NORTH DAKOTA SURFACE WASTEWATER IMPOUNDMENT ASSESSMENT REPORT

by

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CHAPTER 1

EXECUTIVE SUMMARY

The numerical results of the North Dakota SIA are shown in Table I. This table is discussed in more detail in Chapter 4. The table indicates that the great majority of impoundments in North Dakota fall into the Municipal and Agricultural Categories. The other three categories constitute relatively small percentages of impoundments.

Table I. Number of Sites Located and Assessed During SIA

SIA Results

Number of Sites			Number of Impoundments		
Category	Located	Assessed	Category	Located	Assessed
Agriculture	248	248	Agriculture	283	287
Industrial	11	11	Industrial	30	30
Municipal	363	360	Municipal	746	739
Oil & Gas	24	24	Oil & Gas	31	30
Mining	21	21	Mining	74	54
TOTAL	667	664		1164	1140

All impoundments located in North Dakota were assessed in the SIA. This was possible because of an excellent existing data base concerning the location of impoundments and the surface geology of the State. In addition, it was desired to have a comprehensive program to identify all hazardous impoundments for state regulatory and planning purposes.

The results of the assessment phase discussed in Chapter 4 indicate that many surface impoundments are sited in geologically poor locations

and therefore have high pollution potentials. It is estimated that 70-80 percent of sites would be considered to have high or moderate pollution potential. In addition, significant numbers of impoundments were found to be located close to wells or surface water sources. For example, about 20 percent of the impoundments are located within 1600 meters of a well in the direction of groundwater flow. The combination of the two assessment parameters, pollution potential and health hazard, indicates that about 5 percent of the impoundments are considered to have high pollution potential, and in addition, are within 400 meters of a well in the direction of groundwater flow.

The relationship of the results of the SIA to actual groundwater pollution from surface impoundments in North Dakota cannot be determined. Very few cases of documented or suspected groundwater pollution from surface impoundments have been reported in the state. Many factors could act to mitigate the actual danger suggested by high pollution potential or high health hazard values. The most important of these are the estimation of parameters which is inherent in the SIA. These uncertainties can be estimated by the degree of confidence ratings assigned in the study. In addition, the effect of liners, possible self-sealing properties of some waste impoundments, and the remoteness of some sites should be taken into account in any conclusions drawn from the SIA. Within the constraints and limitations of the study, however, the SIA should provide a means for determining the potential effects of the nation's surface impoundments.

Surface impoundments in North Dakota are currently regulated by the North Dakota State Department of Health, the North Dakota Geological Survey, and the North Dakota State Water Commission. The Department of

Health reviews the plans and specifications for municipal, agricultural, and industrial surface impoundments and has developed guidelines for construction of municipal and agricultural impoundments. The State Water Commission, through the water permitting system, reviews all plans for impoundments greater than 12.5 acre-feet, and the Public Service Commission reviews plans for all surface impoundments used in surface mining operations. In the Oil and Gas category, impoundments are regulated by the North Dakota Geological Sruvey under the statuatory authority of the North Dakota Industrial Commission. These regulations were recently made more stringent and seem to provide an adequate program for regulation of these impoundments. The effect of abandoned oil and gas impoundments may be a serious problem in some areas but could not be addressed in this study.

From the results of the SIA, it is proposed that some changes be made in the regulation of surface impoundments. The most important of these would include more detailed site investigation and the requirement of special engineering safeguard and monitoring systems in some particularly hazardous cases. In addition, there is a need for more basic research to determine the effects of surface impoundments upon groundwater systems. Major new regulatory programs should not be instituted until disposal of wastes in surface impoundments is better understood. Research is also needed in the delineation and hydrogeological evaluation of aquifer systems susceptible to contamination by near-surface waste disposal practices.

CHAPTER 2

RECOMMENDATIONS AND CONCLUSION

The North Dakota SIA should provide a good data base for the evaluation of pollution potential from surface impoundments in the state. Since all impoundments located were assessed, the project should give an accurate representation of the site conditions of surface impoundments. The danger to water supplies, should pollution actually occur, can be estimated from the Health Hazard portion of the study. With the SIA data, it will be possible to focus regulatory and research efforts on the impoundments constituting the greatest endangerment to water supplies by prioritizing impoundments based on pollution potential, health hazard or both.

The weakness of the SIA lies in its lack of hard data and reliance on estimation. The available data used to assess sites was highly variable with respect to detail, accuracy and purpose of collection. Few impoundments in North Dakota have been investigated with respect to both materials and groundwater conditions. This lack of local knowledge probably led to a conservative bias in the assessment, that is, sites may have been given higher pollution potential values because of the lack of information on specific site conditions as well as the lack of information on the presence or absence of pollution occurring from impoundments in operation. The assessment of sites by different investigators also led to differences in assessed values. On a national basis, this could be an even more serious problem.

Because of the various assumptions concerning the groundwater and waste systems, the application of the SIA to estimate actual groundwater

pollution cannot be permitted. Many factors may lessen the possibility of groundwater quality degradation or health hazard to individuals. These include pond liners, the possible self-sealing effects of some wastes and possible chemical reactions of the waste with components of the saturated and unsaturated flow systems.

The general conclusions of the North Dakota SIA are presented below in sequential fashion. The basis for the conclusions is developed in later chapters.

(1) The great majority of impoundments in North Dakota fall into the Agriculture and Municipal categories. Numbers of presently operating impoundments in the other categories are low.

(2) Many impoundments (70-80 percent) are located at sites with high or moderate pollution potential.

(3) Substantial numbers of impoundments are located near wells, streams, or lakes. Significant numbers of impoundments are sited in areas with high pollution potential and in close proximity to water supply sources. For example, about 5 percent of the impoundments assessed had a pollution potential (Step V value) equal to or greater than 20 and also were within 400 meters of a well in the direction of groundwater flow.

(4) The number of cases of documented or suspected groundwater pollution from surface impoundments is very small. The amount of actual pollution occurring from surface impoundments is not expected to be significant, but actual pollution occurring cannot be determined from the SIA for the reasons mentioned above. There are an insufficient number of monitoring facilities at surface impoundments in the state to estimate the reliability of the impoundments.

(5) State programs are generally adequate for present purposes. Some minor changes could be made to increase the degree of groundwater protection. For example, there is a lack of data concerning geological conditions at impoundment sites.

(6) The effects of abandoned impoundments, particularly in the Oil and Gas category are not known. These impoundments could present future problems due to their large numbers.

(7) The geological data base used to assess the impoundments is good in most places but gaps do exist in the geologic map coverage.

Recommendations

(1) More site specific geologic and hydrogeologic information should be required prior to construction of surface impoundments. This data should be reviewed by the North Dakota Geological Survey or the State Water Commission with respect to groundwater pollution prior to construction of the impoundment. Guidelines should be set up to provide for stricter engineering standards in cases of toxic wastes, high pollution potential, and high health hazards. This may be partially accomplished by the EPA Hazardous Waste regulations.

(2) A representative number of impoundments in each category should be monitored for possible groundwater contamination under the supervision of the State Health Department. This program should be started to ascertain the basic reliability and safety of surface impoundments. In addition, periodic monitoring can detect changes in the performance of the impoundments and/or liners, as well as long-term changes in groundwater quality around the impoundments.

(3) Basic, systematic study of near-surface materials and their hydrogeologic properties should be encouraged and supported. Proper site selection is a function of the nature of the unsaturated and saturated flow systems as well as the nature of the materials making up the geologic framework of the flow systems.

(4) Each state must be allowed to develop an individual groundwater protection program. Each program should address the varying geological conditions, quantity and characteristics of the wastes, and other site specific conditions. Federal funding and technical assistance can aid in the development of these programs.

CHAPTER 3

SIA METHODOLOGY

Organization and Contractual Agreements

The Surface Impoundment Assessment (SIA) was carried out in North Dakota with the participation of two state agencies; the North Dakota State Department of Health (NDSDH) and the North Dakota Geological Survey (NDGS). The SIA grant was awarded to the State Health Department, which then made contractual agreements with the State Geological Survey and with an independent geologist hired on a consulting basis.

Job assignments for the SIA were split between the two agencies. The State Health Department, assisted by the contract geologist, was responsible for the location and count of all impoundments with the exception of the Oil and Gas category. The contract geologist was an individual with a recent B.S. degree in Geology. His experience in hydrogeology was very limited. The State Geological Survey was charged with lead activity in site assessment, location and count of the Oil and Gas sites, and supervision of the contract geologist. The project leader for NDGS has a Ph.D. degree in Geology and three years experience in environmental geology and hydrogeology. In practice, site assessments were made by both the contract geologist and the NDGS project leader. In addition, sites assessed by the contract geologist were reviewed by the NDGS project leader.

Completion of the final report and formulation of recommendations has been a combined effort between the NDGS project leader and the Director and Assistant Director of the Division of Water Supply and Pollution Control (DWSPC) of the State Health Department.

Data Collection

Location and Count

Location and count of sites in all categories except Oil and Gas was carried out by the contract geologist in cooperation with the Division of Water Supply and Pollution Control. As the regulatory agency for most waste disposal activity, the DWSPC maintains lists of impoundments (through the NPDES permit system) which were included in the Municipal, Mining, and Industrial categories. Agricultural impoundments are also monitored by the DWSPC. Locations of these impoundments were furnished by the U.S. Soil Conservation Service and DWSPC. These lists constitute the primary data source for location and count of the four categories mentioned above. The location and count of impoundments in the Oil and Gas category was accomplished by NDGS because this agency is given regulatory authority by the State Industrial Commission, the regulatory body for the oil and gas industry in North Dakota. The impoundments included in the Oil and Gas category of the SIA are only those in present operation as permitted Salt Water Handling Facilities by the State Industrial Commission. The list of impoundments included was submitted by NDGS field inspectors during the SIA. Because of the large number of oil wells drilled for exploration and production in the 30 years since oil exploration began in North Dakota, only those impoundments presently in operation were included in the SIA. It was not feasible to include all impoundments that have been constructed in the past. The small number of operational pits located reflects the present trend of the oil industry to dispose of produced water in injection wells to deep subsurface strata.

In the Municipal, Industrial, Agricultural, and Mining impoundment categories, it is believed that a very high percentage of the actual number of impoundments present in the State is accounted for in the SIA. As mentioned earlier, the impoundment count in the Oil and Gas categories represents only a very small percentage of all impoundments constructed, but includes all those presently in operation.

Whenever possible, locations of impoundments were verified using U.S. Geological Survey (USGS) topographic maps and North Dakota State Highway Department planimetric maps. Impoundments not shown on maps were assumed to be in the location supplied by the permitting agency. Field checks were made in a few cases mainly of impoundments in the Mining and Industrial categories.

Assessment

During the early stages of the SIA, the decision was made to attempt to assess all impoundments found during the location and count phase of the project. This decision was made for several reasons.

1. It was believed that adequate geologic and hydrogeologic data were available in both published and unpublished forms in various state agencies so that fairly rapid assessments could be conducted which would also be accurate within acceptable limits for the purposes of this first round approximation. These data sources will be described in more detail later.

2. For the purposes of the EPA national program, a representative random sample should be adequate. However, for the purposes of North Dakota state agencies concerned with groundwater pollution, it was desirable to have an assessment program which would identify all the

most potentially hazardous impoundments throughout the State. With the total assessment program, state agencies can begin planning and research activities so that hazardous situations can be corrected and that future waste disposal problems can be prevented.

Data sources for the assessment phase consisted of U.S. Geological Survey topographic maps, North Dakota State Highway Department planimetric maps, and published and unpublished geologic and hydrogeologic information. The most important source of geologic and hydrogeologic information was the County Groundwater Study series of publications. This publication series consists of three reports for each county or pair of counties included in the study. The reports are prepared by a cooperative program between the North Dakota Geological Survey, the North Dakota State Water Commission, and the U.S. Geological Survey. The Part I reports deal with the geology of the county and, in particular, the surficial geological materials. Part II is entitled "Ground-Water Basic Data," and includes geologic and geophysical logs of test holes drilled in the county. In addition, information on wells including depth, aquifers encountered, water levels, chemical quality, and well construction is presented in tabular form. Part III is a report on the groundwater resources of the county in which the location, extent, yield, and other properties of aquifers are discussed and illustrated. One or more parts of this series of reports has been published for almost all counties in the State. Additional information is available in unpublished form for some counties for which reports are not completed.

The county groundwater reports constitute an extremely valuable source of information on groundwater in North Dakota. The degree of

accuracy attained in the North Dakota SIA is directly related to the availability and quality of these reports. In areas where county reports and other information is lacking, the degree of estimation during the assessment is higher and, consequently, required lower confidence rankings for various steps in the rating procedure.

Topographic maps were used for estimation of components of groundwater flow systems such as areas of recharge and discharge, direction of flow of groundwater in the vicinity of the impoundment, and position of intersection of the groundwater flow system with a well or surface water supply source.

Problem Areas in the SIA

Location and Count

Relatively few problems were encountered in the location and count phase of the study. The main difficulty resulted from the location of impoundment sites in land-office grid system coordinates. These locations are given in township, range, section, and specific one fourth or one sixteenth of the section. Because the SIA required data to be submitted in latitude-longitude form, a method of conversion was needed. A computer program provided by USGS was used for this task. Because of this method, locations can be considered accurate only to a sixteenth of a section (40 acres) if the original location was supplied in one fourth of one fourth of a section.

In locations of impoundments in the Oil and Gas category, the following procedure was used. Permits for Saltwater Handling Facilities are given for a particular oil lease within a specified section. Thus,

in order to obtain a more accurate location for the impoundment, the location of the well or group of wells producing from this lease was used as the location for the impoundment. In some cases, this may result in a greater error than with other impoundment locations. For the other categories of impoundments, in a small number of cases, locations given for the impoundment were in error and were corrected when possible.

Assessment

During work on the assessment phase of the SIA, a number of problems arose with respect to application of the rating system to both general and individual situations. These problems can best be discussed by sequential consideration of each individual step in the rating procedure.

Step I

Step I presented some of the most difficult problems in the rating system. Step I involves a determination of the thickness of the unsaturated zone and the type of material which comprises the unsaturated zone. Of the two determinations, the rating for type of material was less difficult to assign. The County Ground-Water reports provide an excellent source of information concerning lithology of surface materials in the counties that have been mapped. The geologic maps are published at a scale of 1:125,000 (½ inch = 1 mile) and the quality and detail of the mapping is generally excellent. In counties with incomplete surface mapping, more general, small scale maps were used. This is not a particular drawback because of the nature of North Dakota surface geology.

Most of the glaciated portions of the State have been mapped in the county mapping program. This area is more critical with respect to waste disposal sites because of the relatively large number of near-surface unconfined aquifers. The areas which have not been mapped in the county mapping program generally lie in the southwestern part of the State. Surficial units in these areas consist of Tertiary formations of sand, silt, clay, and lignite, which are highly discontinuous both vertically and laterally. In the absence of surface and subsurface site investigations at each site, it is possible to assign a reasonable estimated value for unsaturated zone materials based on general knowledge of the stratigraphy of these formations. These estimates usually fall in the middle portions of the chart for Step I.

The determination of the thickness of the unsaturated zone, on the other hand, proved to be a difficult decision in many cases. Almost no site specific data concerning water table depth is available from impoundment construction. In addition, relatively few impoundments are located sufficiently close to perennial streams so that a water table depth corresponding to a stream level can be determined. In general, thickness of the unsaturated zone was usually assigned to the 1-3 meter or 3-10 meter categories based on an interpretation of recharge-discharge relations, surface materials, vegetation, and other factors. A problem arose in connection with the case of confined aquifers which were overlain by material of low hydraulic conductivity. Many cases had a setting which can be described as a considerable thickness of material of low hydraulic conductivity overlying a confined aquifer at depths of several hundred feet or more below land surface. If the depth to the top of the confined aquifer were used and the aquifer consisted of coarse sand,

then the Step I value would be 9. This would result in a high pollution potential for the impoundment because of the relative importance of Step I in the rating system. It was decided that such a rated pollution potential would give a misleading impression of the actual pollution potential of the site. Therefore, the near-surface material of low hydraulic conductivity was considered to be the "aquifer" for rating the thickness of the unsaturated zone. This approach is considered to be reasonable for several reasons.

1. Many small capacity wells do tap such deposits as glacial till and glacial-lacustrine clay. These wells may be screened in such material as thin, discontinuous sand lenses, fractured till horizons, and weathered and fractured shale beds.

2. The pollution potential should be low for an impoundment in cases where the near-surface material is generally poorly permeable. Such areas are usually sought out as sites for waste disposal facilities.

3. In the absence of site specific subsurface data, it is assumed that there is a fairly high probability that some favorable material for well development is interbedded with the low permeability material.

Because of the above reasons, confined aquifers were usually not considered in Step I. Exceptions to this approach were made in cases where important confined aquifers did occur in near-surface positions.

Step II

Step II values were assigned with relatively few major problems. As in Step I, the lack of site specific or nearby subsurface information made estimation difficult. These sites usually received low confidence rankings.

Step III

The rating philosophy for Step III is the result of the arguments presented above for Step I. Because of the stratigraphic complexity and heterogeneity of the glacial sediments which cover most of North Dakota, the glacial drift was treated as an unconfined aquifer, regardless of what materials are mapped at the surface. Therefore, in the great majority of cases, a value of 5 was given to any site at which there were shallow wells in the vicinity. These wells would be very small capacity wells tapping permeable lenses in the glacial drift or even glacial till, itself, in favorable locations. This policy resulted in the assignment of a 5 value for most impoundments. For the remainder of sites, estimates were made of water quality and appropriate values assigned.

Step IV

Step IV values were determined on the basis of tables describing contaminant type and source. In the Municipal category, impoundments were arbitrarily given a value of 3 within the 4952 SIC code range except where wastes were considered to be either more or less hazardous than average for some reason. For example, pre-treatment could result in the site being given a Step IV value of 2, whereas the suspected presence of a waste in addition to the normal municipal waste could result in a 4 or 5 Step IV value for the site.

Step VI

Step VI required the determination of the groundwater flow systems in the absence of actual piezometric data. Therefore, the groundwater

flow path was estimated on the basis of topography and postulated geologic setting. This often resulted in a low confidence ranking for this step.

Two specific problems were encountered. It was our understanding that intermittent streams should be considered surface water bodies for the SIA. Therefore, many sites received a Step VI Case B ranking on this basis. Some of the sites would have otherwise been rated as Case C because of a well within 1600 meters, but not in the postulated direction of flow. Secondly, where houses or farms were indicated on topographic maps within the 1600 m radius of the site, they were usually assumed to have shallow wells for Step VI rating purposes. This assumption is probably valid in most cases.

Step VII

Confidence ratings were carried out according to SIA instructions.

Step VIII

Miscellaneous identifiers were added to appropriate cases.

One general problem encountered in completion of the SIA was the poor return time of data sent to EPA. All coded forms from North Dakota were sent to the EPA regional office in July 1979. Allowing several months for data processing, it was assumed that several months would be available for completion of the final report by the end of 1979. Printouts and maps from EPA were not received until late December 1979. This resulted in several inconveniences. First, time budgeted for report writing had to be used for other projects. When the ADP reports finally arrived, time which had been budgeted for other projects had to be reassigned to the SIA report.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

General

The number of sites and impoundments located and assessed are shown in Table I, derived from the EPA final update report. Examination of the table indicates a few minor discrepancies in the numerical results. For example, in the Agricultural category, the table indicates four more impoundments assessed than were located. The table also suggests that

Table I. Number of Sites Located and Assessed During SIA

SIA Results

Number of Sites			Number of Impoundments		
Category	Located	Assessed	Category	Located	Assessed
Agriculture	248	248	Agriculture	283	287
Industrial	11	11	Industrial	30	30
Municipal	363	360	Municipal	746	739
Oil & Gas	24	24	Oil & Gas	31	30
Mining	21	21	Mining	74	54
TOTAL	667	664		1164	1140

slightly fewer sites and impoundments were assessed than located. According to our state results, all sites and impoundments located were assessed. The source of these errors is not known at this time. At any rate, Table I represents a close approximation of the numerical results of the project. As stated earlier, the goal of the state project team was to

assess all impoundments located. No abandoned impoundments were located or assessed. With regard to presently funtioning surface impoundments, it is the opinion of the state project team that the totals submitted represent a very high percentage of actual impoundments. A conservative estimate of the percentage of impoundments included is 98 percent.

The distribution of impoundments within the specific categories reflects the economic conditions in North Dakota. North Dakota is a predominantly rural, agricultural state. Ninety-two percent of the sites and 88 percent of the impoundments located fall into the Municipal and Agricultural categories. Very little non-agricultural industry is present in the state and industrial impoundments account for only 2.6 percent of the impoundments located. Although surface mining of coal is an important industry in the state, the number of actual mines is about 10. This industry accounts for 6.3 percent of the impoundments located. The status of Oil and Gas impoundments was discussed in Chapter 3. Only active Salt Water Handling Facility lagoons were included. Excluded from the North Dakota SIA were mud pits and emergency pits. Since roughly 7000 oil wells have been drilled in the state, the total number of active and abandoned pits of all types associated with the oil and gas industry would number 10,000 to 20,000. The work required to located or assess these impoundments was not possible within the scope of the present project.

The results indicated in Table I can be compared with those estimates made in a preliminary EPA study (EPA,1978). For North Dakota, the EPA report estimates 2,784 impoundments sites in all categories. If all abandoned oil and gas pits were included, this number would be a

considerable underestimate of the actual number of impoundments of all types. The EPA estimate for municipal sites was 250. This compares with 363 municipal sites located in the SIA. Industrial sites were estimated at 76. The actual number located was only 11; however, if mining sites are considered as industrial, the actual number would be 32, still short of the EPA estimate. The number of agricultural sites can be compated with Table 5 of the EPA report (EPA, 1978, p. 39). The table explanation indicates that impoundment sites are being listed; however, the actual heading on the table indicates that numbers of impoundments are being considered with 543 impoundments in North Dakota. The SIA results (Table I) indicate that 248 agricultural sites with 283 impoundments are present in North Dakota.

Therefore, with the exception of the Oil and Gas category, the SIA results show that the EPA estimates (EPA, 1978) were fairly close to the actual number of impoundments present in North Dakota.

Pollution Potential

The pollution potential of impoundments assessed in the SIA is indicated by the numerical value of Step V in the rating procedure. Step V is the total of four previous values which represent the unsaturated zone, the saturated zone, the drinking water quality, and the type of waste. Of these steps, the last two have a relatively minor effect on the Step V total in comparison to the first two. This is true because most of North Dakota's impoundments were assigned to the Municipal or Agricultural categories which have a fairly small range in possible Step IV values (waste type). In the case of Step III, most impoundments were

given a value of 5 for the reasons discussed in Chapter 3. Therefore, the fraction of the Step V value that represents the sum of Step III and Step IV is very nearly a constant for most of the impoundments in North Dakota. Actually, it is not a constant but varies over a small range of values. This leaves Step I and Step II as the determining factors in the pollution potential of the impoundment.

Step I and Step II are basically a function of the near-surface stratigraphy. The dependence of the pollution potential on the surface geology requires a few general comments about North Dakota surface geology. The surface materials of North Dakota can be grouped into two general types (Figure 1). These types are glacial materials and non-glacial materials.

Glacial materials (drift) cover approximately two-thirds of North Dakota. The materials range from clay-rich till and lacustrine deposits with low permeability to fluvial and near-shore lacustrine sediments with high permeability and high water tables. These permeable glacial deposits constitute the best aquifers in the state on the basis of depth and water quality. The major deposits of this type are shown in Figure 1 in yellow. These areas, and those of similar type but too small in areal extent to include on Figure 1, provide the geological settings which result in high pollution potential for surface impoundments. They are characterized by permeable sediments (sand and gravel) with water tables relatively near land surface. In addition to these surficial deposits, similar materials may be buried at various depths below the surface because of processes during previous glaciations. Impoundments sited in areas of less permeable glacial sediments such as till and offshore lacustrine deposits generally received low Step V values.

NORTH DAKOTA GEOLOGICAL SURVEY
E. A. Noble, State Geologist

SURFACE GEOLOGY OF NORTH DAKOTA

by John P. Bluemle, 1977

Miscellaneous Map 18

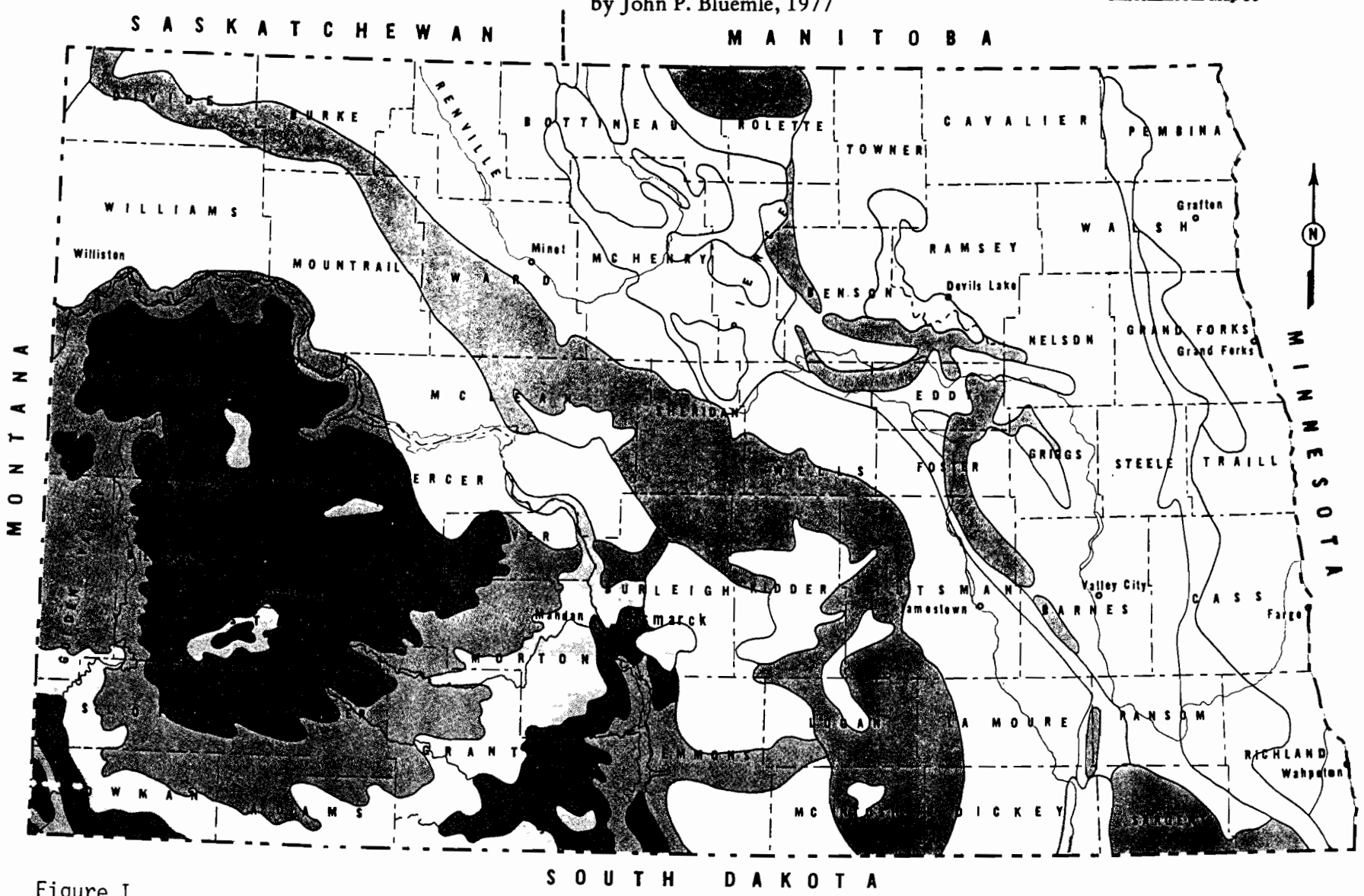

Figure I

CRETACEOUS

- Hell Creek Formation
- Fox Hills Formation
- Pierre Formation

TERTIARY

- White River Group
- Golden Valley Formation
- Sentinel Butte Formation
- Bullion Creek Formation
- Cannonball and Ludlow and Slope Formations

QUATERNARY

Coleharbor Group (glacial drift)

- lake sediment (silt and clay)
- river and beach sediment (sand and gravel)

glacial sediment (till)

- flat to rolling land
- hilly land

0 50 100 MILES

In contrast to the glaciated portion of the state, the non-glaciated southwestern section of North Dakota constitutes a very different set of geological characteristics with respect to pollution potential from surface impoundments. The Tertiary bedrock formations exposed in southwestern North Dakota consist of layered sequences of sand, silt, clay, and lignite. Unconfined, near-surface aquifers are not the common situation. Beds of lignite or sand, which constitute aquifers, are likely to be confined between less permeable beds. The sequence of beds in the Tertiary formations cannot usually be predicted for a waste disposal site without site-specific information because of the lateral discontinuity of the Tertiary formations. Therefore, in assessment of the impoundments in this area, it was usually assumed that material of lower permeability than the aquifer was present between the surface and the most shallow aquifer. As a result, Step V values were generally lower in the southwestern part of North Dakota.

The pollution potential of surface impoundments can best be discussed by consideration of each individual impoundment category.

Municipal

Present North Dakota State Department of Health standards require that municipal waste stabilization ponds or lagoons provide 180 days' storage in a three or more cell system. Raw sewage is introduced to the primary cell which normally makes up about one-half of the total lagoon surface area. The sewage is treated in batch processes as it moves through the three cells, which are isolated from adjacent cells by gated pipe. Discharges are made from the third cell after sampling and testing have indicated the effluent to be discharged meets discharge permit standards.

Current general design and construction requirements include a detailed soils survey be conducted to evaluate the types of soil in the pond area and the permeability of the soil. State standards require that the percolation rate from the pond be less than 1/8 inch per day, and if local soil conditions cannot meet this requirement, a liner of clay or other suitable material must be installed. There are no requirements for monitoring of any seepage from municipal waste stabilization ponds.

Sixty-four percent of the impoundments located and assessed were included in the Municipal category. This precentage is the highest of any category. The distribution of Step V values (pollution potential) for municipal impoundments is shown in Figure 2. The distribution shows a fairly even spread of impoundments across the range of Step V values. The Step V values can be further combined into three groups which could be considered as high (20-24), moderate (15-19) and low (9-14) pollution potential as shown in Table II. When grouped in this manner, the data indicate that approximately one-third of the municipal impoundments have high pollution potential and slightly greater than one-third have moderate pollution potential. Since most municipal impoundments received a Step III value (groundwater quality) of 5 and a Step IV value (waste hazard potential) of 3, as described earlier, an impoundment would have to receive a Step I and Step II total of 12 or more to be placed into the high pollution potential group. Within the uncertainties of the rating system, it is concluded that many impoundments in North Dakota are constructed in materials with conditions conducive to groundwater contamination, should leakage from those impoundments occur. Therefore, municipal impoundments do constitute a potential source of groundwater quality degradation in North Dakota.

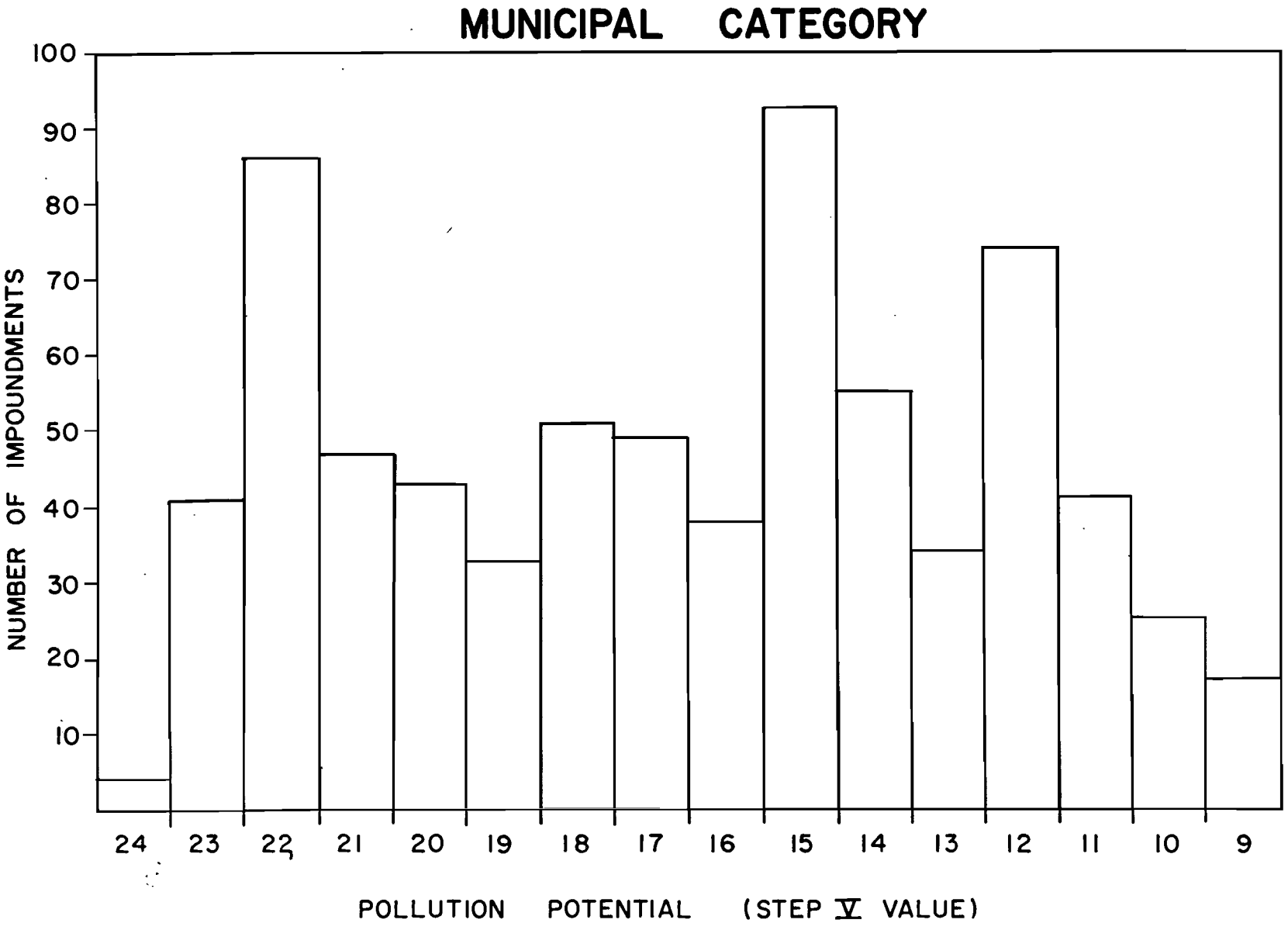
MUNICIPAL CATEGORY
NUMBER OF IMPOUNDMENTS
100
90
80
70
60
50
40
30
20
10
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
POLLUTION POTENTIAL (STEP V VALUE)

Figure II

Table II. Grouping of Municipal Impoundment Step V Values into Classes Based on High (20-24), Moderate (15-19), and Low (9-14) Pollution Potential.

	Step V Values		
	High (20-24)	Moderate (15-19)	Low (9-14)
Percentage of impoundments in the category	30	37	33

Agriculture

Agriculture waste management systems are normally installed with technical assistance from the Soil Conservation Service. The Soil Conservation Service has established design criteria for manure storage pits, aerobic and anaerobic lagoons, and runoff retention ponds. Manure storage pits are usually designed for 180-day storage; aerobic and anaerobic lagoons are sized based upon biochemical oxygen demand loading per acre; and runoff retention facilities are designed to retain the runoff from a 25-year, 24-hour storm. Agricultural waste management systems are not designed for discharge, but must be emptied manually and the wastes spread on agricultural land. Normal design considerations include a soil survey to determine the types and permeability of soils in the area and the depth to groundwater. If permeable material is encountered, a clay liner or other suitable material is installed to reduce the percolation rate. Monitoring systems are normally not installed with agricultural waste systems.

The Agriculture category is the second largest in North Dakota, containing about 24 percent of all impoundments. The distribution of Step V values for agricultural impoundments is shown in Figure 3. This distribution differs from the distribution of Municipal Step V values shown in Figure 2 in that a greater percentage of impoundments fall into

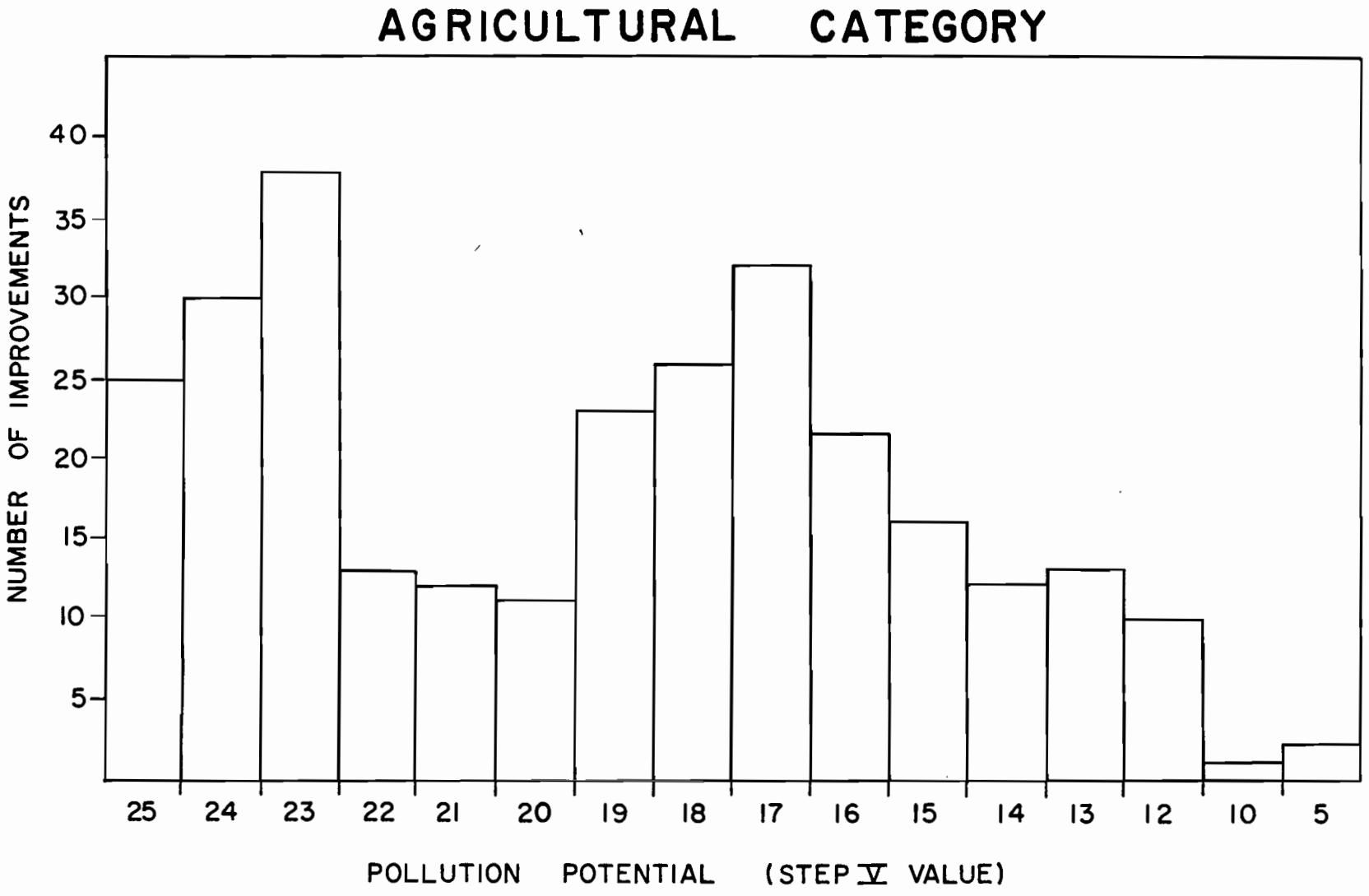
AGRICULTURAL CATEGORY
NUMBER OF IMPROVEMENTS
40
35
30
25
20
15
10
5
25 24 23 22 21 20 19 18 17 16 15 14 13 12 10 5
POLLUTION POTENTIAL (STEP V VALUE)

Figure III

the high and moderate groups of pollution potential values. These percentages are indicated in Table III. A total of 81 percent of agricultural impoundments fall into high and moderate pollution potential groups, as defined in Table III. As indicated in the Municipal category, the data suggest that agricultural impoundments do pose a threat to groundwater quality. The threat may be somewhat greater than municipal impoundments because of the possibility that agricultural impoundments may not be as well designed and constructed as municipal impoundments; however, research indicates that agricultural waste may tend to seal surface impoundments.

Table III. Grouping of Agricultural Impoundment Step V Values into Classes Based on High (21-25), Moderate (16-20), and Low (5-15) Pollution Potential.

	Step V Values		
	High (21-25)	Moderate (16-20)	Low (5-15)
Percentage of impoundments in category	42	39	19

Industrial and Mining

Industrial and mining impoundments constitute about 3 and 6 percent respectively, of the total number of impoundments in North Dakota. These two categories are not graphed by Step V values as the previous categories because of the small number of impoundments. In addition, most industrial and mining sites have multiple impoundments with similar Step V ratings, which further distorts the distribution. The results for these categories do indicate potential problems at some sites. Both categories have sites with high or moderate pollution potentials.

Oil and Gas

Oil and gas impoundments also represent a small percentage of the number of impoundments. In general, these impoundments tend to be located in areas of the state with geological conditions which would result in lower pollution potential rating. There are, of course, exceptions to this generalization. Since all presently operating impoundments have synthetic liners, the potential for actual groundwater pollution is further reduced. The effect on groundwater of abandoned impoundments in this category is not known. It can be assumed, however, because of the large number of such sites, that groundwater degradation has occurred or is occurring at a significant number of sites from abandoned oil and gas impoundments.

Degree of Confidence

An important consideration in the pollution potential phase of the SIA is the accuracy of the assigned values in Step I through Step IV. Because of the nature of the SIA, it is not possible to verify these estimated values. One indication of accuracy is the investigator's opinion of the data used to assess the site. This parameter is evaluated by the degree of confidence rankings assigned for each step. Degree of confidence is assigned by use of A, B, or C designations. There are specific requirements for the use of these letters for each step; however, they can be generally thought of as reflecting high, moderate, or low confidence in the step value given. Table IV is a tabulation of the percentages of impoundments which fell into each of the three degree of confidence groups for each step. The percentage of confidence ratings

in Table IV support earlier general statements about the data collected. With respect to the surface materials (Step I) and subsurface materials (Step II), it is clear that much better data existed for the surface materials. In the case of Step III, the groundwater quality, the high percentages of A and B confidence ratings support the earlier statements that shallow wells do tap near-surface aquifers in the vicinity of most impoundments. This reasoning led to the decision to consider surficial glacial deposits of low permeability as unconfined aquifers instead of rating confined aquifers at greater depths beneath the surface. These percentages also indicate why most Step III ratings were given values of 5, because most near-surface deposits do yield water of sufficient quantity and quality for small supplies of drinking water. For Step IV, the high percentage of B confidence ratings indicates assignment by SIC code in most cases. Step VI confidence ratings will be discussed in the next section. In the North Dakota SIA, sites were evaluated by two investigators. Confidence ratings, as well as rating values in other steps, must be considered to be somewhat variable depending on the investigator involved. The two investigators would not necessarily rate individual sites equally in all cases.

Table IV. Percentage of Impoundments for Each Degree of Confidence Rating, for Each Step

	Degree of Confidence Ratings		
Percentage of impoundments for each rating	A	B	C
Step I	31	52	17
Step II	14	51	35
Step III	71	18	11
Step IV	25	75	0
Step VI	18	59	23

Health Hazard

The Health Hazard portion of the SIA refers to Step VI. This Step involves a determination of the distance of the impoundment from current water wells and surface water bodies. The procedure also requires an estimation of the groundwater flow direction so that letters can be assigned for four specific cases. These cases and their descriptions are: water well in the direction of flow (A); surface water in the direction of flow (B); well or surface water body not in the direction of flow (C); and no surface water or well within 1600 meters of the site in any direction (OD).

The Step VI values are determined independently from Step V, the pollution potential. For example, an impoundment with a worst case health hazard of 9A, that is, a water well within 200 meters of the impoundment in the direction of groundwater flow, could also have a low pollution potential (Step V). This situation might imply that the chance of contamination of the well would not be as great as the health hazard (Step VI) would suggest. Table V is a tabulation of the Step VI results by case (A, B, C, OD), distance, number of impoundments within each case, and percentage of impoundments within each case.

With reference to Table V, 65 percent of the impoundments were included in Case B, which is the case referring to an impoundment located near a surface water body in the direction of groundwater flow. This high percentage is the result of the decision to include intermittent streams as surface water bodies. Had intermittent streams not been considered as having Class B priority in all cases, a greater number of impoundments would have fallen into Class C and OD.

Table V. Step VI Results.

Rating	Percentage of total impound.	Distance (m)	Number of impoundments	Percentage of impoundments in case.
Case A	19			
9A		0-200	80	36
7A		201-400	73	33
5A		401-800	42	19
3A		801-1600	26	12
		Total	221	100
Case B	65			
8B		0-200	556	75
6B		201-400	62	8
4B		401-800	85	11
2B		801-1600	38	5
		Total	741	100
Case C	13			
7C		0-200	61	40
5C		201-400	43	28
3C		401-800	34	23
1C		801-1600	13	9
		Total	151	100
Case OD	3			

There are numerous uncertainties in the estimation of groundwater flow direction as carried out in the SIA. These include the relationship of groundwater flow to intermittent streams, the influence and extent of

drawdown cones in the vicinity of pumping wells, the effects of heterogeneity and anisotropy, and the basic difficulty of interpreting complex geological situations with limited data. These uncertainities are reflected in the degree of confidence ratings for Step VI as shown in Table IV. Eighty-two percent of the impoundments were given a B or C confidence rating in Step VI. These figures should give a subjective evaluation of the reliability of data derived from Step VI.

In order to identify the most hazardous impoundments present in a state, it is necessary to consider cases in which both Step V and Step VI are high, that is, sites in which the geological suitability of the site is poor, and in which the possibility of contamination of water supplies is high. As a preliminary criterion for such situations, the number of sites with Step V totals of 20 or more which also have a Step VI value of 9A or 7A, is considered. This situation could be visualized as all impoundments which are constructed in sandy, permeable sediments overlying unconfined aquifers, and which are also located within 400 meters of a water well in the direction of groundwater flow. This tabulation is presented in Table VI. Table VI gives an estimate of the sites which could be considered as top priority for further investigation.

Table VI. Impoundments with Highest Step V and Step VI Values.

Category	Number of Impoundments with Step V of 20 and Above and Step VI of 9A and 7A	Percentage of impound. in cat.
Municipal	38	5
Agriculture	20	7
Mining	3	4
Industrial	0	0
Oil & Gas	0	0

Conclusions

The data presented in this chapter suggest that groundwater pollution from surface impoundments is a potentially serious problem in North Dakota. The results of the rating system applied in the SIA indicate that approximately 70-80 percent of all impoundments have high or moderate pollution potentials. About 20 percent of all impoundments lie within 1600 meters of water supply wells in the direction of groundwater flow. A further indication of the potential for actual contamination is the number of impoundments which have both high pollution potential and are within 400 meters of wells in the direction of flow. For this worst case situation, about 5 percent of the impoundments qualify. The results of this study indicate that construction of surface wastewater impoundments should be preceeded by detailed site investigations. In cases of poor geological settings with respect to groundwater pollution, engineering safeguards should be required to protect groundwater resources.

CHAPTER 5

WATER TABLE AQUIFERS

No new data concerning water table aquifers were collected during the SIA. Therefore, the purpose of this chapter is to briefly summarize the types of information available with regard to these aquifers.

Water table aquifers are most common in the glaciated portions of North Dakota. These aquifers occur mainly in glacio-fluvial and glacio-lacustrine deposits. These deposits are highly variable in areal extent, thickness, and hydrogeologic properties. These coarse grained glacio-fluvial sediments were deposited in channels, broad, gently sloping plains, or in irregular masses. In many cases, the sediments were deposited on stagnant glacial ice, so that after the ice melted, the deposits were lowered to form hilly, irregular topography. Additional water table aquifers are present in sediments deposited as deltas in glacial lakes or by shoreline processes in the lakes. In eastern North Dakota, these deposits form some of the most important unconfined aquifers. In the non-glaciated portions of the state, most unconfined aquifers occur in floodplain deposits of perennial streams.

Published geologic and hydrogeologic information on the unconfined aquifers is available in the County Groundwater Series of publications described earlier. In these reports, surface materials are mapped at a scale of 1:125,000. Hydrogeologic information, including well inventories, pump test data, and water quality analyses, is available for most of the important water table aquifers.

A new state geologic map at a scale of 1:500,000 is now in the final stages of publication. This map will provide additional infor-

mation on the distribution of surface materials which may contain unconfined aquifers.

As mentioned earlier, the hydrogeologic properties of the unconfined aquifers are highly variable. Some aquifers have sufficient yield to be used for irrigation and public supply. Others are only suitable for domestic supplies. Quality of water from unconfined aquifers is also variable, but in general these aquifers supply the best quality groundwater available. The chemical type is usually calcium bicarbonate or sodium bicarbonate. The water is usually hard but has low total dissolved solids. The aquifers are very susceptible to contamination by improperly designed waste disposal facilities.

A map that would be useful would be a compliation of existing information on unconfined aquifers which would also show presently operating waste disposal facilities. Such a map would point out existing problem sites and would also be useful for site selection for future waste disposal facilities. Aquifers could be classified with respect to pollution potential. This map would be a useful continuation of SIA because of the information collected on the location of surface impoundments in the project. If further funding is available for waste disposal investigation, such a map should be a high priority.

CHAPTER 6

INSTANCES OF GROUNDWATER POLLUTION FROM SURFACE IMPOUNDMENTS

Over the 30 years of petroleum exploration and production in North Dakota, a number of cases of suspected or documented groundwater contamination from surface impoundments have occurred. Only in several instances have legal proceedings been initiated. In these cases, studies made by the North Dakota Geological Survey indicated that contamination of groundwater from surface impoundments had occurred.

In the past, the cause of most problems was the construction of impoundments to contain and dispose of water produced with oil. Natural depressions were used in some cases. Fluids produced during oil production are predominantly salt water brines and the effect on groundwater following seepage from surface impoundments is to cause an increase in total dissolved solids. This contamination is most easily detected by measurement of the chloride ion concentration.

In most cases, impoundments were investigated for possible seepage by the Geological Survey because of suspected or obvious violations of regulations noted by field inspectors. Cases of complaints by landowners concerning actual pollution of well or surface water have been rare. Only several cases of this type have resulted in lawsuits. An example of one such case is the Capa Field in Williams County, North Dakota. In the late 1960s, complaints were received by the State Industrial Commission that wells at several farms had become polluted and were not fit to use. The subsequent investigation by the Geological Survey indicated that the well water contained a high chloride concentration. The probable source of the contamination was determined to be

several surface impoundments in the vicinity of injection wells. These pits were immediately condemned by the Industrial Commission. In a lawsuit brought by landowners against the operator of the field, a monetary settlement was awarded to the plaintiffs. The defendant, Amerada Petroleum Corp., developed alternative sources of water supply for the landowners and no abatement measures were initiated to reclaim the affected aquifers. Continued monitoring of wells in the area by the State Water Commission has indicated a gradual decline in the chloride concentrations.

There have been no documented cases of groundwater contamination from municipal or agricultural surface impoundments. There have been numerous claims of groundwater contamination and land damage surrounding municipal facilities. Municipalities where land damage has been claimed by adjacent landowners include Wyndmere, Colfax, Minto, Cavalier, Jamestown, Grafton, Underwood, Valley City, Northwood, Osnabrock, Wimbledon, Emerado, Rolette, and Park River. In addition, Dodge, Lidgerwood, Esmond, Larimore, Willow City, Reeder, Golden Valley and Linton have seepage from their pond facilities which percolate into groundwater aquifers without claims of land damage. The Health Department has pursued several funding alternatives to no avail to study the problems associated with seepage from lagoons. A project of this nature may be appropriate as an additional assessment of potential groundwater contamination from surface impoundments.

There have been no documented cases of groundwater contamination from agricultural ponds although there exists a potential for such contamination. Due to the remoteness of the agricultural sites and the sparsely populated rural areas, the possibility of detection of ground-

water contamination from these facilities is slight. The average size of North Dakota farms is approximately 1000 acres, and it would be normal for only one farmstead per farm unit. It is very common to have at least one mile distance between farmsteads.

CHAPTER 7

EVALUATION OF EXISTING STATE PROGRAMS

Protection of groundwater aquifers from contamination is the responsibility of the North Dakota State Department of Health with assistance from the North Dakota Geological Survey and the North Dakota State Water Commission. Each of these agencies has its own enabling legislation and rules and regulations for groundwater protection.

State Department of Health

The primary legislation which authorizes the Department to control and prevent pollution of surface waters is Chapter 61-28 of the North Dakota Century Code (North Dakota Water Pollution Control Act). The sections of the statute which directly mention and authorize control of surface water impoundments are:

61-28-01 Statement of policy.

61-28-04 Powers and duties.

61-28-06 Prohibitions.

In addition, Chapter 61-28.1 of the North Dakota Century Code (Safe Drinking Water Act) grants the Department further authority to control potential pollution of groundwater within the State. The sections which directly delegate this authority are:

61-28.1-01 Declaration of public policy and legislative intent.

61-28.1-03 Powers and duties of the department.

The Solid Waste Management and Land Protection Act (Chapter 23-29) allows further protection of surface water impoundments in relation to disposal activities. The sections granting this authority are:

23-29-02 Declaration of purpose.

23-29-04 Powers and duties of the department.

An ancillary statute which ensures that the above mentioned statutes will be enforced is Chapter 32-40 of the North Dakota Century Code (Environmental Law Enforcement Act). This statute grants the Office of the Attorney General the authority to direct other administrative agencies to carry out the responsibilities allocated to them under their enabling legislation.

North Dakota's Administrative Code contains regulations adopted by agencies pursuant to their enabling legislation. Article 33-16 of the Administrative Code contains the primary regulations authorizing control of surface water impoundments and protection of the State's groundwater.

Chapter 33-16-01 of the Administrative Code is the North Dakota Pollutant Discharge Elimination System which specifies the means under which the Department permits surface water impoundments which have the ability to discharge into the State's waters. The key sections of the chapter are:

33-16-01-01 General

33-16-01-02 Acquisition of Data

33-16-01-21 Monitoring, Recording, and Reporting

Chapter 33-16-02 of the Administrative Code contains the standards of water quality for the State of North Dakota. This chapter enables the Department to control those potential sources of surface and groundwater pollution which are not included in the permit system. The chapter also establishes surface water quality standards for the waters of the State. The key sections relating to surface water impoundments are:

33-16-02-01 Declaration of Policy

33-16-02-02 Definition

33-16-02-04 General Requirements

33-16-02-05 General Conditions

Article 33-17 (Public Water Supply Systems) of the Administrative Code further authorizes the Department to control potential sources of groundwater pollution.

The Department, in cooperation with the State Board of Water Well Contractors, enforces Article 33-18 of the North Dakota Administrative Code regarding water well construction and pump installation. Section 33-18-01-05 of that article provides for direct protection of groundwater sources.

Chapter 33-16-03 of the Administrative Code grants the Department the authority to control pollution from surface water impoundments constructed in connection with certain livestock enterprises.

Article 33-20 of the Administrative Code contains the regulations promulgated under authority of the Solid Waste Management and Land Protection Act. Chapters 33-20-01 and 33-20-05 allow the Department to affect control over disposal activities which are nearby surface water impoundments.

In addition to the laws and rules and regulations, it is the Department's policy to require certain information be provided in engineering reports or plans and specifications for sewage disposal systems. This information includes the location and direction of all residences, roads, buildings, commercial developments, water courses, and water supplies within one-half mile of the proposed facility. Soil borings

are required to determine surface and subsurface soil characteristics of the immediate area and their effect on construction and operation of the proposed facility along with data demonstrating the percolation rates to be anticipated at the elevation of the proposed pond bottom. It is also the Department's policy to require compacted clay, bentonite, or other approved material be used to adequately seal areas containing sand, gravel or other porous material and to limit the percolation from the facility to one-eighth inch per day or less.

Although several municipal facilities were installed prior to adoption of this policy, it is the opinion of the SIA project team that the present regulations and policies of the Department are adequate to prevent future contamination from surface impoundments. It may be beneficial to have the soil surveys reviewed by the North Dakota Geological Survey or an independent geologist to determine the likelihood of contamination of groundwater from planned surface water impoundments.

North Dakota Geological Survey

Regulation of the oil and gas industry in North Dakota is one function of the North Dakota Geological Survey (NDGS) under the statuatory authority of the North Dakota Industrial Commission. In the following discussion, the role of the North Dakota Geological Survey in the regulation of surface impoundments will be discussed.

Under the regulations of the Industrial Commission, NDGS issues permits for the operation of Salt Water Handling Facilities. Prior to issuing the permit, the facility is inspected by a NDGS field inspector. In many cases, holes are drilled to the water table around the impoundment and samples are taken and tested for chloride content. If evidence of

seepage is obtained or if other regulations concerning the impoundment are violated, the impoundment is condemned. Through the years, many impoundments have been condemned by this procedure.

On October 1, 1978, new regulations were adopted by the Industrial Commission. Among other regulations for surface impoundments, the rules specify that the impoundment must be lined with an impermeable material and that a monitoring system approved by the State Geologist must be installed. Mud pits and emergency pits are exempted from these regulations. Since adoption of the new regulations, the number of surface impoundments has declined to the number reported in the SIA. Most disposal of produced water is now done by well injection. In addition, many producing operations utilize tanks for collection and storage of produced water for injection.

In the opinion of the SIA project team, the present Industrial Commission regulations and inspection program of NDGS is adequate to prevent future contamination from surface impoundments. This is especially true because of the declining number of impoundments used in the oil industry. The effect on groundwater of abandoned impoundments, mud pits, and emergency pits is not known. Because of the large number of such facilities, an evaluation of their pollution potential or actual pollution of groundwater would be a very expensive and time consuming task. NDGS is beginning a research project soon to determine the migration of chemical components of drilling muds from reclaimed mud pits. An evaluation of abandoned brine disposal pits could best be carried out using earth resistivity. The high dissolved solids content of the wastewater would make detection and determination of extent of contaminated groundwater relatively easy. This could be done as a continuation study of the SIA.

Other Agencies

The State Water Commission regulates the installation of surface impoundments that contain more than 12.5 acre feet of capacity or where the embankment height is greater than 20 feet. These impoundments must receive a water permit from the Commission and during the permit review process, the Commission also reviews the siting information and construction plans and specifications.

The Public Service Commission regulates surface impoundments that contain wastes from coal mining operations. These include all sediment retention facilities. The Commission reviews construction plans and specifications as well as siting information prior to construction of these impoundments.

CHAPTER 8

EXISTING FEDERAL PROGRAMS

North Dakota has assumed responsibility of the North Dakota Pollutant Discharge Elimination System permit program. Under this program, all point source dischargers wishing to discharge wastewater into surface water bodies must submit information concerning their treatment plant and wastewater streams to the State Health Department and obtain a permit for the waste discharge. The Health Department further requires that plans and specifications for all proposed waste treatment facilities be submitted to the Department for review and approval prior to construction. This affords the state the opportunity to review the adequacy of the design of these treatment plants prior to actual installation.

The Department of Health, through the Section 208 Water Quality Management Planning section of the Clean Water Act, has funded a landfill leachate study at Cavalier, North Dakota, and has received authorization to begin a study of the effects of drilling muds and drilling muds constituents on groundwater in western North Dakota. The Department has attempted over the last several years to receive authorization to begin a monitoring program on municipal waste stabilization ponds which are not meeting the 1/8 inch per day percolation standard as established by the Department. This authorization has not been granted. However, the Department plans to continue to pursue this avenue and other sources of funding.

The Department of Health received a grant in January 1980 to initiate development of an Underground Injection Control (UIC) program

pursuant to the Safe Drinking Water Act. Some of the information developed in the Surface Impoundment Assessment program will be useful to the UIC program. The aquifer maps prepared under the UIC program may be useful in evaluating sites for surface impoundments.

The Department of Health will be working with the North Dakota Geological Survey and the State Water Commission in the development of the UIC program. The items of work to be covered in Fiscal Year 1980 include the preparation of aquifer use maps, the analysis of existing laws and regulations and an inventory of underground injection facilities. Some of these work tasks will carry over into 1981 with the development of an UIC program scheduled for 1982.

The inventory of surface impoundments developed under the Surface Impoundment Assessment program will be used by the Department of Health in the inventory of open dumps required under the Resource Conservation and Recovery Act. The state has been delegated the RCRA program for those sites which handle nonhazardous wastes, and the state utilizes the guidelines for siting landfills that are contained in the federal regulations. The state has a Solid Waste Management and Land Protection Act and Solid Waste Management Regulations which comply with the Resource Conservation and Recovery Act. The state does not anticipate any problems with the relationship of these regulations. The state is under the jurisdiction of the Federal Plastic Substances Control Act, which regulates the disposal of toxic substances, and the Nuclear Regulatory Commission Licensing Requirements, which regulate disposal of nuclear wastes.

Recommendations Regarding Federal Programs

The State of North Dakota supports the national policy of protecting groundwater resources. The following recommendations need to be given serious consideration in the development of national policy. The Federal program needs to be based on several premises: It must be realistic and implementible; it must be based on present acceptable technology and practices; it must give consideration to establishing a balance between protection and other needs such as water useage, development requirements (including energy) and economics so that protection requirements, while adequate, do not necessarily interfere with other needs; and the determination of "potentials" for pollution are realistic and not idealistic.

The Federal program must be flexible and must recognize State and local government entities. Varying conditions in each state make it mandatory that each state be allowed to develop its own program that is taylored to the conditions existing in their state. The Environmental Protection Agency should provide technical and financial assistance to develop and implement these programs.

It is also necessary that several sites nationwide be available for disposal of toxic substances so each state does not have individual toxic disposal sites. This should reduce the number of instances of potential groundwater contamination from toxic pollutants. It is also necessary to continue to fund research in the areas of groundwater contamination from surface impoundments which have seepage. Authorities generally exist for control of these problems; however, problem identification is not always complete.

REFERENCE

EPA, 1978, "Surface Impoundments and Their Effects on Ground-Water Quality in the United States - A Preliminary Survey," EPA Report No. EPA-570/9-78-004, 275 p.