A STUDY OF AQUIFER PROTECTION:

THE SPOKANE CASE

by

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A mention of my parents is in order. They were in an automobile accident between the time I finished my classes in 1983 and the completion of this research paper. My mother is a constant positive influence on my life and she is sorely missed. My dad has made my return possible and formed the early foundations of my life. I wish him the best in the absence of his wife.

Finally, I would like to list a few of the influences which helped me in the strive to accomplish this paper. The inventor of whiteout, Hoodoovoo -the ultra intelligent hue of blue-, David, Marsha, and finally Trent.

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ABSTRACT: This case study of the Spokane Valley-Rathdrum Prairie aquifer, deals with the evolution of water quality protection. A number of institutional efforts on multijurisdictional levels have established a piecemeal approach for this aquifer's protection. Federal legislation includes designation as a 'Sole Source' aquifer under sec. 1424(e) of SDWA, and '208' water management programs of the Clean Water Act. Local approaches include Sewage Management Agreements and Utility Local Improvement Districts. Recommendations are made which if implemented would greatly enhance the probabilities of preserving water quality in this aquifer. Key words: aquifer, sole source, Clean Water Act, Safe Drinking Water Act (SDWA), Section 1424(e), total dissolved solids (TDS).

INTRODUCTION

The purpose of this research paper is to explore the institutional efforts to protect the water quality of the Spokane Valley-Rathdrum Prairie aquifer. The aquifer is the sole source of water for the Spokane Metropolitan Area and a large area in Northern Idaho. It is being polluted and the bulk of this pollution has been identified as percolate from septic tank drainfields and stormdrains. Most of the high density septic tank installations servicing approximately

55,000 people are located in the Spokane Valley (Figure 1) just up-aquifer from the city of Spokane, Washington (Todd 1975).

A complex mixture of governments cover the aquifer, many of them overlapping in jurisdiction. The aquifer crosses the Washington/ Idaho border and thus is controlled by two different state governments. It also covers several counties with Spokane and Kootenai counties being the most heavily populated. In Idaho the Panhandle Health District encompasses the five northern counties. Numerous municipalities also lie over the aquifer; Spokane, the largest municipality, is at the bottom end of the aquifer. Traditional elements of upstream/downstream concerns are present due to the slow economy in most of the upper reach of the aquifer and changes wanted downstream.

Institutional responses include the establishment of the aquifer as a 'Sole Source' aquifer under section 1424(e) of the Safe Drinking Water Act, the pursuit of ongoing framework studies for management planning under the purview of the Clean Water Act (sec. '208'), and completion of a USGS analog flow model. New legislation has also been recently passed that is expected to be applied in the aquifer area. Sewerage districts (ULIDs) have been formed and the construction of sewers has begun in the areas of Spokane Valley with the highest densities of housing.

Physical Discription / Early Reports

The geologic history of the aquifer started with one of the gigantic ancient floods during the last ice age. In the early Wisconsin period Lake Missoula broke through it's ice dam and

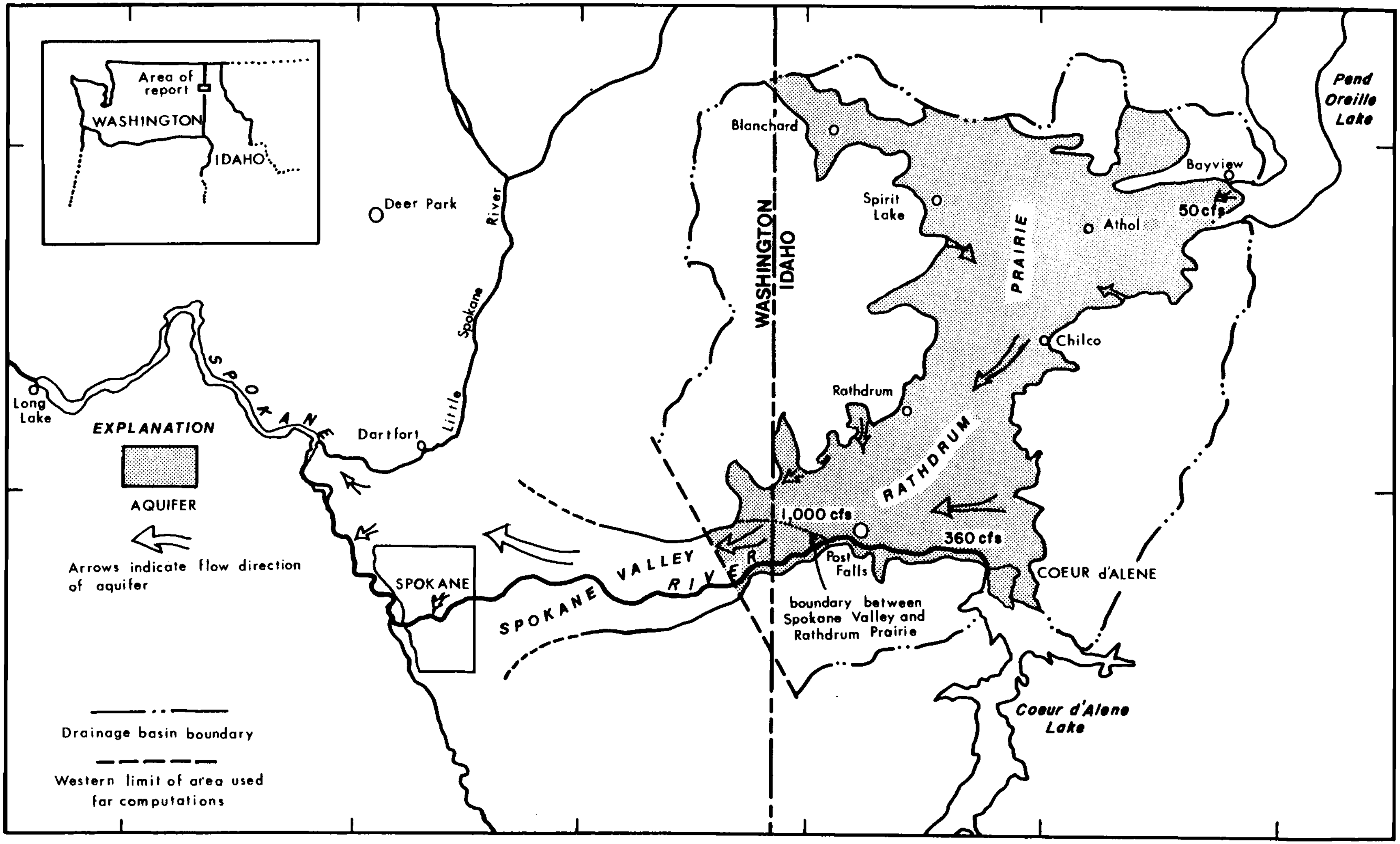


Figure 1. Drainage area of the Spokane Valley-Rathdrum Prairie aquifer.

(SOURCE: adapted from Water Tidings 1975) rushed towards the sea. In this rush it scoured out deep valleys. Following the flood, glacial till was deposited into these valleys forming what is now the Rathdrum Prairie and the Spokane Valley plains. Ice lobes from the same period gouged out other troughs forming the lakebeds of the deep Pend Oreille and Couer d'Alene lakes. These lakes were blocked by highly porous glacial outwash till. In current times these two large lakes are drained both by surface drainage, the Clark Fork River and the Spokane River, and by drainage to the Rathdrum Prairie-Spokane Valley aquifer which flows down the valleys of the same names. This aquifer has been discribed as one of the largest and most efficient aquifers in the world, especially in terms of water yield (Sewell 1965; Anderson 1951; Simons 1953).

The Spokane River and the Spokane Valley-Rathdrum Prairie aquifer are fed from approximately the same watershed areas (Figures 1 & 4). The early scientific studies of the drainage concentrated primarily on the Spokane River, first on it's location then upon it's water budget. Studies on the aquifer have a shorter history. Pluhowski and Thomas calculated a water-balance for the aquifer in 1968. They reported that an estimated flow of 28.3 cubic meters per second (1,000 cfs) went through the aquifer at the state line (Pluhowski 1968). The aquifer covers about 907 square kilometers (350 square miles) and it's recharge zone approximately 1,930 square kilometers (5,000 square miles). The watertable is at about 37 meters (120 ft.), beneath this the aquifer is approximately 85 meters (280 ft.) thick (Spokane Aquifer Water Management Plan 1979; Frink 1964). The calculated water velocity of the aquifer at the state line is 19½ meters (64 ft.) per day. This is a fast rate considering that most normal aquifers flow between a rate of 1½ meters (5 ft.) per year to 1½ meters (5 ft.) per day (Carr 1974; Hammond 1974). The soils of the area are primarily of the Garrison type which has moderate to rapid permeability (U.S. Dept. of Agriculture 1968). The aquifer starts at the southern end of Lake Pend Oreille. It flows down three channels through the Rathdrum Prairie, of which the west channel is the most important. It collects water as it travels from precipitation, ephemeral streams, and local lakes which hang on the sides of the valley. Upon reaching Post Falls it meets the water draining from Coeur d'Alene Lake which increases the flow by a third. It then turns west to proceed down the Spokane Valley. Upon reaching the city of Spokane the aquifer turns north where it finally drains into the Spokane River near the entrance of the Little Spokane River (Agnew 1971; Drost 1978; Water Resources Data for Washington 'Yearbooks').

The aquifer is used as the principal source of water for all uses in the area. Figure 2 shows the locations of the primary wells. The wells in the city of Spokane are mostly of a hand dug construction and acquire water from the top of the watertable down. This forces Spokane to chlorinate due to pollutants. The wells in the county to the east of Spokane are principally of the drilled types and obtain their water from beneath the tainted layer of water.

The ecology movement of the late sixties and early seventies and the concern for matters which are environmental in nature led local citizens and officials at all levels to inspect their surroundings. The people of Spokane looked toward's their water and it's purity.

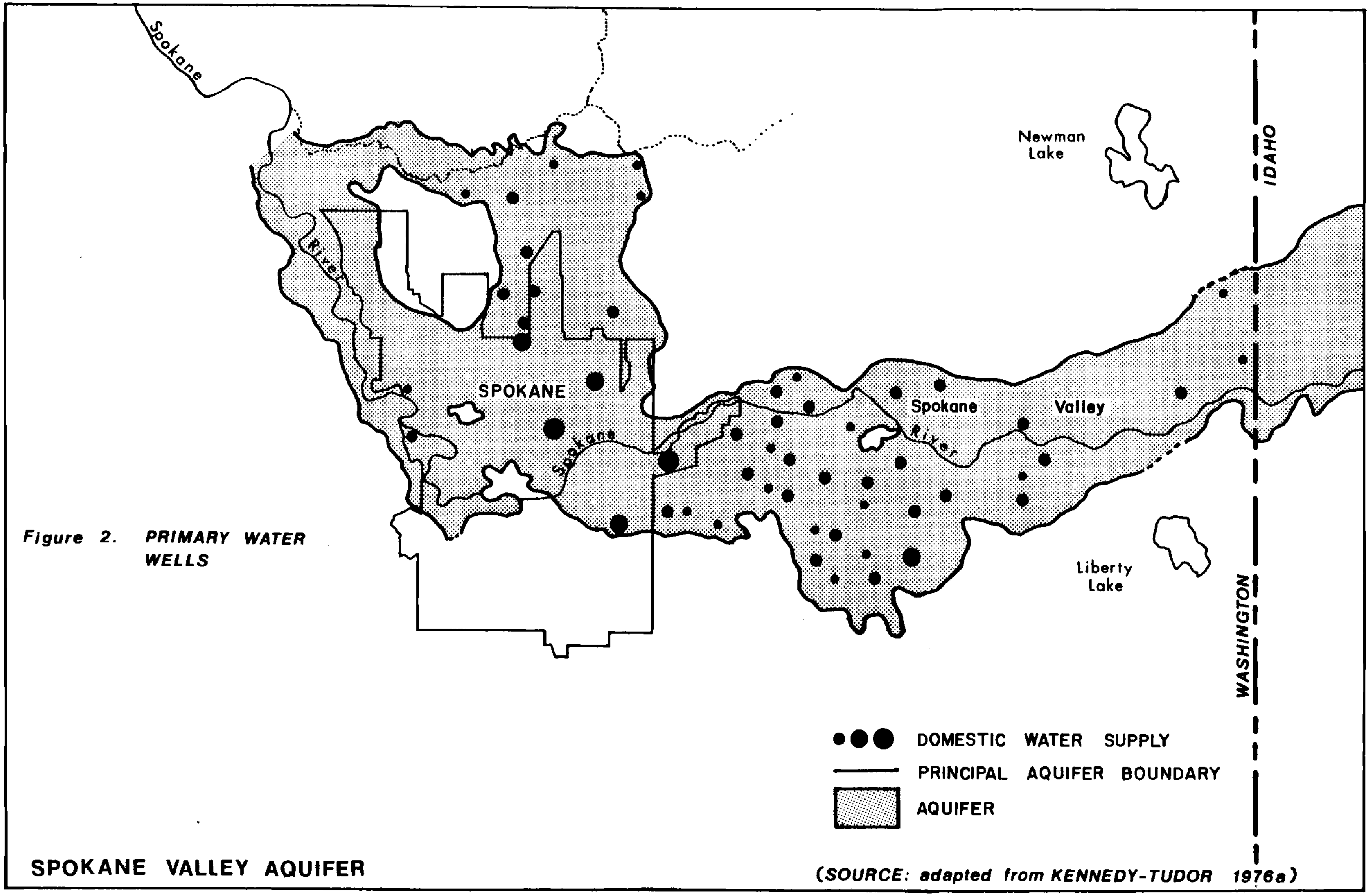


Figure 2. PRIMARY WATER WELLS

Public concern was expressed about the high number of septic tanks between Spokane and it's source of water. Early studies showed that the aquifer was a valuable resource but indicated little about it's actual workings. Thus studies were begun to obtain a better understanding of the aquifer and of it's mechanics. This led to '208'* money being used to develop a management program for the Spokane Valley aquifer.

One of the first aquifer studies dealing with water quality was the Crosby study based on soil investigations in the Spokane Valley. Crosby was trying to determine if moisture was percolating down to the aquifer. Crosby chose drilling sites and did chemical analyses of collected soil samples. He concluded that an algae matt was dispersing the effluent laterally and that salts were being captured by soil particles or being taken up by plants. With the moisture being evapotranspirated while being carried to the surface by capillary action. Thus Crosby saw little chance that the number of septic tanks that were in the Spokane Valley could be doing significant harm (Crosby 1968, 1971a, 1971b, 1971c).

Todd Report

Concern about the quality of waters in the Spokane Valley aquifer and a dispute in the scientific community centered on the

* Section '208', Clean Water Act: Funds are authorized for states to develop water quality management plans. State plans provide for development of activities (e.g., best management practices) related to certain non-point sources (Office of Technology Assessment 1984: 217).

Crosby, et al. study led to the '208' sponsored "Water Resources Study / Metropolitan Spokane Region" study by the Corps of Engineers. As a guide to the direction for this study Dr. David K. Todd, an eminent hydrologist at the University of California, Berkley, was brought in as a consulting engineer in cooperation with Kennedy-Tudor, Inc. the consultants for the Corps. He did a water balance study of inputs to the Spokane Valley-Rathdrum Prairie aquifer. These study results appeared to be contradictory with those from the Crosby report but Todd used materials from the Crosby studies, specifically salt flushing and low soil moisture, in support of his own thesis.

Todd set out with two aims. Firstly to study analytically the drainfield percolation mechanism and secondly to estimate the magnitude of quality changes in the aquifer, if any. His approach contained three elements. He tried to determine the net moisture availability for percolation. Then he estimated the total load of dissolved solids (TDS) carried to the water table and its effects on water quality. Lastly he reexamined the existing water quality data and related investigations for possible confirmations and to suggest field investigations needed.

Subsurface Water Movement Under 'Natural Conditions'

A water balance study using the Thornthwaite method was done by Todd to analyze net moisture availability for percolation on raw land prior to introducing the complexities of suburban development and septic tanks. Monthly averages for precipitation, temperature, potential evapotranspiration, actual evapotranspiration, moisture deficit, soil moisture storage [soil moisture capacity is 12.7 centimeters (5 in.)] and snow pack go into the formulation to calculate total monthly percolation and a mean yearly total. It is important to note that three months have enough precipitation and lack of evapotranspiration to allow percolation. These are the months of late winter, January thru March and the total amount of percolate is 15 centimeters (6.01 in.) (Kennedy-Tudor Consulting Engineers 1976b).

<u>Subsurface Water Movement Under 'Suburban Conditions'</u>

Following the study of the 'natural condition' Todd considered the effects of changes in inputs due to the suburbanization of the landscape. The main emphasis was placed on septic tank effluent. To estimate the effects of septic tank effluent inputs to the water balance formula a density of development had to be adopted. Todd used an average lot size of 1,300 square meters (14,000 sq. ft.) or nearly 7½ lots per hectare (3 per acre), an average family size of four persons and a typical effluent rate of 341 liters (90 gallons) per capita per day. He determined that there was 3.02 centimeters (1.19 in.) per month additional available moisture. He ignored the areas covered by structures, the limited size of leach fields, irrigation, and changed runoff patterns. All of these assumptions favor evapotranspiration over percolation. The 3.02 centimeters (1.19 in.) per month moisture was then reentered into the Thornthwaite water balance and was added to the precipitation amounts to provide total moisture. This showed that actual evapotranspiration changed due to the increase in moisture available and that six months have water available for percolation to the aquifer. There is 36.12 centimeters (14.22 in.) available per year in contrast to the 15.27 centimeters (6.10 in.) under 'natural conditions'. Percolation totals 41% of the total moisture available. This amount should be considered significant. It should be kept in mind that this is a conservative estimate due to the exclusion from consideration of irrigation and runoff waters.

Total Load of Dissolved Solids (TDS)

After defining the amounts of water available for percolation Todd calculated the amounts of 'total dissolved solids' (TDS) reaching the aquifer. A large percentage of TDS (85%) pass through typical treatment plants and through soil and is primarily composed of nitrates, nitrogen, and other dissolved mineral salts (Newcomb 1973). The term TDS is used interchangeably with salinity and 500 mg/l is considered an unacceptably high level for most uses. By using water quality data from the city of Spokane, a value of 300 mg/l TDS was assigned the leachate from the septic tanks. Values for inputs of precipitation, septic tank effluent, lawn irrigation and agricultural irrigation were now calculated for the different planning units of the Spokane Valley. As water moves from planning unit to planning unit successive amounts of water collect and flow down the aquifer. Summing the results of the planning units indicates that there should be 86.6 centimeters (34.1 in.) of accumulated percolate occupying 2.9 vertical meters (9.5 ft.) at the top of the water table. The TDS of this vertical layer of water should vary between 155 to 248 mg/l depending upon mixing with native waters (Figure 3) (Esvelt 1964; Todd 1975).

Existing Water Quality Data & Other Investigations

Todd now went to available water quality data for verification of his calculated quantities. The data was from the USGS-EPA program for June 1973 to March 1974 and Spokane County Health

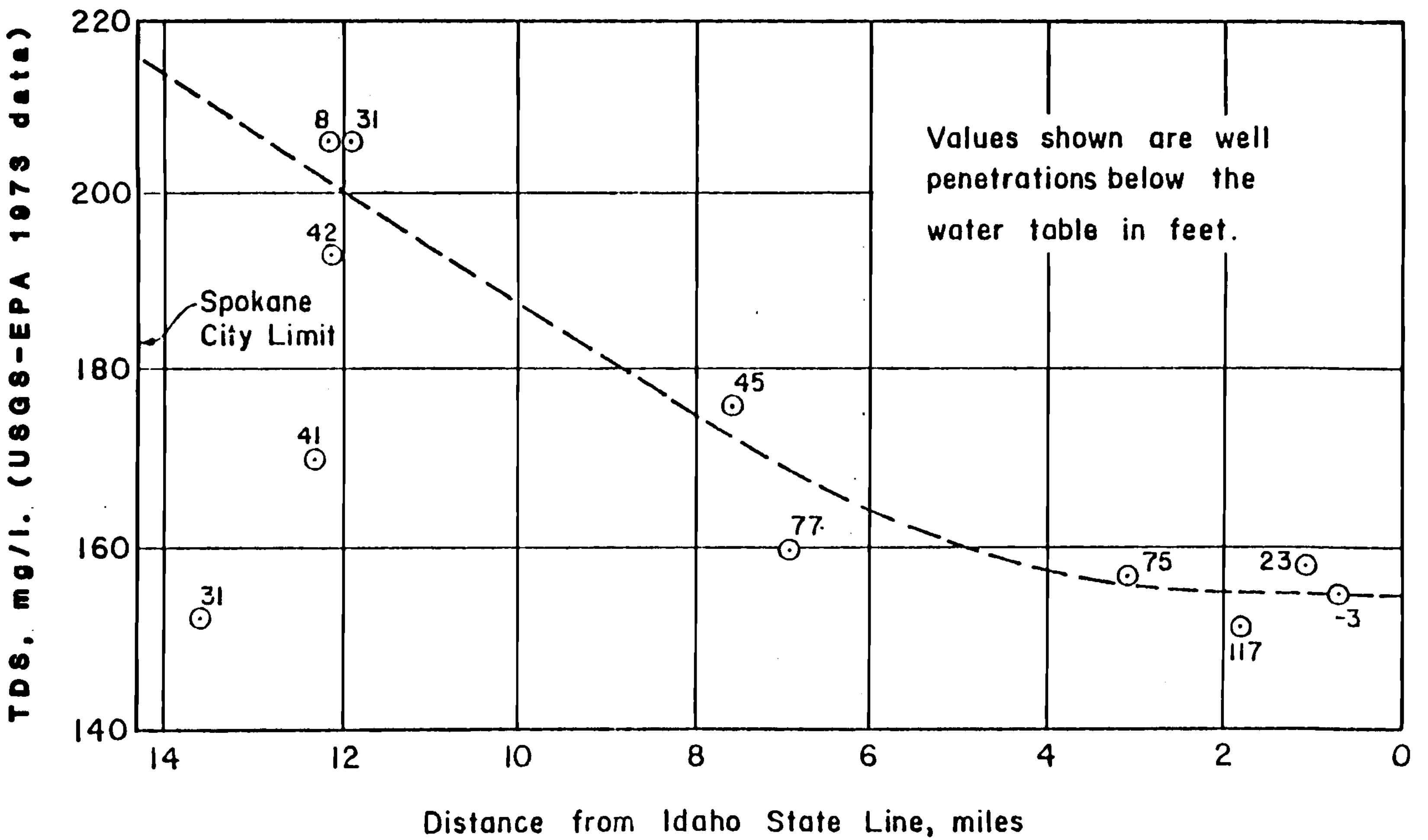


Figure 3. Variation in Measured Salinity of Groundwater in Spokane Valley

(SOURCE: Todd 1975)

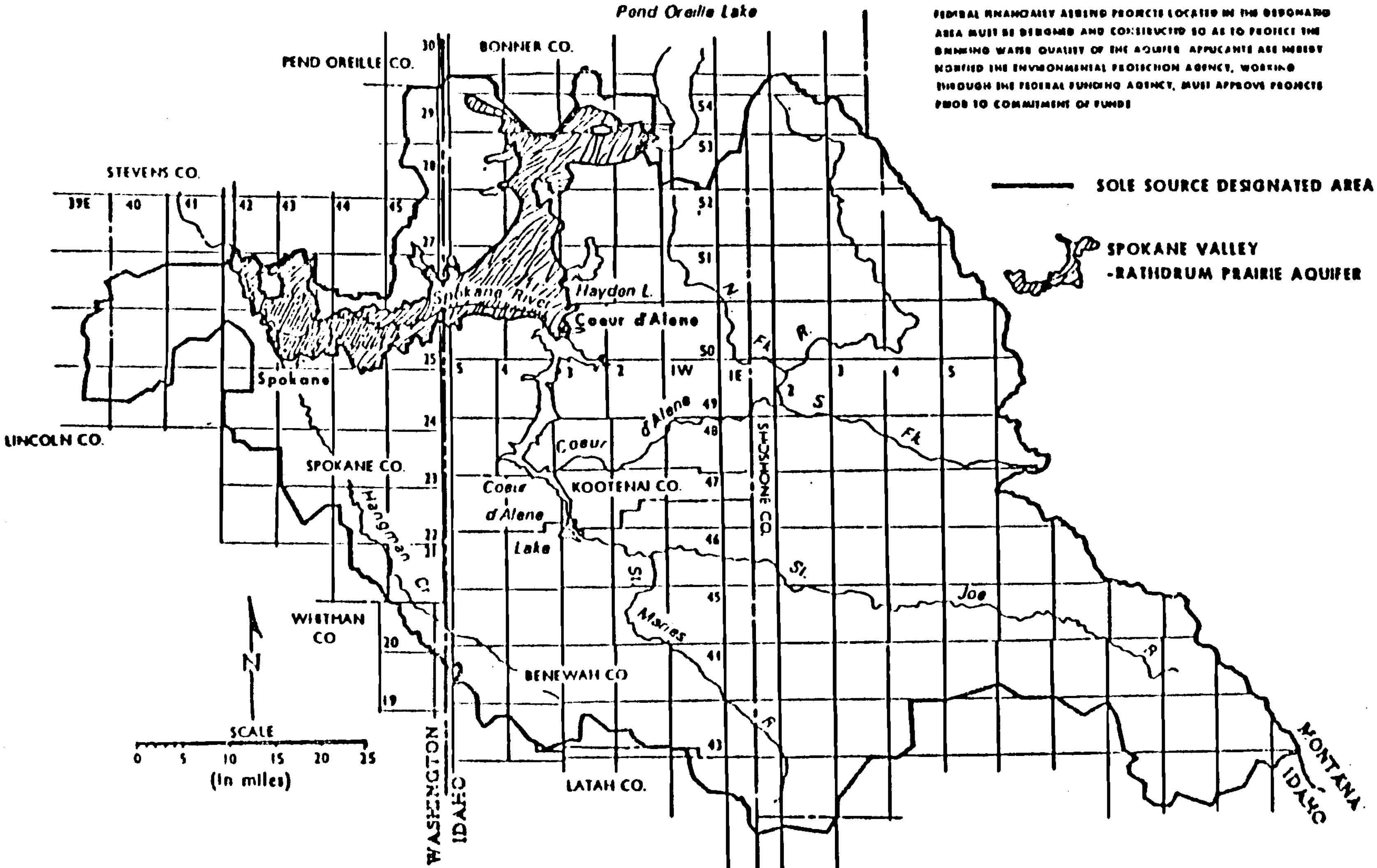
District data covering September 1971 through September 1972. It would be expected that the values for TDS in mg/l would increase as the aquifer flows west. The data show that even though depth specific wells were not available, the existing TDS values in the amounts expected were encountered. With a high value of 216 mg/l TDS in the 1971-72 measurement period at a well 20.6 kilometers (12.8 miles) west of the Idaho State Line. The values are plotted on a graph in figure 3.

With this verification Todd then proposed areas needing additional investigation. These included depth specific water sampling, testing for specific chemicals, discovering the down valley changes in groundwater quality, developing an understanding of variations as a function of depth of well penetration, and the projection of groundwater quality for wastewater management (Esvelt 1977; Todd 1975; Newcomb 1973).

Sole Source Aquifer

In 1974 Section 1424(e) of the Safe Drinking Water Act (PL 93-523) established the designation 'sole or principal source' aquifer. Section 1424(e) was set up to withdraw funding from federally assisted non-complying projects. The designation affected only federally funded projects and not direct federal projects such as dredging by the Corps of Engineers or construction of roads on federal lands. Federally assisted projects committed to prior to the designation date did not come under this law as well as non-federal projects. In accordance with section 1424(e) 'Sole Source' aquifers are supposed to be integrated with local and state water management programs with the EPA having a review function. Any projects where federal financing is a part of a project within the aquifer designated area needs a certificate of non-significant effect on the aquifer from the EPA. In establishing a 'Sole Source' aquifer designation citizens or the regional level EPA assistant director needs to petition for such designation. They must show that there is the potential for degradation of the aquifer; degradation does not have to be proved (EPA 1977; US Code 1982; Congressional Quarterly 1974). The administration of 1424(e) is integrated with the National Environmental Policy Act (NEPA) and it's accompanying steering group, the Counsel on Environmental Quality, advised federal agencies to amend their NEPA regulations to put more emphasis on the evaluation on ground water project impacts. Thus 'Sole Source' application is tied to the environmental impact statement process with projects being reviewed by the EPA for compliance. A "Draft Program Guidance" was developed to help interpret and implement this law. It shows just how to obtain a 'Sole Source' designation for aquifers (EPA 1976).

Washington and Idaho citizens groups in 1976 set out to obtain this status for the Spokane Valley-Rathdrum Prairie aquifer and recharge zone (Figure 4). Petitions were presented by four local community groups. The Idaho Coalition for Shorelands Preservation, The Spokane Audubon Society, Spokane Valley Vera Citizens Committee, and the Spokane Sierra Club. The petitions were recieved by the EPA in December of 1976 (EPA 1978b). The Federal Register noted that "the petitioners are interested in protecting their drinking water source from contamination. They desire controls which are not tied



EPA Figure 4. Spokane Valley-Rathdrum Prairie aquifer 'Sole Source' recharge area. (SOURCE: Lustig 1986a.)

to local politics and industrial and commercial influence" (EPA 1978a). Following public hearings and background information collection the Administrator of the EPA published notification of the 'Sole Source' designation in the Federal Register on February 9th, 1978. This made the Spokane Valley-Rathdrum Prairie aquifer the second such designated aquifer in the nation (Public Law 93-523 1974).

According to Bill Mullen of Region X of the EPA, "as of September of 1986 no projects reviewed have been stopped, but modifications have been worked out on site pretreatment or location of facilities on site, etc.". Mullen stated further "there is a unique opportunity to get a handle on the problem before it gets out of hand and there is an insurmountable cleanup. Degradation levels are not yet irreversible". Four points were given by Mullen as to the benefits derived by 'Sole Source' designation of the Spokane Valley-Rathdrum Prairie aquifer. They are:

1) Increased public sensitivity to the aquifer (Shared with '208' program)

2) It made it easier on local officials to draft water quality directives. (although locals are substantially ahead of most of the rest of the country)

3) It helped spot the Greenacres landfill as a polluter by the monitoring program (conducted under '208' program) and then helped raise the priority to superfund (CERCLA) level.

4) The EPA through connections derived from 'Sole Source' became very supportive of locals especially county officials.

(Mullen 1986)

While it is axiomatic that the 'Sole Source' designation is not a panacea, it has helped heighten awareness in the vulnerability of this valuable resource.

Clean Water Act

Spokane County recieved federal funds under the Clean Water Act, section '208' and '201' (PL 92-500) to develop and implement a program to protect the water quality of the Spokane Valley-Rathdrum Prairie aquifer in Washington. Funds were also obtained from State Referendum 26 for this program. The federal funds were administered by the EPA and the state funds by the Washington Department of Ecology. This program is a delegated part of the Washington statewide '208' Water Quality Management Program (Spokane Aquifer Study 1977).

Two reports have thus far been published in the ongoing '208' program. These are the "Spokane Aquifer Cause and Effect Report" and the "Spokane Aquifer Water Quality Management Plan". The main thrust of the work involved a water quality monitoring network with wells being sampled by Spokane County at about eighty locations, twenty of which were specially constructed depth selective sampling wells. Concurrently in a cooperative program the USGS collected samples from about 150 locations over the same time period. The results of the testing of the samples is the topic of the "Spokane Aquifer Cause and Effect Report".

The report published a number of conclusions and recommendations. A general summary was that Todd was correct in his thesis that total dissolved solids (TDS) were reaching the aquifer. It also found trace amounts of other contaminants for which it urged closer observation. This report gave a data baseline for future sampling analyses of the water quality of the aquifer. The second report expanded on the information of the first to develop a management program for the aquifer. It identified potential threats, developed alternatives, and recommended actions for implementation by decision makers. This included establishment of a preliminary priority sewer service area.

Although '208' funds have handled the bulk of the work, some funds from section '201'#, have been obtained to help pay for the lab work done on the samples (Spokane Aquifer Cause and Effect Report 1978; Spokane Aquifer Water Quality Management Plan 1979).

Hydrologic Flow Model

The USGS as a cooperative agency in the '208' project has developed a hydrologic flow model cf the aquifer. This digital model is a simulation of the Spokane Valley-Rathdrum Prairie hydrologic flow. This model is expected to help researchers and planners in better understanding the dynamics of the aquifer system and to help plan for it's management and for potential hazard mitigation (Bolke 1981).

New Federal Programs

In 1986 new amendments to the Safe Drinking Water Act (SDWA)

Section '201', Clean Water Act: Provides funds for the construction of sewage treatment works and the use of alternative waste management techniques.

were adopted. These amendments provide for three programs to aid the states in improving and protecting water quality. They are the Sole Source Aquifer Demonstration Program (New section 1427), Underground Injection Control Program, and the program to establish Wellhead Protection Areas (New section 1428).

The Sole Source Aquifer Demonstration Program provides for the establishment of 'Critical Aquifer Protection Areas' (CAPA). CAPA are tied to the 'Sole Source' aquifer designations in 1424(e) of SDWA and provide assistance to states in developing and implementing comprehensive management plans for these areas. Financial assistance is limited to four million dollars per aquifer. State limits also exist. Section '208' plans of the Clean Water Act qualify but the funding formula changes.

'Wellhead Protection Areas' give the states a program to help provide protection of wells or wellfields from surface and subsurface contaminants. Identification of potential anthropogenic sources of contaminants within a wellhead protection area and a plan to protect the water supply from these contaminants are the primary aim of this program. A contingency plan for alternate drinking water supplies and a review on new construction within the area with an eye on the potential to contaminate are also included. Underground Injection Control (UIC) is required of states with more than 2,500 active wells using annular injection and participating in the Wellhead Protection Areas program. The EPA Administrator facilitates these processes by making grants to states covering between 50 and 90 percent of the costs of developing and implementing the state plans.

These programs are expected to be fully utilized by the Spokane Valley/Rathdrum Prairie officials but the EPA has not yet issued technical guidance covering these new programs. Thus the effectiveness of them is unknown (EPA 1986a, 1986b, 1986c).

Sewage Management Agreements

The Panhandle Health District (PHD), which covers the five northernmost counties in Idaho, has developed Sewage Management Agreements (SMA) for the control of septic tanks and to manage for water quality over the aquifer. The formation of the PHD was under Idaho legislation passed in 1970 and was designed to provide counties having little financial resources with improved health services. The Environmental Health section of the PHD was given the authority to issue permits for septic tank installations, to enter into contracts with governmental agencies, and to monitor water quality of waters both surface and subsurface. Rathdrum Prairie lies within the jurisdiction of PHD and is the principal recharge zone for the aquifer. Any degradation allowed on this portion of the aquifer's course would exacerbate the problems downstream in the more urbanized Spokane area.

A brief review of some selected statistics will highlight the developments which followed. In the 1960s the county with the largest population in the Idaho Panhandle, Kootenai, had a an annual population growth rate estimated at 9.2%. This rate was expected to remain constant through the year 2000. Extrapolation of this rate gave an expected population for Kootenai county of

46,008 persons in the year 2000. But during the following two decades a much higher rate of in-migration occurred and there were 60,000 persons in 1980. Moreover, most of this population had moved into suburban and rural settings using septic tanks. In mid 1975 a sixteen month monitoring program using 47 wells (16 were discontinued spring 1976) was conducted under the Idaho '208' program. These wells were located on areas over the aquifer. The Idaho state monitoring program was coordinated with the '208' program occurring in Washington state. The monitoring program revealed that wells near the state line had an average concentration of nitrate as nitrate exceeding 7ppm, and that some wells in Coeur d'Alene had peak concentrations above 20 ppm. The U.S. EPA has set the Maximum Contaminant Level in community drinking water at 45 ppm (EPA 1975: 59570). Although the local levels are not as of yet at the EPA Maximum Contaminant Level it is considered important to public health and is cost effective to manage the aquifer so as not to reach this level. The PHD staff members understood the significance of these measurements and proceeded to set policies to mitigate the growing problem. An Interim Policy was put in place effectively stopping new subdivision of land until the '208' study was completed. Upon completion of the '208' study in 1976 PHD established primarily three significant regulations:

1) "Outside the incorporated cities and towns, PHD would not grant a septic tank permit -- needed for new construction -- on lots less than 2.02 hectares (five acres) in size, and"

2) "Inside the incorporated cities and towns, PHD would grant septic tank permits [only] as long

as the municipality had negotiated a Sewage Management Agreement (SMA) with the PHD."

3) Any septic or other system must connect to a sewer upon it's availability (Lustig 1986a: es-5)

The SMAs contain plans in which the local municipalities have agreed to centralized sewage treatment plants or have negotiated alternative management programs. SMAs are based upon civil contracts and must be renegotiated annually. Many construction projects are underway or are waiting until population densities increase to make them economically feasible. The PHD has used it's legislated authority to withhold the issuance of septic permits, thus halting subdivision and restricting annexation of land into current SMA areas until reluctant municipalities negotiate a SMA or comply with PHD requirements.

These PHD actions resulted in a lawsuit. The Idaho Home-Builder's Association filed a complaint against the PHD. The Idaho Board of Health and Welfare rescinded the PHD's authority to implement it's new policy but the PHD in return brought suit against the State Board of Health to reinstate that authority. The PHD also used it's authority granted under the Environmental Health Code to delay all key building decisions on the aquifer. This included a multi-million dollar development in Couer d'Alene. The PHD and Idaho Board of Health and Welfare negotiated an agreement and the PHD rules were re-established and presently remain. The Home-Builder's Association litigation was dismissed on the grounds that judicial review was not sought within the period prescribed by IC 39-418 (Lustig 1986a).

Summary

Recognition that the aquifer is a fragile resource in terms of maintenance of water quality seems to have been accomplished. The water budget of the aquifer has been studied, a simulation model constructed, a baseline water quality study accomplished, and legislation put in place -- all in an effort to avoid major possibly irreversible problems later. The local administrators are well aware of the potential problems and were praised by EPA as pioneers in aquifer research and protection. Yet more effort seemingly needs to be expended. The public understanding of the problem is as of yet mostly lacking. Sewering has been started but it is being fought by a local grassroots interest group. It even accomplished the dissolution of two Utility Local Improvement Districts and is behind a movement to incorporate urban and suburban places in the Spokane Valley into one city.

Recommendations

If the following recommendations were implemented, the probabilities of preserving water quality in the Spokane Valley-Rathdrum Prairie aquifer would improve markedly.

* Implement a program of more frequent and ongoing testing of the water, adding to all testing a wider range of chemical tests (Todd 1975: 21).
* Carry out analytic studies of the quality of water in the aquifer in terms of down-valley changes in groundwater quality.

Also carry out water quality studies on contaminant levels as a function of depth of well penetration (Todd 1975: 20).

* Implement studies of non-point sources of pollution which are recieving too little attention. Studies are also needed to determine the potential impacts of non-hazardous waste, and non-waste such as product pipelines (Office of Technology Assessment 1984).

* Broaden the focus on contaminant sources. A federal document, "Protecting the Nation's Groundwater from Contamination" indicates that most aquifers and programs suffer from their narrow focus on contaminant sources, narrow focus on contaminants, and narrow focus on users. It also decries the fact that state corrective actions usually result from complaints rather than systematic efforts. Systematic efforts to correct these proglems need to be firmly established in the Spokane Valley-Rathdrum Prairie 'Sole Source' aquifer designated area (Office of Technology Assessment 1984).

* Implement a more intense and effective program of public education.

* Actively encourage cooperation between the various jurisdictions, especially between Spokane and Spokane County officials with officials in Idaho. Recognizing that there are upstream costs which benefit downstream users, the staffers at the local levels already share data, laboratory expenditures, and field studies expertise. But more cooperation is needed such as Spokane County and City providing funds for better upstream monitoring and management procedures in Idaho.

* Encourage studies on alternatives to the frictionless watercloset (flush toilet), optimally developing a system that does not have as a part of it's operation the pollution of surface waters or the aquifer. The system should also be divorced from sewering with all of it's attendant disruptions due to construction of the collection pipelines (Leich 1977; Briscoe 1972).

* Establish better knowledge about the relationship between stormwater runoff and water quality in the Spokane Valley-Rathdrum Prairie aquifer (Miller 1986).

* Collect and treat stormwater runoff or develop alternatives which would filter out potential pollutants.

* Complete sewer construction with all possible speed. But this must be accompanied by developing methods that do not disrupt the social fabric of the area due to the attendant costs which displace persons on low or fixed incomes.

* Develop innovative methods of financing sewer construction to lessen costs for affected persons on low and/or fixed incomes.

* Tighten land use zoning and subdivision until sewers are available.

* Broaden the use of Sewage Management Agreements (SMAs) (Lustig 1986a).

* Explore the feasibility and desirability of artificial aquifer recharge as a water quality emergency procedure or as a management tool (Kennedy-Tudor 1976a: 118).

Conclusions

Users of the Spokane Valley-Rathdrum Prairie aquifer need the protection that they are now starting to recieve. Although sewering is widely perceived as being a duplication of services by many residents, it is necessary if the aquifer is to remain the great resource that it has been in the past.

The laws which have been legislated for the mitigation of aquifer problems all seem to be lacking in some element, especially the new 'Sole Source' designation. It did help elevate the Greenacres landfill to superfund status but it's direct limitations are too narrow. The SDWA amendments of 1986 also seem fairly limited. The best approach appears to be the establishment of 'Wellhead Protection Areas'. The PHD 'Sewage Management Agreements' appear to be effective in Idaho but transferability is questionable.

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