufficient threat to human health, wildlife, or wildlife habitat to warrant further investigation to confirm the presence of suspected contaminants and assess potential long-term impacts. According to Navy officials, these nine sites are included in the second-phase confirmation study now under contract by the Navy, which is scheduled for completion in August 1988.

Service officials advised us that they are relying on the Navy to confirm the existence of contamination at the refuge and to clean up the contaminated sites. Since the Navy is responsible for the area's contamination, cleanup will be its responsibility. Navy personnel were unable to provide estimated cleanup costs because the extent of the existing contamination is unknown.

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## Conclusions

The Service and others have undertaken or are planning to undertake efforts to obtain detailed data to confirm the existence, source, and extent of contamination problems on refuges. But once a problem is confirmed, the process of identifying the party responsible for cleanup, deciding on a cleanup plan, obtaining funds to carry out the plan, and cleaning up the contamination can take many years. Both the Superfund and Department of Defense programs involve a lengthy identification and cleanup process. Further, since EPA includes the number of people potentially affected by the contamination as one of its ranking factors for Superfund funding, contamination sites on wildlife refuges that are not likely to threaten human health are likely to be low on the National Priorities List.

If a private concern is found to be responsible for cleanup, court action may be necessary to get it to accept its responsibility. If Interior must ultimately undertake the cleanup process, it will have to obtain funds through its annual budget process.

It is too early to determine the cleanup cost of industrial, municipal, and military contamination on wildlife refuges nationwide because so few refuges are in a cleanup status. EPA's 1984 estimate of the federal cleanup cost for National Priorities List sites ranged from \$6 million to \$12 million each. If all 41 refuges with suspected industrial, municipal, and military contamination must be cleaned up with federal funds, the government's liability could range from \$246 million to \$492 million (41 sites at \$6 million to \$12 million each). Moreover, the cleanup costs at the Wheeler refuge are estimated at \$30 million, which suggests that refuge cleanup costs could be substantially higher.

# Agricultural Drainage Problem Under Study, but Legislative Change May Be Required

Potential agricultural drainage problems go well beyond the geographical area of the Kesterson NWR. The west side of the San Joaquin Valley is subject to agricultural drainage problems that threaten the area's viability both as a leading agricultural region and as a wildlife habitat. Moreover, agricultural drainage from irrigation development projects constructed by the Bureau elsewhere in the West may be contributing to contamination problems at other wildlife refuges.

The irrigation drainage water generated by these projects either flows through surface and subsurface drains into canals, rivers, and streams, which furnish the water to the wildlife refuges or other wildlife management areas, or is not collected but rather flows indiscriminately off the farmland into waterbodies that feed the refuges. The drainwater includes man-made agricultural fertilizers, pesticides, and other chemicals, as well as elements like selenium that occur naturally in soils.

The full extent and consequences of agricultural drainage problems have not been documented, but the potential seriousness of the matter has been recognized. Of the 85 refuges suspected of contamination, the Service determined that 40 may be contaminated by agricultural drainage.

In 1977 the Congress exempted discharges of agricultural drainage from the discharge permit requirements of the Clean Water Act. EPA therefore has no legislative authority to control potential pollution or contamination from agricultural drainage sources.

After refuge contamination has been confirmed as being produced by agricultural drainage, finding an entity to accept responsibility and to pay for the cleanup may be difficult. Federal funding will most likely be required. Federal agencies faced with cleanup responsibilities must seek funds through the budget process on a case-by-case basis. Further, such projects must compete for funding with other agency needs. It is too early to estimate the eventual cost of cleanup at these refuges.

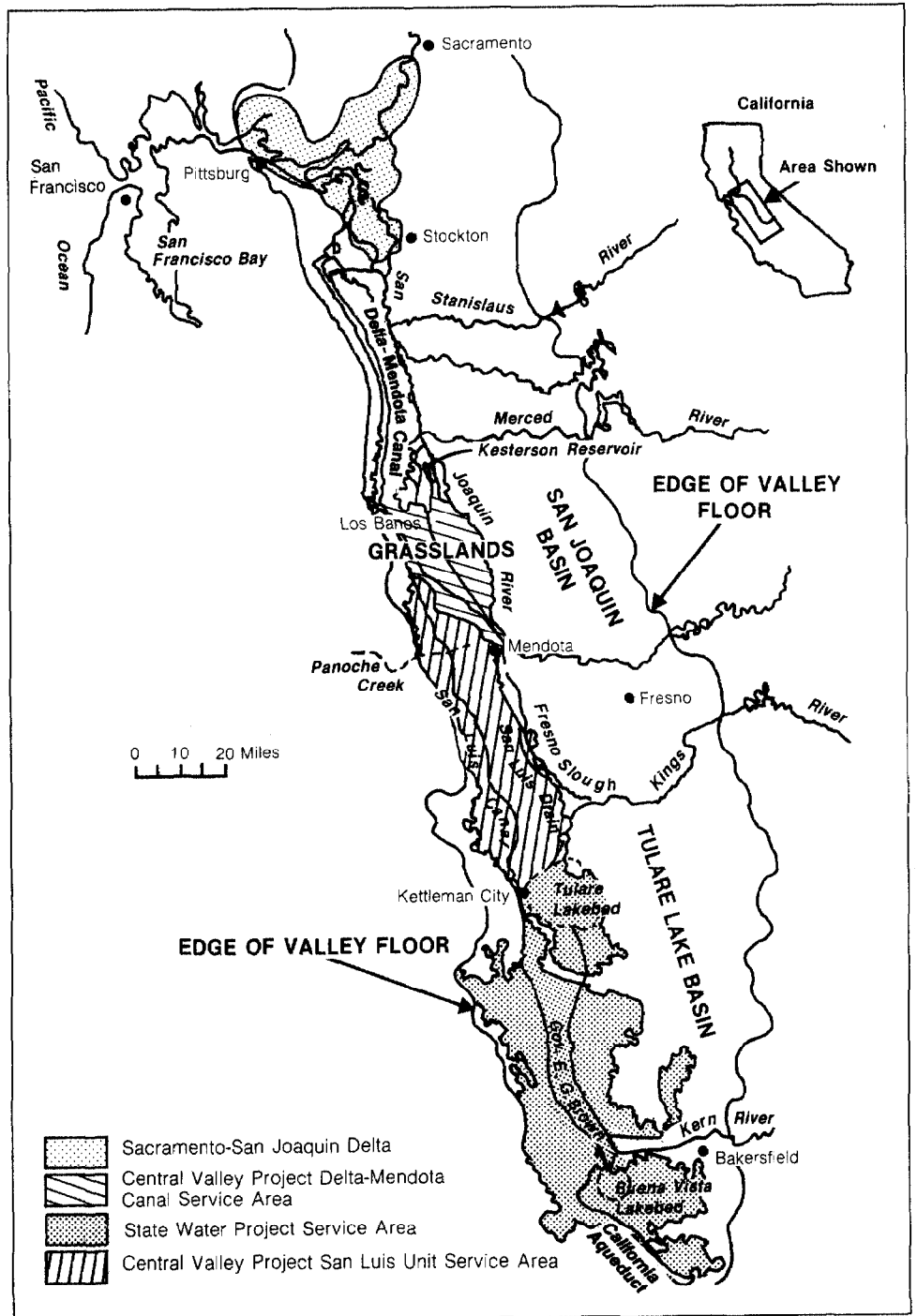
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## Programs to Address Agricultural Drainage Pollution

Sparked by news media reports on the Kesterson NWR and other refuges that depend on agricultural drainage water, Interior initiated two major programs to study contamination in drainage basins served by federal water projects. In 1984 Interior and California began a cooperative effort to study the toxic effects of the drainage problem in the San Joaquin Valley and evaluate alternatives for resolving the problem. In 1986

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**but Legislative Change May Be Required**

**Figure 5.1: Location of the San Joaquin Valley Service Areas**



Source: U.S. Bureau of Reclamation.



Interior initiated an Irrigation Drainage Program to identify and evaluate potential contamination problems in the basins of the West that are served by Bureau of Reclamation projects, with special emphasis on contaminant issues at refuges.

At 40 refuges, 22 of which are being studied under the Interior Irrigation Drainage Program, the Service identified agricultural drainage as a suspected cause of contamination in its 1986 survey report. However, the effects of suspected contamination must be confirmed before corrective actions can be planned or responsible parties called on to assist in the resolution of off-refuge contaminant sources.

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## San Joaquin Valley Drainage Program

The San Joaquin Valley is one of the nation's leading agricultural regions. Its west side has three major irrigation water service areas. (See fig. 5.1.) In the center is the Central Valley Project's San Luis service area, which primarily serves the Westlands Water District. Just north of Westlands is the project's Delta-Mendota Canal service area, which serves several water districts in and around Grasslands Resources Conservation District. South of Westlands is the state's water project service area, which serves water districts in the Tulare Lake Basin area.

The need for adequate drainage to maintain the productivity of agriculture in the San Joaquin Valley has been recognized since the early 1900s. The west side of the San Joaquin Valley has serious agricultural drainage problems affecting several hundred thousand acres. High salt concentrations and inadequate drainage of subsurface water threaten agricultural productivity. Until selenium contamination was reported at the Kesterson NWR, concern over agricultural drainage focused on proper drainage and disposal of salts from irrigation drainwater.

Different disposal methods for subsurface drainage were developed in each of the three service areas. In the San Luis service area, the San Luis Drain was constructed but stopped short at the Kesterson refuge. The Delta-Mendota service area uses a combination of drains, canals, and sloughs to transport drainage to the San Joaquin River. The state service area's water districts use evaporation ponds to dispose of agricultural drainage.

Studies at Kesterson and elsewhere in the valley have shown that significant portions of the valley's subsurface drainage water contain elevated levels of selenium and varying concentrations of other toxic or potentially toxic trace elements. Drainage and disposal of this water has

degraded surface water and groundwater quality and contaminated scarce fish and wildlife habitats. Moreover, public health may also be threatened by elevated levels of chemicals, including trace elements like selenium, in agricultural drainage water.

To address these problems, the Secretary of the Interior and the Governor of California established the San Joaquin Valley Drainage Program in August 1984. The Secretary and the governor named three federal agencies—the Bureau, the Service, and USGS—and two state organizations—the Department of Fish and Game and the Department of Water Resources—as the principal program participants. The program's purposes are to investigate problems associated with the drainage of irrigated agricultural lands on the west side of the San Joaquin Valley and to formulate, evaluate, and recommend alternatives for the immediate and long-term management of these problems.

#### Program Structure

Each of the five agencies is generally responsible for completing studies related to its expertise. The Bureau is studying drainage water management, treatment, reuse, and disposal; socioeconomic and financial analyses; and the design of facilities. The Service addresses the geographic extent and the severity of drainwater contamination of fish and wildlife resources, fish and wildlife toxicity, the accumulation of toxic constituents in the food chain, the restoration of damaged habitats, and the identification of opportunities for fish and wildlife habitat enhancement. USGS addresses the sources, distribution, transport, and fate of selenium and other trace elements in the water and soils. The California Departments of Fish and Game and Water Resources provide assistance and direct technical staff support in cooperative studies.

The estimated federal expenditures for this program for fiscal year 1987 are \$8.8 million. Currently, funds for the federal program activities are made available through annual appropriations for the San Luis Unit of the Bureau's Central Valley Project.

#### Program Objectives

As of February 1987, San Joaquin Valley Drainage Program activities have emphasized on-farm management of agricultural drainage water, drainage water treatment and disposal, water quality monitoring, geohydrologic studies, and fish and wildlife studies. Through 1990, program efforts will emphasize the following priorities: (1) application of findings from ongoing research and studies of drainage-related problems in the San Joaquin Valley, (2) formulation and evaluation of alternative

solutions to the valley's drainage problems, including measures to help meet immediate needs, and (3) recommendation of a comprehensive management plan.

As outlined in the February 1987 drainage program prospectus, potential alternatives for management of drainage-related problems will be addressed in a phase I report. The report will be available in draft for technical and public review by October 1987 and will be finalized by October 1988. This report will be the first major step in the formulation of a comprehensive management plan. A phase II report, the plan itself, will be drafted by October 1989 and finalized by October 1990.

## Fish and Wildlife Studies

A major part of the San Joaquin Valley Drainage Program is directed toward fish and wildlife studies. Elevated levels of toxic trace elements carried in agricultural drainage water have been found in food chain organisms and in fish and wildlife in valley locations other than in the 12 Kesterson evaporation ponds. In the Tulare Lake Basin, for example, elevated selenium and arsenic levels have been discovered in biota (regional plants and animals) collected from evaporation ponds used by migratory birds. Elevated selenium levels in the food chain have also been found in areas throughout Grasslands, which, as the largest remaining contiguous tract of wetlands in the Central Valley, is vital to wintering migratory birds of the Pacific Flyway. As a result of this information, the Service is scheduling major studies of Kesterson, the Grasslands, the Tulare Lake Basin, the San Joaquin River system, and the San Francisco Bay concerning the accumulation of selenium and other contaminants in the water supply and food chain and the effects on fish and waterfowl.

In an effort that is not part of the San Joaquin Valley Drainage Program, the Service is cooperating with the Bureau to identify alternative refuge water supplies and delivery systems in the Central Valley Basin for 10 national wildlife refuges, 4 state wildlife management areas, and the Grasslands Resources Conservation District. (See fig. 5.2.) According to the Bureau, this study will culminate in a report to be issued in late 1987, which will outline a plan for providing a reliable water supply to each refuge.

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## Interior's Irrigation Drainage Program

The Kesterson refuge selenium contamination issue, articles published by the Sacramento Bee newspaper on agricultural drainage and its negative effects on the nation's wildlife, and congressional concern over agricultural drainage water problems have increased Interior's awareness of the potentially harmful effects of agricultural drainage water on wildlife and wildlife habitat. In most cases, agricultural drainage contamination has not been confirmed, nor have the sources and range of contaminants or the extent of the suspected problems been documented. Interior is now attempting to find out more about the effects of agricultural drainage water on refuges and other wildlife management areas receiving drainage water produced from Bureau of Reclamation federal irrigation projects.

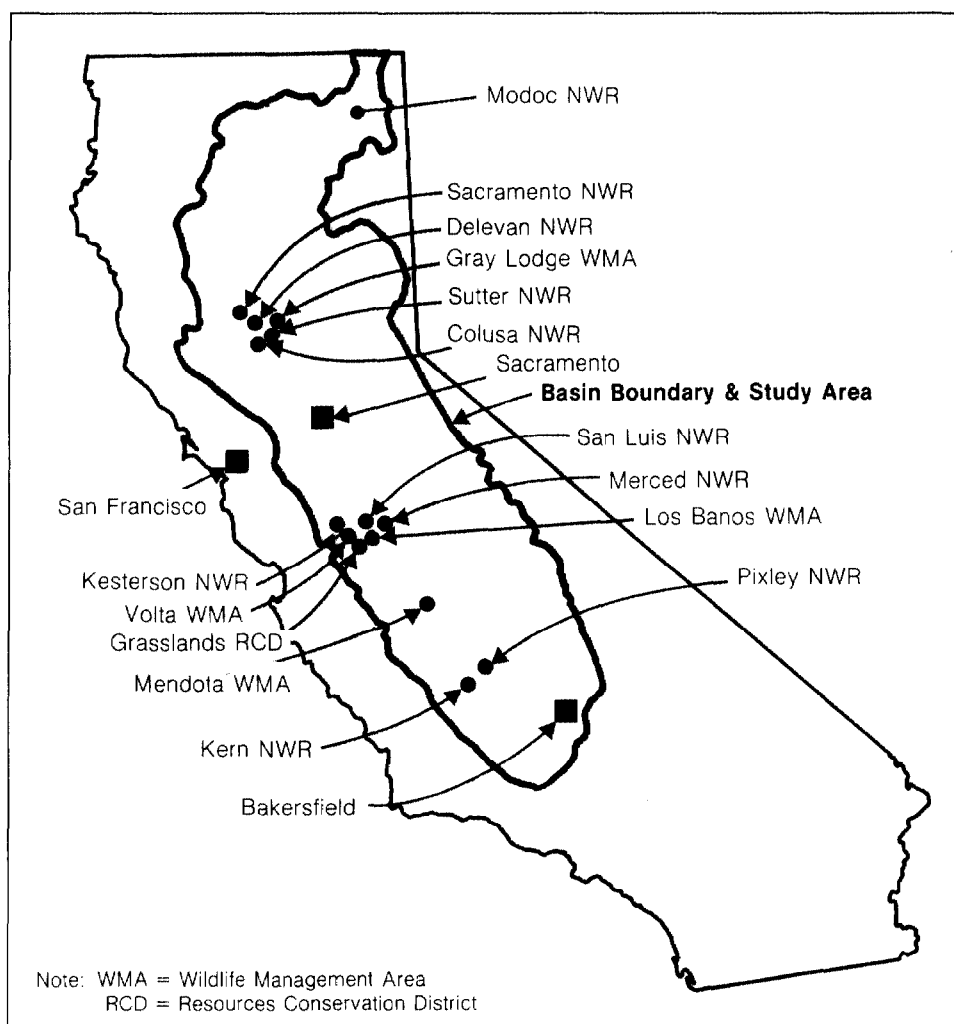
In 1986 Interior established the Irrigation Drainage Program, which is focusing on the quality of agricultural drainage water and its effects on (1) project irrigation or drainage facilities constructed or managed by Interior, (2) national wildlife refuges, and (3) other migratory bird or endangered species management areas that receive water from Interior-funded projects. The initial phase of the program will identify general conditions at selected sites. If this preliminary assessment reveals potential contamination, Interior plans in-depth investigations of suspected sites, including analysis of impacts on wildlife and habitat. If further study and evaluation indicate that corrective action is justified, an inter-governmental planning process will be initiated to identify cost-effective solutions. Although Interior is committed to implementing corrective actions for which it has the authority and resources, it recognizes that in many cases, such as when contaminant sources are outside a refuge, cleanup may require actions by others.

Interior agencies participating in and jointly funding the program include the Service; USGS; and the Bureaus of Reclamation, Land Management, and Indian Affairs. The funding levels are \$986,000 for fiscal year 1986 and \$820,000 for fiscal year 1987. According to the program coordinator, the budget request for fiscal year 1988 is \$3.6 million.

Program studies began in 1986 at 9 irrigation drainage areas that affect 10 Service refuges. Studies at 10 additional irrigation drainage areas affecting an additional 12 refuges will begin in fiscal year 1988. Interior selected the 19 drainage areas for study from 3 sources: (1) a December

**Chapter 5**  
**Agricultural Drainage Problem Under Study,**  
**but Legislative Change May Be Required**

**Figure 5.2: Fish and Wildlife Study Areas, Refuge Water Supply Investigation, Central Valley Basin—California**



Source: U.S. Bureau of Reclamation.

1985 Interior selenium report,<sup>1</sup> (2) the January 1986 Service draft report on refuge contaminant issues, and (3) a request to Interior agencies with land and resources management responsibilities to identify additional sites.

<sup>1</sup>Preliminary Evaluation of Selenium Concentrations in Ground and Surface Water, Soils, Sediment, and Biota from Selected Areas in the Western United States, Department of the Interior Task Group on Irrigation Drainage.

The initial studies where Interior agencies are collecting and analyzing water, sediment, plant, and animal samples formally began on May 30, 1986, at the following nine locations:

- the Lower Colorado-Gila River Valley area in Arizona and California,
- the Salton Sea area in Southern California,
- the Tulare Lake area in the southern San Joaquin Valley area of California (results will be incorporated with the San Joaquin Valley Drainage Study),
- the Sun River Reclamation Project area in Montana,
- the Milk River Reclamation Project area in Montana,
- the Stillwater Wildlife Management area in Nevada,
- the Lower Rio Grande-Laguna Atascosa National Wildlife Refuge area in Texas,
- the Middle Green River Basin area in Utah, and
- the Kendrick Reclamation Project area in Wyoming.

According to a March 1987 Interior news release, final reports of the initial studies are expected to be completed by the end of 1987, except for those for Stillwater and Salton Sea, which are expected in 1988.

---

### **Actions to Address Suspected Contamination at Specific Refuges**

We visited three refuges, in addition to Kesterson, where Interior is dealing with actual or suspected agricultural drainage water contamination. We selected the Stillwater NWR in Nevada and the Cibola and Imperial NWRs in Arizona and California. The Service identified these refuges as being potentially contaminated by agricultural drainage, and Interior included them in its Irrigation Drainage Program.

At these three refuges, the suspected problems identified by the Service have not been confirmed, nor have the sources, ranges, or levels of contamination been documented. Interior's Irrigation Drainage Program, still in its preliminary stages, is attempting to confirm the existence and sources of suspected contaminants. The identification of a suspected problem, the confirmation of contaminants and their effects on wildlife, and the development of a cleanup proposal is a time-consuming process, as demonstrated by the 6 years that have elapsed from the identification of suspected contamination at the Kesterson refuge to the discussion of cleanup actions between Interior and the state. The length of this long-term process and the difficulty of identifying responsible parties—particularly for off-refuge, nonpoint contaminant sources—makes eventual cleanup remote and uncertain.

In addition to the 22 refuges being studied under the Irrigation Drainage Program, the Service has established plans to study the other 18 refuges that its 1986 contaminant issues report identified as having suspected agricultural drainwater contamination. These studies will attempt to confirm the nature, extent, and effect of the contaminant problems and suggest corrective action.

Details on the suspected irrigation contamination at the Stillwater refuge are provided in the following section.

### Stillwater Refuge and Wildlife Management Area

The Stillwater Wildlife Management Area, about 144,000 acres located 75 miles east of Reno, Nevada, was established in 1948 on public lands that had historically been a major stopover for waterfowl during their spring and fall migrations. Its water supply is dependent on drainage from the Bureau's Newlands Project, which has provided agricultural irrigation water to the lower Carson River area since the early 1900s. Stillwater has no rights to fresh water, although it occasionally receives water from Newlands Project releases to the Carson River during high water years. The management area, which includes the 24,000-acre Stillwater NWR, is managed by the Service. (See app. II for a refuge map.)

In 1985 and 1986 the Bureau collected samples and tested the drain water that supplies the management area and found that it contains high levels of selenium. The Service reported the presence of elevated levels of arsenic, selenium, boron, mercury and lithium at the refuge. Mercury—originating from 19th-century silver mining in the area—was identified in fish at levels one to four times the maximum suggested for human consumption. Consequently, Interior placed Newlands in its Irrigation Drainage Program. Interior plans to make a determination of whether the drainage water is potentially harmful to the area's fish and wildlife in October 1988.

During the fall and winter of 1985-86, massive fish deaths, estimated at between 200,000 and 500,000, occurred in the Carson River and Carson Sink, an area north of Stillwater where much of the area's drainage eventually empties. Despite investigations by the Service, the Bureau, and the Nevada Department of Wildlife, the cause of these deaths was never confirmed.

In December 1986 another large fish die-off was discovered in the Carson Sink. In January 1987 Service refuge personnel observed unexplained bird deaths in the same area. The discovery of dead birds in

conjunction with the fish die-off, and the area's history of heavy metal contaminants, caused speculation that the deaths might have been linked or caused by concentrations of man-made chemicals or natural elements such as selenium. However, according to the Service, laboratory evidence did not support these assumptions. The water in Carson Sink ultimately leaves the sink naturally by evaporation, so dissolved solids are left behind to concentrate in the sink's remaining water.

Service personnel have sampled Carson Sink water and plant and animal tissue to determine the cause of the fish and bird die-offs. The Service's laboratory analysis of animal tissue has attributed the bird deaths to avian cholera, a naturally occurring disease. The cause of the fish die-off was not confirmed; however, fishery biologists speculate that it may have been the result of high salt levels in the Carson Sink. Whether these bird and fish die-offs were somehow influenced by the presence of trace elements or other pollutants in the area remains unknown.

The Stillwater area is being studied under the Interior Irrigation Drainage Program to confirm the existence of contamination, determine the extent of the problem, and decide whether cleanup action is required. It is uncertain who will be financially liable for potential cleanup actions if they are required.

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## **Agricultural Drainage Exempted From Regulation**

Aside from the difficulties in confirming the effects of contamination on wildlife and developing a plan for cleanup, the Service faces a legal obstacle to resolving contamination from agricultural drainage water. No federal legal authorities exist to control this type of pollution. According to EPA region IX officials, agricultural drainwater could have been considered a point source discharge under the original Clean Water Act and thus be subject to control under EPA discharge permit requirements. However, a 1977 Clean Water Act amendment served to exempt irrigation drainwater from EPA discharge permit requirements.

The Federal Water Pollution Control Act amendments of 1972 required permits for discharging pollutants from point sources—including agricultural, forestry, and storm runoff. The Administrator, EPA, however, decided to exempt these three pollutant point sources from discharge permit requirements because, in EPA's view, the number of permits involved in the absence of this exemption would simply overwhelm the agency's resources.



However, the National Resources Defense Council challenged EPA's authority to exempt categories of point sources from Clean Water Act requirements. In 1977 the U.S. Court of Appeals, District of Columbia Circuit, held that while some adjustments may be warranted in the discharge permit program, the Administrator, EPA, does not have the authority to exclude certain categories of point source pollution. It held further that the discharge permit is the only means by which a discharger may escape total prohibition of pollutant discharges from point sources.

The Congress effectively reversed this ruling with the Clean Water Act of 1977, which excluded agricultural drainage from the definition of the term "point source." Agricultural drainage is now considered a nonpoint pollutant source. Because this general exemption removes all agricultural drainage from EPA's jurisdiction, EPA has no legislative authority to intervene in those cases in which agricultural drainage contaminates refuges.

However, according to a state water quality official, the amendments do not prevent individual states from regulating agricultural drainage by instituting stricter agricultural effluent standards as part of their approved discharge permit program. According to region IX and Washington EPA officials, they are unaware of any state that has placed pollutant discharge permit requirements on agricultural drainage. California may be the closest to taking such action, as it is now considering revisions to water quality objectives for the San Joaquin River as a result of the San Joaquin Valley agricultural drainage problem. The California State Water Resources Control Board is proposing to establish water pollution control objectives for selenium and other potentially toxic elements entering the San Joaquin River from agricultural drainage and other sources.

Recent Clean Water Act amendments enacted in February 1987, entitled the "Water Quality Act of 1987," established a nonpoint source pollution planning effort. Congressional deliberations preceding the 1987 Clean Water Act amendments recognized that pollution from nonpoint sources, such as agricultural runoff, contribute as much as one-half of all water pollution. States are required to identify navigable waters contaminated by nonpoint sources and to develop management plans to deal with such pollution. It authorizes a total of \$400 million to be spent through 1991 to assist states in setting up their nonpoint management programs. It is too early to tell whether the nonpoint plans will address agricultural

runoff that affects wildlife refuges, and how the states might implement programs to control this runoff.

Another potential avenue for the regulation of agricultural discharges is the Bureau's contracts for delivery of water to water service districts throughout the West. These contracts require water districts to comply with federal and state water quality regulations; however, since state and federal water quality regulations do not address agricultural drainage water, the contract provisions are ineffective. Bureau officials in the mid-Pacific region and Washington told us that they have no plans to modify existing or future contract language to include provisions for controlling the discharge of agricultural drainage. They consider current contract language adequate because the requirement for irrigators to satisfy federal and state water quality regulations is legally sufficient to limit the government's liability for the effects of agricultural drainage water.

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## Conclusions

Interior and the Service have undertaken several actions to address suspected agricultural drainage contamination problems on refuges and wildlife management areas. Efforts to obtain detailed data to confirm the existence, source, and extent of suspected refuge contamination and related agricultural drainage problems and develop cleanup plans include

- the San Joaquin Valley Drainage Program, to identify solutions to the valley's need to dispose of agricultural drainage and the effects of drainage contaminants on wildlife and wildlife habitats, and
- Interior's Irrigation Drainage Program, to confirm and assess the suspected contamination of 22 refuges by agricultural drainage from Bureau of Reclamation water projects.

The Service has also planned to study the 18 other refuges identified in its 1986 contaminant issues report to confirm suspected agriculture-related contamination. These activities are attempting to confirm the existence of potentially harmful contamination and trace its sources. They are expected to result in recommendations for further study to determine the impact of identified contaminants on wildlife and, if necessary, establish refuge cleanup requirements.

Once the suspected problems are confirmed, the process of identifying and confronting the entities responsible for cleanup, deciding on cleanup plans, obtaining funds to implement cleanup, and eventually taking

cleanup action will require many years. Determining harmful effects of identified contaminants on wildlife and wildlife habitat alone involves a lengthy, complicated, and expensive process. If Interior must ultimately undertake and fund refuge cleanup, it will have to obtain funds through the congressional budget process.

We believe that identified point sources of refuge contamination should be subject to an EPA discharge permit. For Kesterson, the contaminant source clearly was an identifiable, specific, point source—the agricultural drainwater coming from the Westlands Water District. The Clean Water Act, however, excludes agricultural drainage from control under the discharge permit requirements. Whether other refuges are being contaminated by point sources of agricultural drainage is unknown, but this question is being addressed now by Interior's studies.

We recognize that for other refuges, agricultural drainwater leaves the farmland as a nonpoint or diffused source, and that a discharge permit cannot be written to control this problem. The newly established nonpoint planning effort may generate new farming techniques, which, when implemented, may help alleviate the runoff of contaminated drainwater into national wildlife refuges.

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## **Recommendation**

We recommend that the Secretary of the Interior evaluate the results of the ongoing studies to determine if agricultural drainage traceable to a single source is occurring elsewhere. If it is, we recommend that the Secretary work with the Administrator, EPA, in preparing a legislative proposal to amend the Clean Water Act to require that agricultural drainage traceable to a single source be subject to discharge permit requirements.

# National Wildlife Refuges GAO Contacted During Its Telephone Survey

Refuges with identified contamination (Total = 26)

<b>Region 1 refuges</b>	<b>State</b>
Butte Sink	California
Johnston Island	Hawaii
Kesterson	California
Lower Klamath	California
San Francisco Bay	California
San Luis	California
Seal Beach	California
Sutter	California
Tijuana Slough	California
<b>Region 2 refuges</b>	
Bosque del Apache	New Mexico
Buffalo Lake	Texas
Imperial	Arizona
Laguna Atascosa	Texas
Santa Ana	Texas
<b>Region 3 refuge</b>	
Crab Orchard	Illinois
<b>Region 4 refuge</b>	
Wheeler	Alabama
<b>Region 5 refuges</b>	
Eastern Shore of Virginia	Virginia
Edwin B. Forsythe	New Jersey
Fisherman Island	Virginia
Great Meadows	Massachusetts
Great Swamp	New Jersey
Iroquois	New York
Sachuest Point	Rhode Island
<b>Region 7 refuges</b>	
Innoko	Alaska
Kenai	Alaska
Yukon Flats	Alaska

During its teleph...

Refuges with no identified contamination (Total = 50)	
<b>Region 1 refuges</b>	<b>State</b>
Anaho Island	Nevada
Ash Meadows	Nevada
Copalis	Washington
Deer Flat	Idaho
Fallon	Nevada
Kilauea Point	Hawaii
Ruby Lake	Nevada
Turnbull	Washington
<b>Region 2 refuges</b>	
Attwater Prairie Chicken	Texas
Maxwell	New Mexico
Moody	Texas
Optima	Oklahoma
<b>Region 3 refuges</b>	
Cedar Point	Ohio
Fox River	Wisconsin
Ottawa	Ohio
Squaw Creek	Missouri
<b>Region 4 refuges</b>	
Banks Lake	Georgia
Blackbeard Island	Georgia
Carolina Sandhills	South Carolina
Chassahowitzka	Florida
Desecheo	Puerto Rico
Egmont Key	Florida
Hillside	Mississippi
Hobe Sound	Florida
Holla Bend	Arkansas
Lake Woodruff	Florida
Panther Swamp	Mississippi
Pea Island	North Carolina
Pinellas	Florida
Tennessee	Tennessee
Upper Ouachita	Louisiana
Wassaw	Georgia

(continued)

<b>Region 5 refuges</b>	<b>State</b>
Featherstone	Virginia
Massasoit	Massachusetts
Moosehorn	Maine
Oyster Bay	New York
Susquehanna	Maryland
<b>Region 6 refuges</b>	
Ardoch	North Dakota
Bone Hill	North Dakota
Hutton Lake	Wyoming
J. Clark Salyer	North Dakota
Lake Mason	Montana
McLean	North Dakota
Pathfinder	Wyoming
Seedskadee	Wyoming
Silver Lake	North Dakota
Slade	North Dakota
Waubay	South Dakota
Wood Lake	North Dakota
<b>Region 7 refuge</b>	
Becharof	Alaska

# National Wildlife Refuges GAO Visited

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## Cibola (Arizona and California)

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### Description

Cibola NWR was established in 1964 to provide wintering habitat for waterfowl and other migratory birds. The refuge's 16,667 acres are located along the Lower Colorado River, in LaPaz County, Arizona, and Imperial County, California. The refuge consists of riverbottom surrounded by a small fringe of desert ridges and washes. A dredged river channel, built by the Bureau of Reclamation, stretches the length of the refuge and divides it in half. Present wetlands include the 600-acre Cibola Lake, approximately 10 miles of Colorado River backwaters, seasonally flooded croplands, and a managed marsh unit. The bald eagle, brown pelican, peregrine falcon, and the Yuma clapper rail are among the endangered species known to use the refuge. The refuge is noted for its winter population of Canada geese and greater sandhill cranes, and its summer population of egrets, doves, and herons.

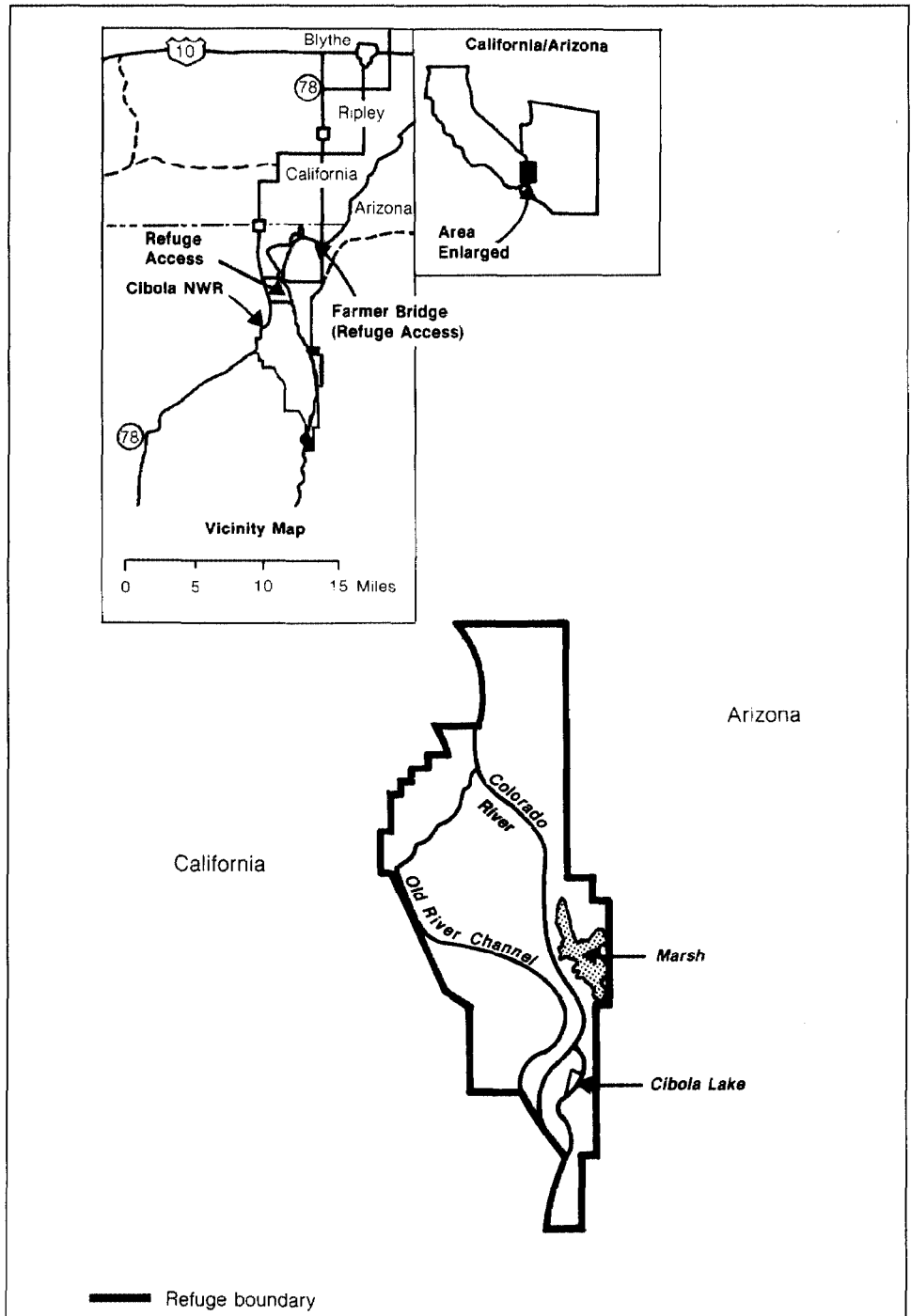
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### Contaminant Issues

The refuge is located near intensively farmed areas and receives water from the Colorado River. The irrigation drainage water flowing into the river from upstream irrigated farm lands contains elevated levels of selenium and other trace elements as well as agricultural chemicals. Colorado River water is used on the refuge to sustain ponds and marsh areas for wildlife habitat. Information from fish samples showed elevated levels of DDT, toxaphene, and selenium. River water used on the refuge is suspected of causing wildlife health problems.

Appendix II  
National Wildlife Refuges GAO Visited

Figure II.1: Cibola National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.



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## Great Meadows (Massachusetts)

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### Description

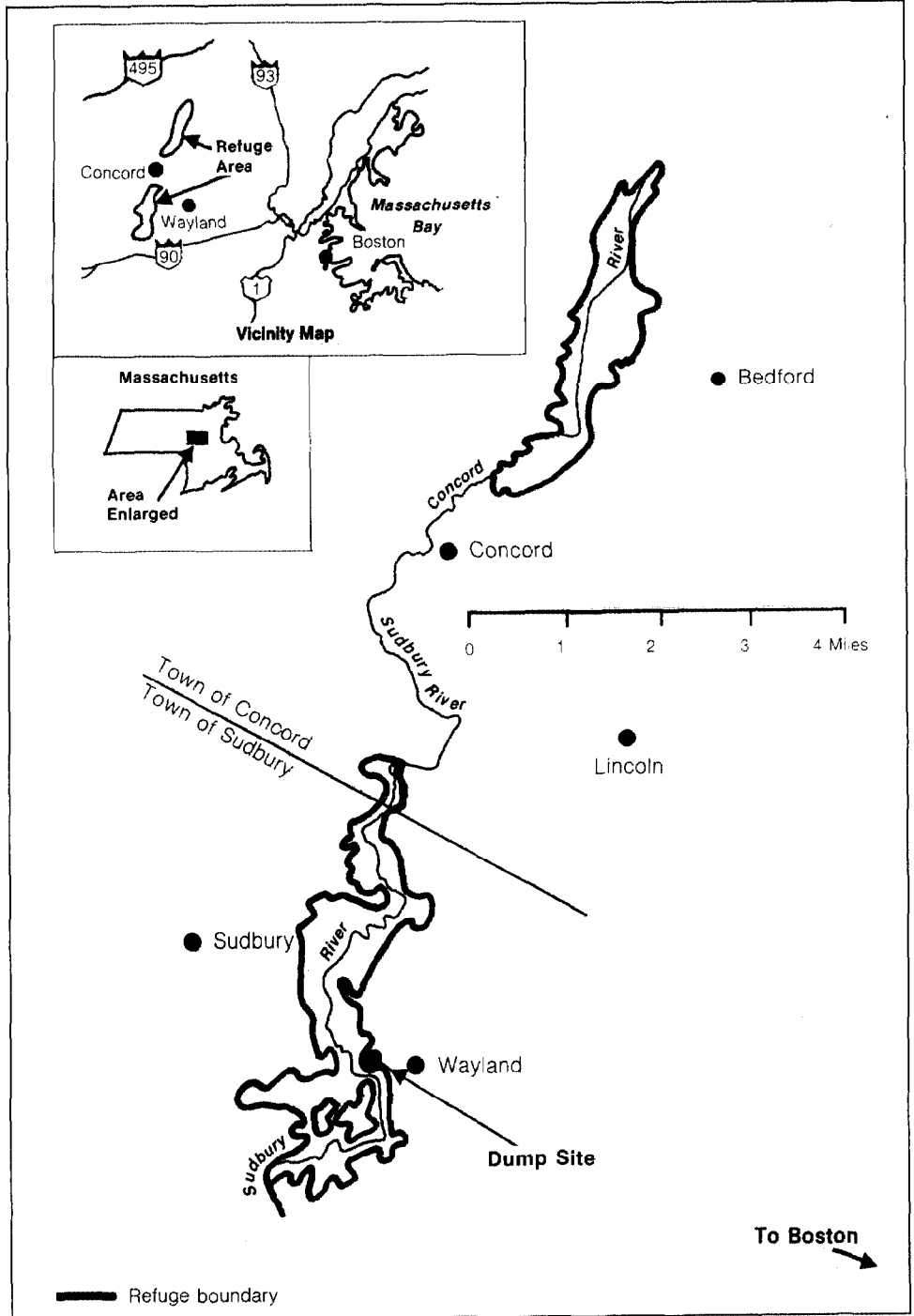
Great Meadows NWR was established in 1944 when 250 acres of wetlands were donated for refuge purposes. The value of the area to migratory waterfowl was recognized and adjacent land was acquired during the 1960s to provide greater protection to the area's wetlands. Flanked by 12 miles of the Sudbury and Concord rivers, the refuge is bounded by several historically significant towns: Bedford, Carlisle, Concord, and Lincoln in Middlesex County, Massachusetts. The refuge encompasses 2,878 acres of woodlands, fields, and freshwater wetlands known for their large population of nesting wood ducks. Great Meadows NWR is encircled by suburban development on all sides and serves several million people with unique opportunities for birdwatching, photography, and environmental education.

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### Contaminant Issues

A hazardous waste dump containing heavy metals is located adjacent to the refuge boundary and drains into the Sudbury River, which forms the main water supply for the refuge. The Service's analyses of fish from the river indicate elevated residues of mercury, chromium, selenium, and lead. In addition, the state took water samples from two reservoirs upstream of the refuge that showed elevated levels of mercury.

Figure II.2: Great Meadows National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.

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## Great Swamp (New Jersey)

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### Description

Great Swamp NWR was established in 1960 to protect wetlands for wildlife and thereby block a proposal to build a jet airport. It was the airport proposal that enabled a foundation to raise more than a million dollars to purchase nearly 3,000 acres, later donated to the Department of the Interior. These acres formed the nucleus of the Great Swamp NWR. Additional land purchases have increased the size of the refuge to 6,793 acres. Approximately 3,660 of these acres have been designated as a wilderness area. The remainder of the refuge is subject to various forms of land and water management to maintain habitat for a wide variety of wildlife. Located in Morris County in north central New Jersey, the refuge is situated within the Great Swamp Basin and is literally a wildlife oasis, totally surrounded by suburban communities and encroaching urbanization.

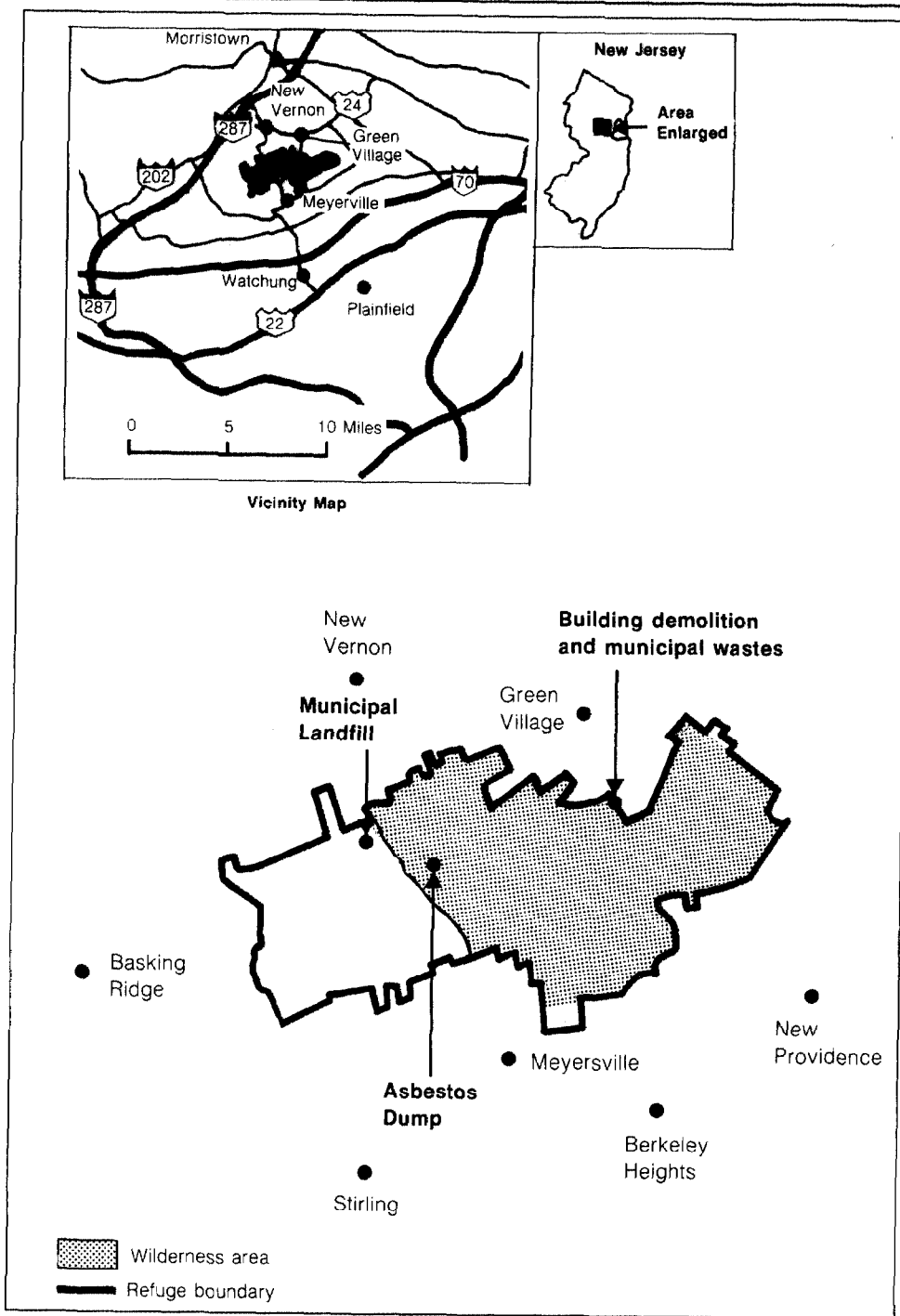
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### Contaminant Issues

This refuge is faced with several contaminant problems. Prior to its establishment, an industry that manufactured shingles and insulation dumped asbestos at a number of sites now within the refuge. The primary dump site is approximately 5 acres. The Service placed a thin layer of topsoil over the dump; however, the asbestos has broken through the soil in places. Effluents from two landfills also affect the refuge. One of the landfills is located both on and off the refuge and its leachate drains through the refuge. The landfill contains building demolition and municipal wastes. The other landfill is located within the refuge and served for a number of years as a municipal dump.

**Appendix II  
National Wildlife Refuges GAO Visited**

**Figure II.3: Great Swamp National Wildlife Refuge**



Source: U.S. Fish and Wildlife Service.

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## Imperial (Arizona and California)

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### Description

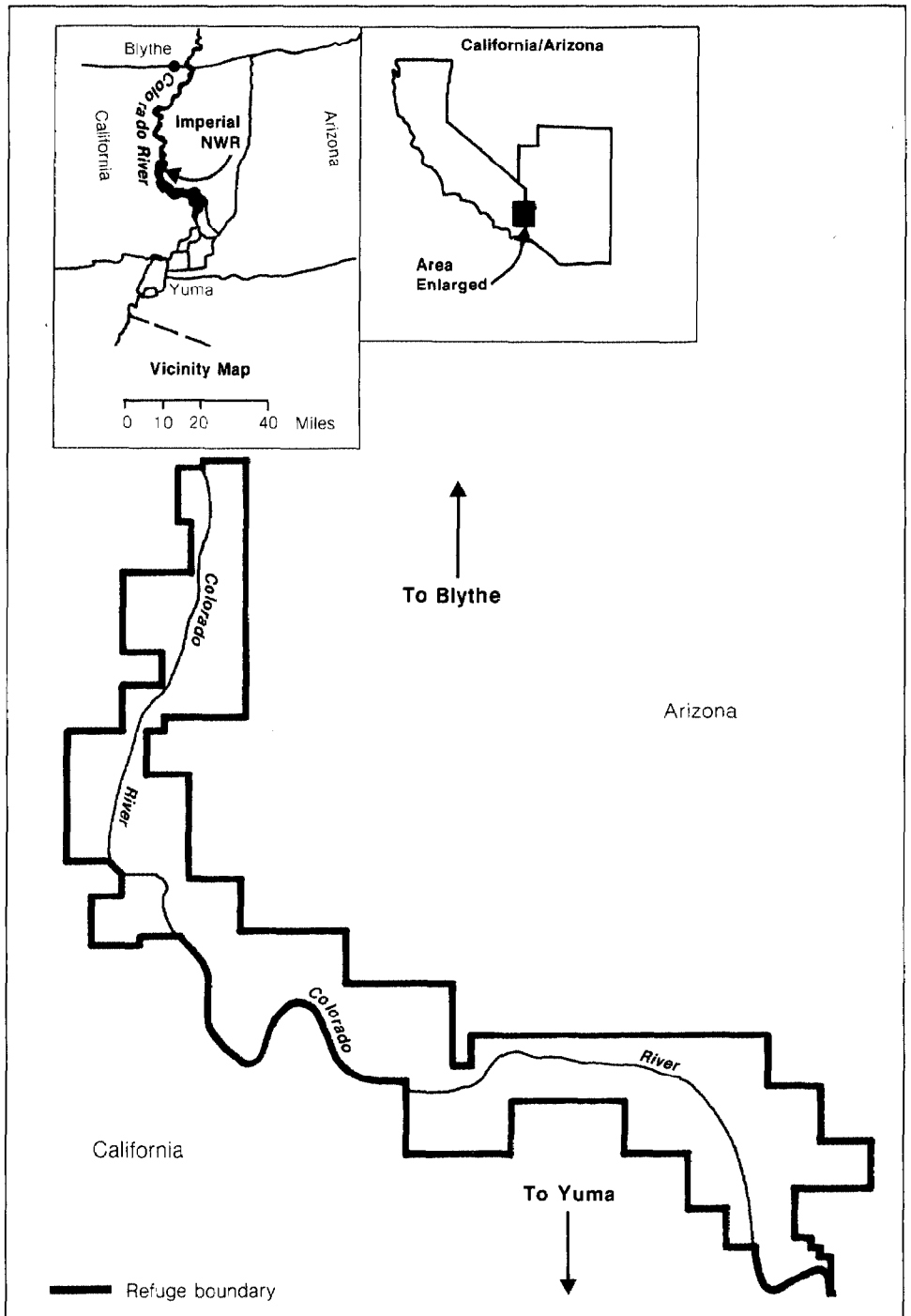
Imperial NWR was established in 1941 to provide migration and wintering habitat for migratory birds. The 25,125-acre refuge is located about 40 miles north of Yuma, Arizona. The refuge straddles 30 miles of the Colorado River with 17,167 acres in Arizona (Yuma County) and 7,958 acres in California (Imperial County). Habitat types include upland desert (10,415 acres), brushland (4,895 acres), natural wetland (7,423 acres), managed croplands (380 acres), and riverine habitat (2,010 acres). Tens of thousands of ducks and coots winter on the refuge, which also provides year-round habitat for the endangered Yuma clapper rail.

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### Contaminant Issues

The refuge is located near intensively farmed areas and receives water from the Colorado River. The irrigation drainage water flowing into the river contains elevated levels of selenium and other trace elements as well as agriculture chemicals. Colorado River water is used on the refuge to sustain ponds for wildlife habitat. Tests of fish samples showed elevated levels of DDT, toxaphene, and selenium. River water used on the refuge is suspected of causing wildlife health problems.

Figure II.4: Imperial National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.

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## Kesterson (California)

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### Description

Kesterson NWR was established on July 23, 1970, through a cooperative agreement that superimposed the refuge on Bureau of Reclamation lands. Located in Merced County, California, Kesterson's 5,900 acres include 1,200 acres of agricultural wastewater evaporation ponds and 4,700 acres of pristine native grasslands, shallow marshlands, and unique vernal pools. The 4,700 acres represent a remnant of the historic San Joaquin River ecosystem and support over 200 species of birds, including eagles, geese, ducks, cranes, and songbirds. The refuge grasslands provide critical habitat for the endangered San Joaquin kit fox plus several unique plant species. The refuge's primary purpose is to serve as a migration and wintering area for waterfowl and other migratory birds. (See fig. 2.2.)

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### Contaminant Issues

Since 1980, ponds at this refuge have received contaminated agricultural drain water containing elevated levels of selenium and other trace elements. Following the discovery of avian reproduction failures and embryonic deformities, intensive monitoring in 1983 and beyond has shown high levels of selenium in water, soil, sediments, fish, and birds.

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## Seal Beach (California)

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### Description

Seal Beach NWR is contained within the U.S. Naval Weapons Station, Seal Beach, California, and is located along the urbanized coast of Orange County. Established in 1972, the refuge encompasses 977 acres of salt marsh and other tidal wetlands. Habitat management is aimed primarily at preserving and restoring the coastal salt marsh that provides habitat for the endangered light-footed clapper rail, California least tern, and brown pelican. Waterfowl and shore and wading birds also use the area.

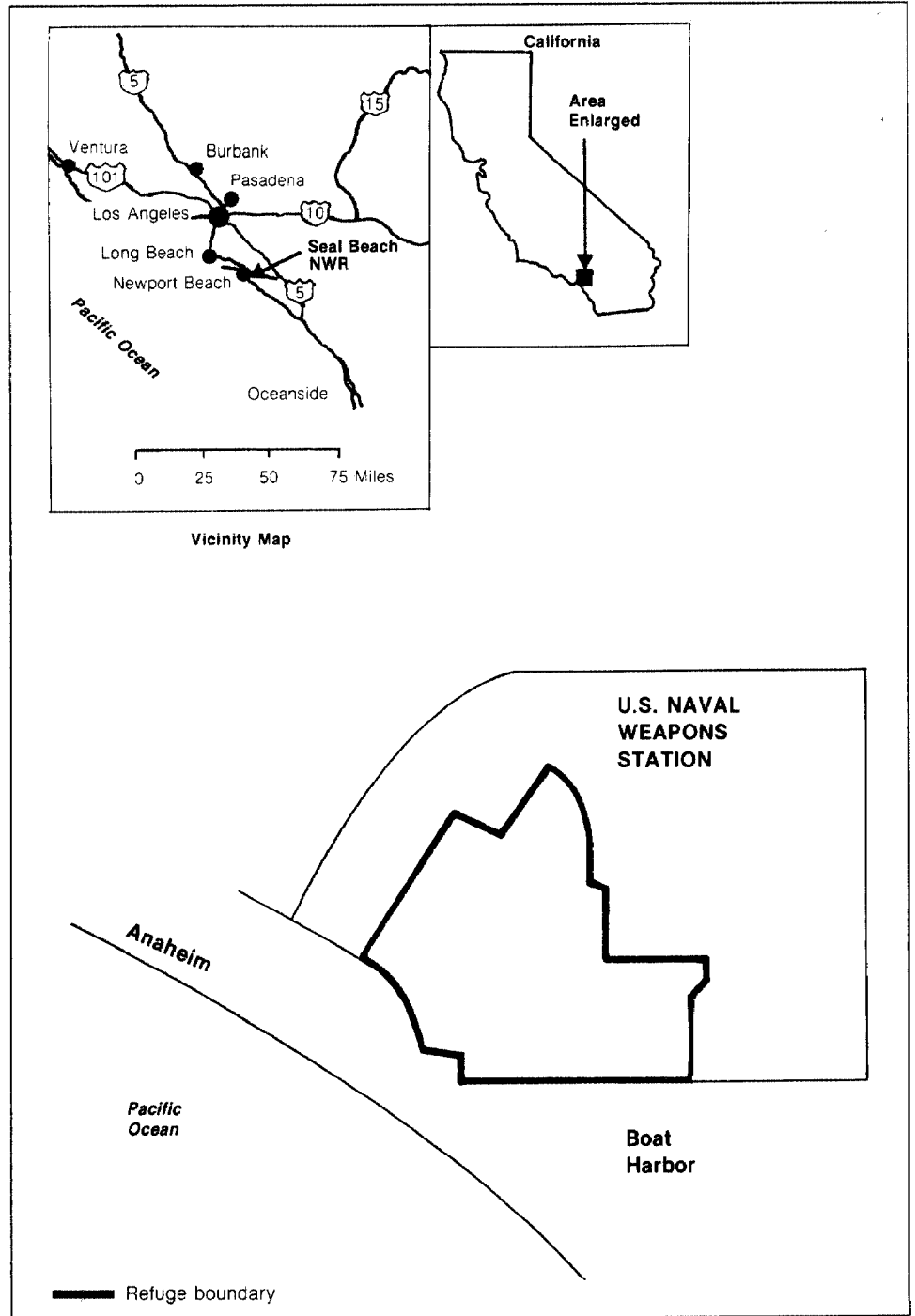
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### Contaminant Issues

From 1945 to 1975, as a result of military activities, wastes from brass cleaning operations, waste battery acid, and other industrial contaminants and live ordnance were deposited at Seal Beach. Nine sites at Seal Beach have been identified as possibly posing a threat to human health or the environment.

Appendix II  
National Wildlife Refuges GAO Visited

Figure II.5: Seal Beach National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.



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## Stillwater (Nevada)

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### Description

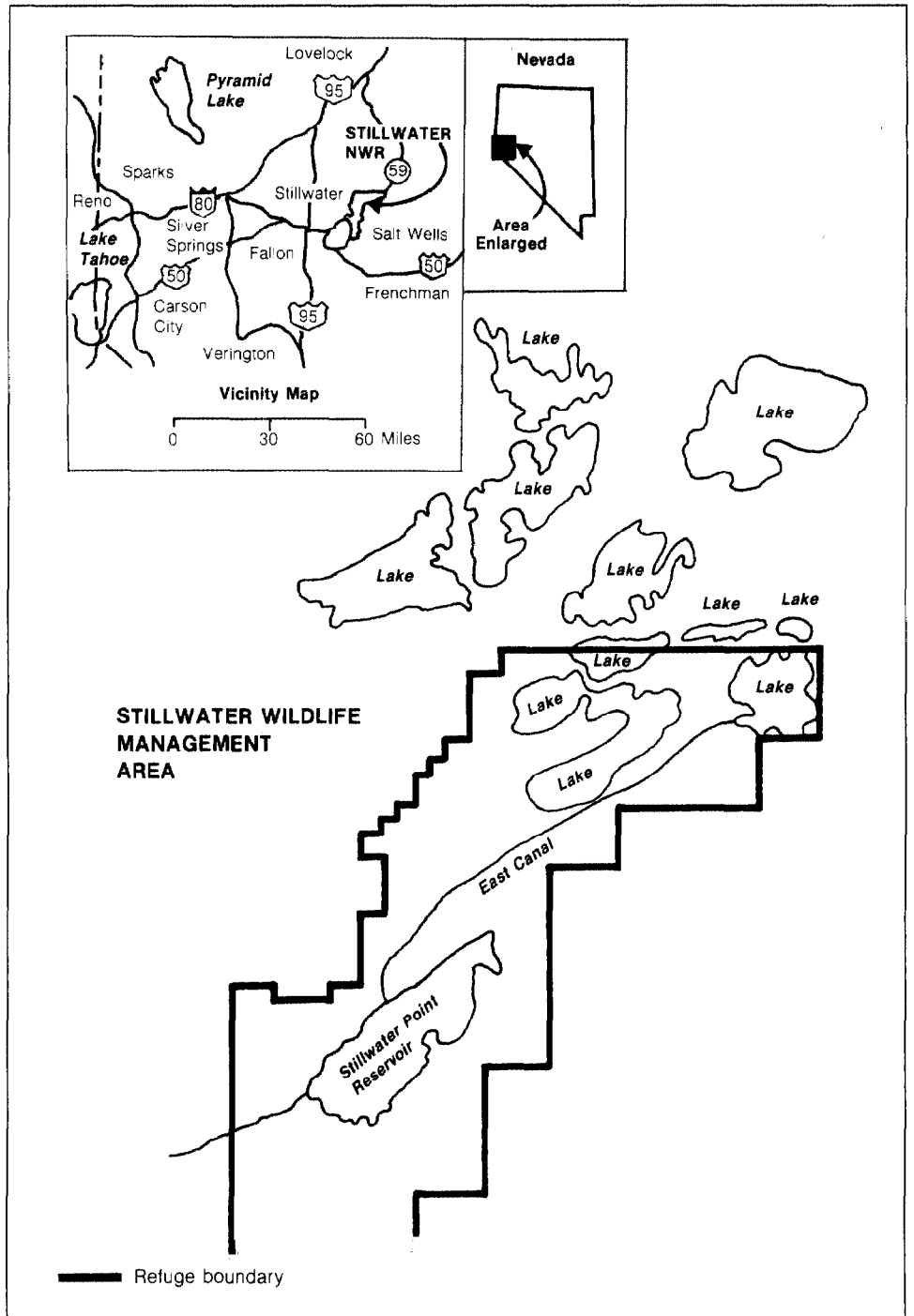
Stillwater Wildlife Management Area (WMA) was established through a tripartite agreement in 1948 involving the Truckee-Carson Irrigation District, the Nevada Department of Wildlife, and the Service. Located in Churchill County, 75 miles east of Reno, Nevada, the management area was established because the area has historically been a major stopover point for migratory waterfowl during their spring and fall migration. Peak numbers of 250,000 ducks, 10,000 geese, and 13,000 tundra swans visit the area during years when water is plentiful. Under ideal conditions, waterfowl produce up to 15,000 young in the area; cinnamon teal, gadwall, and redhead are the principal nesting species. Stillwater WMA encompasses approximately 144,000 acres, including the following habitat types: desert marshes (11,300 acres), open saline water (14,000 acres), and freshwater wetlands (1,200 acres). About 23,000 acres of waterfowl habitat are managed, primarily in the form of 16 impoundments. The water on these areas is obtained through controlled releases and return flows from irrigated farm lands. Within the WMA boundaries, 24,000 acres have been set aside as Stillwater National Wildlife Refuge.

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### Contaminant Issues

This area acts as a sump for contaminants carried in irrigation drainwater. Elevated levels of arsenic, selenium, boron, lithium, mercury, and zinc, as well as high salinity, have been documented in the water.

Figure II.6: Stillwater National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.

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## Tinicum (Pennsylvania)

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### Description

Tinicum National Environmental Center was established in 1972 to preserve, restore, and develop the natural area known as Tinicum Marsh. It was also created to provide a wildlife interpretive center for the purpose of promoting environmental education and to afford visitors an opportunity for the study of wildlife in its natural habitat. Located 1 mile north of Philadelphia International Airport, in Philadelphia and Delaware counties, the center is made up of 900 acres, including 200 acres of tidal marsh and 145 acres of nontidal wetlands. Much of the land is former tidal wetland altered by diking, dredging, or filling. Refuge employees have recorded over 280 species of birds using the area. (See fig. 4.2.)

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### Contaminant Issues

Fifty-eight acres of a 62-acre landfill added to the center in 1980 was used from 1961 to 1974 for disposal of municipal, demolition, hospital, and industrial wastes. Potential toxic concentrations of metals, pesticides, and cyanide have been identified. In addition, sediment samples taken upstream and downstream of a municipal waste landfill located adjacent to the center revealed low levels of PCBs, chlordane, and polycyclic aromatic hydrocarbons.

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## Wheeler (Alabama)

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### Description

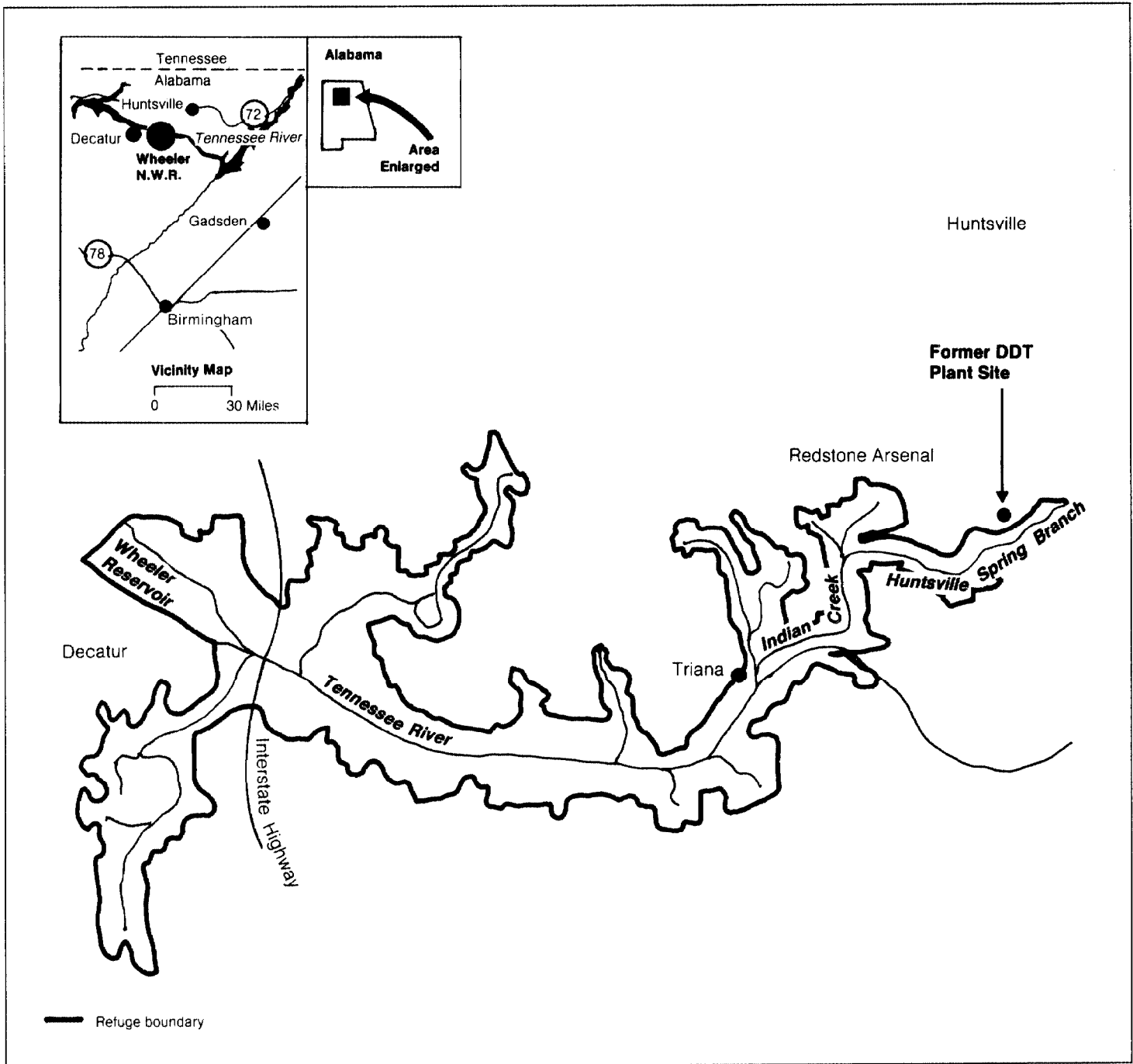
Wheeler NWR was established in 1938 as an overlay project on the Tennessee Valley Authority's Wheeler Reservoir. The refuge was established to provide land for Wheeler Reservoir and as "refuge and breeding ground for migratory birds and other wildlife." Refuge boundaries extend from within the city of Decatur to the city limits of Huntsville and include parts of Morgan, Limestone, and Madison counties. Alabama's largest wintering duck population (40,000 peak) can be found on the refuge, which also hosts one of the southernmost concentrations of Canada geese (35,000 peak). The refuge's 34,000 acres include 15,000 acres of water, 10,000 acres of bottomland hardwoods, 3,000 acres of pine plantations, 5,000 acres of farmland, and 1,000 acres of other upland habitats.

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**Contaminant Issues**

Discharges from a plant that manufactured DDT contaminated a stream that flows through the refuge. DDT has accumulated in fish tissue at levels hazardous to human health as well as to the fish.

Figure II.7: Wheeler National Wildlife Refuge



Source: U.S. Fish and Wildlife Service.

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