COMPONENT FIVE
BASIS FOR ASSESSMENT AND PLANNING

5.1 INTRODUCTION

One of the principles outlined by the Environmental Protection Agency (EPA) is to base State Management Plans (SMPs) on protection activities unique to hydrogeologic settings, pesticide usage patterns, and the agronomic practices of each state. South Dakota will continue to collect data in sensitive and vulnerable areas, providing information on the occurrence, movement, and quality of ground water, while at the same time providing information on the quantity of pesticides used and the location of that use within the state. Many cooperators will be involved in the development and implementation of the SMP.

5.2 SOUTH DAKOTA'S AGRICULTURE

5.2.1 LAND USE

South Dakota depends on agriculture more than any other state in the union. It is the state's number one industry. Sales of agricultural commodities total more than $3 billion each year. A related, South Dakota industry, horticulture, is a $55 million per year industry in South Dakota.

Table 5.1 Land Use Statistics For South Dakota, 1992.

Land Use	Acres	% Of Total
Rangeland	21,932,800	44.4
Cropland	16,436,300	33.3
Water & Federal Land	3,894,800	7.9
Minor Uses	3,256,700	6.7
Pastureland	2,158,000	4.5
Developed Land	1,135,300	2.2
Forestland	540,100	1.0

Source: 1992 Natural Resources Inventory Land Use For South Dakota.

South Dakota had 35,000 farms in 1992, (1992 U.S. Census), averaging 1,263 acres in size. Total land in farms was 44,200,000 acres out of a total of 49,310,080 acres in the state. See Table 5.1 for land use in acres for South Dakota in 1992. Indian reservations comprised 6.9 million acres according to the 1992 U.S. Census. South Dakota has 1.7 million acres of forest, 3.4% of its total land area, according to the 1988 South Dakota's Timber Resources report. See Table 5.2 for a break down of South Dakota's forested land. (This number is different from the one used in Table 5.1 because of the way the two agencies calculate what constitutes an acre of forestland).

Table 5.2 Forestlands Of South Dakota.

Forestland	Acres	% Of Total
Ponderosa Pine	1,400,000	82
Other	204,300	12
Elm/Ash	95,700	6.0

Source: 1988 South Dakota's Timber Resources Report.

In 1992, the South Dakota Agricultural Statistical Service (SDASS) published information on South Dakota crops planted, the acreage for each crop and the percent of the crop acres receiving a pesticide application. The top five crops planted or harvested in South Dakota in 1992 were corn, soybeans, other spring wheat, alfalfa hay, and all other hay. Table 5.3 contains this information.

5.2.2 IRRIGATION

Table 5.3 1992 Crops Planted In South Dakota. Total Acreage And Percent Receiving Pesticide Applications.

Crop	Acres Planted	Acres Harvested	Herbicide %	Insecticide %
	1,000(s) Acres			
WHEAT, ALL	4,385			
Winter	1,650		47	2
Durum	35			
Other Spring	2,700		74	<1
CORN	3,800		92	12
For Grain		3,300		
For Silage		420		
SORGHUM	580			
For Grain		380		
For Silage		100		
OATS	900			
BARLEY	420			
RYE	55			
FLAXSEED	15			
POTATOES	6.5			
SOYBEANS	2,300		95	1
HAY, ALL		4,200		
Alfalfa Hay		2,200		
All Other Hay		2,000		
SUNFLOWER, ALL	400			
Sunflower Oil	390			
Sunflower Non-Oil	10			

Source: South Dakota Agricultural Statistics Service 1992-1993.

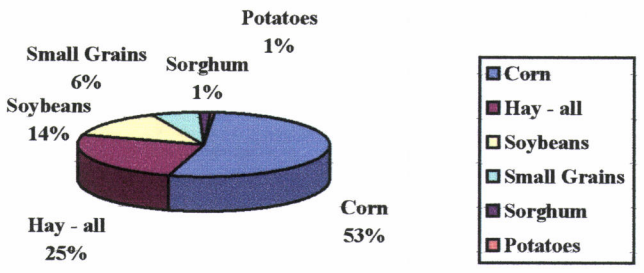
The 1992 South Dakota Irrigation Report indicated ninety-five aquifers or management units within aquifers permitted for irrigation use, with 907,693 acre-feet of ground water appropriated for use. Only 64,892 acre-feet of water was reported to have been pumped, however. According to the 1992 U.S. Census, harvested cropland irrigated in South Dakota in 1992 accounted for 371,263 acres. This equals 4.9% of the farms in South Dakota with some form of irrigation (ground water and/or surface water). See Figure 5-1 for irrigated land acres by crop in South Dakota.

5.2.3 PESTICIDE USE ASSESSMENT

The total number of agricultural pesticides registered in South Dakota as of April 1995 was 1,396 or 19% of the total 7,400 pesticide products registered for that year. Even though non-agricultural pesticide products make up the greatest share of pesticide products registered in South Dakota the registration tracking system does not record what that labeled use is. South Dakota does not record non-agricultural active ingredient totals or private applicator use of agricultural product active ingredients.

Applications of pesticides have been tracked in South Dakota by several means. The first is the South Dakota Department of Agriculture's (SDDA's) Commercial Applicator Summary Form (see Appendix K). The last compiled (statewide) data collection is from the year 1992. The 1992 data for commercial applications indicate 2,4-D (3,705,672 acres) was the most commonly used pesticide, followed by dicamba - Banvel[1] (2,218,910 acres), glyphosate - Roundup (647,214 acres), metsulfuron-methyl - Ally (572,751 acres), trifluralin - Treflan (513,707 acres), and atrazine (467,793 acres). (See data in Table 5.4 for SMP pesticides and the pounds of active ingredient applied for each in 1992. Also, see Appendix F for 1992 Commercial Applicator Summaries.)

Figure 5-1 South Dakota Irrigated Land - 1992.



Source: 1992 SD Irrigation Report.

[1] Brand names used are examples only.

Table 5.4 1992 South Dakota Commercial Applicator Spray Report Summary - For Proposed SMP Pesticides Applications.

SMP Pesticides Chemical Name	Example Trade Names	Acres Treated	Pounds AI Applied/Year
Alachlor	Lasso	290,725	794,915
Atrazine	Atrazine	467,793	477,309
Cyanazine	Bladex	258,180	415,228
Metolachlor	Dual	217,055	459,086
Simazine	Princep	880	3,175

Source: SDDA Commercial Applicator Spray Summary Report 1992. (Proposed SMP pesticides are emphasized).

Table 5.5 South Dakota Pesticide Use By Active Ingredient For Proposed SMP Pesticides.

SMP Pesticides Chemical Name	SMP Product	Pounds AI Applied/Year
Alachlor	Lasso	1,019,981
Atrazine	Atrazine	841,644
Cyanazine	Bladex	848,904
Metolachlor	Dual	1,573,627
Simazine	Princep	12,923

Source: National Center for Food and Agricultural Policy, 1992 Report. (Proposed SMP pesticides are emphasized).

The National Center for Food and Agricultural Policy (NCFAP) collected and organized pesticide use data from several sources. Pesticide use information came from surveys by the National Agricultural Statistics Service, reports from states and selected crops reports from USDA, assessments by USDA, and farmer pesticide use records from California. See Table 5.5 for South Dakota data.

The 1995 report entitled Pesticide Use In U.S. Crop Production from NCFAP for the years 1990-93 also lists agricultural pesticide use in South Dakota. It was estimated that South Dakota placed 20th out of 48 states using only 15.7 million pounds of pesticide active ingredients. This is an estimated 1.8% of the total agricultural pesticide applied in the continental United States. Minnesota, Nebraska and Iowa each applied approximately twice as much pesticide active ingredient as did South Dakota. 2,4-D, trifluralin, metolachlor, alachlor, cyanazine, atrazine, dicamba, propachlor, butylate, and glyphosate round out the top ten pesticides applied in South Dakota for this time period. Table 5.6 lists agricultural pesticide active ingredient use in South Dakota.

Frequency and extent of active ingredient use in South Dakota can be found in Table 5.7. Corn acreage, for example, had applications of alachlor 23%, atrazine 27%, cyanazine 14%, and metolachlor 15%. This information is found in the 1992 South Dakota Crop and Livestock Reporter (SDCLR).

Pesticide use on South Dakota's agricultural land, is usually less than in surrounding states, according to the SDASS. In 1992 South Dakota applicators applied herbicide to 92% of the corn acres. In Minnesota and Iowa the corn acres received herbicide on 99% and 98% of

Table 5.6 Pesticide Use By Active Ingredient (1990-1993).

Pesticide	Lbs Active Ingredient Applied/Year	Pesticide	Lbs Active Ingredient Applied/Year
2,4-D	3,104,461	Imazamethabenz	22,398
2,4-DB	1,723	Imazaquin	6,075
Acifluorfen	28,000	Imazethapyr	46,102
Alachlor	1,019,981	Lactofen	4,500
Atrazine	841,644	MCPA	333,949
Bentazon	291,751	***Metolachlor***	1,573,627
Bromoxynil	162,916	Metribuzin	12,063
Butylate	755,000	Metsulfuron	4,675
Chlorimuron-ethyl	1,485	Nicosulfuron	17,856
Clomazone	15,300	Paraquat	40,266
Clopyralid	20,200	Pendimethalin	302,719
Cyanazine	848,904	Picloram	88,572
Dicamba	824,093	Primisulfuron	1,488
Diclofop	55,995	Propachlor	788,500
Diquat	108	Quizalofop	5,625
EPTC	213,467	Sethoxydim	21,892
Ethalfluralin	140,132	***Simazine***	12,923
Fenoxaprop	17,990	Thifensulfuron	5,442
Fluazifop	27,000	Tribenuron	2,821
Glyphosate	502,637	Trifluralin	1,639,147

Source: National Center for Food and Agricultural Policy - 1990-1993 Survey Data. (Proposed SMP pesticides are emphasized).

the corn acres respectively. Soybean acres in South Dakota received a herbicide application on 95% of the planted acres, while in Minnesota and Iowa applicators applied herbicides to 100% of the soybean acres.

5.3 SOILS

South Dakota has many different types of soils. Although there are numerous factors in soil development, the variation in parent material in the state provides for a variety of soil types. The Black Hills hard rock outcropping, sedimentary formations of the plains, and the glacial drift formations in the eastern half of the state are sources of the state's soils.

Table 5.7 Frequency and Extent of Herbicide Active Ingredient Use in South Dakota 1992.

Herbicide	Area Applied %	Total Applied Pounds
WINTER WHEAT		
2,4-D	38	123,000
Metsulfuron-methyl	31	1,000
OTHER WHEAT		
2,4-D	47	428,000
Dicamba	36	79,000
MCPA	17	143,000
CORN		
2,4-D	14	160,000
Alachlor	23	1,047,000
Atrazine	27	827,000
Bromoxynil	10	92,000
Cyanazine	14	850,000
Dicamba	48	562,000
EPTC	14	2,070,000
Metolachlor	15	1,222,000
Nicosulfuron	7	9,000
Propachlor	5	658,000
SOYBEANS		
Bentazon	18	294,000
Chlorimuron-ethyl	11	2,000
Imazethapyr	34	46,000
Thifensulfuron	9	1,000
Trifluralin	61	1,284,000

Source: 1992 S D Crop and Livestock Reporter.
(Proposed SMP pesticides are emphasized).

Soil development is slow in the igneous and metamorphic rocks in the Black Hills area. Soils formed in these materials commonly are quite shallow and contain large amounts of rock fragments. The sedimentary sandstone, siltstone, limestone, and shale formations have produced different soil characteristics. The Pierre Shale, an Upper Cretaceous formation which dominates the land surface in a large area of western South Dakota is the source of easily erodible expansive clays. The sandstone and sandy shale in the northwestern part of the state are the source of several types of soils including sands, sandy loams, clay loams, silty clay loams, silty clays, and clays. Sandstone and siltstone in the southwestern and south central portions of the state weathered to sandy and silty soils, with wind blown sand hills extending north from the Nebraska Sand Hills.

Soils east of the Missouri River are derived from materials that resulted from glacial drift deposits. Glacial deposits can be described as three major groups: till, outwash, and glacial lake deposits. Till is a mixture of clays, silts, sands, and rock fragments and may be intermingled in any proportion. Outwash materials consist mostly of sand and gravel often overlain by alluvium. Soils developed from outwash are loamy or silty over sandy or sandy-skeletal material. Glacial lake deposits consist of bedded silt and clay with some fine sand. Soils developed in the glacial lake deposits range from loamy fine sand to clay.

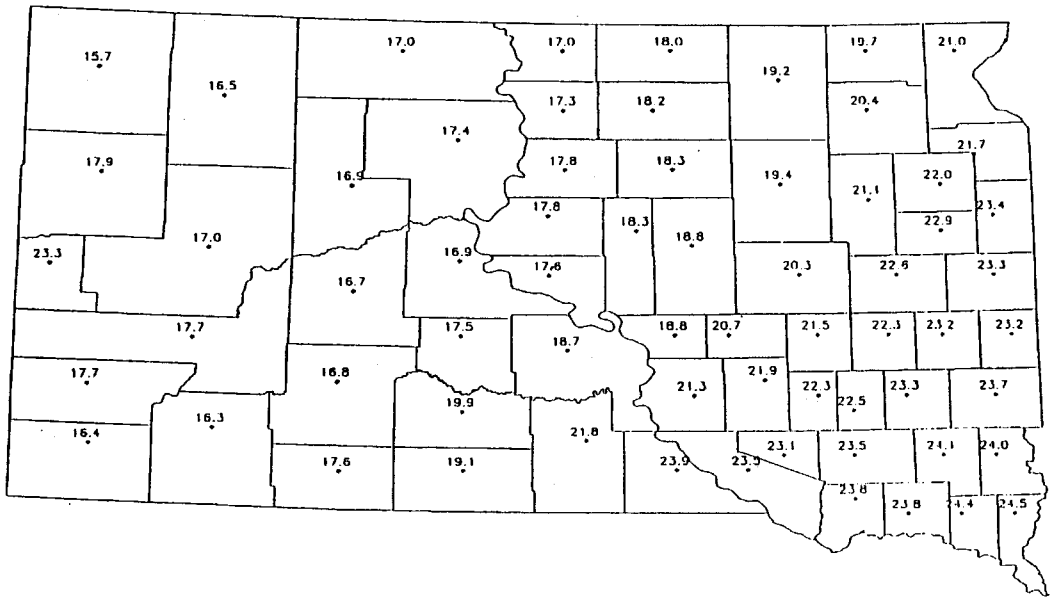
Wind-blown sediments (loess) consisting of silts from western South Dakota mixed with glacial silts are deposited in areas along the Missouri River. Other wind-blown sediments in the eastern part of the state consist of sandy and silty materials. Alluvium consisting of gravel, sand, clay, and silt was deposited by moving water and is found along the major drainage ways in the state. Alluvial soils range from clayey to sandy.

5.4 CLIMATE

South Dakota has a continental-type climate, experiencing rapid fluctuations in temperature with periods of extreme heat in the summer (over 100° F) and cold in the winters (below -20° F). The average annual temperature for the state is 46° F. Average length of the growing season is about 120 days in the northern portions of the state and about 160 days in the southeastern part.

Annual precipitation varies from between 24 and 25 inches in the southeast to less than 14 inches in the northwest. See Figure 5-2 for a map of annual precipitation. Most of the precipitation occurs during the growing season in spring and early summer. Much of the summer precipitation comes from thunderstorms which can be very intense, delivering large amounts of precipitation in a short time. Snowfall averages vary from 30-50 inches in the lower elevations to over 100 inches in the northern Black Hills.

Figure 5-2 Annual Precipitation (in.) 1961 - 1990 Normals.



SOURCE: STATE CLIMATOLAGIST - SDSU.

5.5 NON-AGRICULTURAL PESTICIDE USE

Non-agricultural pesticides (those pesticides not used to produce an agricultural commodity) may consist of pesticides used on forest lands, lawns, golf courses, ornamental trees and shrubs, right of ways, homes, and industrial sites. EPA has estimated that from 20 to 64 million people in the United States apply some form of pesticide to their lawn. If the estimated 8-15 million households that have a commercial lawn company apply pesticides are added, the total increases to 40 percent of the nation's private lawns being treated with a pesticide. South Dakota does not track homeowner use of pesticides. The list of proposed SMP pesticides that appeared in the Federal Register Notice of June 26, 1996 contained pesticides that are used almost exclusively by agricultural users in South Dakota. Until the list is expanded to include pesticides used by the general public, South Dakota will focus its efforts on the higher priority agricultural pesticides.

5.6 APPROACH AND ACTIVITIES TO ASSESS VULNERABILITY OF SOUTH DAKOTA'S GROUND WATER RESOURCES

5.6.1 HYDROGEOLOGY

The assessment of South Dakota's ground water resources has been an ongoing activity in South Dakota for over 100 years. Nearly all of the counties east of the Missouri River have had county-wide reconnaissance-level studies completed by the Geological Survey, a program of the Department of Environment and Natural Resources (DENR), and the United States Geological Survey (USGS). Reports for the county studies are commonly published in two volumes, "Geology" and "Water Resources." Geologic and water resource maps at 1:100,000 scale are available for most of the counties where a study has been completed. The county-wide study reports and maps are the result of geologic mapping, test hole drilling and observation well installation, testing, and monitoring. Test holes were drilled by the Geological Survey Program (GSP) approximately every three miles as part of the county-wide studies.

The GSP has conducted several special assessments to secure water supplies for towns and rural water systems. They have also characterized water resources and the geology for various regions or several-county areas. These studies included test hole drilling, monitoring well installation and sampling, aquifer tests, and the development of conclusions and recommendations for each study.

In addition to the ground water and geologic assessments performed by the GSP and USGS, the DENR Water Rights Program has installed and maintained a network of over 1,600 observation wells. These wells have been used primarily for water level elevation measurements with measurements taken on most of the wells twice monthly through the growing season and monthly or every other month through the winter. Water level information dates back to the mid-1950's, although most of the observation wells were installed in the mid- to late- 1970's. The majority of the observation wells are located in the glaciated region of eastern South Dakota.

Over 32,000 lithologic logs, 3,400 water-quality analyses, and 197,000 water levels have been collected from the county-wide studies, special studies, and the Water Rights' observation well network. These data are stored in computerized databases managed by the Geological Survey and Water Rights Programs and are available to the general public.

Numerous other assessment studies have been conducted by or with funding from federal agencies. These agencies include the Environmental Protection Agency, the USGS, the US Department of Energy, the US Department of Agriculture, and the US Army Corps of Engineers. These assessments have produced geologic and hydrologic maps, estimates of aquifer characteristics, water use data, modeling results, natural resources bibliographies, and resource inventories. Products of the studies include USGS atlases and, geologic quadrangle maps, county soil surveys, summaries of water quality data, water use estimates, domestic well inventories, and other publications.

No formal process of mapping sensitive areas to produce a statewide sensitivity map has been completed. However, determinations of sensitivity have been made by DENR on a site specific basis and on an aquifer basis. A sensitive aquifer consists of water saturated rock, sediment, alluvium, or outwash material through which water can readily move, and has been defined for the purposes of this program as one which occurs at or near the land surface, has thin, permeable overlying materials, and/or does not have a substantial thickness of overlying unweathered geologic materials. Sensitive aquifers may be susceptible to man induced impacts because of their occurrence near the land surface.

The studies mentioned previously in this component have all resulted in maps depicting the aquifers in the state. These maps are used to determine sensitive areas/aquifers based on the above definition of sensitivity. These maps vary in scale from 1:250,000 to 1:24,000. These maps continue to be used as basic sensitivity maps as the state pursues funding to complete the following:

1. A 1:500,000 scale surficial geology map of South Dakota is in preparation by the GSP;

2. Based on existing DENR county aquifer maps, maps depicting surface geology (that are used to make maps depicting sensitive and non-sensitive areas) at a 1:100,000 scale have been produced for most counties where a county study has been completed;

3. The surficial geology of a portion of the state is mapped at a scale of at least 1:100,000. Surficial geology mapping by the GSP is needed in a remaining six counties in eastern South Dakota and some counties in western South Dakota at a 1:100,000 scale; and

4. Using existing hydrogeologic data generated from the county-wide studies and other geologic and hydrologic investigations, the GSP will conduct a pilot project where aquifer boundary mapping will be done based on the surficial geology at a 1:24,000 scale. This will be done to compare the resolution between the larger scale and the 1:100,000 scale to determine if larger scale mapping is necessary.

5.7 FUTURE AND PARTIALLY COMPLETED ASSESSMENT WORK

Future and partially completed assessment activities may include the following:

- County-wide assessments of geologic and water resources in Roberts, Todd and Mellette Counties, other counties west of the Missouri River and several partially completed assessments;
- Continued observation well installation in the Black Hills;
- Black Hills Hydrology Study/Black Hills Water Management Study;
- Installation and sampling of the Statewide Ground Water Quality Monitoring Network;
- Integrating all natural resource data into a state-wide GIS system; and/or
- Expanded commercial and private pesticide use data collection.

5.8 CURRENT AND REASONABLY EXPECTED SOURCES OF DRINKING WATER

Aquifers within South Dakota can be grouped into two categories, unconsolidated sand and gravel aquifers (glacial drift and alluvial), and bedrock aquifers. Glacial aquifers consist of outwash (sand and gravel) deposited by glacial meltwater and occur east of the Missouri River valley. Alluvial aquifers include sand and gravel deposits underlying the major streams and rivers within the state. The glacial and alluvial aquifers are the most abundant and easily accessible sources of ground water for much of the state's population. East of the Missouri River, ground water accounts for about seventy (70) percent of all water used. The water quality within these shallow aquifers is highly variable but is generally suitable for domestic, industrial, and agricultural use.

Deep bedrock aquifers are generally less susceptible to contamination, as they are often overlain by thick clay and shale deposits. The exception is the outcrop areas in the Black Hills. All or portions of some bedrock aquifers such as the Ogallala, and the Arikaree are also susceptible to contamination. Bedrock aquifers are the only source of ground water west of the Missouri River, except for a few small alluvial aquifers along major streams. The bedrock aquifers are used extensively as rural-domestic and stock water supplies and for municipal and industrial use. The majority of the bedrock aquifers are unsuitable for irrigation. Ground water accounts for up to thirty (30) percent of water used in the western part of the state.

South Dakotans are very dependent upon ground water with over 95% of the state's public water supplies serving three-fourths of the state's population. The major sources of ground water for over 30% of the state's population are the shallow glacial aquifers of eastern South Dakota. These shallow glacial aquifers, the bedrock aquifers which crop out in the Black Hills area, and alluvial aquifers which occur throughout the state are the most vulnerable ground water resources in the state. They are vulnerable because they occur in densely populated areas with a high concentration of pollution sources above them, and only thin, overlying materials for protection. In addition to public drinking water uses, ground water is used extensively for irrigation, agricultural uses, commercial and industrial facilities, and domestic uses. The bedrock aquifers in and near the Black Hills, although highly sensitive are not in the Statewide Ground Water Quality Monitoring program and they are not included in Table 5.8. The Black Hills Hydrology Study is addressing these aquifers. This study, when completed, will provide a characterization of ground water quality and quantity in the Black Hills.

Almost 50% of the 453 million gallons of water used daily in South Dakota is ground water. Ground water is highly valued in South Dakota because of the lack of good quality surface water that can presently be distributed for use as drinking water. Only 5% of the public water supplies in the state use surface water. Nearly everyone not supplied by public water systems is dependent upon ground water for domestic use. Ground water supplies over 50% of all the water applied to the land surface for irrigation.

Administrative Rules of South Dakota (ARSD) 74:54:01 classifies all ground water with a total dissolved solids concentration of less than 10,000 parts per million (ppm) as having the beneficial use of drinking water. Ground water quality standards have been set; the standards are based on EPA's maximum contaminant levels for drinking water. All ambient ground water which meets the 10,000 ppm limit for total dissolved solids is to be protected or remediated to meet the ground water quality standards.

5.9 PRIORITIZATION OF AQUIFERS IN SOUTH DAKOTA

South Dakota Codified Law §34A-2-107 requires DENR to prioritize ground water pollution prevention and protection efforts for the state. Prioritization is to be based on ground water quality standards, beneficial uses of water, the extent to which a ground water source supplies or might feasibly supply public water systems or wellhead protection areas, the degree of hazard to public health and welfare, the dependence of local citizens upon ground water supplies, and the vulnerability of ground water supplies to contamination.

To implement the legislative mandate, a resource-based prioritization process was developed based on the potential for contamination and impacts the contamination would have on aquifers or specific portions of aquifers. An aquifer in South Dakota is defined as "a geologic formation, a group of geologic formations, or part of a geologic formation that contains sufficient saturated permeable material to yield quantities of ground water to wells and springs." The following considerations were used to prioritize aquifers or portions of aquifers for the state's protection and planning activities:

- The impacts to public health if the ground water was contaminated;
- The potential of an aquifer/area to be designated as a wellhead protection area;
- The amount of water used or that could be used from an aquifer/area for private and public water supplies and whether there are alternative drinking water supplies;
- The ambient total dissolved solids concentrations (whether it was 10,000 ppm or less);
- The sensitivity of the aquifer/area;
- Any documented water quality problems; and
- Any special considerations (such as connection to surface waters, recharge areas, or high ambient water quality).

It must be noted that delineated and potential wellhead protection areas, are the highest priority areas, regardless of the aquifer or ranking of the aquifer. State cooperators will provide advice and assistance to private well owners regarding the protection of their wells. In places where contamination has been proven every reasonable attempt will be made to afford the same considerations to private wells as is afforded to the Public Water Supply Systems. Minimum wellhead protection areas are recommended for public water supplies in the state wellhead protection program document. Refer to Box 5.1 for aquifer ranking.

Box 5.1
Aquifer Ranking

Highly Sensitive

Whole, or parts of, glacial, alluvial, and bedrock aquifers which essentially occur at the land surface.

Moderately Sensitive

Whole, or parts of, glacial, alluvial, and bedrock aquifers which occur near the land surface and are overlain only with weathered or fractured materials.

Least Sensitive

Whole, or parts of, glacial, alluvial, and bedrock aquifers which are more deeply buried or otherwise buried by an effective confining layer.

5.10 USE OF VULNERABILITY IN THE GENERIC STATE MANAGEMENT PLAN

South Dakota has established a ground-water prioritization process. The process is based on the potential for contamination and the impacts contamination would have on ground water. This process is designed to assess aquifers independent of aquifer size. The following criteria are used to prioritize ground water:

- Areas that will affect public health.
- Wellhead protection areas/public water supplies.
- Private water supplies.
- Ambient water quality with a Total Dissolved Solids value of 10,000 mg/L or less giving it the beneficial use of drinking water.
- Vulnerability
  - * Surficial glacial/alluvial aquifers,
  - * Portions of glacial and bedrock aquifers which exist at or near the land surface,
  - * Intermediate glacial aquifers,
  - * Basal glacial aquifers,
  - * Bedrock aquifers.
- Documented water quality problems.
- Special considerations.

Based on the above criteria, the following ranking for aquifers in South Dakota has been developed:

1. Big Sioux Aquifer;
2. Alluvial aquifers and bedrock aquifer outcrop areas in and around the Black Hills;
3. Parker-Centerville aquifer;
4. All other surficial glacial and alluvial aquifers;
5. Ogallala/Arikaree aquifer;
6. Fox Hills/Hell Creek/Fort Union aquifers;
7. Portions of intermediate and basal glacial and bedrock aquifers where existing at or near the land surface (East of the Missouri River);
8. Intermediate glacial aquifers;
9. Basal glacial aquifers; and
10. Bedrock aquifers.

In addition to DENR's use of the above categorical ranking of aquifers, the ranking was used for prioritizing state ground water research and public education funds. It was also included in the South Dakota Section 319 Nonpoint Source Pollution Management Plan by the Nonpoint Source Task Force.

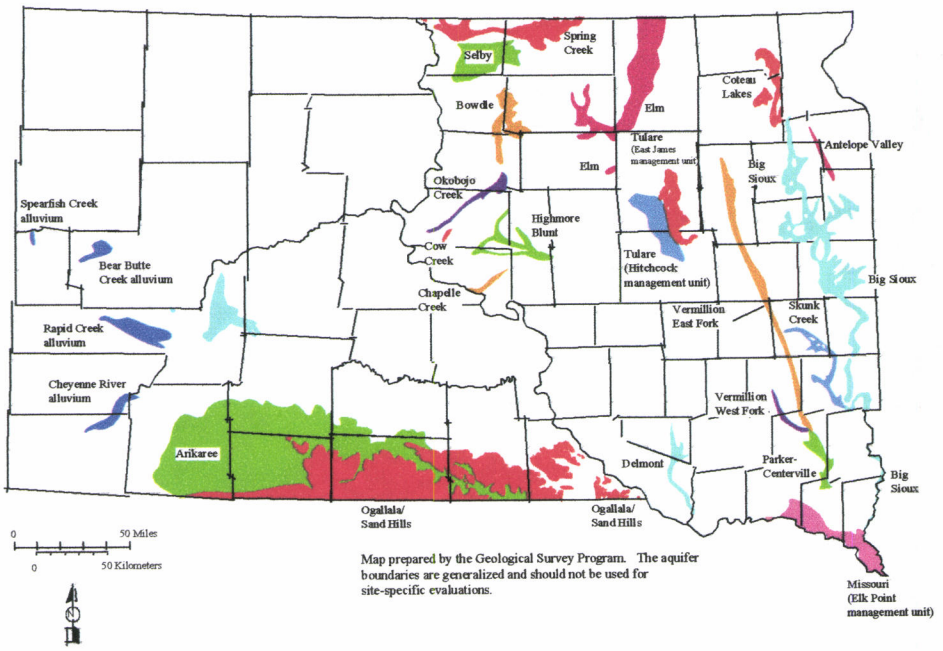
Table 5.8 Aquifer Ranking for the Statewide Monitoring Network.

Aquifer	Aquifer
Big Sioux	Selby
Skunk Creek	Tulare (Hitchcock Management Unit)
Ogallala/Sand Hills	Tulare (East James Management Unit)
Antelope Valley	Delmont
Alluvium - Bear Butte Creek	Elm
Alluvium - Cheyenne River	Arikaree
Alluvium - Rapid Creek	Coteau Lakes
Alluvium - Spearfish Creek	Cow Creek
Missouri (Elk Point Management Unit)	Vermillion West Fork
Vermillion East Fork	Spring Creek
Parker-Centerville	Chapelle Creek
Highmore-Blunt	Okobojo Creek
Bowdle	

Source: Geological Survey Program.

The aquifers included in the highest priority category are listed in Table 5.8 (Aquifer Ranking For The Statewide Ground Water Quality Monitoring Network) and depicted in Figure 5-3 (Aquifers To Be Monitored In The Statewide Ground Water Quality Monitoring Program). The further prioritization of these aquifers has been intended primarily as a planning tool for the installation and incorporation of wells into the network and as a means of budgeting financial, physical, and personnel resources. Each aquifer was ranked numerically based on a subjective prioritization scale which considered sensitivity of the aquifer, land use over the aquifer, other practical sources of water, and the extent of use for drinking water from the aquifer.

Figure 5-3. Aquifers To Be Monitored In The Statewide Ground Water Quality Monitoring Network



Source: Geological Survey Program.

Much work has been done to describe the vulnerability of individual aquifers on a limited site specific basis, such as permitted "point source" facilities. Fate and transport modeling is sometimes required as part of a state permit. A review process may then determine the relative vulnerability of ground water to pollutants of concern from the permitted facility. Vulnerability of ground water in specific aquifers to individual contaminants such as pesticides has not been done.

The SDDA and the East Dakota Water Development District (EDWDD) have completed several county Geographic Information System projects that will provide the State with aquifer vulnerability information down to the sub-county level for SMP pesticides. This cooperative effort began in 1991 with the East Dakota Water Development District and a Clean Water Act, Section 319 project proposal entitled "Implementation of Comprehensive Local Ground Water Protection Measures in the Big Sioux Aquifer Area of Eastern South Dakota". The purpose of this project was stated as to "Facilitate better management for protection of rural and municipal water supplies. This approach utilizes a computerized geographic information system (GIS) which consolidates all available natural resource data in a series of map overlays that allows visual and computerized analysis of the interacting resource layers". The EDWDD, EPA-Region VIII-Ground Water, SDDA, DENR, a local and the state office of the NRCS, SDSU water resource and soil scientists and a local private GIS contractor participated in early project development. This group agreed upon development of different GIS overlays and the specific criteria for digitizing. The SDDA has continued this work and has contracts that meet the criteria for digitizing standards published by the National Cartographic Center of the NRCS. The scale is 1:24,000. The following counties have digitized and attribute data available: Brookings, Codington, Deuel, Hamlin, Minnehaha, Moody Grant, Lake, Clark, Kingsbury, Miner, Turner, Union, Lincoln, and Clay. This work includes GIS layers and attribute data of soils, shallow aquifers, wellhead protection areas, transportation, and hydrography. The surficial aquifers are delineated, designated with an appropriate map scale and combined with soil characteristics from the

South Dakota, NRCS Technical Guide, Table 1 - Soil Interpretive Groups, Column - Hydrologic Group (A-D), with "A" equaling the most vulnerable and "D" the least vulnerable areas.

Pesticide properties are important factors in determining the fate of pesticides in the environment. Properties that determine if a pesticide will leach to ground water include adsorptivity, degradation rate, solubility, and volatility. Information on these properties will be gathered by SDDA and used along with soil properties and surficial aquifer data in the GIS to help determine the fate of pesticides in the environment.

A pilot project, dealing with the Hayti, South Dakota, 7.5 minute topographic quadrangle map, has been initiated to help SDDA determine what types of information will be needed to make pesticides and ground water vulnerability assessments using GIS information layers. The project is designed to provide SDDA with the necessary information to determine the direction and scope of the GIS layers and attribute data currently being collected. The intent of the project is to determine if cyanazine and atrazine pose significant threats to the aquifer in the Hayti quadrangle under differing climatic conditions, using the following GIS layers: soils, geology/stratification, depth to ground water, surface water/wetlands, land use/farming practices, climatic data, elevation, political boundaries, unconfined aquifer data, well location/well data, land ownership, transportation, vegetation/shelterbelts, ground water monitoring data, and chemical application data. Other prioritized sensitive areas in the state will be mapped as funds, time, and personnel become available.

For the Generic State Management Plan, the aquifer sensitivity information will be used in conjunction with the monitoring data to plan future activities for Chemical Specific State Management Plans. The data collected from the monitoring network and the pesticide use data will be used to develop responses to pesticide detections in ground water using GIS, and any applicable agricultural or ground water computer models (Basins for example), to determine the vulnerability of an aquifer or site specific area. The data will be used to prioritize education and information programs that will bring best management practices information to the applicators and other activities presented in Components 7 and 8 of this document.