Citizens League Report

A Strategy for the Waterbelt

Public affairs research and education in the Minneapolis-Saint Paul metropolitan area

CITIZENS LEAGUE REPORT

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INTRODUCTION

The subject of groundwater is immensely complex, both in a policy and in a technical sense. Some major threads in the policy are apparent, however.

Until now, groundwater problems have been seen as separate crises of limited duration and extent, each stemming from a single cause, and each having a single solution. Over time, a variety of agencies and programs have been built up to address these separate crises, each relating to a single piece of the problem with no one entity charged with the overall responsibility. With this fragmentation has come some difficulty in clarifying responsibility and overall direction. We recommend better coordination of groundwater-related activities at the state level. Effective coordination requires comprehensive policies and clear management.

In exploring the problems in groundwater, it became apparent that the problem is not a series of isolated crises, but rather a systemic, chronic problem which needs to be addressed with a long-term, systemic response. The interrelationship between surface water and groundwater needs to be part of the answer. An understanding of the many activities that can cause aquifer degradation should be part of the overall policy. The long term health risks need to be better understood. Cost allocations should be adjusted. A more integrated governmental response is required to meet these needs.

With the realization that groundwater problems are chronic and systematic rather than isolated events, there is a corresponding need to develop appropriate comprehensive groundwater policy. That responsibility lies with the state Legislature. Such a policy needs to include development of a uniform data base, baseline data about aquifer condition, better understanding of health risk, and systematic priorities for cleanup.

Supply

Water is all around us, mostly underneath us. In Minnesota, there is a lot of it. If all of the water underground in Minnesota were above ground, it would put us all 18 feet under water. The water beneath the ground is directly linked to the water in streams and lakes, as well as the water in the atmosphere. This connection manifests itself in at least two ways. First is through the hydrogeologic cycle. Groundwater is part of a physical system of evaporation, flows, precipitation and the like. Intervention at any point will have an impact on groundwater. Second, there are the many human activities involving water. Groundwater becomes surface water when it is pumped up. People who need water must pick from either surface or groundwater. During a drought, users who might otherwise have used surface water will turn to groundwater.

Pollution

Groundwater can be polluted by any number of activities: improper waste disposal, spills, farm activities, and septic systems are some examples. The multiplicity of pollution sources has produced a multiplicity of regulatory and management activities, split among the many levels of government involved.

Besides the problems stemming from current activities, knowledge of problems caused by previous activities is just coming to light. For decades, the unwanted byproducts of industrial activity have been dumped with scant regard for the impact on aquifers. The connection between dumping and groundwater was--and in many respects continues to be--poorly understood. In 1985, the state and nation for the first time are taking stock of the damage and making the first steps to address systematically the destruction of many years. This job is just beginning, but at least it has begun.

Structure

Federal, state, and local government are involved in groundwater management, protection, and use. The Minnesota Legislature sets policy, executive branch agencies carry it out by establishing rules and regulations. Metropolitan and local governments have an important role in land use and waste disposal. Cities operate water utilities, and many special purpose units of government exist because of water management needs.

Because of the complexity of the subject matter, this report is organized into several sections. A background section offers some basic technical information needed to understand the resources. Two appendices describe the major responsibilities of units of government and the main laws in effect which are important in policy. A glossary of terms is included for those unfamiliar with the language used to discuss this issue. The findings, conclusions, and recommendations are grouped into sections on water supply, water pollution, and government structure. These sections offer the committee's analysis of the salient policy issues, what problems exist in groundwater policy, and what should be done about them.

SUMMARY OF RECOMMENDATIONS

Supply

I. Minnesota state government should take a leadership role in establishing state-to-state water transfer policy.

II. The Legislature should make sure a drought water allocation plan is developed and adopted in law.

III. The state's drought allocation priorities should be revised. Only household domestic and municipal use should be given top priority.

IV. The state should increase fees charged by the Department of Natural Resources for groundwater and surface water withdrawals and use the money to finance any new initiatives aimed at protecting groundwater.

Pollution

V. The Legislature should charge the Environmental Quality Board Pollution Control Agency, the Department of Natural Resources, and the Department of Health with several new responsibilities:

* The development of health risk standards.

* The development of a list of cleanup priorities.

* The development of cleanup standards.

* A "report card" on agency performance.

VI. The Legislature should remove the moratorium on siting a hazardous waste disposal facility and set up a new timetable for acquiring a site.

VII. New efforts to allow for the successful collection of household hazardous wastes should be undertaken.

Structure

VIII. The Environmental Quality Board should be reconstituted with a majority of citizen members and with strengthened ability to carry out the coordinating function needed at the state level.

IX. Responsibility for regulation of agricultural chemical use should be transferred to the Pollution Control Agency.

X. The Legislature should review groundwater statutes, the groundwater responsibilities of state agencies, and the executive branch rulemaking process for groundater.

XI. Adequate financing for the development of an appropriate data collection and dissemination process should be provided.

XII. New incentives for the involvement of local units of government in groundwater protection should be developed by the state. These efforts should be designed as incentives for local action, not mandates.

XIII. A matching grant program to allow other counties to take advantage of hydrogeologic studies such as those carried out in Scott and Winona counties should be set up.

FINDINGS ABOUT SUPPLY

Few economic--as opposed to regulatory--incentives exist to conserve or protect groundwater. As an inexpensive, perceived to be abundant resource, groundwater is rarely conserved. Current policy and regulatory structures have not relied on market-based tactics and strategies to protect the resource.

A. Public policy response to pollution and appropriation has so far been entirely regulatory. Although the Department of Natural Resources' (DNR) allocation permit fees do depend on the amount of use, allocation is basically not cost-related.

Water is cheap, compared to most commodities. Compared to utility costs for electricity or natural gas, water costs are low. For agricultural irrigators, the only real costs of using groundwater are the pumping cost and the capital cost of irrigation equipment.

When users must pay additional costs for groundwater use, use declines. The DNR, for example, recently changed its fee structure for permits used in agricultural irrigation. Farmers formerly received permits for a nominal fee no matter how much water was used. The fee structure was changed to take into account the number of acres irrigated. A DNR representative said that the switch resulted in nearly half of the farmers dropping their permits. Similarly, in the Twin Cities metropolitan area, increased sewer charges dramatically reduced the use of water by industry.

B. No supply problem exists now. As documented in the background section, no evidence exists that aquifers in the Twin Cities metropolitan area or the state as a whole are being depleted through overuse although it is possible shallow aquifers in the upper Mississippi basin would not supply river flow in drought conditions. All indications are that the state and region have ample supplies for the future. Minnesota has an enormous amount of water underneath it--enough to cover the state to a depth of 18 feet. This amount of water is roughly equal to the entire amount of water in all of lakes and rivers of the world, not including the major inland seas, such as the Great Lakes. In the Twin Cities metropolitan area, groundwater withdrawals represent less than half of the available supply. Almost all of the groundwater is clean enough for drinking when it is pumped up. Of potential concern is widespread contamination which would mean that the water would be there, but not be useable.

C. A severe drought could create a crisis. Seasonal fluctuation in aquifer levels because of high pumpage could be a threat to stream flow leading either to navigation or municipal water supply problems. In 1976, lack of rainfall reduced the flow in the Mississippi to a level that jeopardized the Minneapolis water system supply. That system serves about a half-million people and has no back-up supply, relying only on the Mississippi River intake. Neither the DNR nor the Army Corps of Engineers is sure of the impact of aquifer discharge on the Mississippi's flow. In drought years and during the winter, aquifers supply all of that flow because no surface runoff occurs.

In summer months, if aquifer recharge were slowed because of pumping and no surface runoff occurred because of drought, the level of the Mississippi might drop below the Minneapolis water intake.

The Army Corps of Engineers has the legal responsibility under federal law to maintain a navigable river channel downstream from Minneapolis-Saint Paul. It has broad legal authority to require upstream users to stop pumping if it were determined that the pumping was interfering with river flow although the Corps is not specific about what it would do in a drought. In addition, the Corps maintains a series of reservoirs at the Mississippi headwaters. These reservoirs were established decades ago to insure sufficient stream flow. Officials say they do not use the reservoirs for stream flow. Only a relatively small river flow is needed to replace the water sent downstream in operating the locks. It is important, however, to maintain enough flow to adequately dilute the sewage effluent entering the river at Pig's Eye.

Following the 1976 drought, the DNR was instructed by the Legislature to do a study on the allocation of all water supplies should another drought occur. As of this writing, that plan has not been developed.

1976 was not the first time the Legislature attempted to fashion a statewide use plan. As early as 1947 the Legislature took action requiring the DNR to plan for state-wide water use, although that plan was not developed.

The Legislative Commission on Minnesota Resources (LCMR) in 1985 appropriated money to develop a water allocation and management plan for the state that would provide criteria for allocation and management of the state's water resources, including a determination of the economic values of water for the economy and the social and environmental value of water.

In 1973, the Legislature established five priority classes for water use. They were subsequently reordered by the Legislature. They now stand, in declining order of priority, as follows: domestic water and municipal supply; consumptive use of fewer than 10,000 gallons per day; agricultural irrigation and processing; power production; and other uses.

D. Minnesota will likely see efforts by other states to find new water resources. Continued population growth in the Southwest and West and strained water resources there will likely increase pressures for those areas to find new water supplies. The Ogallala aquifer, a vast aquifer covering 225,000 acres from Texas to Nebraska, is being depleted for agricultural use. Its water table dropped 10-15 feet because of overuse, leaving some agricultural areas without supply. At the present rate of withdrawal, it is expected to last another 40 years. If use patterns like this persist, other states will have to look for new water sources or have significant industries disrupted.

Groundwater currently is not sold among states and Congress has not established a policy on the subject. Courts, however, often adjudicate rights surrounding inter-state water transfers and, in some cases, have determined that inter-state water transfers come under federal interstate commerce jurisdiction. These cases have generally dealt with surface water. In a recent Supreme Court case, the court did authorize the transfer of groundwater.

Potentially, Minnesota could find itself in the possession of a sought-after resource. Minnesota currently sells several renewable and non-renewable natural resources on national and international markets, including iron ore, agricultural products, and forest products. In Minnesota, groundwater is not thought of as a similar marketable commodity.

Governors from Great Lakes states and premiers from Canadian Great Lakes provinces developed a compact on the use of Great Lakes water. The compact envisions unified action and consent before any major diversions are undertaken. It is not clear what legal status this document has. Under current law, the national government makes policy on interstate water transfers, not states, although an international treaty--such as the one governing the use of the Boundary Waters--would be binding on all governmental units. Whether Minnesota could tax exported water in much the same way it places a severance tax on taconite is open to question but it is unlikely Minnesota could prohibit the export of water, unless some national law granting that authority to the state were passed.

Minnesota law requires that the Legislature be consulted about any large scale transfer of water out of state but the effectiveness of this law remains unclear and has never been tested or applied.

CONCLUSIONS ABOUT SUPPLY

I. A response to potential proposals for large scale transfers of water out of Minnesota should be planned for now before the likely requests become a reality.

Proposals for large scale transfer of surface water or groundwater out of the state pose a potential threat. So far, the state has only taken first steps in preparing its response. The Governor's office is working with other governors and Canadian provincial officials to protect the Great Lakes' resource.

Priority should be given to these efforts. The state will not be able to override federal policy in this area. The transfer of water may create a new resource-based industry not unlike the taconite or forestry industries.

What is needed now is a full understanding of the implications of transfers and what public policy responses are needed. Right now, some people would object if water were sold out of state for certain purposes. Others would object if a resource which could mean economic advantages for the state were not fully developed. With most water used for agricultural production and a surplus of agricultural commodities, large scale diversions of water might be of benefit to farmers elsewhere and detrimental to farmers here. Because of the nature and scope of issues like these, a full and open fact-based debate is needed in advance of requests from other parts of the nation.

The federal government has the authority to set overall inter-state water policy. Ultimately, it will do so, either legislatively or through the courts. Minnesota, and other states in a similar situation, would do well to make their plans now. Minnesota is not alone in possessing this resource and should identify partners to develop active, aggressive policies now, in advance of crises elsewhere.

II. Current state water use priorities are unrealistic.

Current policy ranks agricultural use above electrical generation, even though farmers need electricity to operate pumps. How these priorities would be applied generally in a time of shortage is unclear. The notion of a statewide priority for one use of water--except for domestic and household use--above another seems unwise. In the event of a water shortage, one part of the state might be in a position to cut down on electrical use and another on agricultural use. Priorities of this sort should be developed in response to specific local conditions and not on the basis of statewide fiat.

III. Planning for water use in the event of a shortage is deficient. If a large scale drought were to occur now, no plan would be in place to allocate scarce supplies.

Despite at least two Legislative efforts to prepare for the day when demand temporarily outruns supply, little advance planning has been done. The DNR recently received money from the LCMR to do such planning.

The state is in a wet cycle so, fortunately, no crisis is present. However, the planning for a drought is needed. If no plan is present when the drought hits, major dislocations would follow, dislocations which can be avoided by prudent planning.

IV. Cost is an important conservation incentive that should become part of state policy.

In many instances, the imposition of a small charge for water use--whether through a fee for an allocation permit or a charge for sewage disposal--has created a strong incentive to use less. Currently, such incentives to reduce water use and set use priorities through marketplace means are not used. The state mainly relies on the DNR permit granting process which is not designed for conservation.

The failure to use market incentives stems partially from a lack of a conceptual consensus about water and groundwater. It is not clearly understood whether water is a private resource or a public one.

RECOMMENDATIONS ABOUT SUPPLY

I. Minnesota state government should take a leadership role in establishing state-to-state water transfer policy.

The Governor and Legislature should look closely at the results of the LCMR-financed study under way and adopt appropriate state laws. Minnesota's laws should anticipate, not react to, requests from elsewhere for bulk transfers of water.

The Governor and Legislature should--alone or in concert with other states--do what is necesssary to protect the state's interest in protecting groundwater resources. Minnesota should not expect that other states will go without water while it has plenty. At the same time, Minnesota should be in a position to control the terms of transfer within reasonable limits.

II. The Legislature should make sure a drought water allocation plan is developed and adopted in law.

Following the last drought, the DNR was charged with determining how it would allocate a scarce resource--water--should demand outrun supply. Since then use has increased, but we have been in a wet cycle. No one is certain whether or not groundwater in the Upper Mississippi River basin has been over allocated. No clear policy or understanding has emerged as to what should be done if a drought forces the need to set priorities among users.

In 1985, money became available for an allocation study. This time, the Legislature should follow through, make sure the allocation plan is developed by the agencies involved, review the proposal, and enact a law which will insure an equitable distribution of water in times of scarcity.

III. The state's drought allocation priorities should be revised. Only household domestic and municipal use should be given top priority.

Competing commercial and industrial uses for water should be given equal priority in law. The notion that agricultural irrigation needs should outrank power plant use is unrealistic. Without electricity in a given market, for example, farmers could not run irrigation pumps. Street lights could not be operated. Municipal water operations need electricity to operate. The notion that an entire use category--beyond use to support human life--should outrank another one is questionable. Beyond domestic and municipal use for drinking supplies, other uses should be put on an even footing, as a matter of policy.

IV. The state should increase fees charged by the DNR for groundwater and surface water appropriations and use the money to finance any new initiatives aimed at protecting groundwater.

A user fee approach for groundwater protection offers several advantages. First, it would encourage conservation and wise use of the resource. Second, it would link the beneficiaries of public groundwater protection programs with the costs of providing those programs. Third, it would provide a stable revenue source which has been lacking in the past. Fourth, it would create a healthy tension between users and the government. More reliance on user fees would create a group of people interested in efficient use of the fees by the public agencies involved.

As a policy matter, the Legislature could consider the use of the fee-generated revenue stream to replace general fund spending for groundwater programs. In addition to fees for groundwater withdrawal, the Legislature could consider additional fees on agricultural chemicals, other chemicals, or other substances which are known to be contaminants. Fees for groundwater withdrawals should be set biennially by the Legislature. Because fees on only groundwater would create an incentive for surface water use, the Legislature should set parallel fees for surface water use to make sure the impact is not simply to shift use from one water source to another. The Legislature should address the issue of whether different types of water use should have different fees. Quality, condition, and consumption should be part of the fee structure.

FINDINGS ABOUT POLLUTION

I. Minnesota's groundwater--a vital resource--is vulnerable to contamination by many human activities.

The Pollution Control Agency (PCA) has identified a vast number of potential pollution sources including 1,421 landfills, 700,000 miles of pipeline, 300,000 septic systems, 300,000-500,000 tons of municipal sewage sludge produced annually, 90,000 feedlots, thousands of tons of agricultural chemicals used annually, and more than 100,000 tons of hazardous waste manufactured annually in the state. Potentially, any of these could produce groundwater pollution problems. (Appendix B describes in detail the many human activities which can cause water pollution.)

Much of what happens in people's day-to-day lives can pollute aquifers. Septic systems exist to prevent water pollution but in fact are a means of spreading pollutants into the environment. Any spill or discharge of toxic material may find its way to an underground water resource. Agricultural practices involve chemical and natural substances that pollute water.

II. Understanding and evaluating the impact and scope of groundwater comtamination is just beginning. Regulatory and cleanup efforts are just beginning.

A. Groundwater quality regulation is relatively young. The major environmental acts of the early 1970s, the Clean Air Act and the Clean Water Act, were aimed at alleviating air pollution and surface water pollution. By contrast, the U.S. government still has not enacted a comprehensive groundwater protection law.

Ironically, the Clean Air and Clean Water Acts led to some of the current problems. Because toxins were not allowed in the air or streams, land disposal became the technique of greatest convenience. Now, society is finding that land disposal threatens groundwater. Landfills are a prime example. Backyard trash burning was ended in the early 1970s partially to reduce air pollution. Instead, sanitary landfills were used for waste disposal. Now, the region is finding that landfills cause groundwater pollution.

At the state level, the initial actions of the PCA were directed to air and surface water. PCA representatives said that their efforts to remedy groundwater problems came many years after efforts in other areas were well under way.

B. As officials search for new contaminants, they tend to find them. Recently, the state sampled municipal water wells for volatile organic compounds and found them in many wells. No one is sure how long they have been present because no one looked for them before.

C. Identifying problems in the ground is by its nature more difficult than identifying problems in the air or surface water. One cannot see or smell groundwater. Pollutants, once introduced into the ground, are hard to track. Contaminants may migrate horizontally, vertically, or both. Movement of pollutants is dependent on the geologic conditions. If landfill contamination, for example, is released into the ground, the closest wells will not necessarily be the ones that are contaminated first or at all. For example, leachate released by the Lake Jane landfill in Washington County fouled some, but not all, nearby wells. The contamination did not move from the landfill in a uniform pattern. Constructing an adequate monitoring system simply to trace the nature of an incident of contamination is almost an art. Nonetheless, such efforts need to be pursued with all reasonable means. The LCMR recently issued a grant for a University of Minnesota scientist to develop a computer model for pollution dispersal in aquifers.

D. The region is about to make a dramatic change in its waste disposal practices. Most officials agree that landfills are not going to occupy a central position in waste disposal, largely because of the threat to groundwater they represent. The Legislature banned land disposal of unprocessed wastes in the metropolitan area after 1990. No new landfills are being put on line, although existing ones continue to operate. In some cases, expansion of currently operating landfills is proposed.

New solid waste disposal facilities will themselves generate a hazardous waste stream. Many hazardous substances that now go to landfills will not be allowed in the incineration facilities. They will be segregated from the wastes that will be burned or converted to fuel for burning. No disposal system for these hazardous wastes currently exists in Minnesota.

This year, metropolitan area residents for the first time are paying new fees on landfill use. The money collected through this fee will be used to pay for cleanup of groundwater and to pay for the closure and post-closure costs of landfills. This new money is not expected to be sufficient for complete cleanup of groundwater contamination to the degree to which such cleanup is possible. In addition, the money will be used to help develop alternatives to landfills. State and federal superfund programs also make available money for cleanups. Those cleanup efforts will take many years.

E. The planning for hazardous waste management has not moved as far as activity in solid waste disposal. The Waste Management Act set up a separate Waste Management Board to plan for the disposal of hazardous wastes. That board was supposed to pick a site for a waste disposal facility but the Legislature, responding to public pressure, has put a moratorium on siting a waste disposal facility in the state. Currently, most hazardous waste is shipped out of state. 3M operates a hazardous waste incineration facility which successfully burns hazardous substances generated by the company both inside and outside Minnesota. The ash from this burning, which is also legally a toxic substance, is landfilled outside Minnesota.

The PCA has a proposal pending for the imposition of additional fees on the generation of hazardous wastes to offset the costs of regulating, handling, and disposing of them.

F. Abandoned wells are a potentially significant pollution source. Thousands of water wells have been drilled in Minnesota. No one is certain how many there are or their locations. Because wells provide a direct link between the surface and an aquifer, an unused well which is not sealed properly can be the means for an aquifer--otherwise protected--to become polluted. Surface water, possibly contaminated with any number of substances, can be carried directly into an aquifer. Wells which cut through several aquifers can be conduits for the movement of pollution from one aquifer to another. Well casings, unless the well is properly sealed, eventually deteriorate, allowing water to flow from one aquifer to another.

Perhaps the most dramatic example of pollution reaching an aquifer through a well occurred in St. Louis Park. The contamination of municipal water supplies in that city was widely reported. The city's public works director said that the main sources of contamination of city water wells were spills of large amounts of creosote, including a rail car spill during the 1920s. The rail car spill occurred directly above an open well, and the creosote poured down the well into the aquifer.

Currently, well construction and abandonment is regulated by the Department of Health. According to that department, about 10,000 new wells are drilled in Minnesota each year. Representatives of the department said that the state does not currently have the staff to carry out a comprehensive program of inspection and enforcement throughout the state. Such a program would involve a great deal of field inspection which the department does not undertake. The state now employs four people to implement the program statewide.

G. Minnesota and the nation have only just begun large scale cleanup efforts. For generations, burial of waste material or simple abandonment was an accepted practice. Industry, agriculture, commercial, and household users thought nothing of it. Few, if any, efforts were undertaken to identify what was going in the ground. Now, it is becoming clear that pumping wells will bring back up to the surface that which has been put in the ground, including the leakage from 55 gallon drums buried near sites of use, leachate from accumulations of household trash, or water which has passed through a surface impoundment of feedlot or municipal waste.

The state and federal superfund programs are the first systematic attempt to identify improper industrial disposal, assess its impact, and attempt to clean it up. The superfund program does not include all possible sources of pollution. It leaves out, for example, most agricultural use, septic systems, and above-ground and underground storage facilities. These superfund cleanups are the first steps and therefore represent important progress. Nonetheless, they are only the beginning steps.

III. Few estimates exist of the portion of groundwater supply which is polluted or unuseable.

The June, 1983 "Assessment of Ground Water Contamination in Minnesota," a report from the PCA, said:

"A clear picture of the overall extent of ground water contamination in Minnesota does not exist. The primary reason is that statewide ground water monitoring programs at waste disposal and other facilities are relatively new...Existing regulations for ground water monitoring programs at waste disposal facilities are generally vague, sometimes ignored or poorly implemented and in the past infrequently enforced."

The report said no systematic approach has been established for monitoring groundwater. The PCA has a system of 360 wells which are used to develop a systematic survey of groundwater quality in various aquifers over a five-year period. In most cases, the samples show no contamination exceeding problem levels. The PCA report noted that the number of incidents in which samples contain traces of contaminants or contaminants above acceptable levels is increasing.

A Health Department hydrologist estimated that less than one percent of Minnesota's groundwater is contaminated.

Although estimates of this sort provide some understanding, they pale in comparison to the exhaustive data available about surface water and air quality.

Pollution is identified in an ad hoc, reactive fashion. Currently, incidents of groundwater contamination or contamination of drinking water supplies are identified on a case-by-case basis. When groundwater contamination is suspected, local or state officials may be called upon to develop a monitoring system. The state and federal Superfund programs are the first attempt to develop a systematic listing of pollution sites.

Under the national Safe Drinking Water Act, drinking water systems are sampled regularly by the Department of Health. When the tests turn up chemicals at levels above the standards set by the U.S. Environmental Protection Agency, the source of the pollution is identified and the regulatory agency, the PCA, determines what sort of cleanup is needed. If the contamination cannot be contained, the wells are closed. The PCA identifies polluted aquifers as part of its normal regulatory activities. County officials monitoring wells near landfills find parts of aquifers contaminated from time to time.

Overall, there is no systematic, comprehensive program for assessing the quality generally of groundwater. The PCA's current efforts are acknowledged to be limited. Development of a comprehensive system would be expensive and difficult. Assessing the quality of the state's groundwater in a systematic fashion could involve hundreds of wells and thousands of tests. Given the nature of groundwater flows and groundwater contamination, the

frequency of testing would be an issue. When new wells are drilled, the water is tested, but only for a few substances. These records therefore do not constitute an adequate measure of ambient groundwater quality.

IV. The degree to which polluted groundwater can be cleaned up is unclear.

Groundwater cleanup presents enormous technical problems and is very expensive. No one can be certain when an aquifer is totally clean because no one can be sure how far the contamination has spread. Once the contamination has escaped into the ground, it is difficult to track.

An environmental contractor described a cleanup involving a fire at an agricultural co-op during which many agricultural chemicals were washed into the ground and turned up in the aquifer being used for the town's water supply. The contractor was able to pump water from the affected area and treat it. After a few months, the chemicals were no longer present in nearby wells. In most cases, such clear cut problems and solution to them are not the case.

Groundwater cleanup technology is relatively new. The president of the environmental contracting firm said that new technologies are coming into use swiftly and frequently. Currently, most cleanup and water treatment activities involve filtration or chemical treatment. Biologically-based technologies for cleanup and treatment are being researched. Treatment technologies can create new problems. For example, the Saint Paul Water Utility's general manager said that if carbon treatment were added, all of the chemical changes it would create could not be known in advance. Carbon treatment would remove certain chemicals, but might result in new bacterial growth.

V. Scientific evidence does not provide a full answer to health questions arising from groundwater contamination. Health risk assessment involves not only scientific but economic, political, and value-related questions.

A. Science can show risk levels but it does not provide a complete answer in assessing safety for low-level exposure to many chemicals. For one category of chemicals--mutagens--no safe level of exposure can be determined scientifically.

One concern often cited to us about human safety problems resulting from groundwater consumption was low-level, long-term exposure to chemical compounds. Few studies exist that determine the long-term effect of low-level exposure to certain chemicals. Long-term tests to determine the risks involved in low-level exposure have not taken place. Determining the impact of long-term, low-level exposure is extremely difficult in any event because of the multiplicity of factors which can cause disease in a person over a period of many years.

B. Little is known about the potential health effects of ground water contamination. The issue of long-term, low-level exposure to chemicals is central in health protection efforts related to groundwater. Science cannot say for sure whether long-term exposure to chemicals in parts per trillion or billion will cause cancer, but regulators are being asked to determine at what level it is possible to allow these chemicals to be present in drinking water without creating a health risk.

Current safety assessments are based on the assumption that any given chemical will be found alone in groundwater; no safety assessment for potential synergistic reactions of many chemicals is made. Presence of more than one chemical contaminant may increase or decrease the health risk. There is little understanding of how chemicals may change as they pass through soils.

Decisions about permissible levels of chemicals are made in a political setting. Ultimately, citizens and public officials will have to determine what level of risk they are willing to live with. Regulators can then translate that determination into rules and procedures.

C. Currently, there is little or no evidence of acute disease or toxic response from water consumption in Minnesota. Significant incidences of acute disease or poisoning because of the use of groundwater supplies for household use are virtually unknown today. Generations ago, infectious diseases often were transmitted by water supplies. Problems of this nature are greatly reduced today.

VI. Current policy formation and public discussion of groundwater takes place in an emotionally charged atmosphere. Groundwater contamination is also a perceptual issue.

Concerns about groundwater contamination created severe political problems for county and metropolitan officials seeking new landfill sites in the Twin Cities metropolitan area. Public meetings to discuss landfill siting were volatile, angry sessions, with people adamant in their opposition to landfills nearby. In one case, a private firm offered to buy a public landfill, monitor nearby wells, and secure additional liability insurance requested by the public sector. The landfill company wanted an expansion of the landfill's permit in return. The offer was refused.

Often, a simple lack of knowledge inhibits succesful implementation of needed programs. At other times, it seems as if the facts are not at issue but rather that people are not interested in debating tradeoffs but are instead interested in absolute solutions.

Attempts to develop alternative waste disposal options have encountered political problems as well. An attempt to site a trash burning facility in Minneapolis was unsuccessful after opponents brought pressure to bear on city, county, and state officials. Hennepin County did, however, find an alternate site for the facility elsewhere in Minneapolis. The Ramsey-Washington proposal to burn fuel made from trash was opposed by a group concerned that burning solid waste would pollute the air.

NSP was unable to test the burning of certain waste-contaminated liquid when local residents lobbied against it, even though the proposal had received approval from health officials.

The public's emotional response is understandable. Scientists can offer no conclusive evidence that the presence of extremely low levels of chemical exposure will not cause disease. When these 100 percent commitments are not forthcoming from public officials, the public will resist efforts to store, dispose of, or transport unsafe materials. The credibility of scientists and public officials is sometimes open to question. People remember that sanitary landfills were supposed to be safe and now are being told that the landfills endanger well water.

In many cases, the public perceives a problem even when scientists are not willing to say one exists. When chemicals are found at any level, people may become afraid. Currently, testing equipment can detect substances at the level of parts per billion or parts per trillion at which level there is no known health significance.

In certain municipalities, citizens remain concerned about potential health hazards from their water in the wake of a serious incident of aquifer pollution that resulted in chemical contamination even though the water now must pass a series of tests much stricter than those required in other cities.

VII. Efforts needed to resolve groundwater pollution problems will be of a similar scope to those required to resolve surface water problems.

In the early 1970s, the state and nation embarked on a broad-based effort to clean up rivers and streams, an effort which has cost billions. So far, those efforts have borne substantial results locally and nationally.

In many respects, the state and nation are in the same situation now with groundwater that they were with surface water in the early 1970s. The first efforts are under way, but no clear consensus has emerged on many topics. The big expenditures are still ahead. Certainly, the successful resolution of major problems is some years off.

VIII. Current policy relies on a crisis response to each instance of pollution. The continuing discovery of pollution points to a systemic problem, not a series of one-time crises.

Society has only recently begun to pay attention to groundwater contamination. As the search for pollution continues, new sites will be found. Efforts undertaken under the superfund law, for example, have led to longer and longer lists of contaminated sites.

Searches for new contamints will likely reveal problems. Currently, drinking water is tested for only a few chemicals. If the list of chemicals tested for is expanded, they will be found.

Few priorities are set for cleanup. Under current practice, each time a pollution incident is identified, an ad hoc cleanup effort is set up. No priorities are set first. No attempt is made to determine if the money spent could be better used elsewhere on

cleanup or for remedial measures. The expense of applying a crisis approach to each contamination incident will lead to enormous cleanup costs. The cost-effectiveness of this effort is questionable.

Currently, cleanup standards are being set in the field by field-level officials. The PCA uses an ad hoc approach to determining cleanup standards.

Minnesota's stated policy now is one of non-degradation even though the de facto policy does not conform to this model. The PCA's 1983 report, "Ground Water Protection Strategy Framework for Minnesota," states that the non-degradation policy is not feasible. The implied response of non-degradation policy is that cleanup action would be undertaken no matter what the cost, even though less expensive options were available. One need look no farther than Minneapolis and Saint Paul. No one concerned about health would propose that surficial (at the surface) aquifers in industrial areas of these cities could be used to provide drinking water, but no one is trying to clean them up, either. In other cases, vast and expensive efforts are made to clean up wells serving only a few people.

The hazardous waste contamination in Rosemount is a case in point. Wells serving a few households are producing contaminated water. A nearby site was used by the University of Minnesota for disposal of certain chemicals. The land in the area is used for a variety of industrial activities and it is likely that pollution is widespread. Current plans are to clean up the wells to a level which exceeds the standards of the Safe Drinking Water Act. This means that the water there will have lower levels of chemical presence than is required for municipal systems.

In addition to being illogical and expensive, this policy holds no assurance of maximum protection of public health.

CONCLUSIONS ABOUT POLLUTION

I. Existing state and local programs to protect groundwater will solve many current pollution problems and prevent many new ones. They will also create new problems and leave unresolved in many cases the question of what to do about pollution which occurred years ago and is now coming to light.

The end of reliance on landfills and new efforts to dispose of commercial toxic wastes--spurred largely by policy embodied in the waste management act--will help the state and region end several major pollution sources. Counties have the responsibility to plan solid waste disposal systems that do not rely on landfills. In the metropolitan area, the Metropolitan Council has the responsibility to make sure that the plans fit together. It can use its broad authority to ensure orderly development and to make sure that potentially polluting facilities are kept away from sensitive areas. Statewide, the Waste Management Board is developing a management plan for hazardous wastes.

These efforts are only now taking shape and emotional debates continue about specific siting and technical matters. Still, it appears that many destructive activities--unlined landfills, large scale disposal of mixed municipal garbage by burial, and improper disposal of toxic wastes generated commercially--will no longer be standard practice.

The state has not come to grips with final disposal of hazardous wastes. The new disposal system now evolving creates new challenges. In the solid waste disposal system now envisioned, the issue of household-generated toxic wastes is not fully addressed. Many of the household-generated toxins will be incinerated and thereby rendered harmless, but in other cases, the wastes will not be burned but segregated from the other solid wastes to be burned. Pilot programs are under way for the collection of household hazardous wastes but the question of final disposal remains unaddressed. The state's plans for disposal of commercial hazardous wastes does not include plans for a final resting place for wastes which cannot be recycled or reused. Incineration always creates an ash residue, and, so far in Minnesota, no disposal facility for these wastes is available. By delaying state-of-the-art waste management facilities on risk grounds, society as a whole may experience greater risks through improper waste management.

The new disposal systems for household and hazardous wastes will rely on charges to the users to cover the extra costs needed to pay for proper disposal. Industries using and manufacturing hazardous materials will have as part of their cost of doing business the costs of proper disposal. Households will see increased waste disposal fees to cover the higher costs of incinceration.

Cleanup priorities are lacking. Of particular significance is cleaning up sites where hazardous materials were buried years ago. State and federal superfund laws address some of these instances, but not all. Moreover, the superfund efforts do not really provide a complete solution because superfund cleanups result in the removal of toxins from one location to another.

The state currently has no systematic mechanism to set priorities for cleanup as new problems sites are uncovered. The superfund mechanism is an important first step, but its focus is on industrial pollution, not on all pollution sources, and on the cleanup of improperly disposed-of wastes, not continuing protection efforts.

Cleanup standards are lacking. Generally, standards exist for the severity of the hazard, but not for the degree to which cleanup should be carried out. The state and federal superfund programs have an extensive priority setting apparatus involving the number of people affected, the potential for spreading, the health risk of the contaminant, and the potential for impact on municipal or private supplies.

Right now, no one can say for certain how extensive a cleanup is necessary in any given case. Cleanup standards for the Rosemount chemical site, where a public entity, the University of Minnesota, will pay, require cleaner water than that in Minneapolis' and Saint Paul's municipal systems. Even with cleanup meeting those standards, some individuals are concerned that the Rosemount cleanup is not extensive enough.

Often, cleanup efforts do not involve any cost sharing by the parties who will benefit directly, leading to unrealistic demands for cleanup standards. At both Lake Jane and Rosemount, only a few wells are involved and the families involved are not expected to pay for new water supplies. If pollution continue to be found, it may be impossible to pay the total costs out of public revenues.

The public has become sensitized to groundwater pollution issues through the siting processes. The people who will end up bearing the health risks clearly will want them minimized. Many of the confrontations which surround these controversies stem from the inability of technical people to give ironclad assurances about such issues as what really caused the pollution, how effective cleanup action will be, and what the long-term health risks are. Disputes over cleanup and siting of perceived-to-be-dangerous facilities will continue until reasonable answers are found to health questions and the public accepts the risks involved in disposal facilities.

RECOMMENDATIONS ABOUT POLLUTION

I. The Legislature should charge agencies with several new responsibilities, listed below:

* The Health Department should develop better health risk standards. The Health Department should be assigned the responsibility of developing and articulating health risk standards to provide a benchmark against which individual cleanup efforts would be measured. Leadership is sorely needed in this area. The federal government has developed some standards, but not enough. The state should continue to use federal standards where they exist but move now to clarify the risks involved in areas not covered by federal standards. Right now, the public is concerned about the safety of very low levels of contamination and reacts negatively to proposals for the construction of industrial facilities that generate and handle hazardous waste, as well as disposal facilities. A failure to resolve these problems is detrimental to economic growth and environmentally sound waste management. It also makes priority setting for cleanup difficult.

* The PCA should develop a list of priorities for cleanup efforts. Right now, the only orderly attempt to clean up improper disposal activities is being undertaken through the state's superfund law. These efforts--laudable first steps--are largely directed to toxic chemicals and improper disposal sites. State cleanup priorities should be set more broadly to include contamination from agricultural activity, sewage, feedlots, and any other sources. The PCA should work with the Health Department as that department develops relevant health risk standards. The PCA may elect to do this priority setting itself or to contract with another organization to do so.

* The PCA should develop cleanup standards. Currently, the PCA decides what is appropriate in each case and if the involved parties do not like the proposal, their recourse is through the courts. The PCA should take the lead and determine some benchmark tests for cleanup. It should also set some threshold for when cleanup makes economic sense.

The Legislature should explore ways in which cost-sharing could become part of cleanup programs. For example, if a new water system is needed by a golf course because well water is contaminated, the owners--who will benefit from the cleanup--should pay some portion of the cost so they are not in a position to make unrealistic demands. Replacement water systems exceeding minimum health standards should include some sort of co-payment by the beneficiaries. A determination of when it is appropriate, and at what level, to use public money should become a more explicit part of public discussion of cleanup efforts.

* The EQB should develop a "report card" on agency performance. Currently, the only critique of agency effectiveness comes through legislative oversight which so far is insufficient. Given the growing importance of groundwater protection efforts as a central environmental matter for the state, a comprehensive picture of the effectiveness of the many and varied programs is needed. Agency effectiveness would benefit from a thorough review. Specific programs which should be reviewed are the well water and safe drinking water programs at the Department of Health, the pesticide and herbicide regulation programs at the Department of Agriculture, and the PCA's regulatory efforts on waste disposal, feedlots, and other facilities. A deadline for the completion of these reviews should be set in advance. The entity to do the reviews should be the Environmental Quality Board changed through the proposal described in the structural recommendations section of this report.

II. The Legislature should remove the moratorium on siting a hazardous waste disposal facility and set up a new timetable for acquiring a site as part of a satisfactory solution to the problem of hazardous waste disposal.

The availability of out-of-state disposal options is not likely to continue forever. Minnesota should be prepared for the day when it must dispose of its own wastes here.

The Legislature should therefore drop the existing moratorium on completion of the hazardous waste disposal facility siting process. A new timetable for site selection should be developed, and this time the deadline should be observed. The Waste Management Board is working from a list of candidate sites. It should continue with this list, but should also be allowed by the Legislature to consider new sites--public or private--volunteered by communities.

III. New efforts to allow for the successful collection of household hazardous wastes should be undertaken.

Managing the commercial and industrial hazardous waste stream is in many ways easier than managing the household waste stream. A different management approach is needed for households. What is lacking now is even the most rudimentary opportunity for families to dispose of household quantities of toxic materials. People have no place to throw half-empty paint cans except in with the rest of their garbage.

As a first step, the PCA should develop a program for the collection of these substances. Some pilot programs to collect household hazardous wastes have already begun. Counties, because they are the governmental entities charged with the responsibility for waste disposal, should be in charge of the programs. The counties should dispose of collected household hazardous waste as if they were a commercial generator of them.

FINDINGS ABOUT STRUCTURE

I. State, metropolitan, county, and other levels of government have a role in the protection of groundwater. Several state agencies have responsibilities for groundwater programs. Groundwater protection is not the central mission of any governmental entity or agency.

A. The Legislature sets overall groundwater policy. The Legislature determines the main policy outline for groundwater, surface water, and environmental protection, and determines which executive branch agencies will be given latitude to implement the laws. Important recent legislative initiatives include the waste management act, the ban on landfilling unprocessed solid waste in the metropolitan area, and, in 1985, a statute giving outstate counties broad latitude in water planning and management.

The federal government plays an important role in directing state efforts. Most of the major federal anti-pollution laws described in Appendix A involve a state-federal partnership in which the federal government gives overall direction but allows the states to carry out the actual regulation and enforcement.

B. The Department of Natural Resources regulates groundwater withdrawal. With some exceptions, any appropriation of groundwater requires a permit from the DNR. The exceptions are: for household use on a system serving fewer than 25 people; for test pumping; for withdrawals of fewer than 10,000 gallons per day and less than 1,000,000 gallons per year; or for agricultural field tile or open ditch drainage systems. The average fee for DNR appropriation permits is about $30. More than 5,000 such permits are currently held. Roughly 10,000 have been issued since the program began in 1947.

Each permit allows the use of a certain volume of water. Through these permits, the DNR can estimate groundwater use in the state or any region of it. The DNR maintains a computerized file of monthly use reports. Annual totals are audited for management, allocation, and planning purposes. However, metering is not required for many uses so the accuracy of the permit figures can be called into question. Permitees may be using more water than the permits allow, or may have requested permits for a high level of water use which is not ever attained. The DNR has not determined whether it has overallocated drought-condition supplies in river basins.

The DNR commissioner is given latitude to limit the amount of use allowed through the permit and require that permit applicants submit relevant water use information, including water use alternatives, the hydrology of the region, and the impact of the water's return to the environment.

C. The Pollution Control Agency has general responsibility for preventing the pollution of groundwater. Most anti-pollution regulatory activities are the responsibility of the PCA. The PCA regulates feedlots, oil and gas storage tanks, septic systems, hazardous waste facilities, landfills, drainfields, pipe lines, and dumps.

D. The Department of Health is responsible for public health. When groundwater is used as a drinking supply, the Department of Health regulates its use under the federal Safe Drinking Water Act. A more complete description of this law is contained in appendix A. That act sets standards for some, but not all, pollutants which might cause health hazards. The law stipulates how often water systems of various sizes are supposed to be tested. If the Department of Health finds more pollutants than the standards in law, it works cooperatively with the PCA and local water users to find a solution. Sometimes wells are closed and alternative supplies are developed or treatment to remove the contamination is recommended.

The Department of Health also is responsible for maintenance of the state's well code program. Wells in Minnesota are required to be built to certain standards and well drillers are required to turn over to the department information about the geology, yield, location, depth, and function of wells as well as other information. These reports are a primary source of geologic and hydrologic information for the state. Representatives of the department say they do not have the staff to carry out full and complete oversight of well drilling activity.

E. The Department of Agriculture is responsible for the regulation of farm chemical use. Unlike general chemical use, which is regulated by the PCA, the Department of Agriculture regulates farm chemical use and other pesticide use. Certificates are required for use of certain chemicals, but not all. The regulations of farm chemical use are included on the labels. Representatives of the department said they do little field inspection to insure proper chemical use.

F. The Environmental Quality Board is responsible for overall coordination of state environmental protection, including groundwater. The EQB is made up of the heads of agencies with significant environmental policy responsibility (Agriculture, Energy and Economic Development, Health, Natural Resources, Pollution Control, and Transportation), plus five citizens appointed by the Governor. It has typically been chaired by the chief of the State Planning Agency and is staffed by that agency. In statute, among other responsibilities, it has the responsibility for coordinating all of the state groundwater protection programs. State water programs were previously coordinated by a Water Planning Board, which was merged into the EQB in 1983.

G. The state Waste Management Board, an independent agency, was established to insure proper disposal of hazardous wastes. Under state law, the waste stream is divided into two parts: solid and hazardous. (Although it has been established that improper disposal of solid wastes causes groundwater problems, the terms solid and hazardous are used in this report in conformance with the way they appear in state law. A more complete definition appears in Appendix A.) The Waste Management Board is in the process of drawing up a statewide plan for hazardous waste disposal. Part of its charge was to site a waste disposal site. The board undertook

an extensive series of hearings and meetings. It identified four candidate sites but the Legislature issued a moratorium on the siting process as it neared completion. The 1986 Legislature is expected to take up the issue of siting a hazardous waste disposal facility. The Waste Management Board also has certain solid waste management responsibilities.

H. The Water Resources Board administers the state's watershed act and Surface Water Management Act. It is made up of five citizens, appointed by the Governor, who are not employees of government. Its quasi-judicial functions are: a) reviewing water management plans of watershed districts and of other water managing units; b) establishing watershed districts; and c) serving as a forum for certain appeals.

I. In the Metropolitan area, the Metropolitan Council has a significant role in groundwater protection. Charged with guiding the region's physical and economic growth, many Metropolitan Council activities are related to environmental protection. The Council is coordinating county plans for safer waste disposal. The council is involved in the siting of environmentally sensitive facilities. Through its land use planning efforts, the council can exert influence on groundwater because land use is important in groundwater protection.

The Council is also coordinating the efforts of water planning units (counties, watershed districts, and water management organizations) that are developing surface water management plans for the region under the Metropolitan Surface Waters Act.

The council oversees the activity of the Metropolitan Waste Control Commission, the largest sewage treatment operation in the state.

J. Counties have responsibility for developing new waste disposal systems. As noted, counties are central to the development of new solid waste disposal facilities. Counties also have broad public health responsibilities as local, general-purpose governments and specific health protection responsibilities under the Community Health Services Act. Outside of the metropolitan area, county government often does not have the staff needed for some of these efforts.

In southeastern Minnesota, counties are fashioning a response to special groundwater problems there. Because of the karst geology, characterized by fractured limestone below ground, allowing easy access of surface contaminants to drinking water supplies, they are especially vulnerable to groundwater pollution related to farming practices and other pollution sources. Through joint action, counties are developing protection ordinances, outreach programs, and other activities designed to protect groundwater.

Other counties--Scott and Winona--have taken the lead in developing generalized subsurface geologic data to help guide land use decisions. Atlases of subsurface conditions were developed at a moderate cost in conjunction with the Minnesota Geological Survey. Officials in those counties said the atlases are useful in directing land use decisions properly.

The 1985 Legislature passed a law granting new authority for counties in non-metropolitan Minnesota for planning and water management. As a result, counties now can develop water management plans.

K. Municipalities operate many of the water utilities in the state. These systems are important water delivery systems for many Minnesotans. More than 90 percent of the state's municipal water systems use groundwater.

When wells used to supply water to these systems are contaminated, it is each city's financial responsibility to find alternative sources. Cities like New Brighton and St. Louis Park that have had well problems have had to spend public money to find new water supplies.

L. Municipalities and counties make land use decisions which have an impact on groundwater resources. Municipalities, and in some cases counties, make decisions about the location of factories, agricultural operations, and transportation facilities. Local units can use land use controls to insure land use is compatible with groundwater protection goals.

M. State law divides the waste stream into two portions: solid and hazardous. In outline form, the Waste Management Act requires counties to plan for disposal of solid waste. In the metropolitan area, the Metropolitan Council is required to review and coordinate county plans. The Waste Management Act divided the waste stream into solid and hazardous wastes. Hazardous wastes are specifically defined as substances which may either cause illness or death and substances which pose substantial harm to health or the environment if improperly stored, managed, or disposed of. (A fuller description of the Waste Management Act is contained in Appendix A.)

The law makes a distinction between wastes and substances which are potentially dangerous if disposed of improperly but still have not been used for one purpose or another. The law also exempts hazardous wastes generated by households.

The effect of the legal distinction is to divide the waste stream into two different disposal systems which would be managed and regulated separately. In this report, the term hazardous waste will refer to the wastes so defined in law. It should be kept in mind, however, that other wastes and substances not defined as hazardous are in fact hazardous.

N. The state established a system to integrate groundwater data collected from various sources. The various state agencies collect information from a variety of sources. The Land Management Information Center (LMIC), a state run computer data base and information service, is supposed to integrate all of this information. Programs financed by the LCMR require that the

information collected be compatible with the data systems used by LMIC. LMIC integrates other land use and resource information for the state but has not done so for groundwater because of a lack of money.

Currently, data collected by various agencies is not organized to maximum effectiveness. Several speakers noted deficiencies in data organization. Well log records, for example, required under the state's well code are organized chronologically and not geographically, making them less useful for land use planning. Many agencies collect data but no one agency is charged with knitting all of it together.

II. Minnesota, to a greater extent than many states, is in a position to manage and conserve its own groundwater.

Unlike some other states, major watersheds and aquifers are within the control of Minnesota policy makers.

Most of the recharge area for the aquifers used by the Twin Cities metropolitan area, for example, lie within state boundaries.

Minnesota does not have many of the groundwater problems of other states. For example, Minnesota policy makers do not have to be concerned about salt water intrusion. Minnesota also is not a major chemical manufacturer, meaning fewer chemical dumps are likely to be present here than in places like New Jersey, California, New York, and Michigan. Multiple aquifers are present in most parts of the state in contrast to places like Florida, Louisiana, and Long Island, New York. In Minnesota, therefore, water can be obtained from deeper aquifers while the ones closer to the surface are cleaned.

CONCLUSIONS ABOUT STRUCTURE

I. Additional efforts to knit together state-level groundwater protection programs are needed.

Legislative oversight of executive branch performance and of overall policy is fragmented among several committees. Changes occur in almost every legislative session, but little attempt is made to knit together the threads of water policy into a consistent fabric.

Although the fragmentation of responsibility for groundwater protection is often cited, few realistic alternative arrangements exist. State-level executive branch organization of groundwater programs, with the exception of the Department of Agriculture's responsibilities discussed below, is arranged properly. Because groundwater protection and management is a combination of environmental, health, and natural resource issues, PCA, Health, DNR, and other entities are logically involved. No other structural arrangement is more logical. Various programs have grown up over the years in response to specific problems. As the programs developed, they were assigned to agencies in a logical fashion.

Merging state efforts would not necessarily lead to greater efficiency or effectiveness. The same number of people would still be employed after a merger of agencies. A merger would further dilute the agenda of the newly-created department.

Removing groundwater programs from existing agencies and creating a new agency would remove the people running the programs from contact with other professionals in their discipline. Health officials responsible for water, for example, would be separated from officials responsible for other dimensions of health.

Although the activities of PCA, Health, and DNR are often criticized, little evidence exists that the agencies do not work well together. Representatives of the departments noted that people from them work together successfully in the field when contaminated wells are found.

II. What is missing is a top-level institutional arrangement to mesh the activites of the major agencies involved.

The lack of overall policy responsibility and coordination is troublesome and should be addressed. Because comprehensive groundwater regulation, management, and planning will involve many disciplines and issues, a successful policy will have to involve an integrated effort by many agencies.

The problem is not improper responsibilities of any given agency but rather a lack of coordination among them. No statutory functional check and balance system exists whereby one branch of government has an incentive to critique the performance of

another. The EQB is supposed to be the entity which coordinates executive branch environmental actions but as currently structured it cannot be expected to do so. The EQB is dominated by the heads of the agencies that are supposed to cooperate. In fact, it does not do so.

In the metropolitan area, a centralized planning body with adequate staff and enough legal authority--the Metropolitan Council--is in place, but nothing similar exists for the rest of the state.

III. One anti-pollution activity--agricultural chemical regulation--is performed by the department which is supposed to promote agriculture. Promotion and regulatory activities should be carried out by separate agencies.

An exception to the pattern cited above is that of agricultural chemical regulation. Currently, the Department of Agriculture is responsible for that function. It has none of the other responsibilities for anti-pollution regulation, those responsibilities belonging to the PCA. Department of Agriculture officials say they do almost no field inspection and allow the system to regulate itself.

IV. In addition to a lack of coordination, a specific problem exists in data collection and dissemination. The state lacks certain pieces of information needed for successful policy making.

Few baseline data about the condition of aquifers are available. Currently, agency data is never centralized or put together in a common and useful format. LMIC performs a similar function for other resource and land use data. LMIC has not performed the data integration job on groundwater data because of a lack of money.

V. The enforcement ability of local units of government, especially outside the metropolitan area, is largely untapped. Local level identification, analysis, and action to solve certain problems offers greater promise than relying exclusively on a state response.

State-level regulation in areas such as agricultural chemical use, feedlot management, septic systems, and certain water well problems can be enhanced by parallel local-level efforts. Local officials can respond to specific conditions in their commmunities as is the case in southeastern Minnesota where counties are fashioning a response to groundwater problems associated with the karst geology and agricultural land use.

Geology, land use, and economic activity differ around the state. Because anti-pollution efforts must take into account these differences, a localized response makes sense.

Protection efforts associated with chemical use, feedlot management, septic systems, and water wells will involve many individuals, businesses, and local officials. For example, not all counties have adopted standards for septic system installation and

management. If such standards were mandated, then the state could limit the need for centralized sewers in communities. For protection efforts to succeed, the people involved need to have a sense of identification with the problem. They need to see it as their problem, and not as something forced upon them by rules promulgated by a bureaucratic agency housed in Saint Paul.

In order to develop statewide protection programs, agencies would need expanded personnel and financial resources, which they are not likely to receive. Local units already are highly involved in law enforcement and can be held accountable for implementing state-directed programs.

Many people have pointed out that septic system pollution, a potentially significant source, has been largely alleviated through efforts involving a partnership of several levels of government as well as a widespread public consciousness of potential problems. A similar organizational response can be expected to yield similar results if applied to comparable problems.

VI. Local governments have the authority to make land use decisions needed to protect groundwater. Sometimes they have inadequate information to do so or have chosen not to act.

In at least two parts of the state--the metropolitan area and in the southeastern area--local government has taken action about land use. In the metropolitan area, the comprehensive land planning of the Metropoltian Council has put in place a framework for decisions about potentially polluting facilities. Also, under the Metropolitan Surface Waters Act, the Metropolitan Council is currently coordinating the development of surface water plans for the region. In southeastern Minnesota, the special problems associated with the karst geology provoked a response from the counties. Counties there are paying more attention to water well location, agricultural practices, and the prevention of dumping in sinkholes.

RECOMMENDATIONS ABOUT STRUCTURE

I. The Environmental Quality Board should be reconstituted with a majority of citizen members and be strengthened to carry out the coordinating function needed at the state level.

The state should move to an arrangement similar to the one for metropolitan government where the Metropolitan Council is responsible for planning and coordination and the various operating agencies are in charge of implementation and administration. The EQB should have the following characteristics:

* Review authority for executive branch groundwater program budgets. Agency budgets for groundwater programs should be reviewed and commented upon by the new entity with the Legislature making the final determination on agency budgets.

* Appointment of additional citizen members by the Governor so that citizens are a majority. A problem in the current EQB structure is that it is made up largely of agency people who are serving a dual function on the EQB. On the one hand, they represent their agencies and the interest groups represented by the agency. On the other, they are supposed to formulate overall state policy and, as part of this reponsibility, critique the performance of the agencies they lead and the constituencies of those agencies.

* A staff with enough independence to have credibility. The EQB should be staffed by an independent staff, not people from the State Planning Agency. Although the current Planning Agency staff do not have direct conflicts, they do sometimes have conflicting responsibilities. The executive director for the new entity should be chosen by its governing board.

II. Responsibility for regulation of agricultural chemical use should be transferred to the PCA.

Responsibility for regulation of pollution is currently with the PCA with this exception. No valid reason for the agricultural exception has been demonstrated. Because the Agriculture Department is put in the position of performing two conflicting roles--promoting the industry and policies beneficial to it on the one hand and on the other regulating the industry--it is unlikely the regulatory function will be performed at maximum effectiveness. Educational efforts to help farmers grow crops with less environmental disruption should continue to be the responsibility of the Department of Agriculture.

III. The Legislature should review groundwater statutes, the groundwater responsibilities of state agencies, and the executive branch rulemaking process.

The Legislature should review all of the groundwater laws currently on the books, review them for consistency, review the assignments of responsibility to executive branch agencies, and review rulemaking authority of executive branch agencies.

IV. Adequate financing for the development of an appropriate data collection and dissemination process should be provided.

The state has in place an institution, the Land Management Information Center, expressly designed to pull together all groundwater data. It has not done so because of inadequate financial support. A small investment in data integration would yield substantial dividends over time. The Legislature should determine an appropriate revenue source for the program. In addition, it should follow LCMR's lead and require that data collected by state agencies be compatible with the data integration needs of LMIC to facilitate LMIC's job.

V. New incentives for the involvement of local units of government in groundwater protection should be developed by the state. These efforts should be designed as incentives for local action, not mandates. They should be a means by which local officials can identify and address the special problems in their own communities.

This approach offers several advantages, as follows:

*It makes the intimate knowledge of local conditions by local officials part of the management structure. A local effort could incorporate the detailed knowledge of business and other activities which local officials possess. A more localized approach would also allow integration of anti-pollution efforts with local land use and building code activities.

* It creates an incentive for local elected officials to take ownership of water management problems. Currently, most water regulation is the state's responsibility. Many of the tools to solve water problems--mostly through wise land use policies--are local prerogatives. Local officials are not anxious to identify new problems to solve. An incentive is therefore appropriate to get them to act.

* It preserves the state's responsibility to set standards and make sure regulation is carried out. Typically, state-level regulation is called for to allow for statewide standards and to make sure that the regulation takes place. Local regulatory efforts are seen as ineffective because the local units are less able to resist pressures to relax regulations stemming from the desire to gain a competitive economic advantage. In the system we envision, the state would continue to set standards and would preserve the right to move regulatory responsibility back to the state if the local unit failed to carry through its responsibilities.

* It makes possible more effective use of state personnel and technical resources. By allowing decentralized implementation and enforcement, state agencies could move more into a broker role, in which they would work with local officials to find solutions to specific problems. State officials expert in the well code, pollution flows, and cleanup responses could share their expertise with local officials. This technique worked well in fashioning an effective response to septic system pollution problems. This approach would allow a more effective use of state resources. As a means to facilitate this approach, state agencies should be encouraged to coordinate the location and activities of their regional offices. Currently, the regional offices of major state agencies are often not located in the same towns, making it hard for them to act in concert.

We see a system in which the state continues its standard-setting and in which state agency personnel move more into a broker role. Specifically, we propose the following:

Outstate counties that develop comprehensive water management plans should be granted new authority by the state to pay for and implement the plans. Any outstate county that develops a comprehensive water management plan that is approved by the state Water Resources Board would be granted new authority. Such counties would be allowed latitude to expand the use of fees--described in the plan--for regulation of feedlot management, agricultural chemical use, septic systems, underground storage tanks, water wells, and shoreland management. The initiative to develop a plan would have to come from the county involved; the state should not mandate the development of water management plans.

Plans would be reviewed by PCA, DNR, the Department of Health and the State Planning Agency before they could be approved. These new water management plans would also have to be consistent with health services plans already mandated for counties.

Once a plan is approved, regulatory and fee authority for the items mentioned above could shift from the state agency involved to the county if such a transfer of authority were specifically called for in the plan and a process set forth to carry it out.

The state should revoke the regulatory and fee authority from the county if it determined that the plan was not being carried out. State agencies should retain this authority because it has the final responsibility to protect the environment. As a practical matter, it can be expected that the various state agencies will follow the regulatory effort of those counties which choose to take the state up on its offer for new authority and will notify the Water Resources Board if they think enforcement efforts are deficient.

Any new federal or state money for water-related anti-pollution efforts should be granted first to counties that have developed approved plans. The federal re-enactment of the Clean Water Act is likely to include grant money for non-point pollution abatement. Other new state or federal programs may also contain grant programs for anti-pollution efforts. As a matter of policy, the Legislature should make sure that counties that have developed their own comprehensive plans for groundwater protection get priority access to this money.

As an incentive to get counties moving, the state should offer a matching grant to counties for the planning efforts. To implement this proposal counties will have to invest some of their own money. As an incentive to get counties to act, the state should offer to pay half of the planning costs. Cost-sharing is appropriate because the counties have to be put in a position to identify water problems as their own and not respond to the program as merely a way to get some money from the state.

Counties should be encouraged to use Community Health Services money for educational and outreach programs to help develop public consciousness about groundwater programs. Counties may seek to integrate public education efforts as part of their integrated groundwater protection efforts. They should be free to use the state health services grant money in a more flexible fashion to do so.

VI. A matching grant program should be established to allow other counties to take advantage of hydrogeologic studies such as those carried out in Scott and Winona counties. Scott and Winona counties, in cooperation with the Minnesota Geological Survey developed generalized subsurface maps that make possible more effective land use decisions and other related regulatory efforts. These atlases were developed at a modest cost and have proved to be very useful to local officials. Similar efforts can help other counties enforce their regulations. They also can serve as an educational tool for county elected officials and staff.

BACKGROUND

A vast supply of useable groundwater underlies the state of Minnesota.

Groundwater is the water occupying the pores, space fissures, cracks, or solution cavities below land surface.

The total volume of groundwater in Minnesota is believed to be approximately 300 trillion gallons or 270 cubic miles. Excluding the major inland seas such as the Great Lakes, this is equivalent to all the fresh surface water in the lakes and rivers of the world. Almost all of it is of drinking water quality. Not all of it can be readily obtained.

If, for example, we could take Minnesota and turn it upside down to let all of the water run out, the amount would be enough to create an 18-foot deep lake the size of the state. Slow drainage of this enormous reservoir through low depression in the land (lakes and streams) provides continuous flow to our rivers during the winter and in droughts.

Major inconsistencies and problems associated with this vast underground reservoir are its uneven distribution and its need for replenishment through rainfall. Also, man-made pollution dumped in and on the land has contaminated it in many places.

Of the 270 miles, it is estimated that 185 cubic miles are in bedrock aquifers, 60 cubic miles in buried drift aquifers, 9 cubic miles in surficial aquifers, and 15 cubic miles in basement igneous bedrock aquifers.

Throughout most of the state, it is possible to drill wells and find water for commercial and personal use. In some places, such as southeastern and southwestern Minnesota, finding potable well water is more difficult than in the rest of the state.

Groundwater is one part of the hydrologic cycle: the circulation of water in vapor, liquid, and solid physical states. Water moves through the cycle via evaporation, transpiration, precipitation, surface water flows, percolation to aquifers, and groundwater flows from aquifers to streams and wells.

Five aquifers--water-yielding rock material--lie beneath the metropolitan area as distinct layers within a large, soup-spoon shaped geologic structure. The structure has been described as having its handle tilted upward to the north, spilling to the south.

The aquifers are (from the surface downward) a glacial drift aquifer (often present at the surface), the St. Peter aquifer, the Prairie du Chien-Jordan aquifer, the Ironton-Galesville aquifer, and the Mount Simon-Hinckley aquifer. The aquifers differ in size and shape. Some are roughly as big as the metropolitan area and others extend far beyond the region.

Water movement in the metropolitan area aquifer system is extremely complex. A United States Geological Survey (USGS) scientist, Michael Schoenberg, described his computer model of the aquifer system as using long runs on a supercomputer to simulate water flows. The scientist said that he has left several variables out of his study to keep the model simple.

Water moves at vastly different rates in different aquifers. According to the USGS, water moves in the Mount Simon-Hinckley aquifer at a rate of 0.00005 feet per day while in the Prairie du Chien-Jordan aquifer, it moves at a rate of about 25 feet per day under natural conditions. Flow rates may be greater near wells.

Different types of rock material have different water bearing characteristics. Water in sand, for example, will not travel at the same speed or in the same fashion as water in gravel. As noted, in some bedrock formations, water moves quickly. The Prairie du Chien-Jordan aquifer was described as a "sponge with group of pipes on it," meaning that water can be distributed around the aquifer easily.

Water sometimes moves more easily from one aquifer to another. The Mount Simon-Hinckley, for example, is largely confined by almost impermeable layers of rock material. Surficial (at the surface) aquifers are affected by actions on the land surface. Other aquifers are protected by confining layers of rock, but those confining layers may be intersected by river valleys, glacial valleys, or other geologic formations. Human construction activities, especially wells, may break through natural confining layers, allowing pollution to move from one aquifer to another.

Aquifers are interconnected with surface water. During periods of low flow, including winters, streams are recharged only by aquifers. During periods of high flow, streams replenish aquifers. In the karst region of southeast Minnesota, a region characterized by highly porous rocks and fractured geology, the interaction between surface water and groundwater is often direct and quick. Streams flow underground. Sinkholes, common in southeastern Minnesota, connect surface activities to aquifers.

The extreme complexity of groundwater flow makes regulation and environmental protection of aquifers more difficult. It is a three-dimensional medium. Pollution can reach an aquifer from a variety of sources creating difficulties in pinpointing pollution sources. The Legislative Commission on Minnesota Resources recently issued a grant for the development of a computer model to facilitate the tracking of pollution in aquifers. Pollution does not move as quickly in aquifers as in streams. Because one portion of an aquifer is polluted does not mean the resource is unuseable everywhere. The aquifers used to supply drinking water to the Twin Cities metropolitan area are polluted in a few places and clean in most others.

Pollution may enter an aquifer and remain in one place without contaminating drinking water supplies. In St. Louis Park, for example, some city wells had to be shut because of creosote contamination. The city's public works director said that most of the contamination of wells was a result of spills, including a rail car spill 50 years ago directly above an open well. The spilled contaminants had run down through an open well into the aquifer where they remained stable for years. Newer city wells were drilled too close to the contamination, which no one knew was there, and yielded polluted, unuseable water.

In the karst region of southeastern Minnesota, the upper aquifers are locally vulnerable because of interaction with surface contaminant sources. By contrast, in the Twin Cities region, with less pronounced karst geology, deeper, bedrock aquifers are better protected from pollution.

Surficial aquifers in the Twin Cities metropolitan area are vulnerable to contamination because of all the human activity at the surface. No one would drill a shallow, sandpoint well in industrial areas in south Minneapolis, Saint Paul's east side, or Columbia Heights and expect to find potable water. Drilling deeper wells would, however, yield drinkable water.

The Metropolitan Council is evaluating groundwater resources in the region and preliminary reports document the presence of an abundant supply. One draft ("Water as a Resource," February, 1985, not yet completed and approved) said, "There literally is no location in the [metropolitan area] where groundwater could not be obtained to some extent if a well were drilled to a maximum of 1,000 foot depth. If such a well were drilled, there would be several depths at which adequate supplies of good quality water would be encountered."

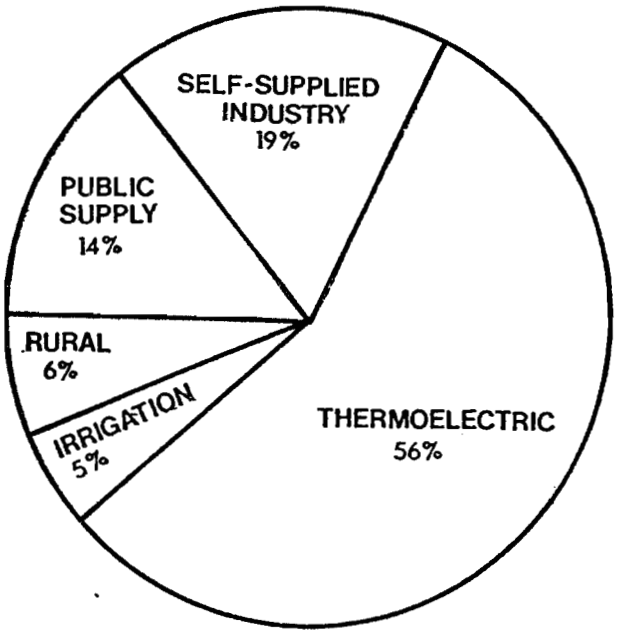
Minnesotans may drill wells and withdraw water basically without charge. Groundwater in Minnesota comes under the legal doctrine of American Reasonable Use Doctrine of Riparian Rights. Under this doctrine, a landowner has a priviledge to make reasonable beneficial use of available groundwater. A state permit is required for groundwater withdrawals under a system of priorities. (In some instances, groundwater use which is affecting uses nearby may be subject to a court's jurisdiction, but, as a general rule, groundwater use is the landowner's prerogative.) Under the legal doctrine of riparianism, a landowner may use water as long as its use does not unreasonably interfere with the supplies of other users.

In contrast, many western states adhere to a legal doctrine of prior appropriation, which means that the first person to use the water has the first right to use that amount in the future. Amounts in excess are the rights of the second user.

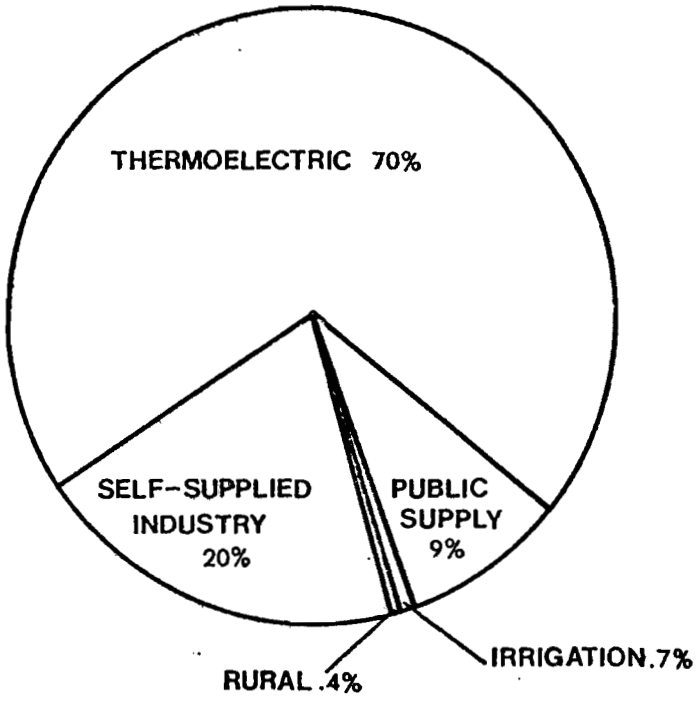
In 1980, groundwater withdrawals in Minnesota totalled 243.8 billion gallons, according to a Department of Natural Resources (DNR) report. That represents less than one percent of the total. Of that amount, 38 percent was for public supply, 28 percent for rural use, 22 percent for irrigation, 12 percent for self-supplied industry, and .6 percent for thermoelectric use. (see adjoining pages.)

Minnesota Water Use-1980

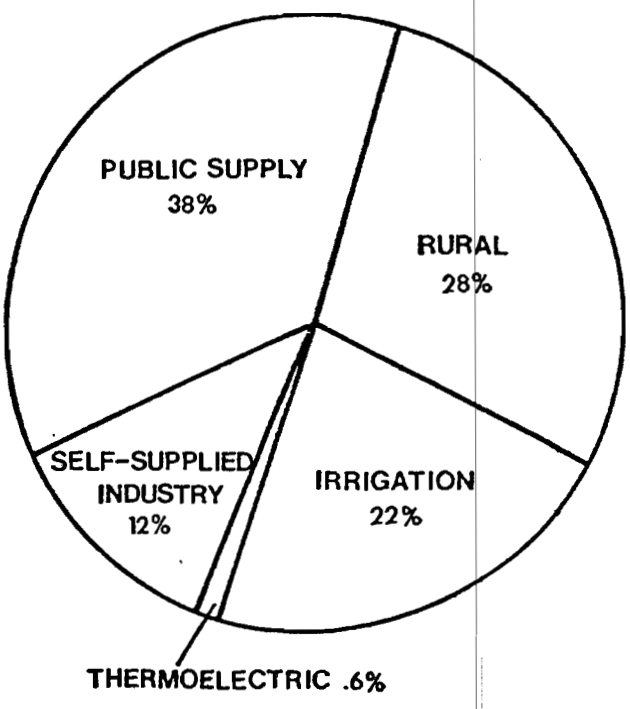
TOTAL WATER WITHDRAWN
GROUND WATER & SURFACE WATER
Total= 1125 Billion Gallons



SURFACE WATER WITHDRAWN
1980
Total= 881.2 Billion Gallons



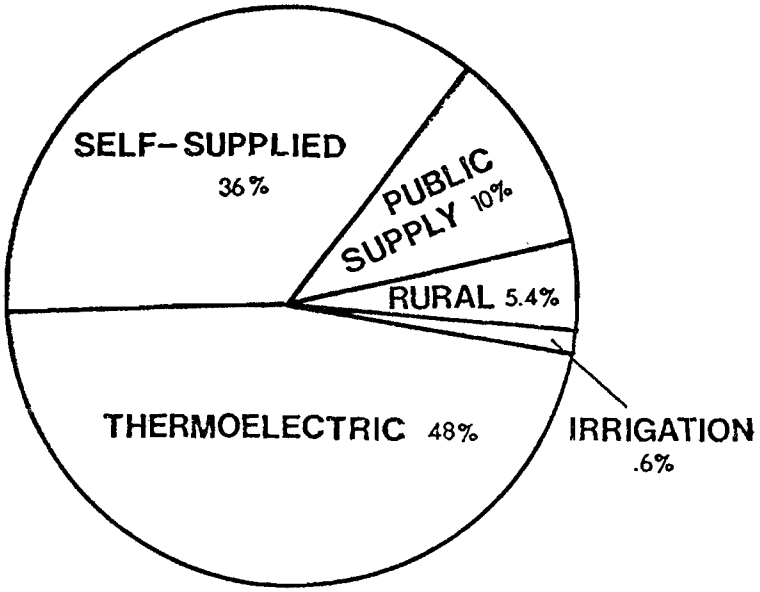
GROUND WATER WITHDRAWN
1980
Total= 243.8 Billion Gallons



SOURCE: Department of Natural Resources

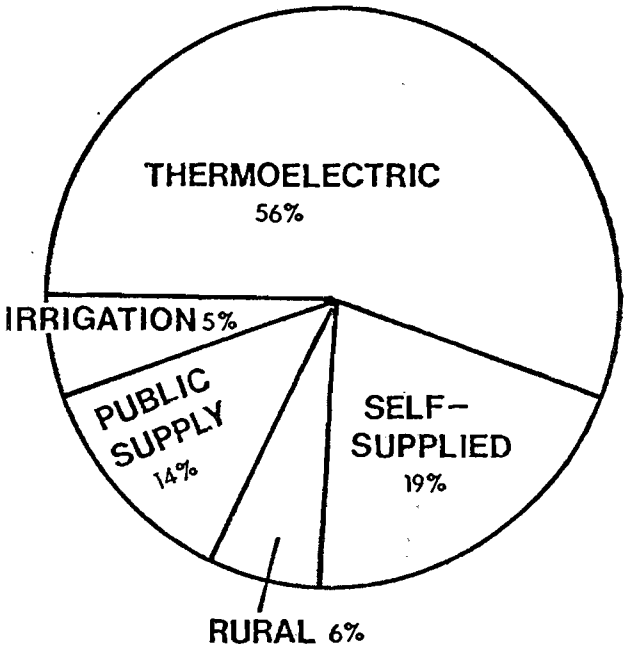
1970...

TOTAL WITHDRAWN
1270 Billion Gallons

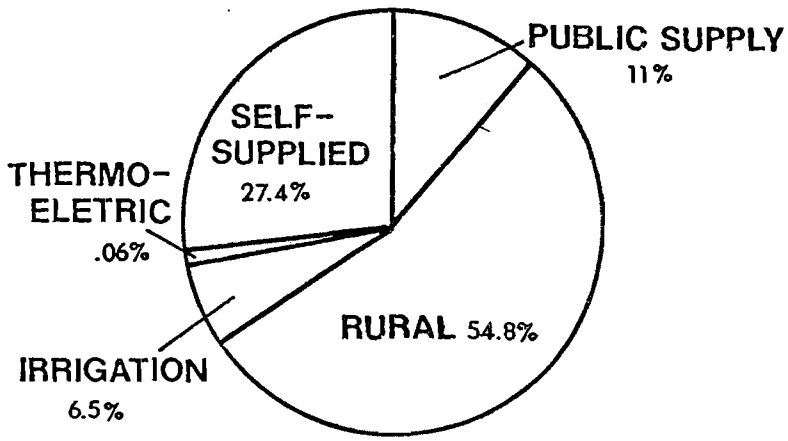


1980...

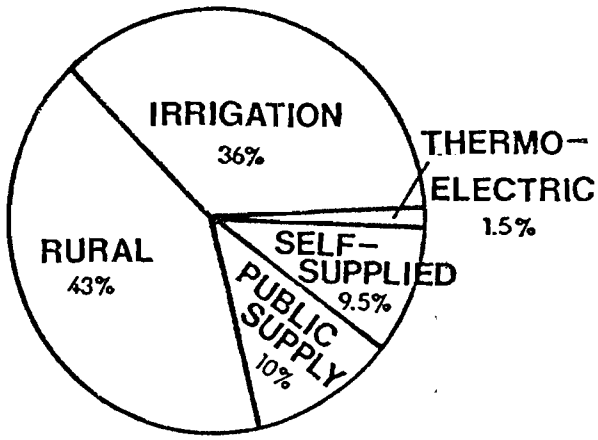
TOTAL WITHDRAWN
1125 Billion Gallons



CONSUMED
113 Billion Gallons



CONSUMED
160 Billion Gallons



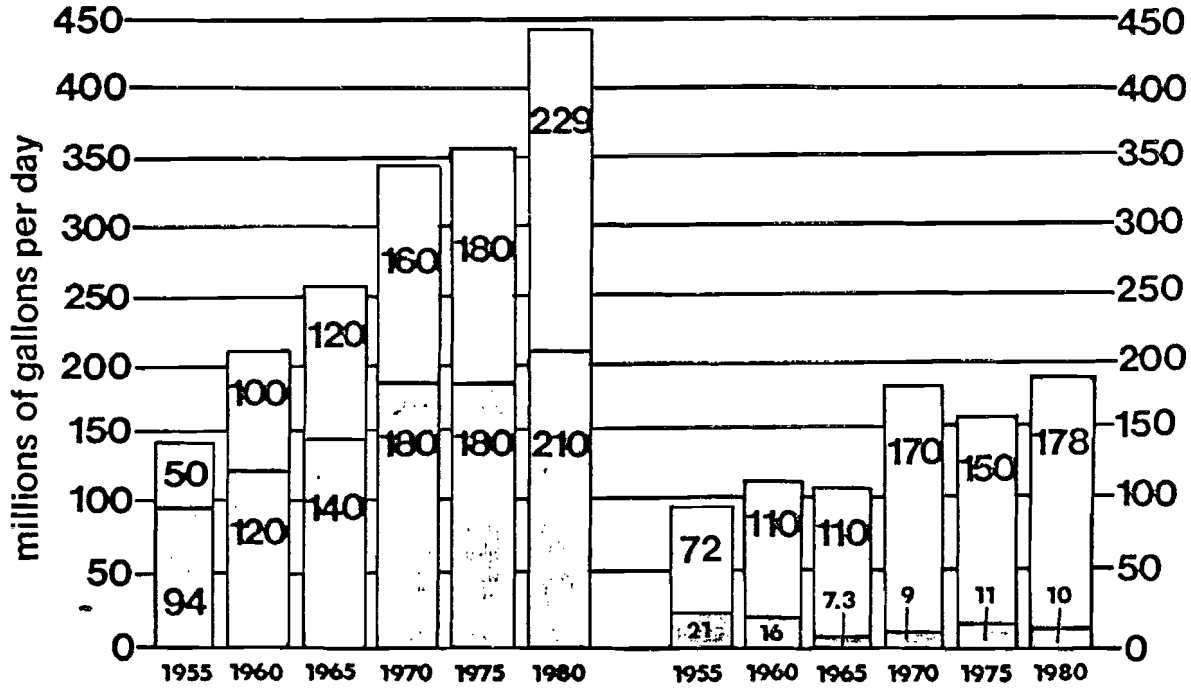
SOURCE: Department of Natural Resources

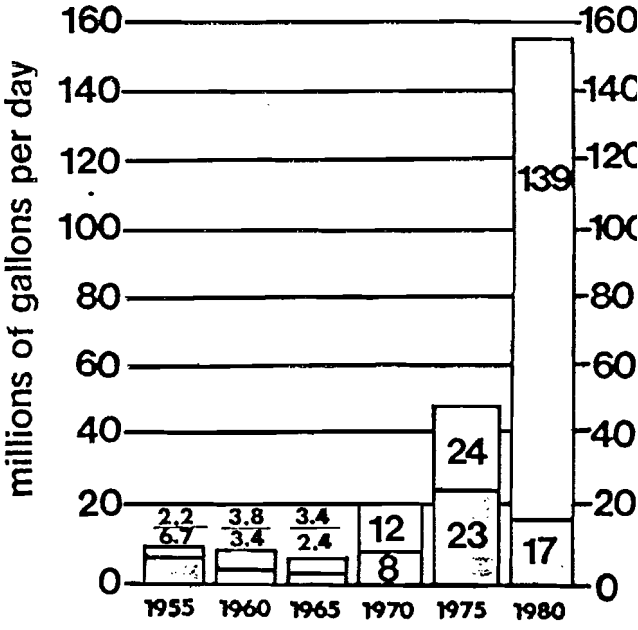
Water Use In Minnesota, 1955–1980

PUBLIC SUPPLIES:
(Domestic, Commercial & Industrial Use)

RURAL:
(Domestic & Livestock Use)

IRRIGATION





SURFACE WATER

GROUND WATER

from U.S. Geological Survey Circulars 398, 456, 556, 676, 765

SOURCE: Department of Natural Resources

Use of groundwater for irrigation purposes has increased sharply. (see DNR bar graph on water use.) In 1955, 50 million gallons per day of groundwater was used for irrigation, but by 1980, 229 million gallons per day were used. According to figures from the Agricultural Extension Service and the DNR, the number of acres irrigated has grown tenfold in the 1970s. In 1970, 44,379 acres were irrigated. In 1980, 470,000 acres were irrigated.

According to the Metropolitan Council's Development Guide (chapter on water), total groundwater use in the region is roughly one-fifth of the available daily supply. Fewer than 200 million gallons per day are being pumped out of an available daily supply of roughly one billion gallons per day.

The USGS scientist studying the Twin Cities' aquifer system said that the aquifer system is not in danger of being used up. He pointed out that when wells are pumped aquifers adjust to the pumping by increasing recharge. Pressure levels in the aquifers drop until a new equilibrium is established. Schoenberg said that the Twin Cities' aquifers are now in equilibrium. When wells were first drilled about 100 years ago, water flowed from them because the pressures were so great. Other USGS work has documented a decline in pressure in the region's aquifers.

Representatives of the DNR said that so far there is little or no evidence that aquifer levels--to the extent that they are monitored--are dropping. Seasonal and annual variations are common in aquifer water levels. Generally, water pressure levels decline in the summer and increase in the winter. One DNR official showed a tabulation of water levels of a local aquifer in Stearns County, a county where much irrigation takes place. The water levels dropped in summer but rose in winter, with the overall trend over several years slightly upward.

Depletion of aquifers has been documented in arid parts of the nation with the sharp declines in water levels in the Ogallala aquifer, a massive aquifer stretching from Texas to Nebraska, the most commonly known. It is possible to use up water resources when natural recharge is insufficient, but virtually no evidence exists to show the depletion or overuse of aquifers in Minnesota. There may be a problem in the upper Mississippi River basin where irrigation wells may be depleting shallow aquifers, aquifers which recharge the Mississippi at times of little rainfall. For the Twin Cities region, depletion is clearly not the case.

In the metropolitan area, the use for self-supplied industry is declining. Irrigation use and municipal use is increasing. A formerly important groundwater use, lake level maintenance, has all but disappeared.

Percentage of Groundwater Withdrawal by Use Category

Time Period	Public Supply	Self-supplied Indust.	Irrigation	Dewatering	Lake-level Maint.
1880-1900	37	63	0	0	0
1901-10	18	59	0	0	23
1911-20	15	75	0	0	10
1921-30	10	67	1	0	22
1931-40	10	68	1	0	21
1941-50	13	82	1	0	5
1951-60	20	73	1	0	6
1961-65	26	67	1	0	6
1966-70	29	63	1	4	3
1971-75	40	52	2	5	1
1976-79	44	42	9	4	1

SOURCE: Groundwater Use Trends in the Twin Cities Metropolitan Area, Minnesota, 1880-1980, U.S. Geological Survey, Metropolitan Council of the Twin Cities & MN Dept. of Natural Resources, 1983

Withdrawals by Aquifer (see attached chart)

Reports from the USGS show that total groundwater withdrawal has declined from previous highs. Drawing a conclusion from any one year may be misleading. In dry years, people are likely to use more groundwater than in wet years.

A Metropolitan Council study on Twin Cities metropolitan area water use identified a similar trend. Overall water use is levelling off in the region although per capita household use may continue to increase. The Metropolitan Council noted that conservation efforts could reduce household use. In drought years, sprinkling bans and other techniques have been shown to reduce household use of water in Minnesota cities and in other places in the nation.

Both the USGS and the Metropolitan Council identified charges for wastewater treatment as the reason for declining industrial use of water. Should wastewater treatment charges continue to increase, the incentive to use less water will become greater. Without disposal charges, groundwater would be an almost free commodity with few or no incentives for conservation.

[Mgal/d, million gallons per day]

Time period	Glacial drift		St. Peter		Prairie du Chien-Jordan		Ironton-Galesville		Mount Simon-Hinckley		Total	
	(Mgal/d)	(Percent of total)	(Mgal/d)	(Percent of total)	(Mgal/d)	(Percent of total)	(Mgal/d)	(Percent of total)	(Mgal/d)	(Percent of total)	(Mgal/d)	(Percent of total)
1880-1900	<0.1	—	0.1	1	0.6	90	<0.1	2	0.1	7	0.7	100
1901-10	<.1	—	.1	3	4.2	89	.1	2	.3	6	4.8	100
1911-20	<.1	—	.5	4	7.6	67	.7	6	2.6	23	11.4	100
1921-30	<.1	—	1.3	5	15.6	64	1.4	6	6.1	25	24.4	100
1931-40	.4	—	2.1	4	36.2	71	2.5	5	10.1	20	51.3	100
1941-50	2.7	4	1.7	2	49.6	70	3.5	5	13.9	19	71.4	100
1951-60	6.2	5	1.7	2	88.1	75	4.4	4	16.7	14	117.1	100
1961-65	8.1	6	1.4	1	107.9	76	4.4	3	20.8	15	142.6	100
1966-70	11.4	6	1.5	1	144.5	78	5.4	3	22.8	12	185.6	100
1971-75	12.5	6	1.4	1	155.3	78	7.0	4	22.7	11	198.9	100
1976-79	12.6	6	1.3	1	156.8	80	6.7	3	19.2	10	196.6	100

SOURCE: United States Geological Survey, Groundwater-Use Trends in the Twin Cities Metropolitan Area, Minnesota, 1880 - 1980

GLOSSARY OF TERMS

Some of the language in this report is technical or semi-technical. This section explains most of the terms with which a general reader may not be familiar. The definitions are either from dictionaries or the Environmental Protection Agency.

Abatement. The reduction in degree of intensity of pollution.

Activated carbon. A highly adsorbent form of carbon used to remove odors and toxic substances from gaseous emissions. In advanced waste treatment, it is used to remove dissolved organic matter from waste water.

Adsorption. The attachment of the molecules of a liquid or gaseous substance to the surface of a solid.

Air pollution. The presence of contamination substances in the air that do not disperse properly and interfere with human health.

Ambient. Unconfined or open.

Background level. The level of pollutants present in ambient air or water from natural sources.

Carcinogenic. Cancer-producing.

Chlorination. The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds.

Chronic. Long-lasting or frequently recurring, as a disease.

Conservation. The protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

Dump. A site used to dispose of solid wastes without environmental controls.

Effluent. Waste material discharged into the environment, treated or untreated. Generally refers to water pollution.

Fecal coliform bacteria. A group of organizations found in the intestinal tracts of people and animals. Their presence in water indicates pollution and possible dangerous bacterial contamination.

Feedlot. A relatively small, confined area for raising cattle that results in lower costs but may concentrate large amounts of animal wastes. The soil cannot absorb such large amounts of excrement and runoff from feedlots pollutes nearly waterways with nutrients.

Hazardous wastes. Waste material which by their nature are inherently dangerous to handle or dispose of, such as old explosives, radioactive materials, some chemicals, and some biological wastes. Minnesota law also contains a specific delineation of hazardous--as opposed to solid--wastes as part of its waste management act. In Minnesota, counties are responsible for solid waste disposal and the state for hazardous waste disposal.

Heavy metals. Metallic elements like mercury, chromium, cadmium, arsenic, and lead, with high molecular weights. They can damage living things at low concentrations and tend to accumulate in the food chain.

Holding pond. A pond or reservoir usually made of earth built to store polluted runoff.

Hydrology. The science dealing with the properties, distribution, and circulation of water.

Hydrologic cycle. Also known as water cycle. A sequence of phenomena showing how water moves in a never-ending revolution. Water in the oceans continually evaporates, putting water vapor into the atmosphere. Precipitation (rain or snow) puts the water on the ground where it can become surface water (lakes, ponds, puddles), or surface runoff (streams or rivers), or seep into the ground and be stored as groundwater. Eventually the water will travel back to the ocean, to begin the cycle again. The exchange between the earth atmosphere is accomplished by the heat of the sun, the winds, and the pull of gravity.

Impoundment. A body of water confined by a dam, dike, floodgate, or other barrier.

Infiltration. The action of water moving through small openings in the earth as it seeps down into the groundwater.

Leachate. Materials that pollute water as it seeps through solid waste.

Leaching. The process by which nutrient chemicals or contaminants are dissolved and carried away by water, or are moved into a lower layer of soil.

Mutagens. Any substance that causes changes in the genetic structure in subsequent generations.

Nonpoint source. A contributing factor to water pollution that cannot be traced to a specific spot, such as agricultural fertilizer runoff or construction sediment.

Organic compounds. Natural or synthetic substances based on carbon. Organic compounds can become part of the water supply through water treatment methods, from industry, sewage treatment plants, runoff, and from spills and accidents.

Pesticide. Any substance used to control pests ranging from rats, weeds, and insects to algae and fungi.

Point source. A stationary location where pollutants are discharged.

Pollutant. Any introduced substance that adversely affects the usefulness of the resource.

Pollution. The presence of matter or energy whose nature, location, or quantity produces undesired environmental effects.

Recharge. The process by which water is added to the aquifer.

Reservoir. Any holding area, natural or artificial, used to store, regulate, or control water.

Riparian rights. Entitlement of a land owner to the water on or bordering his or her property, including the right to prevent diversion or misuse of it upstream.

Rodenticide. A chemical or agent used to destroy rats or other rodent pests, or to prevent them from damaging food, crops, or other items.

Runoff. Water from rain, snow melt, or irrigation that flows over the ground and returns to streams. It can collect pollutants from air or land and carry them to the receiving waters.

Salt water intrusion. The invation of fresh surface water or groundwater by salt water.

Sanitary landfill, landfill. Protecting the environment when disposing of solid waste. Waste is spread in thin layers, compacted by heavy machinery and covered with soil daily.

Septic tank. An enclosure that stores and processes wastes where no sewer system exists. Bacteria decompose the organic matter into sludge, which is pumped off periodically.

Solid waste. Useless, unwanted, or discarded material with insufficient liquid to be free-flowing. The Minnesota waste management act also contains a specific definition of solid--as distinct from hazardous--waste. See entry on hazardous wastes.

Solid waste disposal. The final placement of refuse that cannot be salvaged or recycled.

Solid waste management. Supervised handling of waste materials from their source through recovery processes to disposal.

Synergism. A cooperative action of two substances that results in a greater or lesser effect than both of the substances could have had acting independently.

Toxic substances. A chemical or mixture that may present an unreasonable risk of injury to health or the environment.

Water pollution. The addition of enough harmful or objectionable material to damage water quality.

Water quality criteria. The levels of pollutants that affect use of water for drinking, swimming, raising fish, farming, or industrial use.

Water quality standard. A management plan that considers: 1) what water will be used for; 2) setting levels to protect those uses; 3) implementing and enforcing the water treatment plans and 4) protecting existing high quality waters.

Water table. The level of groundwater.

Wells. A water source that can be built by hand or power tools.

WORK OF THE COMMITTEE

The committee which wrote this report was formed by the League Board of Directors in July, 1984. The charge to the committee was:

"The principal charge to this committee is to recommend the essential elements of public policy which will regard groundwater as a crucial, and possibly threatened, resource.

"The groundwater in Minnesota, while plentiful in supply and generally uncontaminated, is vulnerable on both counts. It continues to be available to users at very low prices, with few restrictions on how much can be withdrawn. Public attention has focused most recently on efforts to eliminate disposal practices which cause eventual contamination of water, and recent legislative action is accelerating efforts to clean up disposal sites. The extent of cumulative contamination remains largely unknown, with some observers forecasting an inevitable crisis and others relying confidently on chemical treatment capacity.

"Setting aside the unknowns, it is clear that the capacity to think of water supply as a strategic resource for this region is not very much developed. An elaborate but essentially disjunctive array of boards and councils hold various segments of responsibility for water policy, but its formulation and implementation remains most uncoordinated.

"In formulating its recommendations the committee should deal with these questions:

- "How adequate is the current basis for local government decisions on land use? Have we shifted to guidelines which do minimize the potential for new contamination sources? Are we getting consistent decisions across local governments? Does local government have the tools and resources for controlling ground water contamination?

- "Does the existing clean-up effort include a systematic search for undocumented disposal sites? If not, what is the best approach to this part of the problem?

- "How complete is legislative direction on water supply and quality? Do we need an institutional framework for managing this resource? Is existing policy clear about accountability, about where to go with a crisis?

- "What policy framework do we need which anticipates greater pressure on the supply of groundwater from this region?

- "The committee will look at the southeastern part of the state including the metropolitan area because of its geology, which is particularly susceptible to ground water contamination."

A total of 22 people participated actively in the work of the committee. They are:

Lois Yellowthunder, Chair
Donna Anderson
Douglas Barr
Marianne Curry
Bernice Hanson
Michael Hestick
Rudolph Hoagberg
David Hols
Larry Kelley
Norma Lorshbough
Marilyn Lundberg
Rick Person
Mary Jane Rachner
Edwin Ross
Dudley Russell
Barry Schade
Susan Schmidt
Alan Shilepsky
Charles Smith
Raymond Swanson
Erling Weiberg
Paul Zerby

In addition, Irma Sletten contributed her views through telephone conversations with the League staff.

The committee met a total of 47 times between July 10, 1984 and October 8, 1985. During that time, it met with a variety of experts and reviewed a vast amount of printed material on pollution, groundwater and water use, the legal structure of groundwater management, practices in other states, federal and state policy, health risk, and related topics.

Resource persons who spoke with the committee were:

Russell Adams, professor, soil science department, University of Minnesota
Dr. Calvin Alexander, dept. of geology & geophysics, University of Minnesota
Mike Ayers, supervisor, environmental health program, Washington County
Carol Ann Barth, research director, Citizens for a Better Environment
Don Brauer, consultant
Linda Bruemmer, senior hydrologist, MN Environmental Quality Board
Don Chmiel, senior consultant, permits department, Northern States Power
Bob Clough, manager, regulatory activities department, Northern States Power
Gary Dodge, vice president, Metro Recovery Corporation
Gary Englund, chief, water supply & general engineering, environmental health division, MN Department of Health
Rondi Erickson, president, Bay West, Inc.
Michael Fresvik, supervisor, agronomy services, MN Department of Agriculture
Sandra Gardebring, chair, Metropolitan Council
Jim Garvin, senior engineer, Donahue & Associates
John Holck, supervisor, groundwater unit, MN Pollution Control Agency
Robert Hutchinson, director, environmental services, Anoka County
Loni Kemp, director, Preston office, The Minnesota Project
Richard Koppy, director, public works department, City of St. Louis Park
Leonard Kremer, vice president, Barr Engineering
John Madole, regulatory compliance section, solid & hazardous waste division, MN Pollution Control Agency
Senator Gene Merriam, Minnesota Senate
Tom Mogran, general manager, Saint Paul Water Utility
Allan Mulligan, chair, Government Task Force on Environmental Quality Board

Ron Nargang, assistant executive director, Soil & Water Conservation Board
Representative Darby Nelson, Minnesota House of Representatives
Forrest Nowlin, attorney, Larkin, Hoffman, Daly & Lindgren law firm
Bruce Olsen, geologist, MN Geological Survey
Christine Olsenius, director, Freshwater Society
Richard Pecar, consultant, Resource Management Associates
Senator Randolph Peterson, Minnesota Senate
James Powell, office of Senator Dave Durenberger
Hedia Rieke, water allocation unit supervisor, MN Department of Natural Resources
Edwin Ross, hydrologist, MN Dept. of Health
Ken Salzberg, professor, Hamline University School of Law
Michael Schoenberg, hydrologist, U.S. Geological Survey
Larry Seymour, director, division of water, MN Dept. of Natural Resources
Mel Sinn, executive director, MN Water Resources Board
Roger Steinberg, area extension agent, University of Minnesota Agricultural Extension Service
Jeff Stevens, assistant professor, environmental health department, University of Minnesota
Conrad Straub, former professioner, environmental health dept., University of Minnesota
Russ Susag, director, environmental operations, 3M Company
Ron Thompson, senior hydrologist & unit supervisor, groundwater unit, MN Department of Health
Tim Thornton, attorney, Rider Bennett Egan & Arundel
Ray Thron, director, division of environmental health, MN Department of Health
Sarah Tufford, hydrologist, division of waters, MN Department of Natural Resources
Matt Walton, director, MN Geological Survey
Dale Wikre, director, solid & hazardous waste division, MN Pollution Control Agency

In addition, Gary Dodge and Mike Anderson supplied the committee with a great deal of background material. The Citizens League and the Groundwater Quality & Supply committee thank these resource guests for their time and assistance in helping with this study.

The committee was assisted in its work by Robert de la Vega, Alison Crane, Donna Keller, and Joann Latulippe of the League staff.

APPENDIX A

Federal laws provide the underpinning of most environmental protection efforts. Most of these programs established in federal law require or offer an opportunity for state and local involvement. In addition, the state has passed several important environmental protection laws. The major national and state environmental laws are described in this appendix.

The Clean Water Act of 1972. The law was the first in a series of major environmental laws which had a significant impact on water management policy. It was aimed mainly at cleaning up surface water pollution. The law's objective is to restore and maintain the physical, chemical, and biological integrity of the nation's waters.

The act set up standards for the development of water quality criteria, established pollution discharge and dredged or fill material discharge, and set up a planning process for water management.

Ironically, these provisions designed to limit the disposal of toxins into surface water (along with the Clean Air Act's limitations on burning as a disposal option) made land disposal the preferred disposal option. Land disposal created many of today's groundwater problems.

A major element of the law is a grant program for wastewater treatment plants. It was through this law that federal money became available for the construction of many of the Metropolitan Waste Control Commission and outstate wastewater treatment facilities.

The Community Health Services Act. This state law mandates that counties have a health services plan as part of a block grant program which finances many health services. As a general rule, counties have not emphasized environmental health programs as part of either the planning or the service component of this program.

Comprehensive Environmental Response, Compensation and Liability Act (Superfund). The law authorizes a public response whenever there is a release or threat of release of hazardous substances, pollutants, or contaminants into the environment which may represent an imminent and substantial danger to public health or welfare. The law levies an excise tax on the production of petroleum and chemical feedstocks, setting up a fund for the compensation of injured parties and for cleanup. It also establishes liability for the cost of response actions on responsible parties and provides for the compensation of expenses incurred by government in identifying responsible parties.

States may become the lead agencies for the law's enforcement by entering into an agreement with the Environmental Protection Agency (EPA). The law provides that states pay at least 10 percent of the costs of remedial activities.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). This law requires the registration of all pesticides, their classification for general or restricted use, and allows the EPA to ban the use of pesticides that are dangerous to people, animals, or the environment. It also requires the EPA to set standards for the storage and disposal of pesticide containers and excess pesticides.

States may assume responsibility for the enforcement of FIFRA provisions, using the EPA-generated standards.

Resource Conservation and Recovery Act. The law requires the establishment of regulations for hazardous waste generators, transporters, and owners or operators of facilities who treat, store, or dispose of such wastes. It sets up a logging system, whereby dangerous substances are tracked from their manufacture to their final use.

States may implement the federal regulations, using the federal standards as minimums. In order to qualify for federal financial assistance, states must establish certain waste disposal plans.

The Safe Drinking Water Act. The law is a central element in the protection of public health. It lists the substances that water utilities must test for and the maximum levels at which the substances can be present in public drinking water. The EPA is supposed to develop standards for all contaminants, but, as a practical matter, EPA has only developed standards for some chemicals. The law stipulates testing for 10 inorganic parameters, six organic parameters, five radiochemical substances, and two other substances. The law stipulates the frequency at which testing of water supplies must take place. The frequency of testing depends on the size of the community served, with larger systems required to test supplies daily.

Water systems serving fewer than 25 persons are exempt from the regulations of the Safe Drinking Water Act, meaning that no regulation occurs of wells serving isolated homes.

The Minnesota Department of Health assumed responsibility for the implementation of the law in this state. Gary Englund of the Department of Health said that tests of public drinking water systems in the state have turned up levels of chemicals exceeding the maximum levels on some occasions. He expressed greater concern about the number of chemicals for which no tests were conducted.

State Well Code. Minnesota has a strict code for the design, construction and abandonment of water wells. Improperly constructed, designed, or abandoned wells are a threat to groundwater. Wells can be a conduit for pollution to move between aquifers. Uncapped wells can be paths by which contaminants travel from the surface into aquifers, as was the case in St. Louis Park. About 10,000 wells a year are drilled in Minnesota. Under the department's program, well drillers are required to file reports once they have drilled the well. The reports state the well's use and location. The well code stipulates the distance a

well must be located from potentially hazardous facilities such as sewer lines, septic systems, feedlots, and the like. The Department of Health official responsible for the program, Ron Thompson, said the greatest threats to wells are from pollution sources less than 50 feet away.

Thompson noted that there are probably about a half million abandoned wells in Minnesota and that the state does not know where most of them are. Often, when records are checked, the locations listed for wells are incorrect. In addition, many thousands of wells were constructed, used, and abandoned without any official record of them.

Waste Management Act. The state's Waste Management Act, passed in 1979, is an important feature in groundwater protection efforts. The law was intended to develop a system for the safe disposal of solid and hazardous wastes. It is this law which defines the two major elements of the waste stream as hazardous and solid, although it is generally conceded that solid wastes can cause health problems, too. The disposal of solid wastes in landfills led to groundwater problems in many areas. The state, through the Waste Management Board, is responsible for developing a hazarous waste management plan and for siting a hazardous waste disposal facility. The counties are responsible for solid waste disposal. In the metropolitan area, the Metropolitan Council is responsible for making sure that the plans of the seven metropolitan counties are consistent.

An important amendment to the act was passed by the 1985 Legislature. That amendment banned landfill disposal of unprocessed mixed municipal waste after 1990 in the metropolitan area. As a result, metropolitan-area counties have accelerated their efforts to find alternatives to landfill disposal.

State agency activities.

Research. The University of Minnesota's schools of Public Health and Veterinary Medicine conduct groundwater research paid for by the Legislative Commission on Minnesota Resources. The Minnesota Geological Survey, which also conducts research, is part of the University.

Regulatory programs. The Pollution Control Agency runs programs on municipal and industrial wastewater treatment facilities, feedlot permits, individual sewage treatment systems, and solid and hazardous waste. The Department of Health operates groundwater quality control: water well construction code, safe drinking water, and community health services programs. The Department of Natural Resources operates appropriation permits, aquifer tests, and well inventory programs. The Department of Agriculture operates pesticide and fertilizer control programs.

Monitoring. The PCA operates a groundwater quality monitoring program. The DNR operates observation wells and fish hatcheries and works with the United States Geological Survey on monitoring supply.

Planning. The Minnesota Water Planning Board was merged into the EQB in 1983. The EQB is responsible for environmental review. The Soil and Water Conservation Board prepares a plan as part of its administration of a state cost-sharing program for soil and water conservation. The Waste Management Board administers the Waste Management Act. The PCA is charged with developing an agricultural pollution control strategy and a groundwater protection strategy. The Southern Minnesota Rivers Basin Board developed a resource plan for the southeastern Minnesota tributaries basin.

Technical and financial assistance. The Soil and Water Conservation Board, Soil and Water Conservation Districts, and the U.S. Department of Agriculture all run conservation services.

Education and training. The University of Minnesota's Agricultural Extension Service and departments of Soil Science, Agricultural Engineering and Agronomy, Entomology, and Plant Pathology provide educational services. State agencies with regulatory responsibility also do training and informational programs in conjunction with regulatory activities.

APPENDIX B

Any number of human activities can create groundwater problems. This appendix describes the most common problems identified so far in Minnesota. It relies heavily on the PCA's 1983 study on "Ground Water Protection Strategy Framework for Minnesota," the PCA and State Planning Agency document, "Ground Water in Minnesota," published in 1984, and "Protecting the Nation's Groundwater from Contamination," a report by the Office of Technology Assessment, a branch of Congress.

Solid waste disposal. Of the 15 known landfill sites in the metropolitan area, 13 are known to be leaking. Landfills in outstate Minnesota are often located improperly and no one knows how many unrecorded dump sites exist. Wells serving individual households have been closed as a result of leachate from sanitary landfills though municipal water supplies have been largely unaffected.

A 1980 statewide inventory of landfills and dumps showed there were approximately 1,421 in existence. This includes some closed sites. Of those, 127 have PCA landfill permits. Of these, 51 do not have required groundwater monitoring. Of the unpermitted facilities, virtually none have any systematic monitoring systems.

Landfill leachate contains a variety of toxic substances. Whether the toxicity of landfill leachate results from the disposal of household wastes or from the disposal of commercial-industrial wastes is not entirely clear. One speaker told the committee that most of the landfill sites where major problems have occurred are landfills that accepted industrial wastes. A state task force on household hazardous wastes determined that concentrations of household quantities of hazardous substances can create enough waste to produce contamination.

The state Legislature undertook two significant actions on landfills in the mid-1980s. A 1985 amendment to the Waste Management Act outlawed landfill disposal of mixed municipal solid waste in the metropolitan area. As a result, no new landfills for mixed municipal wastes are likely to be sited. A 1984 law allows metropolitan area cities and counties to levy new fees on solid waste with the fees used for waste reduction and recycling, as well as remedial action to clean up landfill-related pollution problems.

Hazardous waste material. Both Minnesota's Waste Management Act and most federal laws covering waste disposal identify substances which are inherently toxic and hazardous, as opposed to other types of wastes which are presumed to be less threatening. Minnesota's 6,000 manufacturing firms are estimated to produce 174,000 tons of hazardous waste per year, according to the Waste Management Board. Most of the manufacturing operations producing hazardous wastes are in the Twin Cities metropolitan area. The federal Resource Conservation and Recovery Act requires that hazardous substances be tracked from their creation to their disposal. Anyone handling the substance must obtain a permit.

According to the PCA, the state has 139 hazardous waste treatment, storage and disposal facilities, 173 industrial surface waste impoundments, 60 industrial large septic systems, and 5,500 bulk liquid storage tanks.

Fuel storage and transport. "Protecting the Nation's Groundwater from Contamination," a report by the Office of Technology Assessment, a branch of Congress, reports that 2.5 million storage tanks and 700,000 miles of pipeline are buried throughout the nation. The current state of regulation over the facilities is minimal. The 1985 Legislature directed the PCA to develop rules for underground storage tanks, but exempted most of the tanks used by farmers. Compared to such facilities as landfills or feedlots, little is known about the condition of fuel storage and transport facilities. Many of the underground storage facilities provide minimal safeguards. Many are simply one or two sheets of steel. Few are monitored for leaks, beyond the extent that the facility operator monitors inventory. Almost none have groundwater monitoring systems similar to those for area landfills.

The federal report notes that many of the underground storage tanks for gasoline stations, built in the 1950s and 1960s, are nearing the end of projected useful lives. Studies in Michigan and Illinois indicate that 25 to 50 percent of all underground tanks are leaking. According to the PCA, 135 leaks were reported in Minnesota during 1980 and 1981 with a net fuel loss of 378,000 gallons. Both Metropolitan Council chair Sandra Gardebring and James Powell, an aide to Senator David Durenberger, expressed concern to this committee that leaking fuel storage tanks and pipelines may be a currently-undetected contamination source for groundwater. They both noted the lack of a regulatory structure for oil and gas pipelines and storage facilities. Powell said federal studies have shown that underground storage and transport facilities account for the largest number of contamination incidents, although not the most damaging incidents.

Sewers/septic systems. Improperly constructed, designed, or maintained sewers and septic systems can contaminate groundwater. The express purpose of septic disposal systems is to put wastes, wastes which lead to health problems if improperly disposed, to the environment without causing problems. Minnesota has 300,000 septic systems, according to PCA estimates. About one-third of all Minnesota homes have septic systems. The success of the regulation of septic systems was noted by several speakers. In the 1940s and 1950s, the Health Department identified many instances of well fouling because of improper septic systems. Problems persist with septic systems in less densely populated areas because of the number of systems. It is impossible to know the condition of all of the systems in the state.

The public investment in wastewater treatment in the metropolitan area and around the state is vast. Roughly $400 million was spent to upgrade wastewater treatment in the metropolitan area by the Metropolitan Waste Control Commission (MWCC). Total capital

investment in wastewater treatment for the state during the 1970s was roughly $900 million. The portion of wastewater receiving secondary-level treatment (the current regulatory goal) in Minnesota has increased from 20 percent in 1952 to 98 percent in 1980.

Sludge disposal. The PCA estimates that 300,000-350,000 tons of municipal sewage sludge--a byproduct of wastewater treatment, an effort to clean surface waters--are produced annually in the state. About 80 percent of the total is generated in the Twin Cities metropolitan area. The preferred disposal option for the sludge is land spreading, but because the sludge often contains heavy metals, it often cannot be disposed in this fashion. New efforts to remove heavy metals from the sewer systems through hazardous waste management are expected to alleviate the metals-in-sludge problem.

Animal wastes. Feedlots can be significant generators of pollution. Impoundments of agricultural feedlot wastes can cause a variety of groundwater problems. Farmers have turned to impoundment of feedlot wastes because the wastes are no longer allowed in streams and rivers under the provisions of the Clean Water Act. Impoundments contain large quantities of animal wastes and create demands on the environment on the order of magnitude of small cities. The PCA estimates that there are 90,000 feedlots in the state. Of these, 13,000 are operating with permits and 3,500 considered to have surface impoundment areas.

Especially in areas such as southeastern Minnesota where the connection between surface runoff and aquifers is direct, improperly sited or run feedlots can create problems.

Agricultural chemical use. Currently, chemical use is an integral part of farming in Minnesota and the nation. The types of chemicals used by farmers fall into two broad categories: pesticides/herbicides and fertilizers. Pesticides and herbicides present a special problem because they are by their nature designed to kill or poison something living. A representative of the Department of Agriculture told the committee that 34,000 pesticides are registered for use in the United States by the EPA, of which 7,400 are registered for use in Minnesota. Many chemicals are not used in Minnesota because they are not designed for pests which live here. The PCA estimates 3,163 pesticide applicators in the state and 544 restricted use pesticide dealers. The Department of Agriculture regulates the use of farm chemicals. Users of pesticides and herbicides are required to use them in the manner stated on the labels but almost no monitoring of the actual use takes place. Because of the cost of pesticides and herbicides, it can be assumed farmers are not wasting them. Certain types of chemicals, because of their higher risk, can only be used by licensed and certified people.

Problems often occur in the disposal of pesticide and herbicide container. Disposing of many containers at the same place may

result in a concentration of pesticides which otherwise would not occur. Rainfall can wash out the containers. In southestern Minnesota, many farmers dump waste in sinkholes, which is especially dangerous because the sinkholes may be conduits to aquifers.

Fertilizers are another issue. The same pollution--high concentrations of nitrates--results from natural and manufactured fertilizer. Nitrate contamination also results from non-functioning septic systems. Because nitrate pollution can come from many sources, tracing a contamination incident back to its source is difficult. In many cases, it is difficult to tell where nitrate pollution is coming from. No one knows what the background levels of nitrates are for rivers, streams, or aquifers in rural Minnesota.

Road salt. Road salt use has been identified as a groundwater threat. The introduction of salt into an aquifer may render it unfit for several uses. Piles of road salt being stored for use as an ice remover can easily be washed into an aquifer.

According to the PCA, the Minnesota Department of Transportation has 217 salt storage locations and local units have 359.

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