SOLE SOURCE AQUIFER BACKGROUND STUDY: CROSS-PROGRAM ANALYSIS

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T A B L E O F C O N T E N T S

L I S T O F E X H I B I T S

FOREWORD

This document is one in a series of documents that summarize the designated and pending Sole Source Aquifers (SSAs) in eight of the ten U.S. Environmental Protection Agency (EPA) Regions. These documents resulted from an EPA study that assessed the status of the Sole Source Aquifer Program. In addition, the information obtained from this study was used to (1) assist in the streamlining of the SSA designation process and (2) assist in establishing criteria for identifying critical aquifer protection areas in response to the 1986 amendments to the Safe Drinking Water Act (SDWA).

Additional information on the Sole Source Aquifer Program can be obtained from the Office of Ground-Water Protection in Washington, D.C., and from the ten EPA Regions.

ACKNOWLEDGEMENT

This report was prepared by the Office of Ground-Water Protection (OGWP), U.S. Environmental Protection Agency (EPA), Washington, D.C. Mr. William G. Stelz of OGWP served as the Project Manager for EPA, assisted by Mr. Paul Violette. Booz, Allen & Hamilton Inc. and Dames & Moore under Contract No. 68-03-3304 assisted in the preparation of this report. EPA Regional OGWP representatives deserve thanks for their cooperation in the review of this document.

EXECUTIVE SUMMARY

The Sole Source Aquifer (SSA) Program was established under Section 1424(e) of the Safe Drinking Water Act (SDWA) of 1974. This section authorizes the EPA Administrator to determine that an aquifer is the "sole or principal" source of drinking water for an area. The program also provides for EPA review of Federal financially assisted projects planned for the area to determine their potential for contaminating the aquifer. Based on this review, no commitment of Federal financial assistance may be made for projects "which the Administrator determines may contaminate such aquifer," although Federal funds may be used to modify projects to ensure that they will not contaminate the aquifer.

On September 23, 1986, EPA's Office of Drinking Water (ODW) officially transferred its responsibilities for administering the Sole Source Aquifer Designation Program to the Office of Ground-Water Protection (OGWP). In an effort to smooth the transition of responsibilities and help OGWP identify ways to administer the SSA designation program provisions efficiently, OGWP undertook this study of the SSA designation process.

This report represents an historical account of the past SSA program. New guidance released by EPA in February 1987, "Sole Source Aquifer Designation Petitioner Guidance," will be the basis of the SSA program henceforth. As part of this SSA Background Study, EPA has published separate Regional reports describing the individual SSAs within each respective Region.

The overall objectives of the background study were to:

- Identify SSAs that have been designated and petitions that are pending
- Characterize the similarities and differences between SSAs
- Understand what information sources and analyses are needed to designate an aquifer
- Collect information on the designation process and procedures so that EPA may develop a more streamlined designation process.

To collect information on the SSA program, a project team interviewed EPA Regional staff and reviewed Regional files on both designated and pending SSAs. Three-person teams consisting of an EPA representative, a senior policy/institutional analyst, and a senior hydrogeologist conducted the Regional visits.

The project team's information gathering indicates that, to date, 23 aquifers have received SSA designation, 19 others have petitions pending designation, and eight petitions are considered to be inactive. The following is a summary of cross-program analysis of the institutional and policy characteristics of the petitions received and the hydrogeologic characteristics of the petitioned aquifers, as determined by the team's investigation.

(1) Institutional/Policy Characteristics

EPA Regions have received petitions rather consistently over the past 11 years, with a peak in submissions in the early 1980s. Environmental groups represent the largest petition groups, although petitions were submitted by local governments, citizens, and local water suppliers as well. About one-half of the petitions were submitted in an attempt to stop or affect a specific project. Landfills and publicly owned treatment works (POTWs) were the two types of facilities most likely to cause petitioners to submit SSA applications. The other half of the petitions was submitted to protect ground-water resources.

Once the Regions received the petitions, they either collected additional data or contacted the USGS and outside consultants. To provide public participation, the Regions held public hearings and accepted written public comments. State and local governmental agencies often provided written comments as well.

The Regions largely used three criteria to determine whether an aquifer should be designated. They were: (1) at least 50 percent population dependency on ground water, (2) the existence of alternative water supplies, and (3) the vulnerability to ground-water contamination. Two-thirds of the petitions providing such information indicated over 90 percent dependency of the population on ground water. In fact, almost half of the petitioned aquifers have been characterized as providing 100 percent of the drinking water supply.

The second criterion, alternative water supplies, was interpreted differently by various Regions. Some Regions addressed only available, existing sources as alternatives, while other Regions considered undeveloped, potential sources as well. The Regions used no formal approach or methodology to measure the third criterion, vulnerability. Typically, the Region reviewed real hydrogeologic characteristics and declared the aquifer to be vulnerable.

For designated SSAs, most Federal financially assisted projects reviewed by the Regions were approved without modification. For a few projects, modifications were made in order to be approved for the SSA area.

(2) Hydrogeologic Characteristics

Petitions contained up to nine different types of hydrogeologic information. Ground-water use and pollution source data were most commonly included in the petitions. Lithologic and formation nomenclature were usually presented as excerpts from geologic reports. Ground-water flow, water table depth, and other hydrologic data were generally not included in the petitions. Taken as a whole, the petitions alone were not adequate for making a delineation determination.

Petitioners and the Regions were approximately equally likely to use hydrogeologic criteria as a basis for delineating SSAs. Worth noting, however, is that the Regions frequently revised the petitioners' original boundaries once more comprehensive and sophisticated technical information had been reviewed. In many cases, these revisions were the result of the Region including the recharge area and/or streamflow source zone in the delineated area. In fact, all delineated SSAs included the aquifer recharge area and 70 percent included the streamflow source zone.

In terms of size, over two-thirds of the aquifers were less than 1,000 square miles while several were larger than 12,000 square miles. Over half of the aquifers were in unconsolidated deposits. Most aquifers behaved as single hydrologic units (i.e., 25 of 42 aquifers or 60 percent). The remaining 40 percent were multilayered, containing several definable water-bearing zones. The Regions in all cases treated multiple and confined aquifer systems as "leaky," assuming that unconfined, overlying units would contribute pollutants to the underlying units.

For ground-water flow characteristics, the petitioners generally based the analysis on surface topography and rarely used ground-water models. The depth to ground water was less than 30 feet in almost two-thirds of the cases. Shallow depths were often considered to represent susceptibility to contamination. The petitions often listed pollution sources that contributed to making the aquifers more vulnerable to contamination.

More detailed information on individual SSAs is available in the individual Regional reports, which are intended to complement this cross-program analysis.

I. INTRODUCTION

The Sole Source Aquifer (SSA) Program was established under Section 1424(e) of the Safe Drinking Water Act (SDWA) of 1974. This section authorized the Administrator of the Environmental Protection Agency (EPA) to determine that an aquifer is the "sole or principal" source of drinking water for an area. The program also provided for EPA review of Federal financially assisted projects planned for the area to determine their potential for contaminating the aquifer. Based on this review, no commitment of Federal financial assistance may be made for projects "which the Administrator determines may contaminate such aquifer," although Federal funds may be used to modify projects to ensure that they will not contaminate the aquifer. As of August 1987, there have been 23 designated SSAs nationwide; 19 remain in some stage of review. These SSAs are listed in Exhibit I-1 and depicted on a map of the U.S. in Exhibit I-2.

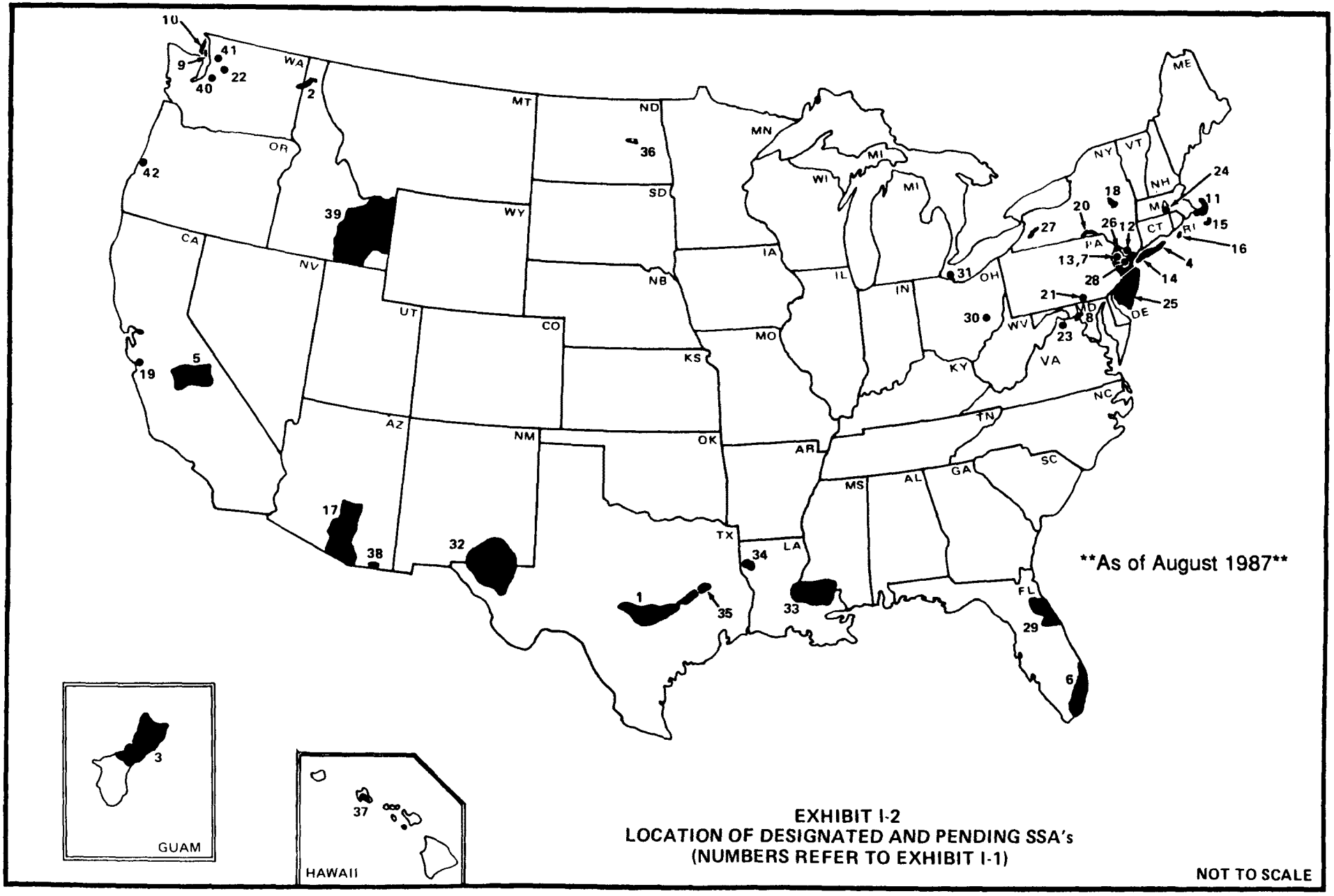
On September 23, 1986, the Office of Drinking Water (ODW) officially transferred its responsibilities for administering the SSA designation program to the Office of Ground-Water Protection (OGWP). As an initial step in developing its program implementation strategy, OGWP issued guidance (Sole Source Aquifer Designation Petitioner Guidance, February 1987, hereafter referred to as the SSA Designation Guidance) that has streamlined the SSA designation process. This guidance has been designed to ensure that the SSA designation time frame will be consistent with the eligibility criteria of the SSA demonstration program authorized by 1986 amendments to SDWA. Also, additional information and definitions with respect to the SSA program can be obtained from this document.

To develop the SSA Designation Guidance and to effectively administer the SSA program, OGWP conducted a review of the 12-year old SSA program. The purpose of the review was to collect background historical information about the SSA designation process. This background information consisted of both hydrogeologic data on each designated and pending SSA and policy/administrative information on the designation process itself. The study involved three separate and distinct tasks. Task 1 included the preparation of a directory/listing of the key documents supporting each designated or pending SSA and the production of a map of the designated and pending SSAs. Task 2 involved development of a profile of each SSA. In addition, information gained on the SSA

EXHIBIT I-1
List Of Sole Source Aquifers*

DESIGNATED	PENDING	INACTIVE
1. Edwards Aquifer, TX	24. Quaboag River Valley, MA	South Kingstown, RI
2. Spokane-Rathdrum Prairie, WA-ID	25. New Jersey Coastal Plain, NJ	North Kingstown, RI
3. Northern Guam	26. State of New Jersey	Highland (Ramapo Valley), NJ
4. Long Island, NY	27. Cattaraugus Creek-Sardinia, NY	New Castle, DE
5. Fresno Co., CA	28. Mt. Olive, NJ	Oakland Co., MI
6. Biscayne Aquifer, FL	29. Volusia-Floridan, FL	Carrizo-Wilcox, Bastrop Co., TX
7. Buried Valley, NJ	30. Pleasant City, OH	DeSoto Parish, LA
8. Maryland Piedmont, MD	31. Catawba Island, OH	East Helena, MT
9. Whidbey Island, WA	32. Delaware Basin, TX-NM	
10. Camano Island, WA	33. Capital Area-Baton Rouge, LA	
11. Cape Cod, MA	34. Wilcox-Shreveport, LA	
12. Ridgewood, NJ	35. Edwards Aquifer-Barton Springs, TX	
13. Upper Rockaway Basin, NJ	36. New Rockford, ND	
14. Brooklyn-Queens, NY	37. Pearl Harbor-Honolulu, HI	
15. Nantucket Island, MA	38. Naco-Bisbee, AZ	
16. Block Island, RI	39. Snake Plain, ID	
17. Upper Santa Cruz & Avra-Altar Basin, AZ	40. Newberg Area, WA	
18. Schenectady-Niskayuna, NY	41. Seven Lakes, WA	
19. Scotts Valley, CA	42. North Florence Dunal, OR	
20. Clinton Street-Ballpark, NY		
21. Seven Valleys, PA		
22. Cross Valley, WA		
23. Clarke Co., VA		

*As of August 1987



As of August 1987

EXHIBIT I-2
LOCATION OF DESIGNATED AND PENDING SSA's
(NUMBERS REFER TO EXHIBIT I-1)

NOT TO SCALE

designation process supported ongoing development of the SSA Designation Petition Guidance. Task 3 encompassed generation of this report including the Region-by-Region summaries and creation of a dBase III data file to access, compare, and manipulate data on the characteristics of aquifers and petition review process. This data file may be accessed by EPA Regional personnel through OGWP.

1. Information Collection Methodology

On this assignment, EPA and its consultants visited eight of the ten EPA Regions. These visits entailed interviews with Regional staff and a review of Regional files on both designated and pending SSAs. Three-person teams consisting of one EPA representative, one senior policy/institutional analyst and one senior hydrogeologist conducted the visits. The teams did not visit Regions V and VII because of their low level of SSA petition activity.

The teams reviewed documents that significantly contributed to the designation process. The analysts used data from these notes and files for further assessment of the process. Exhibit I-3 lists the types of information reviewed in the Regional files.

Typically, the teams interviewed Regional EPA staff using a protocol consisting of general questions about the process. The questions primarily dealt with the designation process, hydrogeologic and policy issues, the draft guidance on SSA designation, petition characteristics, and review of projects receiving Federal financial assistance.

2. Report Organization

This report presents the results of the cross-program analysis. It also summarizes the key characteristics of all the aquifers and analyzes similarities and differences among Regional programs as well as among individual aquifers. Its focus is on both the administrative and technical aspects of the historical SSA designation process.

Published separately are eight Regional volumes that contain data on SSAs in the respective Regions. These documents include information about the hydrogeologic characteristics of the SSAs and the institutional

EXHIBIT I-3

Type Of Information Reviewed And Extracted From Regional Files For Each SSA

- Name and type of petitioner
- Reason(s) for petition submittal
- Contents of the petition
- Federal Register announcements regarding receipt of the petition and request for public comment
- Response to Federal Register announcements (i.e., written or verbal comments)
- Public hearings records
- Hydrogeologic data and reports
- Ground-water use information
- Pollution sources and vulnerability records
- Population data
- Alternative source studies
- Existing contamination
- Current treatment practices
- Schedule of designation
- Memoranda of Understanding (MOU) with other Federal agencies
- Role of local/State governments in the process
- Projects receiving Federal financial assistance reviewed
- Other relevant and appropriate information.

functioning of the review and designation process. The information describes what was in the petition, how it was handled by the Agency, the supplemental studies undertaken, and the criteria used in the Regional decision-making process.

II. OVERVIEW OF REGIONAL DESIGNATION PROCESS

1. Implementation Strategies

Some Regions have used different approaches in implementing the SSA Program. These implementation differences resulted to some extent from differences in Regional interpretation of the SSA program regulations proposed in September 1977, but also from differences in Regional and State hydrogeology and regulatory philosophies. For example, some Regions encouraged public hearings and workshops to increase community awareness of possible ground-water contamination within the SSA. In order to address technical concerns, many Regions responded by contracting for a more extensive hydrogeologic assessment of the proposed aquifer(s). The U.S. Geological Survey (USGS) was often used in order to obtain the necessary data.

2. Petitions

EPA received SSA petitions from individual citizens, environmental groups, local governments, and public water suppliers. The technical detail provided in each petition was highly variable, and the Regional staff often requested more information.

As a rule, the petitions were submitted either to provide for aquifer protection or as a perceived method to inhibit the siting of an unwelcomed project. In many cases, the Regions faced simultaneous support and opposition to SSA designation from the petitioners, other interested parties, and local and State governments affected.

3. Project Reviews

After an aquifer is designated as an SSA, all Federal financially assisted projects are subject to review by EPA before final approval is granted. To carry out this review function, each Region signed a Memorandum of Understanding (MOU) with Federal agencies that provide project funds. This process allows EPA to assess the environmental impact of Federal financially assisted projects and to offer modifications where necessary. As a result of this review, some projects have been modified, but the SSA program has not resulted in cancellation of any projects.

4. The Designation Process

Pursuant to the draft SSA regulations, all EPA Regions followed the same general steps in performing the review of

petitions and designation of SSAs. These steps are briefly described below.

Review Petition for Adequacy -- When a petition was submitted to a Region, the initial step was to review the contents of the petition to ascertain its completeness. A complete petition was expected to contain all the information and maps described in the proposed SSA regulations. The petition content requirements from these regulations are contained in Exhibit II-1. The Regions generally did not request additional data from the petitioner. The Regions formally requested the petitioner to submit more information in only six cases.

Acceptance of Petition -- Following the review for completeness and submittal of any additional requested data, the Region formally accepted the petition and began its technical review.

Technical Review of Petition -- The Regions performed independent reviews of the petition's data to ascertain whether the aquifer met the criteria for an SSA. These reviews often involved collection of additional data and review of citations of technical documents listed in the petition. In many cases, the Regions contracted with the USGS to perform additional studies of the aquifer. The collected information served as the basis for the findings of the Region.

Public Comments and Hearings -- The Regions published Federal Register notices indicating receipt of the petition, specifying the time and location of any public hearings, and requesting public comments.

Findings and Designation Determination -- The data in the petition, subsequent studies, and information developed in the comments provided the basis for the Regional designation decision. The data were evaluated in terms of the criteria listed in the proposed regulations.

Submittal of Action Memorandum to EPA Headquarters -- The Regions submitted an action memorandum to EPA Headquarters explaining their findings and providing a recommendation on the designation decision. The details in the action memorandum varied according to the specific nature of each SSA.

Designation Time Frame -- In general, the time frame for this designation process varied depending on local needs, hydrogeologic factors, and administrative constraints. In many cases, the designation time directly reflected the level of technical detail required by the Regional staff.

EXHIBIT II-1

Petition Content Requirements
Under Old Designation Process

Per the Proposed Regulations (42 FR 51620, September 29, 1977), Section 148.10, Petition Submission Requirements:

(a) Name, address, and telephone number of the petitioner

(b) Statement of the requesting person's interest in the Administrator's determination

(c) Statement of why contamination would result in a significant hazard to public health

(d) All pertinent information regarding

(1) The aquifer and its location

(2) The location of the aquifer area the petitioner alleges is the sole or principal source of drinking water

(3) The population in the area described in (2)

(4) Alternative sources of drinking water for the area

(5) The recharge and streamflow source zone(s) for the aquifer

(6) The sources of recharge to the aquifer and their location

(7) Projects which might contaminate the aquifer through the recharge zone

(8) The public water systems utilizing water from the aquifer, the number of people served by each system, and the water treatment provided by each system

(e) Maps showing, to the best of the petitioner's knowledge

(1) The location and boundaries of the aquifer

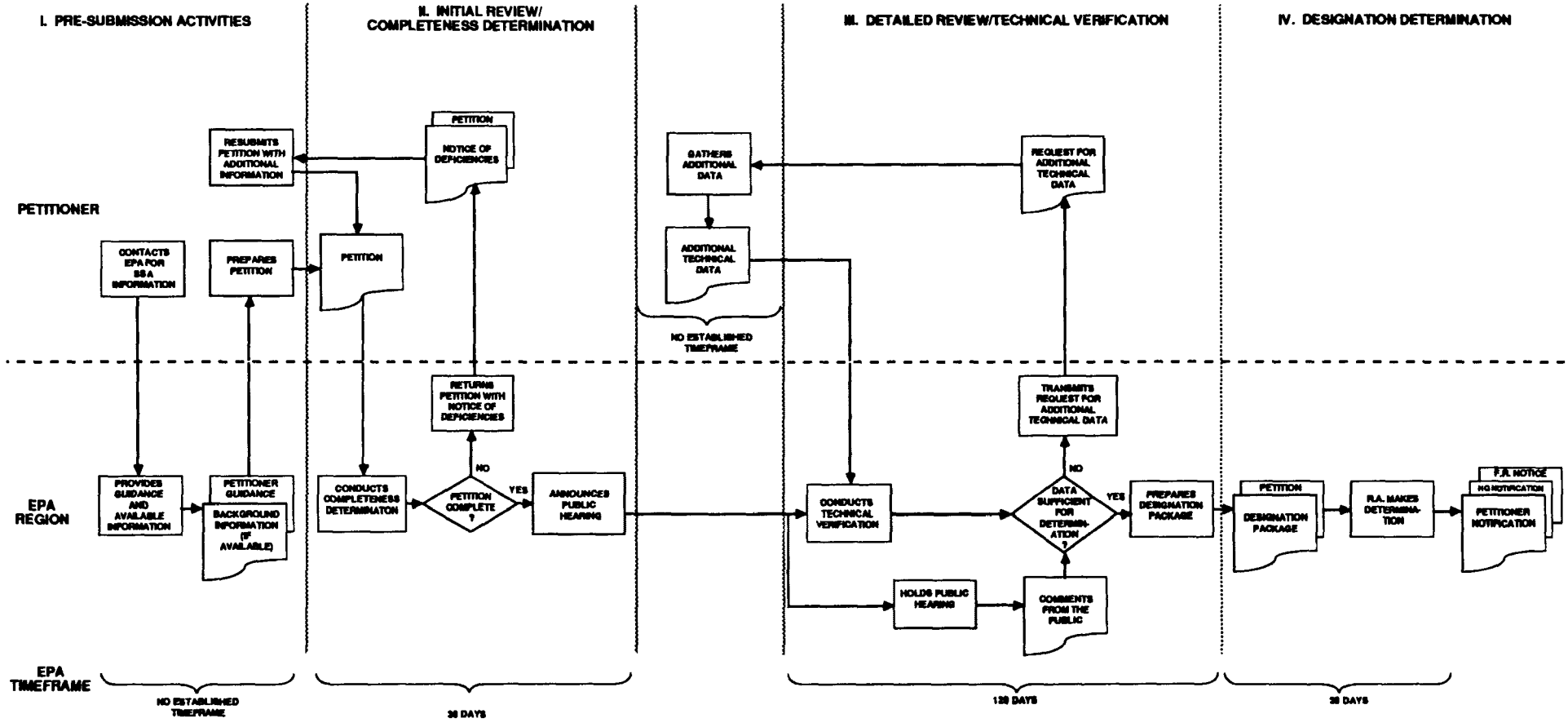
(2) The location and boundaries of the recharge zone(s)

(3) The location of the source(s) of recharge to the aquifer

The SSA Designation Guidance released by OGWP has established a uniform time frame for designation as well as established a new process. (See Exhibit II-2.)

EXHIBIT II-2

NEW SOLE SOURCE AQUIFER DESIGNATION DECISION PROCESS



III. CROSS-PROGRAM ANALYSIS

A major objective of this report was to summarize the SSA designation process based upon data reviewed during visits to eight EPA Regions and discussions with Regional personnel. This chapter presents that summary in two parts:

- Review of the institutional/policy characteristics of the SSA program
- Review of the hydrogeologic characteristics of the aquifers.

Information collected on all aquifers that are either designated (i.e., 23 SSAs) or pending designation (i.e., 19 petitions currently under consideration) formed the basis for these analyses.

Petitions withdrawn from the process by the petitioner or not considered by the Region typically had insufficient information for the purposes of this cross-program analysis. Generally, no information was collected from the States, petitioners or other sources not in the Regional files.

1. Institutional/Policy Review

The institutional/policy review addressed four topics:

- Petition and petitioner characteristics
- Regional response to petitions
- Use of designation criteria
- Review of projects receiving Federal financial assistance.

In reviewing petitions and petitioner characteristics, three areas were assessed: the type of petitioner, the reason for the petitioner's actions, and the content of the petition. This also included looking at trends in who submitted the petition and why.

Review of the Regional response to receipt of a petition consisted of an evaluation of how the Region acted on a petition, including the reliance upon the petitioner's data and the extent of independent Regional data collection and analysis. The role of the USGS in providing additional information was specifically noted.

Review of the Region's use of designation criteria was based on the criteria contained in the regulations EPA proposed for the SSA designation process (42 FR 51620) on September 29, 1977. The five criteria proposed for SSA designation were:

- Availability of alternative sources of drinking water
- Size of the area and population served by the aquifer
- Susceptibility of the aquifer to contamination through the recharge zone (i.e., vulnerability)
- Location of the aquifer
- Number of public water systems utilizing water from the aquifer, the number of people served by such systems, and the treatment provided by such systems.

The review documented which criteria the Regions used in their decision-making and how these criteria were addressed by both the petition and each respective Region.

Finally, a review was performed of the effectiveness of the project reviews following designation. Because only a few Regions had discrete records of the results of these reviews, the analyses are general in nature with few specific examples of Regional activity.

(1) Review Of SSA Petitions

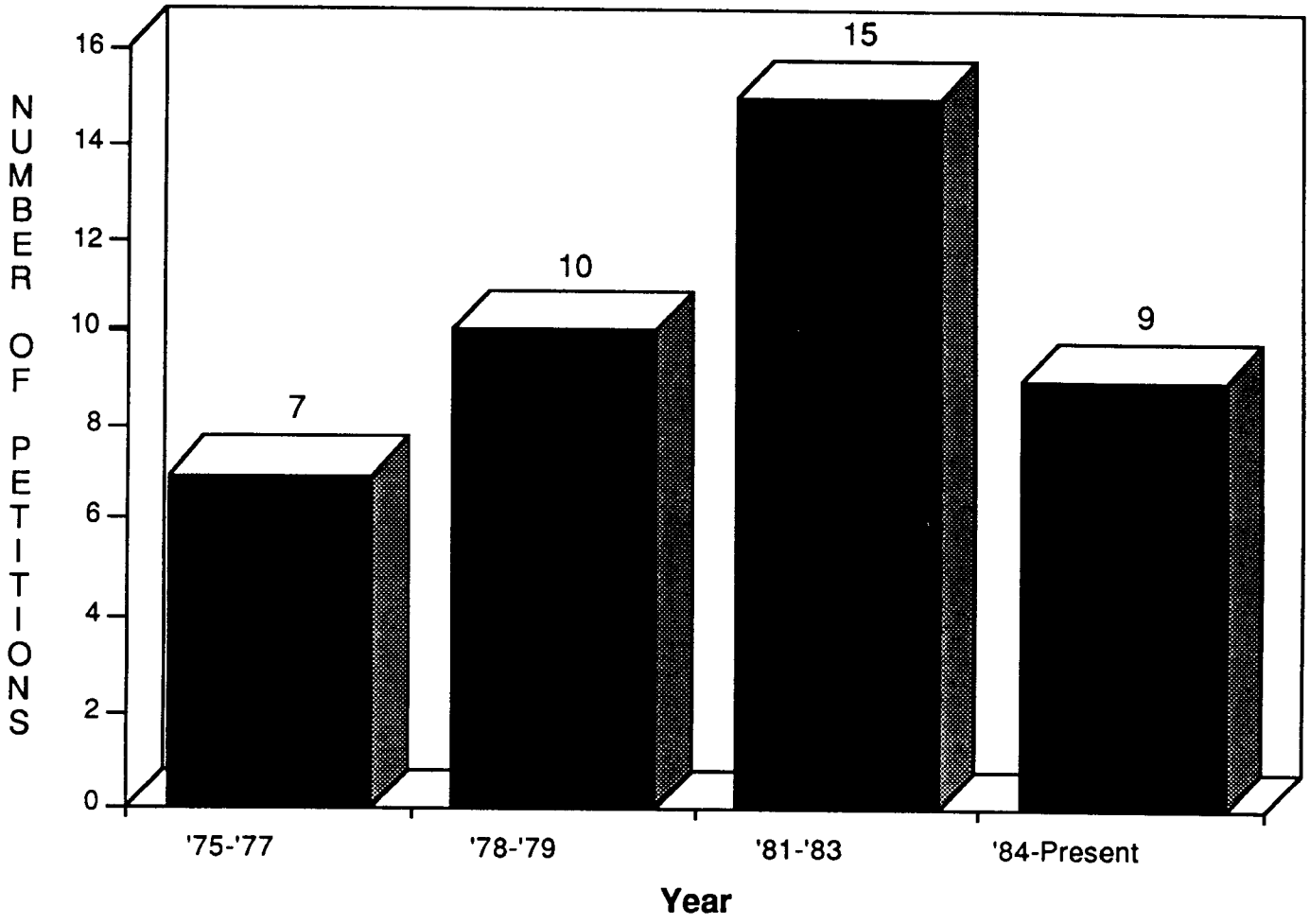
Review of the petitions revealed information that may be divided into three distinct areas: the year of petition submittal, the types of petitioners, and the rationale for petition submittal.

Petition Submittal Date -- Petitions were submitted to the EPA Regions rather consistently over the past 12 years. Exhibit III-1 breaks out the years of submittal of petitions since 1975. There was no obvious reason for the peaking of submittals in the early 1980s.

Several possible explanations include:

- Increased public and regional awareness of the process
- Belief that the resulting designation can provide protection of ground-water resources
- General increasing concern for ground-water protection aside from the SSA process.

EXHIBIT III-1
YEAR OF PETITION SUBMITTAL



Type of Petitioner -- A total of 45 original petitioners were identified. The term original petitioners was used because in many cases additional petitioners submitted documents in support of the original submission and declared themselves to be petitioners. For the most part, these additional petitioners were national environmental groups and local officials.

As Exhibit III-2 indicates, environmental groups, both local and national, comprised the largest petitioner group (40 percent). These petitioners often sought to protect a local source of drinking water from a variety of general or specific threats. The next largest group, local governments, represented about one-third of the petitioners. These local governments also demonstrated concern about the preservation of local area ground-water resources. Almost 20 percent of the petitioners were individual citizens, many of whom were concerned about a local project or development that might affect their drinking water. The smallest group was the local water suppliers (nine percent), who realized that contamination of the ground water could represent considerable costs to them.

Concerns of Petitioners -- In about half the cases, the petitioners identified aquifer protection as their principal concern. In the remainder, the petitioners were attempting to stop or influence a specific project through the aquifer designation process. Exhibit III-3 shows that 20 petitions could be identified as attempts to stop or influence a specific project. This was determined through the petition information itself or petitioner correspondence with the Region. Such projects included landfills, publicly owned treatment works (POTWs), pipelines, and government installations. In fact, the first SSA designation petition (the Edwards Aquifer) was submitted in response to environmental concerns about the effects of two housing projects on recharge to the ground-water supply in the San Antonio, Texas, area. Landfills triggered more petitions than any other specific project. In Region X alone county landfill planning was responsible for three different petitions.

Half the petitions identified overall improvement or protection of ground-water resources as their principal concern. These petitions usually cited previous examples of ground-water contamination that forced treatment or the closing of wells. The petitioner typically stated that it would be nearly impossible to provide large populations with alternative water supplies if the ground water were to become contaminated; however, socioeconomic analyses which would asses the impact of alternative water supplies were generally lacking in the petitions.

EXHIBIT III-2
DISTRIBUTION OF PETITIONER TYPES

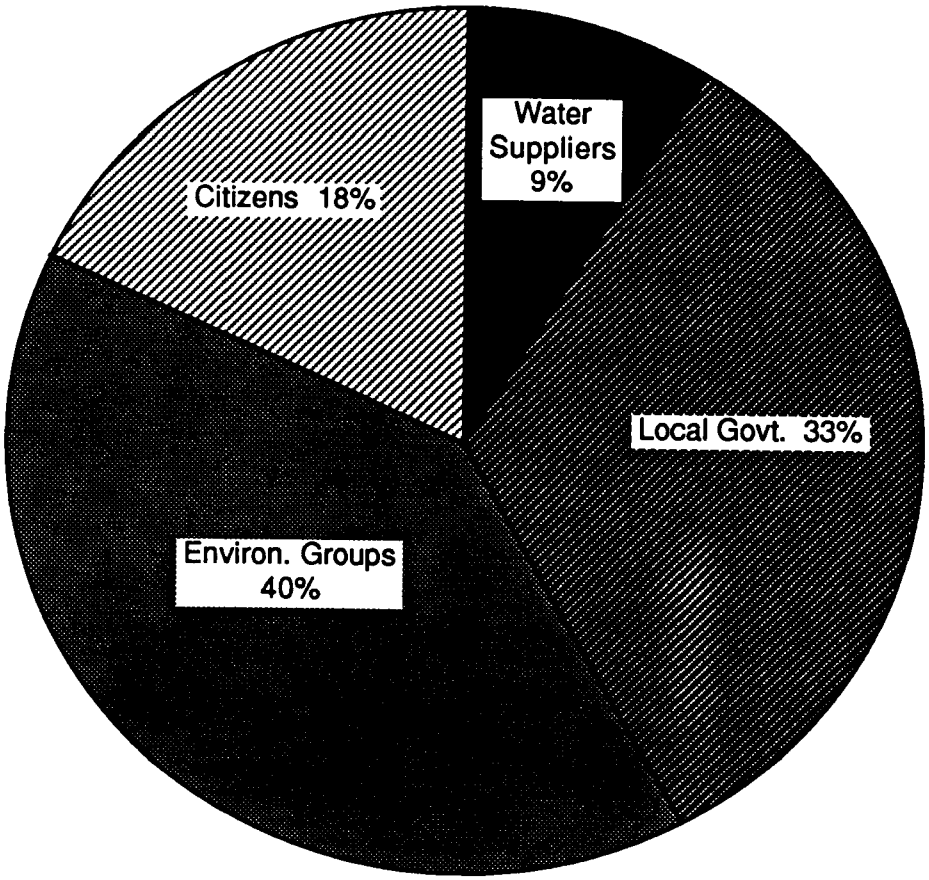
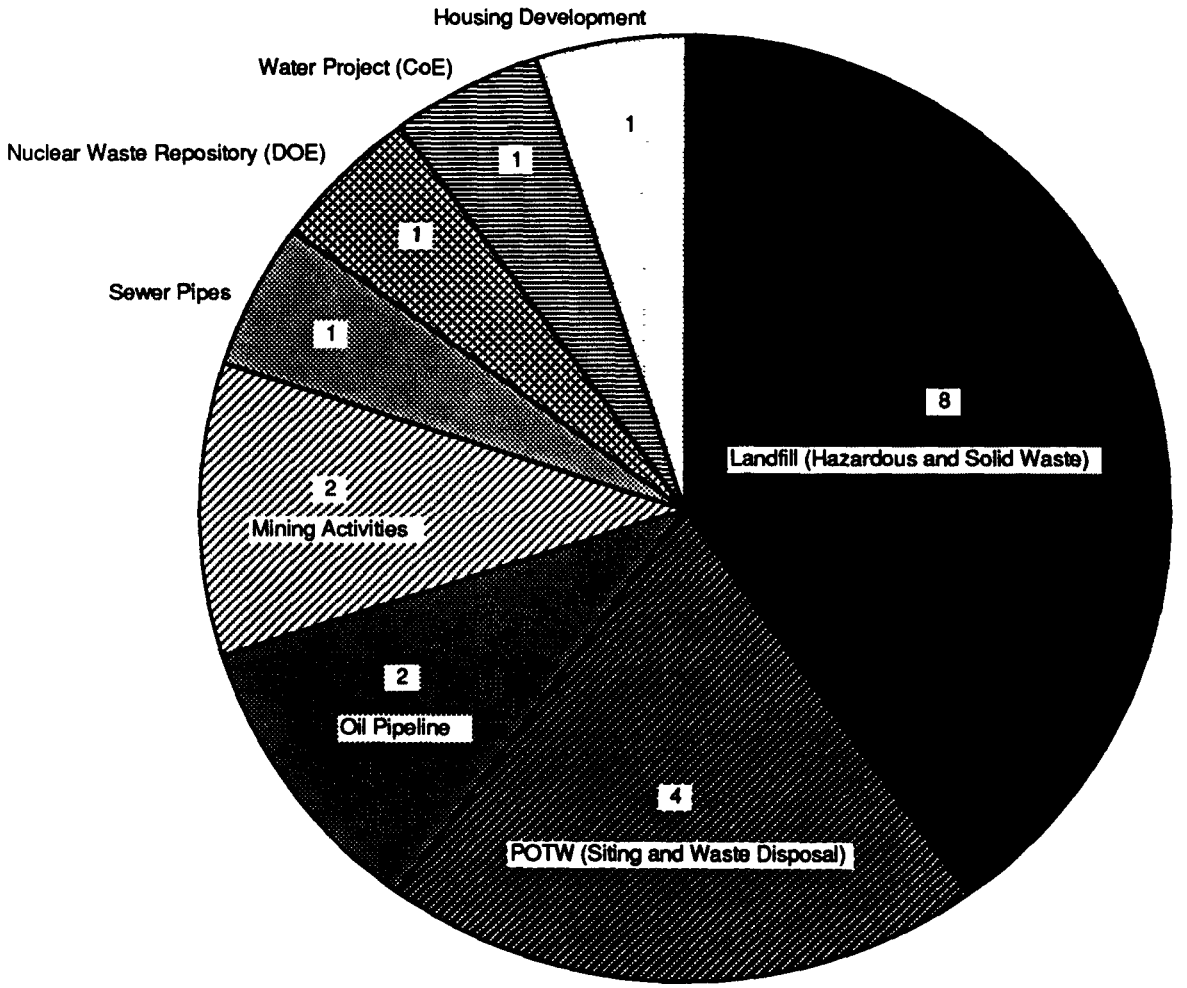


EXHIBIT III-3
CONCERNS OF PETITIONERS



(2) Review Of Regional Response

The Regions normally accepted SSA petitions when they were first submitted. In fact, Regions have returned only six petitions to the original petitioner, requesting further information before accepting them. In a number of cases, the Regions requested additional data. The petitioner submitted the data as an addendum to the petition without having to resubmit the entire petition.

Petition Completeness -- Many petitions were incomplete upon submission. In many cases, the petitions lacked basic information on population served by the aquifer and on alternative sources of drinking water. The petitions often contained inadequate technical documentation to describe the boundaries of the aquifer, the aquifer service area, or the recharge area and streamflow source zone.

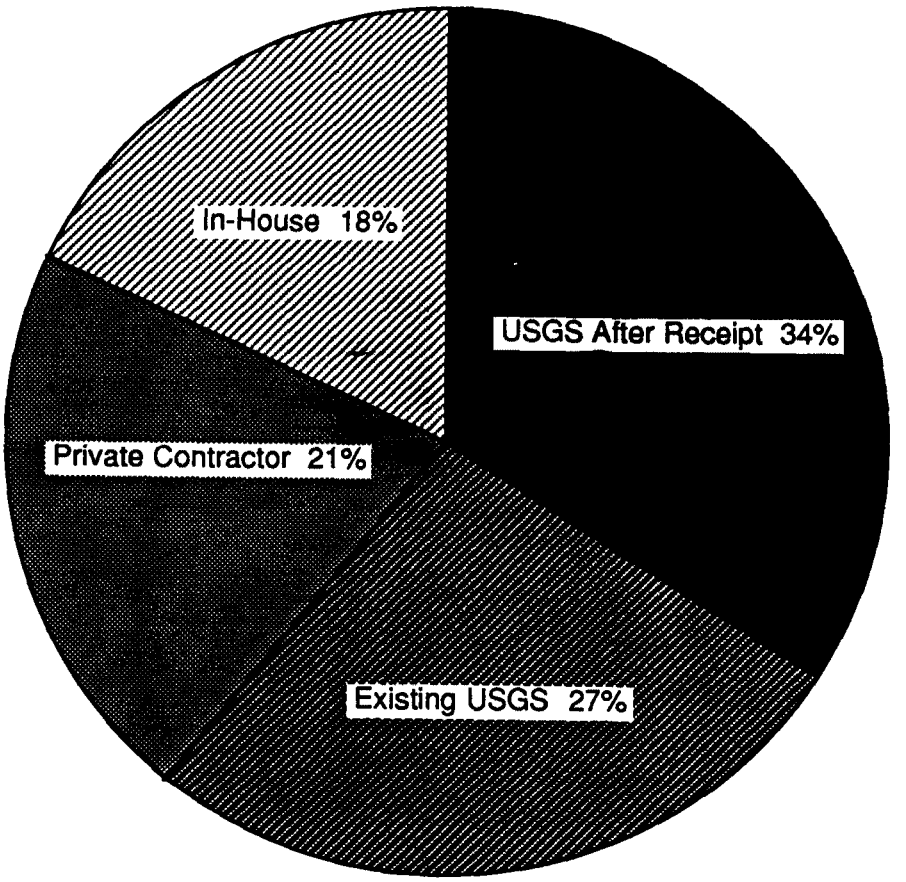
The type of petitioner was not indicative of the kind and amount of data provided. Petitions submitted by citizens groups were as likely to be as complete as those prepared by local governments or water suppliers. The Biscayne aquifer petition, which was submitted by a group of citizens, was complete in the information provided. Petitions submitted by local governments varied in quality. The Guam petition, submitted by the Governor, was complete, while a petition from four local governments in Massachusetts lacked important information.

The completeness of the petition seemed to be dependent on the available resources. Where extensive hydrogeologic investigations already had been completed by either the USGS or a State agency, the petitions contained substantial technical data. The extent of local public support also appeared to affect the completeness of the petitions. Petitions submitted by well-supported local groups generally were the best petitions in terms of the depth and breadth of information provided.

Technical Review -- Once the petition was accepted, the Regions took a variety of steps in performing the technical review of the documents. These generally fell into several identifiable categories, as shown in Exhibit III-4.

In about one-third of the cases, the Regions asked the USGS to perform a study of the hydrogeologic conditions of the aquifer. In the mid-1970s, the EPA and USGS negotiated a Memorandum of Understanding (MOU) that funded USGS hydrogeologic studies of 12 aquifers. Several of the Regions used this MOU mechanism to provide supplementary technical documentation. Although thorough, USGS studies typically took a year or more to complete. For this reason, some Regions chose to do their own technical documentation.

EXHIBIT III-4
DISTRIBUTION OF REGIONAL REVIEW EFFORTS



In about one-quarter of the cases, a USGS study had already been completed in the area and was included in the petition as a reference or direct citation. Such was the case with the Edwards Aquifer, where technical studies had been performed for several years prior to petition submission. The petitions for several aquifers, most notably Cape Cod, were submitted on the basis of the data and conclusions provided in an existing USGS study.

In about 20 percent of the cases, the Regions used outside consultants' studies as the basis for their technical review. This was often the petitioner's contractor and funding was provided by the petitioner.

For the remaining 18 percent of the petitions, the Regions performed an in-house review of the petitioner's data without outside support. In most cases this resulted in the development of a technical support document. In every case, it resulted in an independent assessment of the petition's data and an evaluation based on the designation criteria.

Public Comments And Hearings -- A final aspect of the Regional response to petitions involved public participation in the decision-making process through public comments and hearings. In every case, the Regions published notice of the receipt of a petition and invited public comment on the proposed designation. Depending on the public interest expressed or adverse comments received, the Regions held one or more public hearings in or near the designated area specified in the petition. In this way, the Regions hoped to achieve maximum public involvement in the designation process.

The public comment period is also the point at which State and local government agencies often voice their support or opposition to the proposed designation. Strong opposition has generally delayed the designation process.

(3) Review Of The Use Of Designation Criteria

The 1977 proposed regulations identified criteria for making a determination with respect to SSA designation. The Regions, for the most part, used three of these criteria to determine whether an aquifer should be designated:

- Percent of population dependent upon the proposed aquifer for drinking water
- The existence of alternative water supplies
- The vulnerability of the ground water to contamination.

Population Dependency -- Exhibit III-5 shows the large range and distribution of populations served by the aquifer in the designated SSA areas. As shown, the range extends from less than 1,000 persons to well over several million persons. The distribution approximates a bell-shaped curve with the mean in the range of 10,000 to 100,000 people.

In contrast, the distribution of the percentage of the population dependent on the aquifers is skewed markedly. Of 27 aquifers for which population data were available, two-thirds were more than 90 percent dependent on the aquifer for drinking water (see Exhibit III-6). In fact, most of these aquifers were characterized as providing 100 percent of the drinking water supply. These included a number of islands that depend entirely on ground water for drinking water.

Alternative Water Supplies -- A second, related criterion the Regions considered in making designation determinations was the existence of alternative sources of drinking water. In some instances, Regional staff performed capacity calculations under drought conditions to determine the ability of the alternative to meet the demand. These studies were only capacity based; no Region performed formal economic feasibility studies of potential alternative water supplies.

Those Regions that did not attempt a capacity study considered only existing ground-water supply systems as feasible alternatives. As a rule, development of nearby streams, lakes, or aquifers as viable alternatives to the proposed aquifer was not considered.

Vulnerability of Ground Water -- The Regions used no formal mechanism or approach for measuring vulnerability. A review of the site's hydrogeologic characteristics based on conventional vulnerability concepts produced recommendations. Many petitions cited well contamination as proof of vulnerability. The State of Louisiana however, developed a "Quantitative Pollution Index" under a Section 208 grant to study the Capital Area Aquifer. The State mapped geology, land use, soils, and risk levels, and used these to develop a measure of vulnerability related to recharge and permeability. No real use has yet been made of findings other than to raise concern over the high levels of risk in the study area.

(4) Review Of Projects Receiving Federal Financial Assistance

Under the Safe Drinking Water Act, aquifer designation requires the Regions to review all Federal financially assisted projects within the designated area. Such projects

EXHIBIT III-5
Population Served by SSA

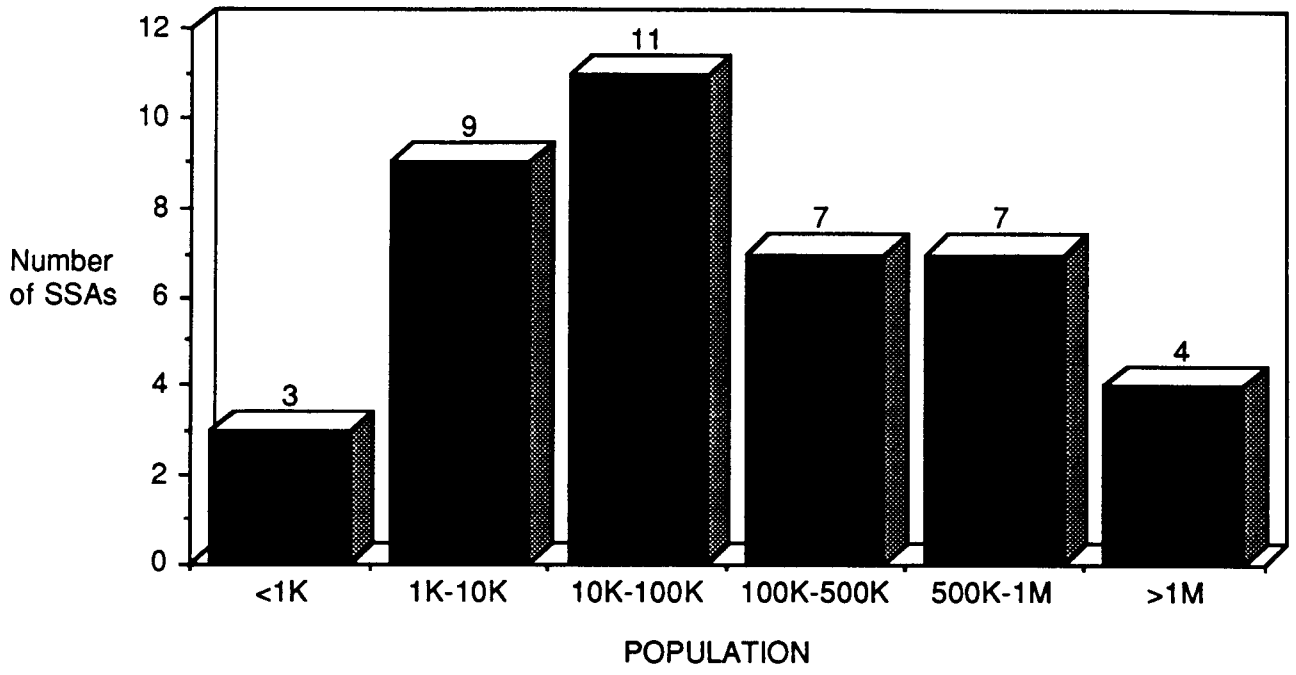
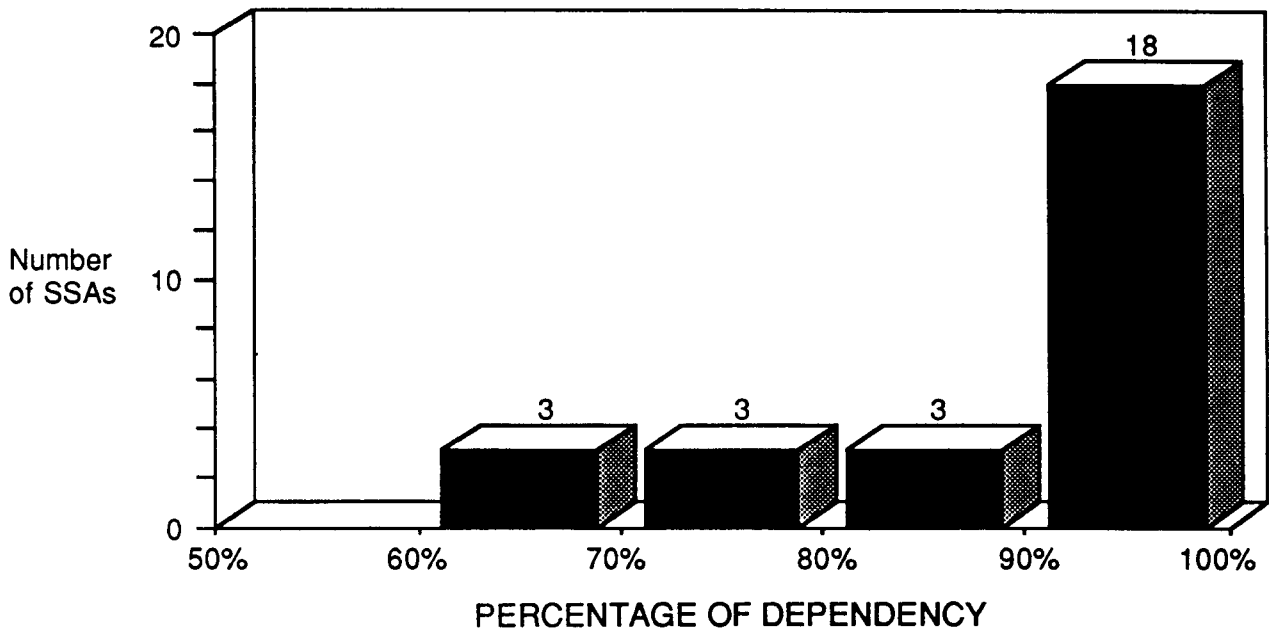


EXHIBIT III-6
Percentage of Population Using SSA



included new housing developments financed through Federal mortgage instruments, Federal highway system modifications and additions, funds for improvements on POTWs, airport renovations, and economic development grants, among others. Direct Federal actions, such as DoD activities, did not require a review. In order to be informed of such projects, each Region signed an MOU with each Federal agency that provides project funds. Almost all Regions have MOUs with the Farmers Home Administration (FmHA), the Federal Highway Administration (FHA), the Veterans Administration (VA), and the Federal Aviation Administration (FAA). In all, there are 11 Federal Administrations or Departments that have signed MOUs with EPA Regions.

The information on project reviews indicated that over 90 percent of the projects reviewed were preliminary reviews followed by an in-depth review if necessary. Community Development Block Grants and Federal mortgages to housing developers were typical of this kind of project. For example, on Long Island, between 1978 and 1981, 127 projects were cited as requiring review. Initial screening indicated only 12 of the projects needed an analysis to determine if they affected the SSA. The types of projects that most often required review were airport modifications, large housing developments proposing to use septic systems instead of an available sewer system, and highway construction.

Most projects that were subjected to a review of possible environment impact were approved without modification. No project was ever cancelled or stopped as a result of an SSA impact review. However, there were projects that required modifications:

- Regions I and II both required several proposed housing developments to connect to the available sewer system or lose their Federal funds.

- A Region II analysis required a Federal highway route to be changed. Region IV required design modifications for highway interchanges due to possible effect on the SSA.

- Region I required the removal of on-site hazardous wastes and old underground storage tanks at an airport. FAA funds could not be used in the cleanup effort.

2. Review Of Hydrogeologic Data

Hydrogeologic information was necessary to define the spatial limits and the vulnerability of SSAs. The technical

hydrogeologic information included in each accepted petition varied with petition, but as the SSA program matured, each Region required similar kinds of information. This section examines the hydrogeologic features of SSA petitions as defined by the:

- level of technical information
- basis of aquifer boundary delineation
- aquifer size
- lithology
- hydrologic complexity
- vulnerability to contamination.

(1) Level Of Technical Information

SSA petitions usually provided limited technical information. In most cases, the petitions contained excerpts from or references to published technical reports developed by the USGS, State agencies, water companies, or universities. There were, however, exceptions. For example, Guam provided a well-organized, technically complete petition that required little additional technical support.

In most cases, the petitioners used maps to define the spatial limits of the proposed aquifers. These maps commonly consisted of topographic or geologic maps that had been enlarged or reduced to fit on an 8-1/2 x 11-inch piece of paper. In general, petitioners requesting protection for larger areas were more likely to submit small-scale maps, while those wishing to protect smaller areas more frequently submitted medium-scale maps. For 15 percent of the petitions no map was provided that depicted the designated area. Map scale information is summarized in Exhibit III-7.

Nine different types of hydrogeologic information commonly included in the petitions were identified. Exhibit III-8 presents the frequency of occurrence of these data in the petitions. This exhibit indicates the availability of information rather than its quality or adequacy.

In general, the common concern among petitioners was the degradation of ground water. Exhibit III-8 indicates that ground-water use and pollution source data were most commonly included in the petitions. The ground-water use information generally considered population usage estimates and lists of public water supplies or annual yields. In most cases, the proposed development project was presented as the primary source of contamination even though it may not have been constructed yet.

Lithologic and formation nomenclature were presented most frequently in excerpts from geologic reports.

EXHIBIT III-7

Percentage Comparison Between Petitioners' Map Scale And Associated Land Area

Land Area Size (mi sq.)	Map Scale (1 inch equals) Large (0 - .38 mi)	Medium (.39 - 3.9 mi)	Small (4.0+)
0-50	10%	33%	
50-100		13%	
100-1,000	20%	47%	100%*
1,000-10,000	70%	7%	
10,000+			

*1 site only.

EXHIBIT III-8

Technical Data Presented In Petitions

Hydrogeologic Data	Occurrence in Petition by Percentage
Ground-Water Use	90%
Pollution Sources	78%
Lithology	61%
Vulnerability	59%
SW/GW Relationships	56%
Ground-Water Quality	51%
Ground-Water Flow	24%
Water Table Depths	19%
Hydrologic Data	15%

Generally, no attempt was made by the petitioner to describe or characterize the physical properties of the geological environment.

SSA petitions generally did not include ground-water flow, water table, and other hydrologic data. Most hydrologic assessments discussed ground-water/surface-water relationships such as whether streams were gaining or losing. Water quality was generally referred to as being "good." Discussions of specific parameters were rare.

For the most part, the extent of technical information presented by petitioners did not provide sufficient basis for a determination. Many petitioners did not supply maps or inadequately defined the boundaries of the proposed SSA. Data that were submitted generally did not define the specific hydrogeologic conditions that exist and the Regions often requested the petitioners to submit more data. In addition, the Regions at times developed their own supplementary data bases to define the boundaries when necessary.

(2) Basis Of Aquifer Boundary Delineation

Where the original petitions employed maps to delineate the SSA boundaries, these boundaries were determined by any of a number of hydrologic, lithologic, and political/ cultural features. In some cases, a combination of features was used to define the aquifers. Exhibit III-9a displays the principal delineation criteria used by petitioners and the associated numbers of petitions. Exhibit III-9b in contrast presents the principal delineation criteria that EPA Regions used for the same set of aquifers.

Comparing Exhibits III-9a and III-9b indicates that both petitioners and the Regions were most likely to use hydrologic criteria to delineate SSA boundaries. Although petitioners and Regions relied on hydrologic features approximately equally often, it is important to note that for around 50 percent of petitions received, EPA subsequently revised the SSA boundaries proposed by petitioners. The frequency of these revisions is due to EPA often modifying or expanding the proposed boundaries based on more extensive information collected in the review process or through public hearings. An example of an EPA boundary modification is given in Exhibit III-10.

Though the Regions did not completely define any areas by political and cultural features, they did use metes and bounds as a legal accommodation to define SSA boundaries. Exhibit III-11 is the first of nine pages listing turning points that enclose the Spokane Valley-Rathdrum Prairie

EXHIBIT III-9a

Principal Criteria Used by Petitioners to Delineate SSA Boundaries

Criteria	Number of Petitions	% of Total
Hydrologic	24	60
Political/Cultural	4	10
Lithologic	3	7.5
Combinations	8	20
Not Determined	1	2.5
Total	40	Total 100%

EXHIBIT III-9b

Principal Criteria Used by EPA Regions to Delineate SSA Boundaries

Criteria	Number of Petitions	% of Total
Hydrologic	23	57.5
Political/Cultural	2	5
Lithologic	2	5
Combinations	10	25
Not Determined	3	7.5
Total	40	Total 100%

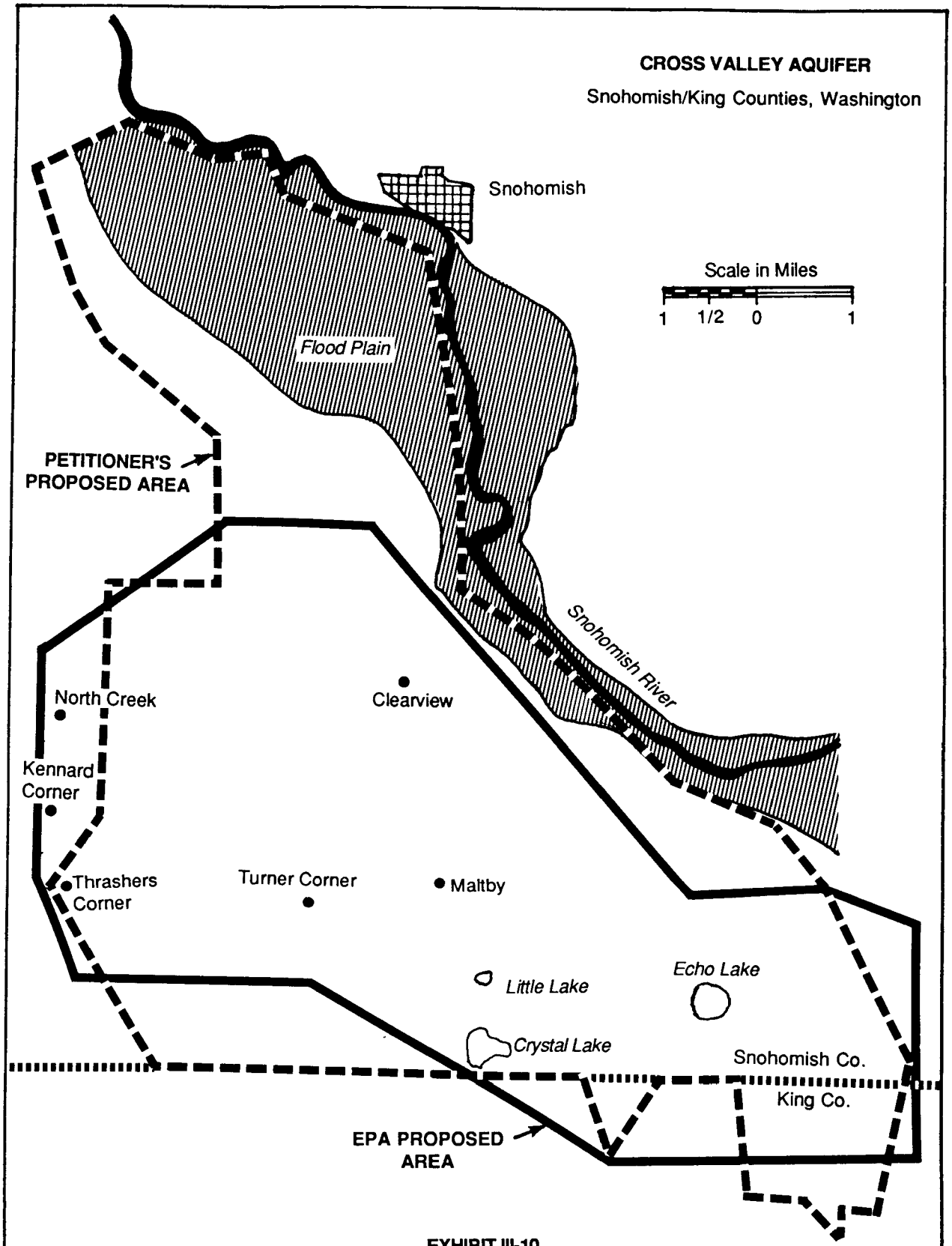


EXHIBIT III-10
RELATIONSHIP BETWEEN PETITIONER'S PROPOSED SSA AND THAT APPROVED BY EPA

Beginning at the mouth of the Little Spokane River in Section 32, T.27N., R.42E.W.M. and following the channel of the Little Spokane River upstream to the mouth of Deadman Creek in Section 33, T.27N., R.43E.W.M.; thence up the channel of Deadman Creek to the section line between Sections 2 and 3, T.26N., R.43E.W.M.; thence south along the section line to the northeast corner Section 22, T.26N., R.43E.W.M.; thence east ½ mile along the north line of Section 23 to the northeast corner of the NW¼ NW¼ Section 23, T.26N., R.43E.W.M.; thence south ½ mile to the southeast corner of the NW¼ NW¼ Section 23, T.26N., R.43E.W.M.; thence east about 3/4 mile to the section line between Sections 23 and 24, T.26N., R.43E.W.M.; thence south ½ mile along the section line to the west quarter corner Section 24; thence east about 1½ miles to the northeast corner NW¼ SW¼ Section 19, T.26N., R.44E.W.M.; thence south about 3/4 mile to the southeast corner NW¼ NW¼ Section 30, T.26N., R.44E.W.M.; thence east about 1½ miles to the southwest corner NE¼ NE¼ Section 29, T.26N., R.44E.W.M.; thence south ½ mile to the southwest corner SE¼ NE¼ of Section 29; thence east about 3/4 mile to the center of Section 28, T.26N., R.44E.W.M.; thence north ½ mile to the north quarter corner Section 28; thence east about 2½ miles to the northeast corner Section 26, T.26N., R.44E.W.M.; thence south ½ mile to the east quarter corner Section 26; thence east 1 mile to the east quarter corner Section 25, T.26N., R.44E.W.M.; thence in a northeasterly direction to the north quarter corner Section 30, T.26N., R.45E.W.M.; thence north about 1½ miles to the center of Section 18, T.26N., R.45E.W.M.; thence in a north-northeasterly direction about ½ mile to the northwest corner NE¼ NE¼ Section 18; thence north 1 mile to the northwest corner NE¼ NE¼ Section 7, T.26N., R.45E.W.M.; thence west ½ mile to the south quarter corner Section 6, T.26N., R.45E.W.M.; thence north 1 mile to the north quarter corner Section 6; thence east ¼ mile to the southwest corner SE¼ SE¼ Section 31, T.27N., R.45E.W.M.; thence north 2 miles to the northwest corner, NE¼ NE¼ Section 30, T.27N.,

EXHIBIT III-11

METES AND BOUNDS FOR THE BOUNDARY DELINEATION OF THE SPOKANE VALLEY – RATHDRUM PRAIRIE AQUIFER

Aquifer. Similar approaches were used for several other aquifers, including the Biscayne Aquifer in Florida and the Cross Valley Aquifer in the State of Washington.

Topographic divides were often used to define the areas where recharge and surface water flow were directly related to ground water in the area of concern. In some cases, abrupt changes in water quality were also used for definition purposes.

As mentioned above, many SSA boundaries were formed by both hydrological and political/cultural criteria. For example, the SSA boundaries of the New Castle, Delaware, Aquifer were extended by the Region to the Maryland-Delaware State line. Conversely, many of the potential areas based on solely political/cultural features were modified by the Regions to conform to hydrological criteria.

Hydrogeologic Considerations in Boundary Delineations -- Three major areas were considered in the delineation of an SSA: the aquifer, its recharge area, and its streamflow source zone. The relationships among these areas must be understood in order to delineate an SSA properly.

An aquifer is defined as a geologic formation, a group of formations or a part of a formation that yields water to wells and springs. Examples of single formation aquifers are the Conestoga formation of the Seven Valleys Aquifer in Pennsylvania (Exhibit III-12), and the glacio-fluvial valley fill deposits in the New Rockford Aquifer in North Dakota (Exhibit III-13). Examples of aquifers that include many geologic units are the limestone formations of the Edwards Formation in Texas or the volcanic flows of the Snake River Aquifer in Idaho.

An aquifer recharge area was generally interpreted as the land surface over which water infiltrates to the aquifer or where ground water discharges to streams that flow to the aquifer. In some settings, the recharge area may coincide with the aquifer. However, in many instances, the recharge area extends beyond the aquifer. For example, the Seven Valleys SSA was expanded by the Region to include the entire ground-water basin (see Exhibit III-12). Here, the Wissahicken and Marburg Formations were included in the SSA, since they were in the recharge area of the Conestoga formation. Similarly, the New Rockford Aquifer is currently undergoing further study to determine the extent to which the till deposits recharge the underlying valley fill deposits, which serve as the primary aquifer material. (See Exhibit III-13.)

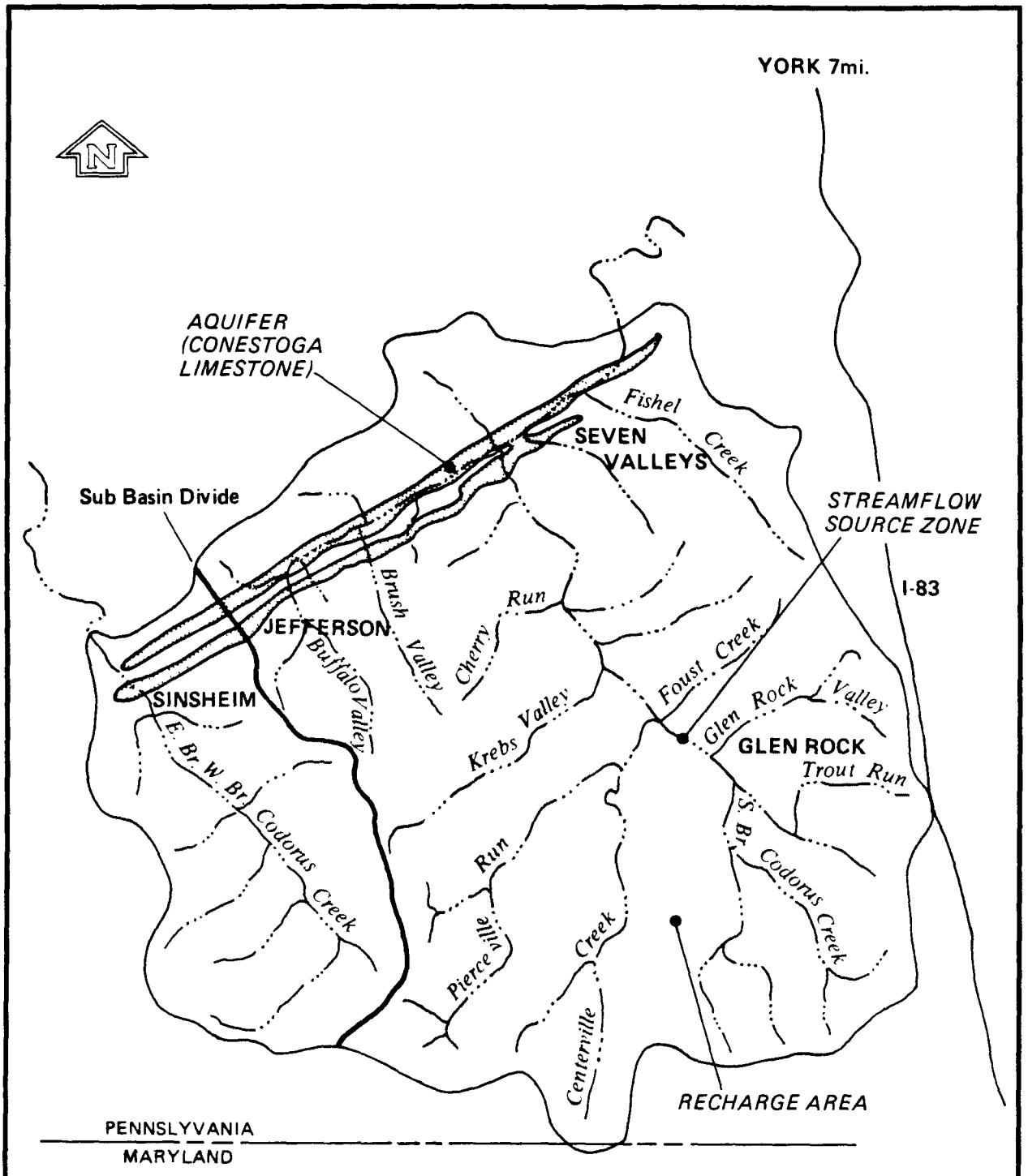


EXHIBIT III-12

AQUIFER RELATIONSHIPS, SEVEN VALLEYS AQUIFER, PENNSYLVANIA

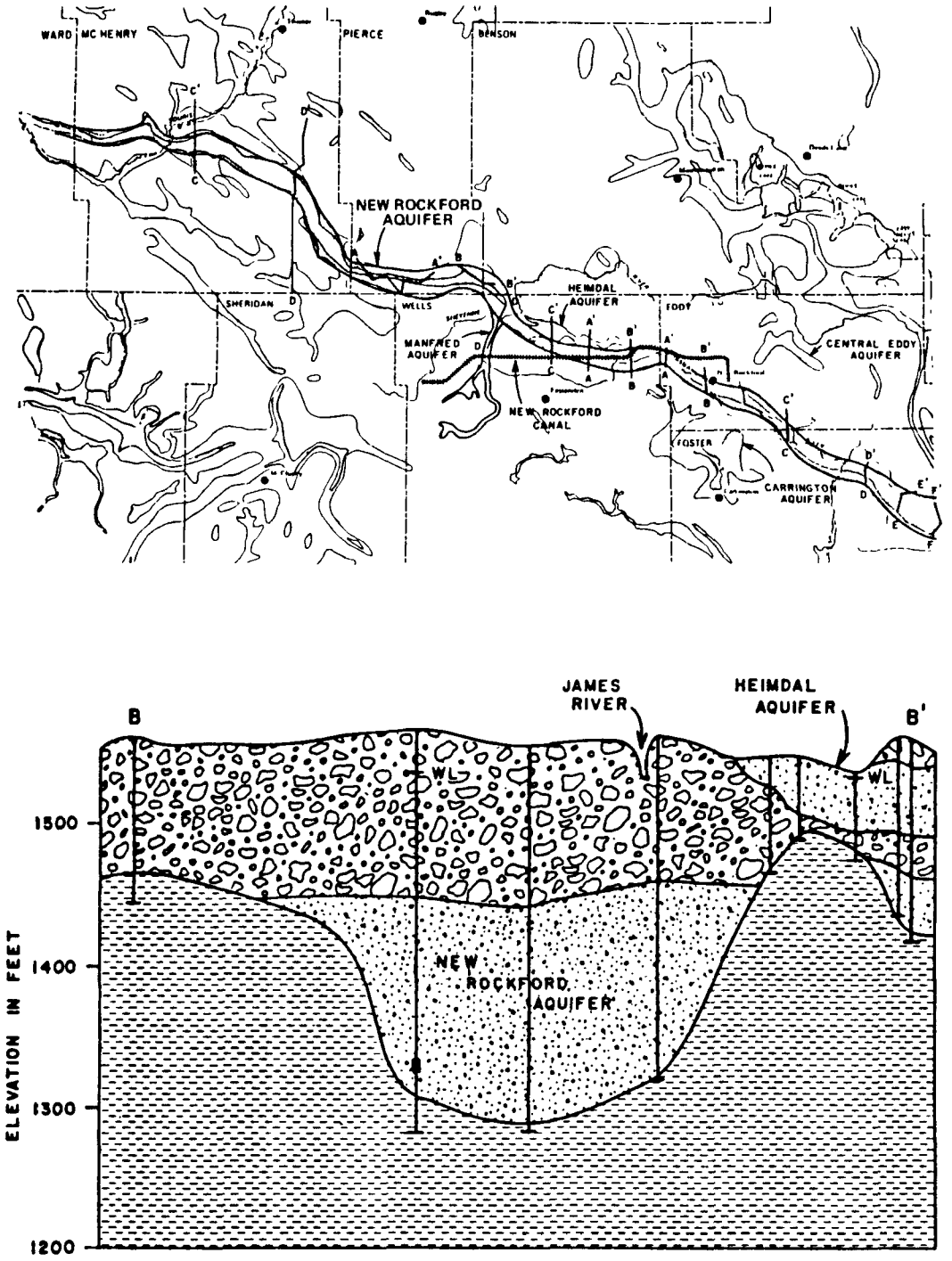


EXHIBIT III-13

AQUIFER RELATIONSHIPS, NEW ROCKFORD AQUIFER, NORTH DAKOTA

It is likely that SSA designation ultimately would include some of the overlying till as its recharge area.

A streamflow source zone is defined as the land area from which runoff contributes to streams and lakes that drain or recharge an aquifer. Often the recharge area and streamflow source area coincide, but this was not always the case. The most notable examples were the Biscayne (Exhibit III-14), Spokane Valley-Rathdrum Prairie, and Edwards Aquifers. In each case, a well-developed surface water system existed outside the SSA and transported water into it. In the case of the Biscayne Aquifer, Lake Okeechobee and its drainage system are connected to a canal network within the aquifer. Water recharges the ground water from these canals during the drier months of the year. Similarly, a small percentage of water is supplied to the Spokane Valley-Rathdrum Prairie Aquifer from a lake which lies outside the designated area.

Regional recommendations always included the recharge zone as part of the SSA delineation. Seventy percent of Regional recommendations also included the streamflow source zone as part of the SSA (see Exhibit III-15). The streamflow source zone was generally excluded from a designation if it either provided low volumes of water to the aquifer or would produce a significantly larger management area. For example, the Snake River Plain Aquifer would be increased from 9,600 square miles to 36,000 square miles if the entire streamflow source zone were included in the SSA.

It should also be noted that Regional designation recommendations for confined aquifers have always been extended to include the recharge zone (Exhibit III-16). In addition, all Regions that evaluated confined aquifers included the recharge areas in the delineated area.

The ability to easily define an aquifer in the field is important to water resource planning, facility siting, and protection. Thirty-five percent of the aquifers can be easily identified by metes and bounds, roadways, municipal jurisdictional lines, rivers, shorelines, and other rather obvious, permanent features. Thirty-eight percent utilize such features as topographic divides and prominent outcroppings, which are moderately obvious. Twenty-seven percent have boundaries that are very difficult to determine without extensive study. These use quality concentration criteria, such as the "badwater line" of the Edwards Aquifer, are determined through models or are especially obscure, as in the New Rockford Aquifer.

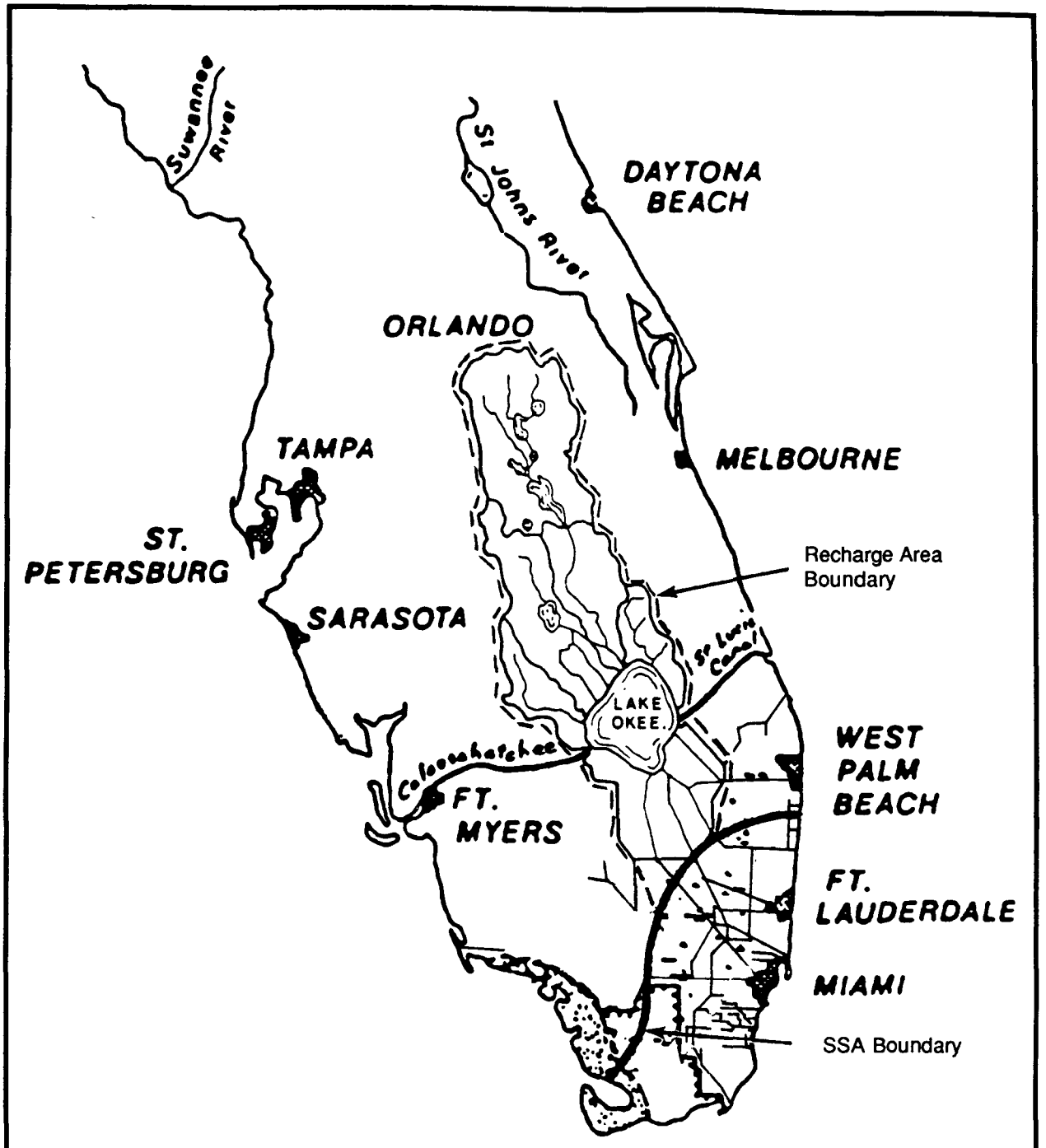


EXHIBIT III-14
AQUIFER RELATIONSHIPS, BISCAYNE AQUIFER, FLORIDA

Exhibit III-15

Areas Included In SSA Approved Or Recommended For Designation

	Percent
UNCONFINED AQUIFERS (39)	
Aquifer And Recharge	14
Aquifer, Recharge, And Streamflow	64
CONFINED AQUIFERS (11)	
Aquifer And Recharge	27
Aquifer, Recharge, And Streamflow	73

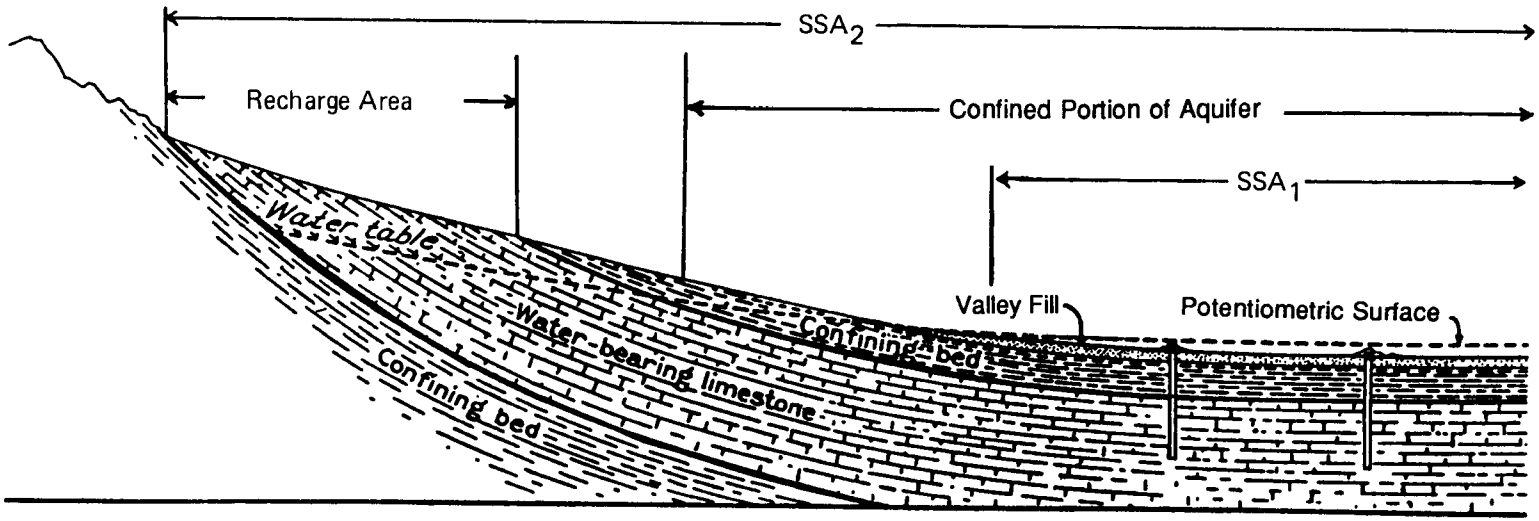


EXHIBIT III-16
AQUIFER RELATIONSHIPS, THEORETICAL ARTESIAN SYSTEM

(3) Aquifer Size

Over two-thirds of the aquifers were less than 1,000 square miles. The smallest area was Block Island, Rhode Island, which is seven square miles. The largest was the Delaware Basin in Texas, which is 12,000 square miles. Exhibit III-17 summarizes the size of the aquifers.

(4) Lithology

Exhibit III-18 summarizes the major rock types that exist in the aquifers. Over half the aquifers were in unconsolidated deposits. A small percentage was in crystalline rocks.

Lithologic complexity and the extent of confinement were two factors significant in the delineation of SSAs and their water-bearing characteristics. Sixty percent of the aquifers essentially behaved as a single hydrologic unit, even though certain zones may have been more productive than others. Multilayered aquifers comprised the remaining 40 percent. These aquifers generally had several definable water-bearing zones associated with the specific lithologic units. Exhibit III-19 lists aquifers according to their hydrologic complexity.

Though multiple systems contained isolated or semi-isolated water-bearing units, they were not necessarily artesian. Only 14 percent of the areas designated or under consideration contained artesian units. In all cases, however, the Regions treated multiple and confined artesian systems as "leaky," assuming that the overlying, unconfined units would contribute pollutants to the "confined" units beneath them.

(5) Hydrologic Complexity

Reconstruction of ground-water flow in SSA studies was not clearly defined, even in USGS reports. Often general cross-sectional flow patterns were included such as in Kings and Queens Counties, New Jersey Coastal Plain Aquifers, State of New Jersey, or in Guam (Exhibit III-20). In cases where basin morphology was used to delineate aquifer boundaries, flow was characterized by surface topography. The best examples of relatively detailed reconstruction were the New Rockford and Seven Valleys Aquifers (Exhibit III-21) where illustrations depicted local flow conditions. In the former case, these directions were critical to the selection of which areas were included if designation was made.

EXHIBIT III-17

Aquifer Size

Size Range (mi sq.)	Percentage	Avg. Size (mi sq.) in Range
0 - 50	29	31
50 - 100	8	83
100 - 1,000	31	204
1,000 - 10,000	29	4,424
Over 10,000	3	12,000

EXHIBIT III-18

Lithology

Major Rock Types	Percentage
Unconsolidated Deposits	53
Carbonate Sedimentary Rocks	15
Clastic Sedimentary Rocks	12
Igneous Rocks	5
Metamorphic Rocks	3
Multiple Lithologic	12

EXHIBIT III-19

Aquifer Complexity

Single	Multiple
Cape Cod, MA	Long Island, NY*
Nantucket Island, MA	Brooklyn-Queens, NY
Quaboag River Valley, MA	Clinton Street-Ballpark, NY
Block Island, RI	Schenectady/Niskayuna, NY
Buried Valley, NJ	Cattaraugus Creek-Sardinia, NY
Ridgewood, NJ	New Jersey Coastal Plain, NJ
Mt. Olive, NJ	State of New Jersey
Upper Rockaway Basin, NJ	Volusia-Floridan, FL*
Seven Valleys, PA	Edwards Aquifer, TX*
Maryland Piedmont, MD	Edwards Aquifer-Barton Springs, TX*
New Castle, DE	Naco-Bisbee, AZ
Biscayne Aquifer, FL	Upper Santa Cruz & Avra-Altar Basin, AZ
Capital Area-Baton Rouge, LA	Fresno Co., CA*
Carrizo-Wilcox-Bastrop County, TX	Seven Lakes, WA
Wilcox-Shreveport, LA	Newberg Area, WA
New Rockford, ND	
Northern Guam	
Scotts Valley, CA	
Pearl Harbor-Honolulu, HI	
Spokane-Rathdrum Prairie, ID-WA	
Snake Plain, ID	
Camano Island, WA	
Whidbey Island, WA	
Cross Valley, WA	
North Florence Dunal, OR	

* Contains Artesian Systems.

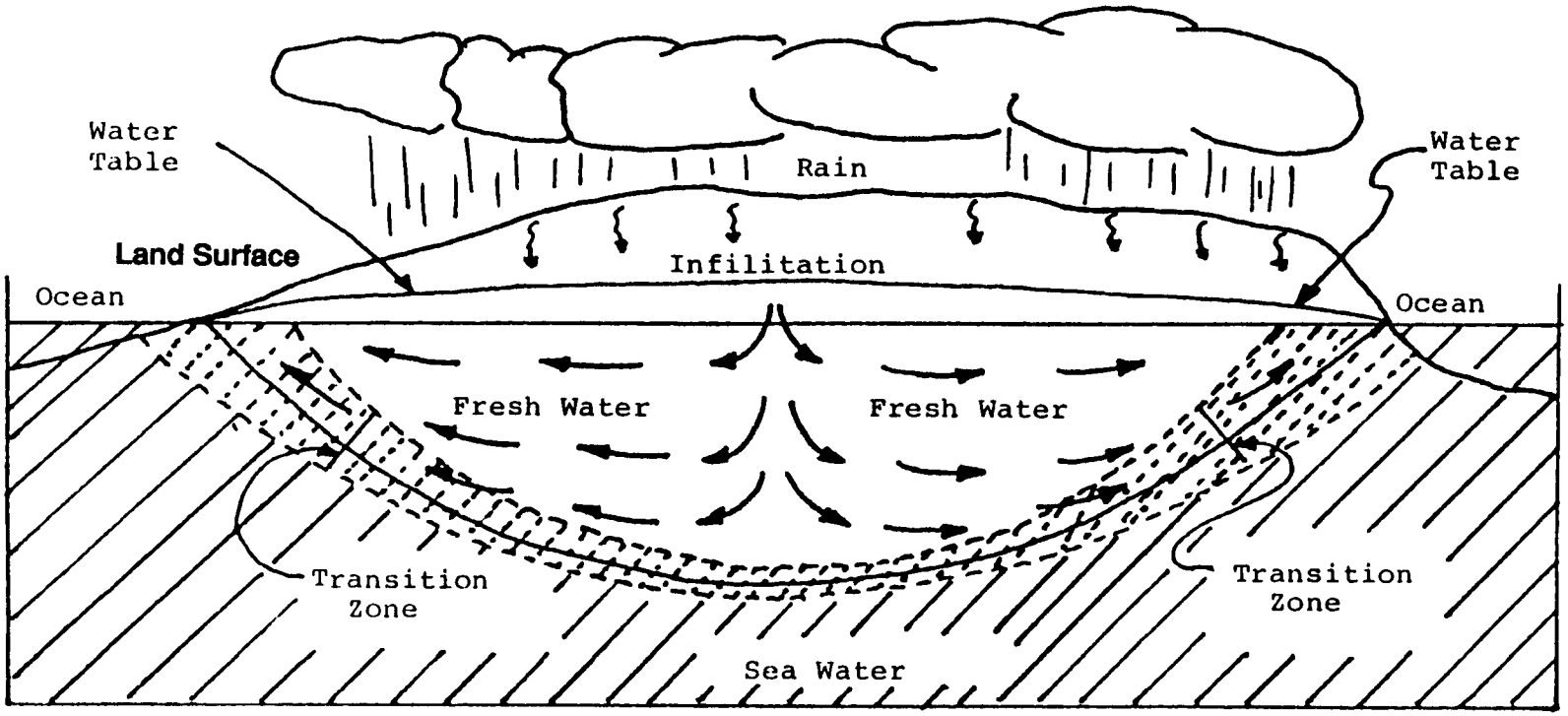


EXHIBIT III-20

GENERALIZED GROUND-WATER FLOW, GUAM

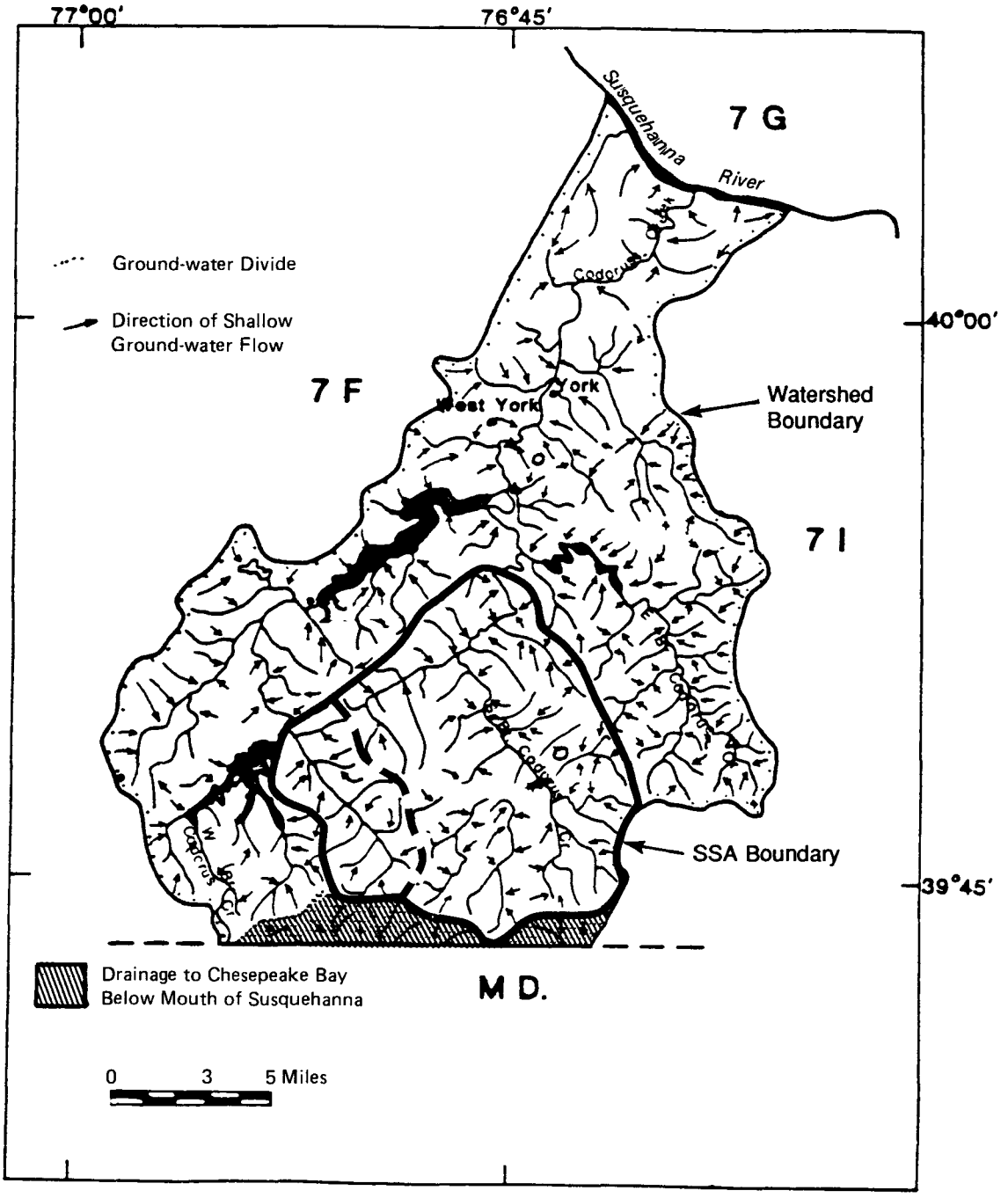


EXHIBIT III-21
LOCATION AND DIRECTIONS OF GROUND-WATER FLOW AT OR NEAR THE TOP OF THE ZONE OF SATURATION

Ground-water models were rarely used to delineate boundaries or reconstruct ground-water flow. Thus far, the Seven Lakes and Tulalip Reservation Aquifer in Region X is the only case in which a model was used to define the extent of the aquifer. A major USGS study had been conducted in the area for purposes other than SSA designation prior to petition submission. A three-dimensional, finite difference model defined the aquifer boundary and ground-water flow systems. Model results, when available, have been considered by Region X for delineating the aquifer and recharge area boundaries.

References in the Regional files to model use in designating SSA boundaries also exist for the Biscayne, the Volusia-Floridan, the Barton Springs, and the Camano Island Aquifers. For instance, in the late 1960s, an electrical analog model was used in the Biscayne Aquifer to evaluate a hydrologic relationship between canal and ground-water recharge. Since designation in 1979, other model usage has been known to have occurred for this aquifer, but this information was not in the Regional files. The other three aquifers contained references to two- and three-dimensional, USGS finite difference models by Trescott, et al., which defined the hydrologic properties of various formations. These studies were conducted independently of SSA considerations.

For most aquifers, ground-water quality was considered good. Ground-water quality data were usually general in content, and summary data were often presented in association with water use and ground-water pollution discussions. Most file data presented information on total dissolved solids (TDS), iron, sulfates, and chlorides as they related to salt-water intrusion.

(6) Vulnerability to Contamination

In 64 percent of the aquifers investigated, water tables were within approximately 30 feet of the land surface. The approximate depth to the water table was greater than 60 feet in 30 percent of the aquifers. The remaining 6 percent have water tables that are moderately deep, between 30 and 60 feet. Water table data were commonly related to vulnerability in unconfined aquifers. Locations with a shallow water table depth were considered especially susceptible to contamination.

In most cases, the petitions identified potential pollution sources that were a cause of concern. These sources were offered as evidence of aquifer vulnerability and potential impact on the quality of drinking water. The typical petitioner's approach was to list a number of

pollution sources, some of which may have caused documented water quality problems. Normally, such lists included underground storage tanks, sanitary landfills, surface-water runoff, agricultural practices, on-lot disposal, and sewage treatment plants. Additions were generally related to local concerns associated with specific locations, e.g., salt-water intrusion, canals, underground injection wells, and oil and gas activities. Rarely were actual pollution incidents identified by name and location. Only in the Maryland Piedmont Aquifer was a list of specific, Federally-supported potential contamination or pollution sources identified by the petitioner.

3. Summary Of Cross-Program Analysis

The following is a summary of the institutional and policy characteristics of the petitions received and the hydrogeologic characteristics of the petitioned aquifers.

(1) Institutional/Policy Characteristics

EPA Regions have received petitions rather consistently over the past 11 years, with a peak in submissions in the early 1980s. Environmental groups represent the largest petition groups, although petitions were submitted by local governments, citizens, and local water suppliers as well. About one-half of the petitions were submitted in an attempt to stop or affect a specific project. Landfills and publicly owned treatment works (POTWs) were the two types of facilities most likely to cause petitioners to submit SSA applications. The other half of the petitions was submitted to protect ground-water resources.

Once the Regions received the petitions, they either collected additional data or contacted the USGS and outside consultants. To provide public participation, the Regions held public hearings and accepted written public comments. State and local governmental agencies often provided written comments as well.

The Regions largely used three criteria to determine whether an aquifer should be designated. They were: (1) at least 50 percent population dependency on ground water, (2) the existence of alternative water supplies, and (3) the vulnerability to ground-water contamination. Two-thirds of the petitions providing such information indicated over 90 percent dependency of the population on ground water. In fact, almost half of the petitioned aquifers have been characterized as providing 100 percent of the drinking water supply. The second criterion,

alternative water supplies, was interpreted differently by various Regions. Some Regions addressed only available, existing sources as alternatives, while other Regions considered undeveloped, potential sources as well. The Regions used no formal approach or methodology to measure the third criterion, vulnerability. Typically, the Region reviewed hydrogeologic parameters of the aquifer and declared it to be vulnerable.

For designated SSAs, most Federal financially assisted projects reviewed by the Regions were approved without modification. For a few projects, modifications were made in order to be approved for the SSA area.

(2) Hydrogeologic Characteristics

Petitions contained up to nine different types of hydrogeologic information. Ground-water use and pollution source data were most commonly included in the petitions. Lithologic and formation nomenclature were usually presented as excerpts from geologic reports. Ground-water flow, water table depth, and other hydrologic data were generally not included in the petitions. Taken as a whole, the petitions alone were not adequate for making a delineation determination.

Both petitioners and the Regions most often used hydrologic criteria as a basis for delineating SSAs, and they were approximately likely to rely on these delineation criteria. Worth noting, however, is that the Regions frequently revised the petitioners' original boundaries once more comprehensive and sophisticated technical information had been reviewed. In many cases, these revisions were the result of the Region including the recharge area and/or streamflow source zone in the delineated area. In fact all delineated SSAs included the aquifer recharge area and 70 percent included the streamflow source zone.

In terms of size, over two-thirds of the aquifers were less than 1,000 square miles while several were larger than 12,000 square miles. Over half of the aquifers were in unconsolidated deposits. Most aquifers behaved as single hydrologic units (i.e., 25 of 42 aquifers or 60 percent). The remaining 40 percent were multilayered, containing several definable water-bearing zones. The Regions in all cases treated multiple and confined aquifer systems as "leaky," assuming that unconfined, overlying units would contribute pollutants to the underlying units.

For ground-water flow characteristics, the petitioners generally based the analysis on surface topography and

rarely used ground-water models. The depth to ground water was less than 30 feet in almost two-thirds of the cases. Shallow depths were often considered to represent susceptibility to contamination. The petitions often listed pollution sources that contributed to making the aquifers more vulnerable to contamination.

*U.S. Government Printing Office : 1988 -516-002/80527