

**North Dakota Geological Survey**

Wilson M. Laird, State Geologist

**Miscellaneous Series 24**

**STUDY OF THE SPOIL BANKS ASSOCIATED WITH LIGNITE  
STRIP MINING IN NORTH DAKOTA**

A Report Prepared for the Thirty-Ninth

Legislative Assembly

by

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and

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Reports of the Coal Mine Inspectors Department provided a list of currently active mines and was the source of much of the data pertaining to the history of lignite mining. George B. Easton, State Coal Mine Inspector was most cooperative in furnishing locations of active mines and also a great many of the abandoned operations.

Soils analyses were run by the Soils Department of North Dakota State University. They also provided an interpretation of the results in terms of salt tolerances of the trees and plants normally grown in North Dakota.

Mr. Robert Morgan and Mr. Wilbur Boldt of the North Dakota Game and Fish Department and Mr. Duane Green, Assistant State Forester accompanied us on inspection tours of some of the spoils areas and provided a background on some of the rehabilitation that has been done in their game management areas. Mr. Paul Slabaugh and Mr. Limstrom of the U. S. Forest Service also visited some of the larger spoils piles areas. Mr. Limstrom has been actively working with rehabilitation of spoils areas through the Central States Forest Service and he furnished us with a report of his observations concerning rehabilitation of the North Dakota spoils areas.

The coal mine operators were generally very cooperative during the field studies of these areas as well as in answering our preliminary questionnaire. All of the major operators attended the public hearing and offered their suggestions in regard to the problem.

Mr. Bill Sebens of the Soil Conservation Service and other members of the Soils Conservation Service attended the public hearing and provided valuable information in regard to costs of leveling of these areas.

Mr. Russell Stuart, State Game and Fish Commissioner attended the public hearing and expressed the views of his department. He and Mr. Green and members of their staffs were consulted during formulation of the recommendations.

# SPOIL BANKS ASSOCIATED WITH LIGNITE STRIP MINING,

Their possibilities for rehabilitation.

by  
Clarence G. Carlson  
and  
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## INTRODUCTION

Senate Resolution NN; passed by the Thirty Eighth Legislature of the State of North Dakota, directed the State Geological Survey to investigate the problems of leveling and rehabilitating lands disrupted by strip coal mining operations (Appendix A). The resolution further authorized the Geological Survey to secure the assistance of any state department, agency, board or commission to assist in the investigation. Following these instructions an investigation was conducted which was designed:

- 1) To determine the areal extent and condition of spoil piles from previous strip mining operations;
- 2) To determine the areal extent of current operations and current practices in regard to rehabilitation; and
- 3) To make recommendations in regard to future operations.

The problems created by strip coal mining operations and rehabilitation of the spoil piles are basically one of determining what is the most desirable land usage when the stripping operations have been completed. If the problems are to be resolved objectively, there are a number of considerations which must be kept in mind. The first consideration is the value of the land to the economy of the state prior to mining; the second consideration is the value of the lignite and lignite mining industry to the local area and the state during mining operations, and the third consideration is the value of the land after mining operations cease. Although the latter consideration prompted the present study, all three are important and must be kept in mind if satisfactory solutions to the problems are to be achieved.

The areas affected by lignite mining are confined to the western half of North Dakota where lignites of the Ft. Union group are near the surface (Fig. 1). The larger mining operations are mostly in the northwestern part of the state with only five counties, namely Burke, Divide, McLean, Mercer and Ward Counties, having more than 300 acres of disturbed lands at the present time. There are presently no active operations in Divide County. If power plants now under consideration should be developed, Oliver County may expect some large scale operations in the future.

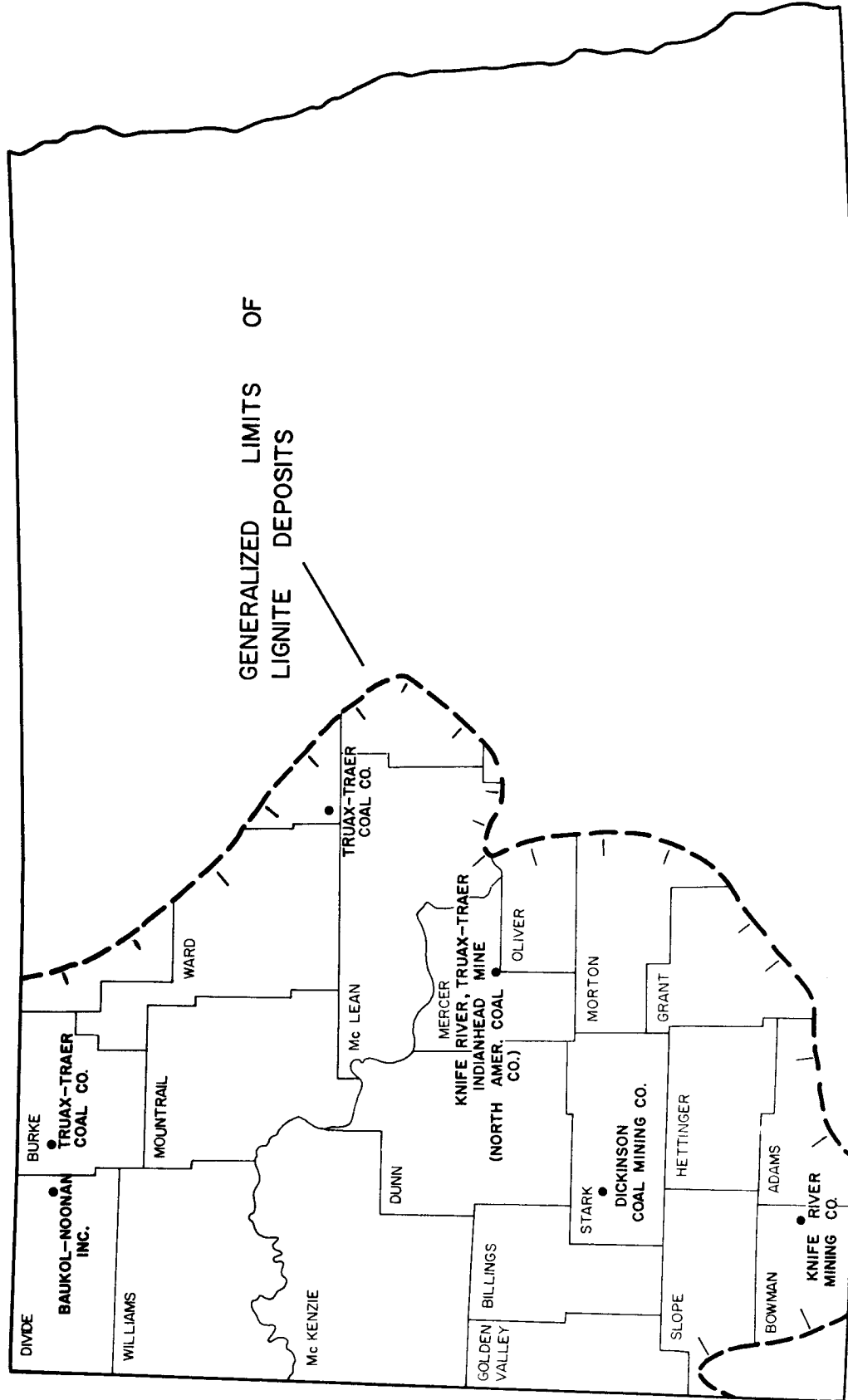


Figure 1 - Map showing location of lignite deposits and larger mines.

Land values in the coal mining areas according to statements made by coal company representatives at a public hearing range from 35 to 75 dollars per acre. The average price of farm land of this area sold in 1963 was reported to be 50 dollars per acre by the North Dakota Farm Research bimonthly bulletin (v. 23, no. 4, p. 10).

The value of the lignite on a per acre basis will vary with the thickness of the lignite seam. If the total tonnage of the stripping operations in North Dakota in 1962 is divided by the acreage disturbed, the average tonnage per acre is about 14,250 tons. The value of the lignite based on an average price of about \$2.26 per ton, would be about \$32,200 per acre. Since royalties range from 5 to 12 cents per ton, a farmer who owned the mineral rights would receive between \$700 and \$1,700 per acre for an average acre of coal lands when the area was mined.

The value of the lignite industry to the state in terms of total effect on the economy is difficult to estimate, but the valuation of the lignite sold in 1962 is placed at nearly \$6 1/2 million dollars.<sup>1/</sup> To this one must add the effect of payrolls of the mining companies, the utilities, the transportation industries and other secondary goods and service industries related to the mining industry to arrive at the effect on the economy as a whole.

The value of the land after mining operations cease depends upon the extent of rehabilitation. In most cases rehabilitation has been minimal, with the spoil areas left much as they were when mining ceased, but some planting has been done and a few areas have been put to new uses. In order to put the entire study in its proper perspective, perhaps a brief history of lignite mining in North Dakota will serve to emphasize the position of the lignite industry in the economy of the state.

### HISTORY OF LIGNITE MINING

The lignite mining industry began in western North Dakota when the early settlers found it to be a convenient source of fuel and began mining it for domestic use. These operations generally began along streams or coulees where the lignite was present at the surface and could be gathered for fuel by merely loading it on wagons or where lignite seams were exposed in the banks along coulees where underground drifts could easily be driven into the banks. When the lignite was near the surface, the second step was generally to work back from the stream bed, stripping off the overburden by means of horses and scrapers. Where the overburden was too thick to remove, a drift might be driven into the bank and underground mining might proceed or the working might be abandoned. Since means of stripping were rather inefficient, much of the lignite was mined by underground methods in the early days.

<sup>1/</sup> Coal Mine Inspectors Forty Ninth Annual Report, 1962.



Figure 2 - A small abandoned dozer and scraper operation. Old pit - left center; Spoil piles - right center. Location - Pederson Mine in NW of Section 10, T. 152 N., R. 98 W., McKenzie County, North Dakota. Abandoned - 1953.

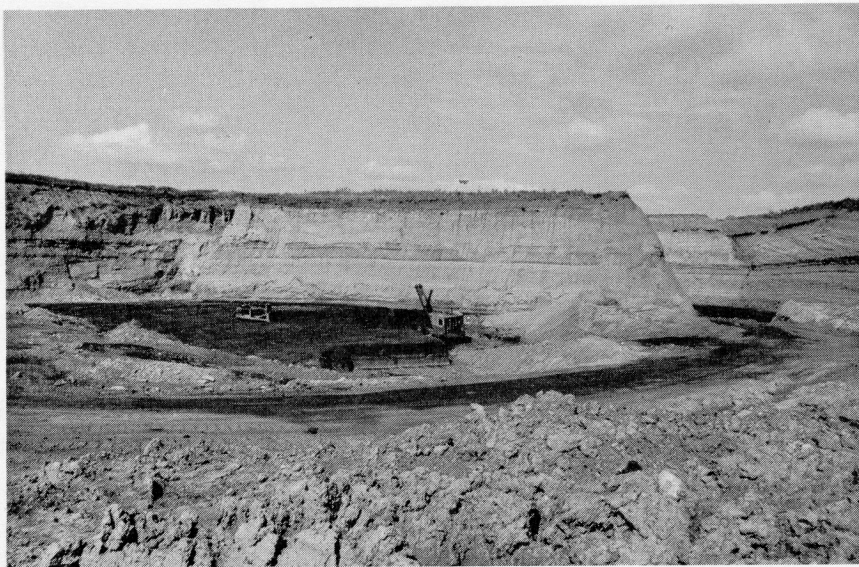


Figure 3 - A view of an active dozer and scraper operation taken from the spoil pile. Dozer and loading shovel in active pit area. Location - Ecklund Mine in the NW NW of Section 8, T. 142 N., R. 79 W., Burleigh County, North Dakota.





Figure 4 - Spoil piles from an abandoned dragline operation as viewed from roadway. Location - Baukol, Noonan Pit in NW of Section 10, T. 162 N., R. 95 W., Divide County, North Dakota.

With the advent of draglines, tractors, and bulldozers, more overburden could be economically removed, so stripping operations have gradually replaced the under-ground operations. Since the dragline is the most efficient means of removing large quantities of overburden, this type of operation is used by all of the larger operations and now accounts for most of the strip mine production.

The tonnage mined in 1884, the first year for which statistics are available, was about 35,000 tons.<sup>2/</sup> Production statistics show a rather steady increase in lignite production to an annual rate of over 100,000 tons in 1900, 500,000 tons in 1911, and 1 million tons in 1922. It may be of interest that in 1923 stripping operations accounted for only 24 per cent of an annual production of about 1,435,000 tons. By 1933, annual production had increased to about 1,870,000 tons with 61 per cent produced by stripping operations. Total production continued to increase to an annual rate in excess of 2 million tons in 1937 and more than 3 million tons in 1950. Since 1950, production has fluctuated from a high of about 3,280,000 tons in 1951 to a low of about 2,325,000 tons in 1958. Since 1958, the rate has again been rising and in 1962 about 2,850,000 tons were produced. The percentage produced by strip mines increased to 71 per cent in 1943 and to 99 per cent in 1953. In 1962, only three underground mines were operating in North Dakota and they accounted for only 0.1 per cent of the total production.

<sup>2/</sup> State Coal Mine Inspectors Reports, 1927-1962, were the source for all production and license statistics.

In contrast to the increasing annual rate of production, the number of mines operating has shown a decline over the years. Table I shows that the peak year for mine licenses was 1935 when 357 licenses were issued, 199 of which were for underground mines. The number of mines operating and the percentage of underground mines has shown a rather steady decline since then to a low of 48 licenses in 1961, only 3 of which were for underground mines.

Year	No. of Licenses	Strip	Under-Ground	Year	No. of Licenses	Strip	Under-Ground	Year	No. of Licenses	Strip	Under-Ground
1962	50	47	3	1950	104	80	24	1938	312	169	143
1961	48	45	3	1949	93	67	26	1937	307	159	148
1960	49	46	3	1948	107	75	32	1936	355	185	170
1959	52	48	4	1947	119	80	39	1935	357	158	199
1958	58	51	7	1946	118	71	47	1934	340	130	210
1957	61	54	7	1945	138	80	58	1933	301	103	198
1956	70	61	9	1944	184	106	78	1932	283	100	183
1955	75	66	9	1943	184	109	73	1931	290	100	190
1954	75	65	10	1942	204	114	90	1930	259	75	184
1953	83	69	14	1941	248	136	112	1929	213	68	145
1952	90	72	18	1940	309	174	135	1928	227	71	156
1951	99	75	24	1939	326	192	134	1927	227	81	146

TABLE I - COAL MINE LICENSES BY YEARS

In 1963, 45 strip mines were operating, 35 of which were dozer and scraper operations while 10 were dragline operations. However, the 10 dragline operations accounted for about 87 per cent of the total production, so that in terms of land usage and area of spoil piles these operations are by far the most important.

#### STRIP MINE SPOIL PILES

Current strip mine operations are of two general types:

- 1) Dragline operations; and
- 2) Dozer and scraper operations.

Each general type has its own characteristic type of spoil pile and hence its own special problems of rehabilitation. A summary of the typical operation of each type will show the nature of the resulting spoil pile and provide a background for resolving the problems of rehabilitation.

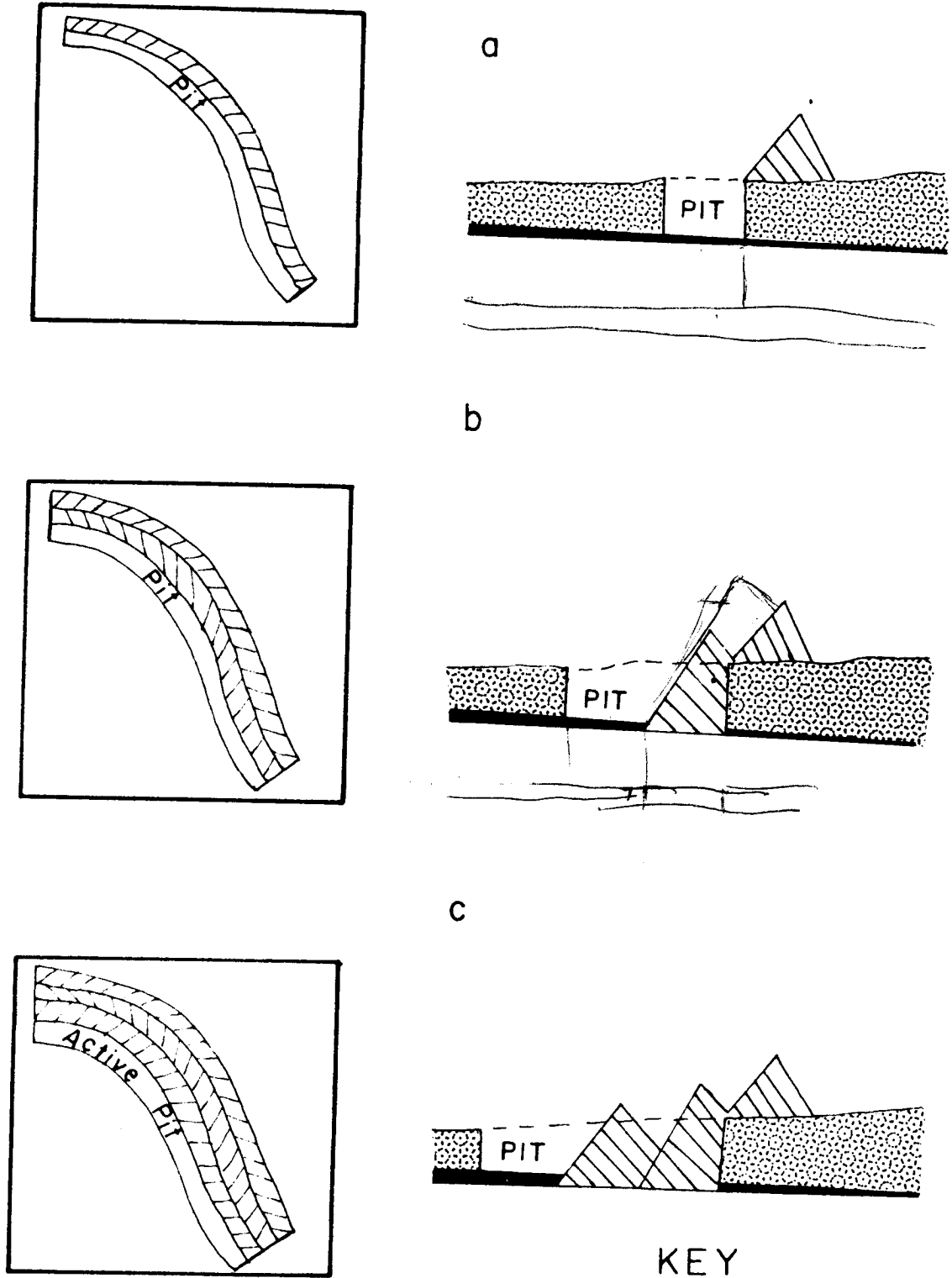





Figure 5 -- Schematic diagram of typical dragline operation. Left side shows plan view; right side a cross-sectional view, with operations proceeding from a to c.

KEY	
	OVERBURDEN
	LIGNITE
	SPOIL PILES

A typical dragline operation follows the sequence outlined in Figure 5a - 5c, with subsequent additions until the area is either mined out or abandoned. Since the overburden from the first cut must be dumped on the original land surface, the outside pile is always the highest pile. Its height depends on the amount of overburden removed, but these piles generally range from 25 to 40 feet above the general surface with slopes of about  $40^{\circ}$ . Subsequent strips are then dumped in the previously mined strips. The height of these piles also varies, but generally range from about 8 to 20 feet high with slope angles of about  $40^{\circ}$ . The end resultant of the dragline operations is a series of conical ridges which parallel the original pit operations (see Fig. 8).

The normal practice in removing the overburden from the lignite is to deposit materials in the reverse order of their original state. Hence, the topsoil is generally placed at the base of the pile. Subsequently, silts, sands and clays of the bedrock containing the lignite seams are deposited on the spoil piles, and, since the lignite beds are usually directly overlain by clay, the piles are generally capped by clay.

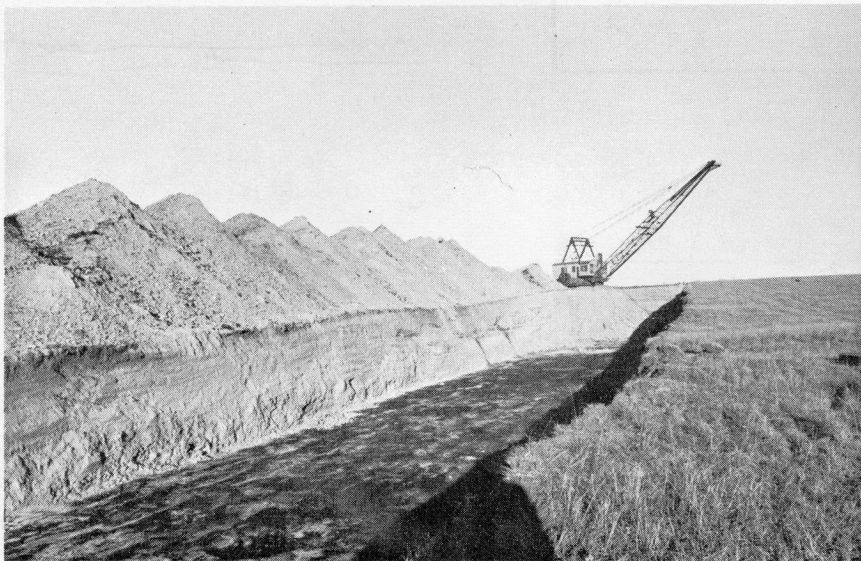


Figure 6 - A view of a dragline showing the first cut of an active dragline operation. Location - Traux-Traer, Hazen Mine in NE NW of Section 16, T. 145 N., R. 86 W., Mercer County, North Dakota.



Figure 7 - Pit and spoil piles of an active dragline operation. The most recent pile (bordering the pit) is nearly barren; older piles in background (right side of picture) have a vegetative cover, although in this instance it is mainly weeds. Location - Knife River Mining Company - Beulah Pit in SE of Section 8, T. 144 N., R. 87 W., Mercer County, North Dakota.



Figure 8 - Spoil piles of an abandoned dragline operation. Spoil pile in right foreground and continuing along right side of photo represents the first or outside cut. Piles to the left of initial pile are lower, representing succeeding cuts. Abandoned pit at far left. In the left background is town of Noonan. Location - Baukol, Noonan Pit in NW of Section 10, T. 162 N., R. 95 W., Divide County, North Dakota.

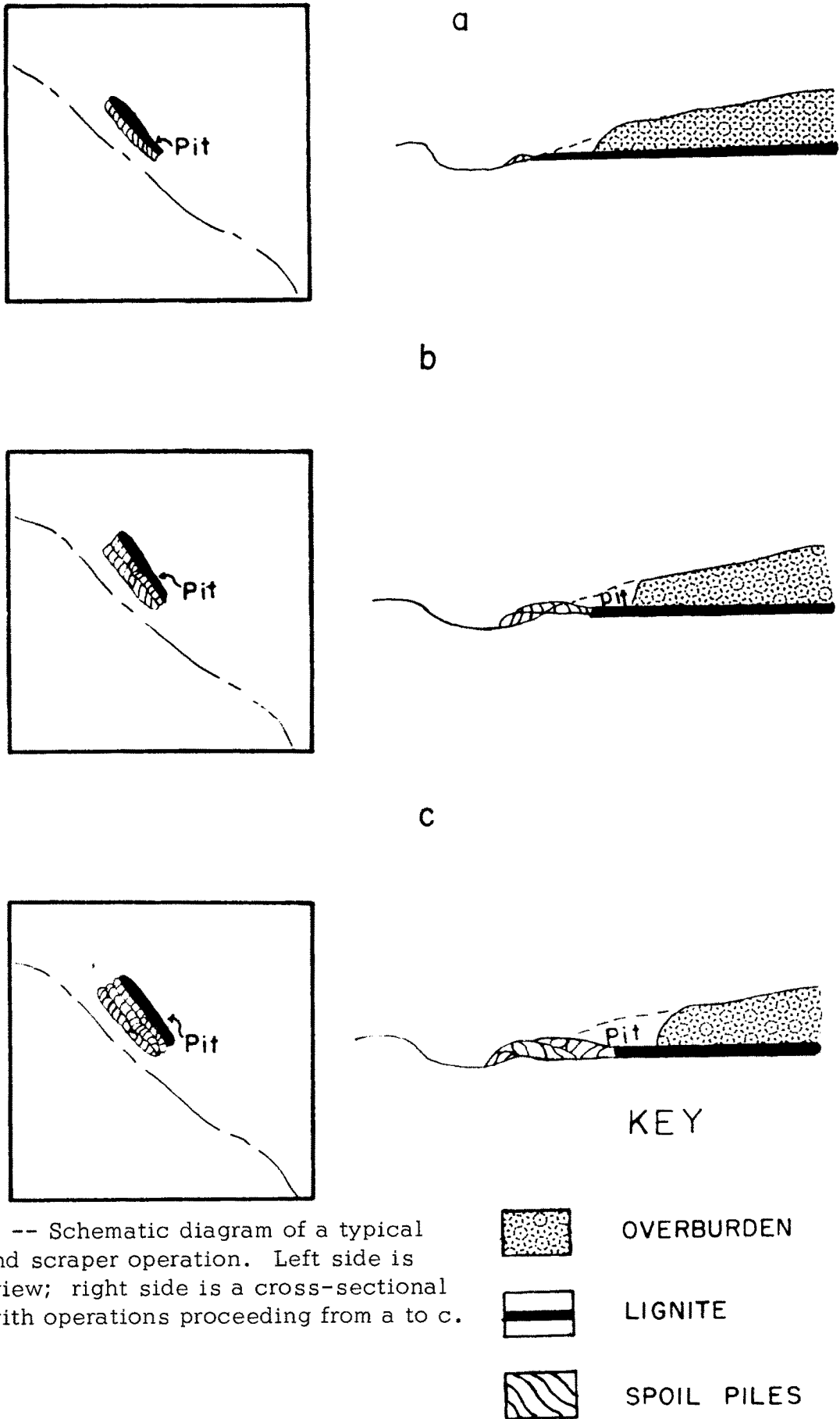


Figure 9 -- Schematic diagram of a typical dozer and scraper operation. Left side is a plan view; right side is a cross-sectional view, with operations proceeding from a to c.

A typical scraper and dozer operation follows in the sequence of Figure 9a - 9c. Most of these operations began along drainages and the overburden from the first cut was moved down the valley. Subsequent overburden is then pushed out over the previous pile with the process continuing until it becomes uneconomical to remove the overburden. These spoil piles tend to be relatively flat topped, with a gentle slope towards the pit and a relatively steep slope only on the outside of the pile.

The soil is removed first in this operation also, but, it may be spread out more, or it may be spilled over the end of the pile. The piles do not get as high in this type of operation, and, since they are usually along the valley walls, the piles are often lower than the bank along the pit wall. The tops of these piles are also generally very clayey and the material is generally tightly packed by the scraper operations so vegetation has a difficult time getting started.



Figure 10 - View of active dozer and scraper operation taken from pitwall. Active pit with loading shovel in left foreground. Spoil piles in center and right foreground. Note gentle slope of spoil piles toward the pit and lack of vegetation. Location - Bonsness Mine in NW of Section 27, T. 162 N., R. 93 W., Burke County, North Dakota.

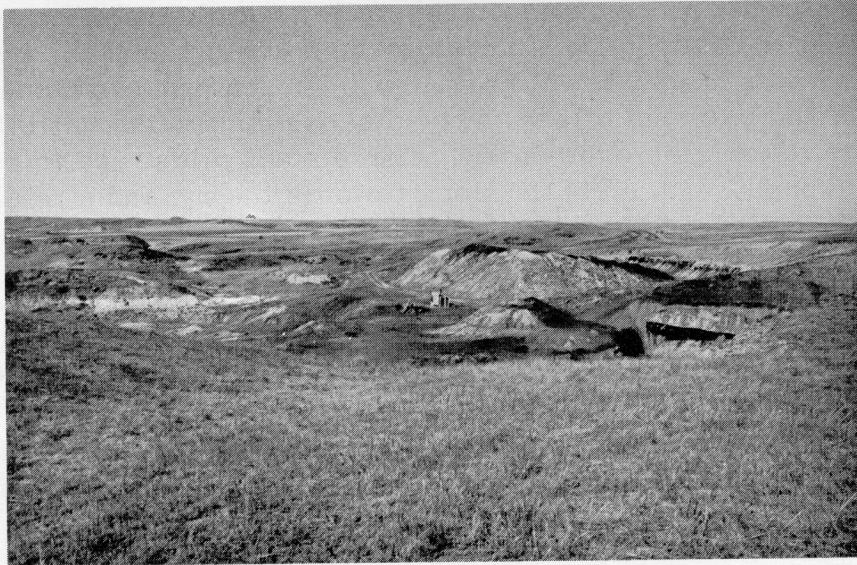


Figure 11 - View of active dozer and scraper operation with spoil piles in center of photo. Active pit partially obscured by pitwall in foreground and spoil piles. Left background shows semi-badland topography. Location - Nygaard Mine in SW of Section 36, T. 152 N., Range 98 W., McKenzie County, North Dakota.



Figure 12 - View of recently active dozer and scraper operation. Pitwall in center background, spoil piles in center foreground are partially covered with vegetation. Location - Landaker Mine in SE of Section 21, T. 153 N., R. 90 W., Mountrail County, North Dakota.



## METHODS OF STUDY

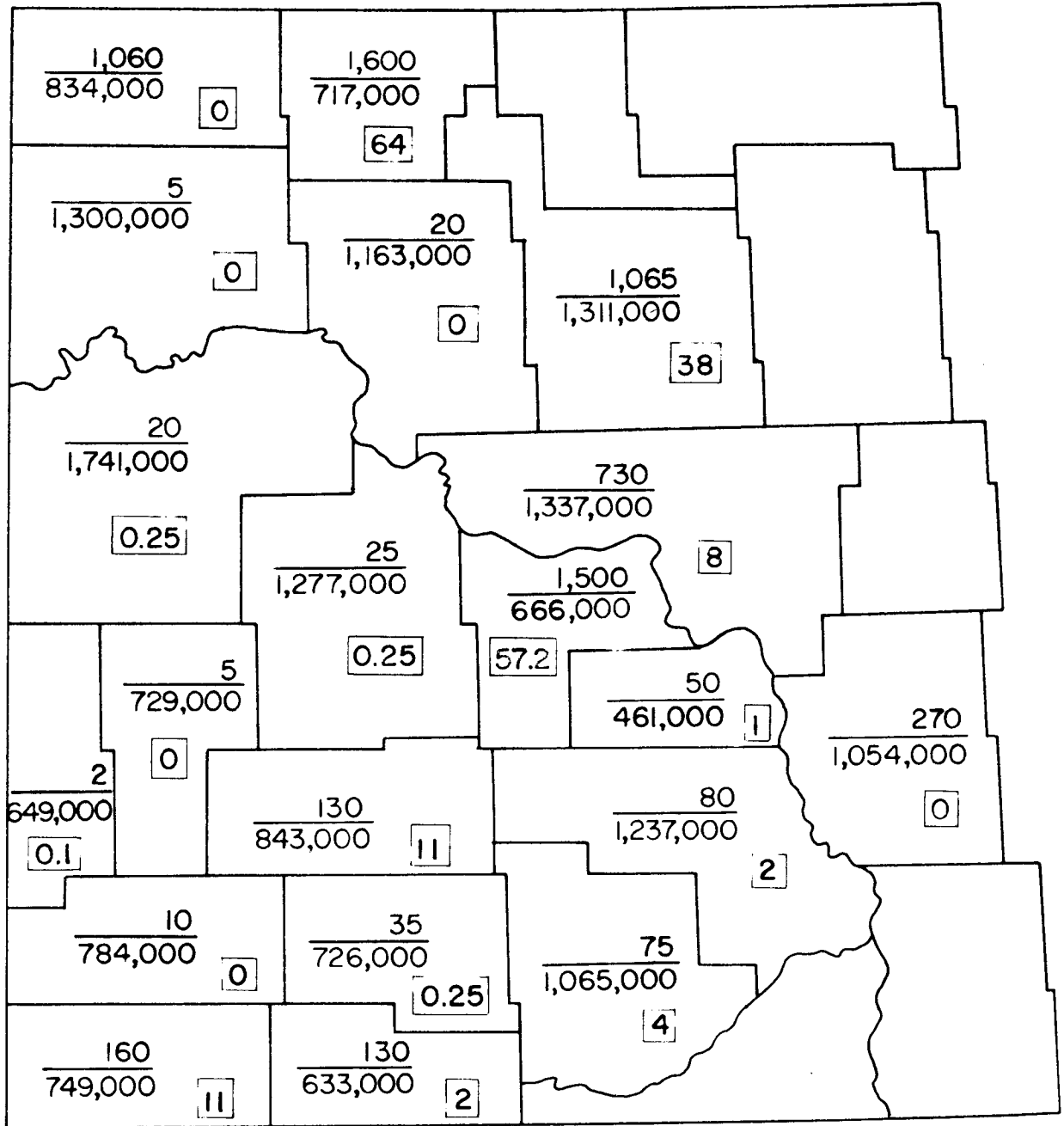
The present study began with the sending of questionnaires to each of the 45 active strip coal mine operators in North Dakota. Thirty-four replies were received. One mine had previously been sold, so only 10 mines failed to reply and they accounted for only 1.6 per cent of the 1963 production. Through these questionnaires, information was obtained regarding the location of mines, extent of previous mining, current rate of mining, type of mining operations, condition of spoil piles and feeling in regard to laws concerning spoil piles.

Following the preliminary questionnaire, a reconnaissance survey of most of the active and many of the inactive strip mines in North Dakota was made by Carlson. In this survey, he attempted to estimate acreage of disturbed lands, gather information regarding the type of soil and vegetation on existing spoil piles, collected soil samples for Ph analyses and any miscellaneous information which might later prove useful.

A public hearing was held by the State Geologist, Dr. Wilson M. Laird, at the State Capitol building in Bismarck on April 15, 1964, at which any interested parties were invited to present their views in regard to the spoil banks problems. Industry statements were received from Knife River Coal Mining Company, Truax-Traer Coal Company, Baukol-Noonan, Incorporated, Union Carbide Corporation, Basin Electric Power Cooperative, North American Coal Corporation, and New England Coal Company. Statements were also received from the Extension Service of North Dakota State University, the State Game and Fish Department, the State Soils Conservation Service, some county officials from Mercer and Oliver Counties, two State Legislators and a few other interested individuals.

During the course of the testimony, a wide range of viewpoints were expressed in regard to what the ultimate use of the spoil bank areas should be. In general, the testimony was largely concerned with the type and amount of rehabilitation which should be done, costs of such rehabilitation, original land values, tax yield to local governmental units from coal mining areas, spoil pile areas and wildlife areas and previous experience in revegetation of spoil pile areas. There was general agreement that most areas can be revegetated, however there were some differences of opinion as to whether we have had enough experience to proceed with specific plans for revegetation or whether a period of experimentation is needed.

The reconnaissance survey, supplemented by aerial photos of some areas, questionnaire replies, and production statistics indicate that a cumulative maximum of about 7,000 acres have been disturbed by strip mining operations as of January 1, 1964, with a current rate of about 200 acres per year. Since the total land area of North Dakota is about 44,450,000 acres, the strip mining to date has affected only about 0.016 per cent of the total land area. Twenty counties have previously been affected by strip mining, with active operations in fifteen counties. Approximate acreages disturbed, and the current rate of mining is shown in Table II.



LEGEND

$$\frac{10}{784,000} = \frac{\text{ACRES DISTURBED BY STRIP MINING OPERATIONS}}{\text{TOTAL ACREAGE IN COUNTY}}$$

$$\boxed{57.2} = \text{ACREAGE DISTURBED IN 1963}$$

Figure 13 - Map showing areas of mining and acreage disturbed.

County	Acreage Stripped	Current Rate in Acres per Year	County	Acreage Stripped	Current Rate in Acres per Year
Adams	130	2	McKenzie	20	0.25
Billings	5	-	McLean	730	8
Bowman	160	11	Mercer	1500	57
Burke	1600	64	Morton	80	2
Burleigh	270	0.1	Mountrail	20	-
Divide	1060	-	Oliver	50	1
Dunn	25	0.25	Slope	10	-
Golden Valley	2	0.1	Stark	130	11
Grant	75	4	Ward	1065	38
Hettinger	35	0.25	Williams	5	-

TABLE II - Acreage Disturbed by Strip Mines and Current Rate of Disturbance.



Figure 14 - An earth-fill dam using spoil pile material to provide a stock watering pond. Location - Ledahl Mine in NE of Section 10, T. 154 N., R. 100 W., Williams County, North Dakota.

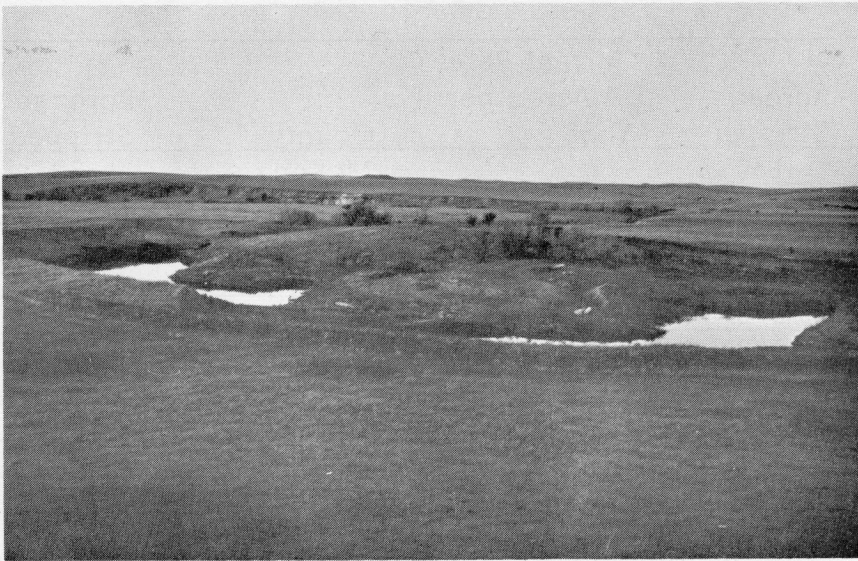


Figure 15 - An active dozer and scraper operation located in pastureland where the old pit may be used as a stock watering pond. Location - Sampson Mine in NE SW of Section 34, T. 144 N., R. 96 W., Dunn County, North Dakota.



Figure 16 - Abandoned scraper operation now used as pastureland. Old spoil piles along bank (right center) are quite similar to slump blocks (center and left center) along bank. Location - Weigum Mine in SW SW of Section 20, T. 146 N., R. 89 W., Mercer County, North Dakota.

## CURRENT REHABILITATION PRACTICES

At the present time, rehabilitation practices are at the option of each operator to do as he sees fit with his own operations. Therefore, current procedures are quite varied, but most operators have recognized that the general public is becoming increasingly interested in rehabilitation of these spoil piles so some operators are making an effort to re-utilize some of these lands after mining operations cease.

Rehabilitation practices have included making a dam with the spoil piles for a stock watering pond (Fig. 14), using the old pits for stock watering ponds (Fig. 15), and one old pit has been stocked by the State Game and Fish Department to be used as a fish pond. Both of the previously described types of stripping operations leave areas suitable for this type of rehabilitation.

The dozer and scraper type of spoil piles, because of their original location are often used as pastureland (Fig. 16) but because of packing during stripping operations and the generally low fertility of the overburden, vegetation is usually sparser on the spoil piles than on undisturbed lands. The dragline type of spoil piles have also been used as pastureland, but the vegetative cover is quite sparse and generally less productive than the undisturbed areas (Fig. 17). The practice of grazing these lands has caused some browsing of the trees and has been blamed for killing off some efforts to revegetate certain spoil areas.

In the Wilton area, abandoned dragline spoil piles have been leased by the State Game and Fish Department for a game management area. They have done some tree planting and some aerial grass seeding with satisfactory survival rates (Figs. 19 and 20). The abandoned pit is apparently used as a swimming hole by some area residents. Some fish have also been planted in this pit.

The Custer Mine, located near Garrison, has also been leased as a game management area by the State Game and Fish Department. They have, with the aid of the Garrison Sportsman Club, conducted a development plan involving the planting of about 40,000 trees in the period from 1950 to 1959. It has been conducted on an experimental basis, using a great variety of trees, so that survival and growth rates for the various species could be recorded. However, since the planting was done by volunteer labor, the planting was not done on a systematic basis and as a result survival rates can only be recorded in a general way. Reports by the Game and Fish Department through April of 1960 and field observations by the writers in 1963 indicate very satisfactory survival and growth rates for most species (Figs. 21 and 22).



Figure 17 - Abandoned dragline operations now used as pastureland. Location - North American Pit in NE of Section 24, T. 144 N., R. 89 W., Mercer County, North Dakota.

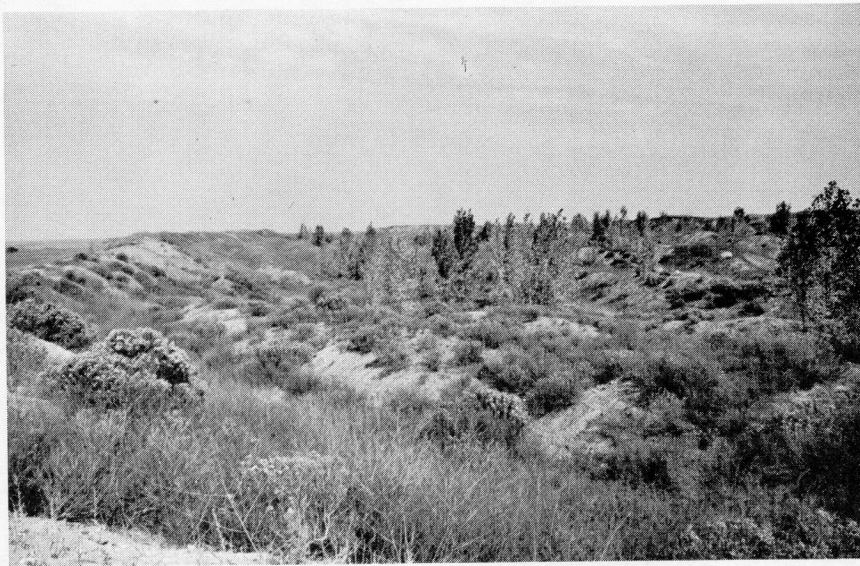


Figure 18 - Vegetative cover of weeds, low bushes and trees on abandoned dragline operations. Location - North American Pit in SE of Section 24, T. 144 N., R. 89 W., Mercer County, North Dakota.



Figure 19 - Trees and grass growing on abandoned dragline operations. Mine abandoned in 1943. Trees planted by sportsmen club. Location - SW SW of Section 31, T. 143 N., R. 79 W., near Wilton, Burleigh County, North Dakota.



Figure 20 - Abandoned dragline pit showing pond in old pit and tree growth in surrounding area. Location - SW SW of Section 31, T. 143 N., R. 79 W., Burleigh County, North Dakota.

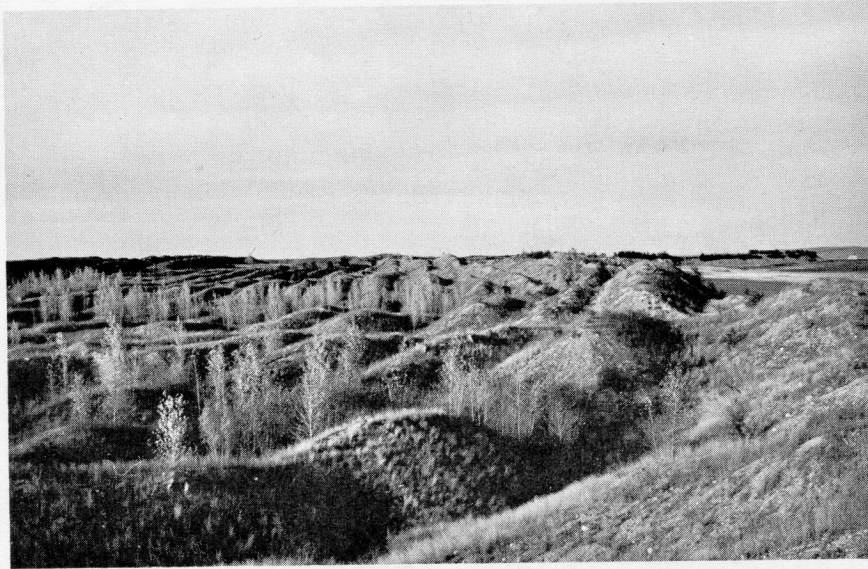


Figure 21 - Trees planted in 1954 on abandoned dragline spoil piles. Location - Custer Mine in SE of Section 18, T. 148 N., R. 83 W., Mercer County, North Dakota.

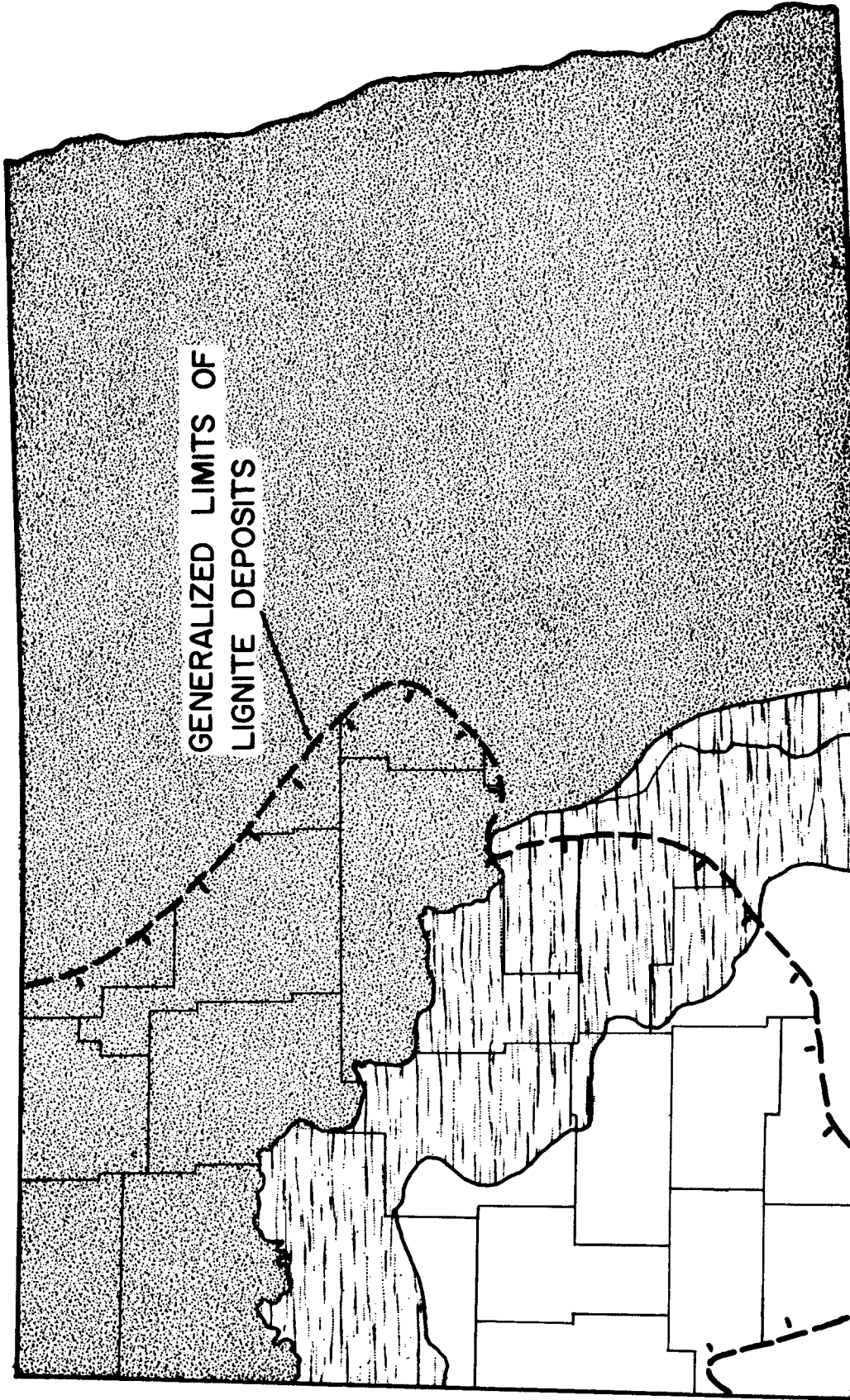


Figure 22 - Trees planted in 1951 at the Custer Mine. Spoil pile is about 35 feet high. Location - NE of Section 18, T. 148 N., R. 83 W., Mercer County, North Dakota.



The Knife River Coal Mining Company is presently modifying their stripping operations so that before the dragline is moved to extend the pit, they remove as much topsoil as they can reach with the bucket and distribute it over the top of the spoil pile formed in the stripping operation. While this practice will not cover the whole pile with topsoil, it will at least put some of the topsoil on the top, rather than the bottom of the spoil piles. This should be of benefit in getting a vegetative cover started. The Knife River Coal Mining Company has also started an experimental planting program at their Beulah Mines, planting about 20,000 trees in the spring of 1964.

The Truax-Traer Coal Company has a clause in their contract for supplying coal to the Basin Electric Plant calling for restoration of the spoils areas to a "gently rolling" topography. They expect to accomplish this by using a different type of stripping operation. They will use a machine called a wheel excavator and through a system of conveyor belts they expect to produce a gently rolling topography with a minimum of further leveling.






-  **GLACIATED AREA; Variable thickness of drift overlying bedrock.**
-  **GLACIATED AREA; But drift is patchy to non-existent.**
-  **UNGLACIATED AREA**

Figure 23 -- Map showing limits of glaciation and areas of glacial drift.

## SUMMARY OF FINDINGS

Soil samples were collected from many spoil piles and the Soils Department of North Dakota State University ran 22 analyses for us. The Ph ranged from 4.0 to 8.8, with only two samples on the acid side. Most of the samples were in the range from 7.6 to 8.3 which is within the range of most of the native soils of these areas. Therefore, the problem of acid soils which is often a problem of spoils piles areas in the eastern United States is not expected to be a problem in the revegetation of North Dakota spoils piles.

Soluble salt tests showed a range in specific conductance readings from 36 to 370. The Soils Department has a salt tolerance code to interpret these readings with a range from 0 to 4. The samples from the spoils piles fall within the 0 to 2 range on this code, so in some areas species must be selected on the basis of salt tolerance, but the values are within the range where salt content should not be an insurmountable problem.

Although all of the commercial lignite production in North Dakota is obtained from the Ft. Union Formation of Paleocene age, there are differences in Geology between some of the major mining areas which are significant in regard to rehabilitation. In most of southwestern North Dakota the Ft. Union Formation, consisting of alternating layers of lignite, clay, silt and sand, is present at the surface. However, north and east of the Missouri River glacial drift, consisting of unsorted or poorly sorted clay, sand, silt and gravel particles overlies the Ft. Union Formation. In general, the glacial drift seems to provide more favorable conditions for vegetative growth, probably due in part to the poorer sorting of these materials, providing better moisture conditions and due in part to humus and other plant nutrients contained in the drift. The Custer Mine near Garrison and the Wilton Mine in Burleigh County where revegetation projects have been most successful are both located in areas where a considerable portion of the spoils piles are composed of glacial drift. The Velva Mine of the Truax-Traer Company in Ward County has similar physical properties and systematic planting projects should be equally successful there.

The Mines of the Truax-Traer Coal Company and Baukol-Noonan, Incorporated, in Divide and Burke Counties, are also in glaciated areas, but the glacial drift is thin and the spoils piles are composed mainly of Ft. Union materials. In the older spoils piles in this area, the piles are generally capped by yellowish clay and except for vegetation in the troughs vegetation is sparse on most of these piles. Even with serious efforts to revegetate these areas, it will probably take some time to develop a successful program. In the newer mining areas of Burke County, the overburden is also mainly Ft. Union materials, but they are sandier, so they may provide more suitable material for revegetative purposes.

The Mercer County area has also been glaciated, but there is little or no glacial drift in the areas being mined. The spoils piles are almost entirely composed of clays, silts and sands of the Ft. Union Formation. In most of this area, there is a "blue" clay directly overlying the lignite seam which is being mined and a large percentage of the spoils piles are composed of clay and most of the spoils piles are capped by this clay. Revegetation of these areas will probably be more difficult than in areas where glacial drift is present, but previous revegetation attempts have been partially successful in these areas, and with some experimentation successful plans can surely be developed for revegetating these areas also.

At the hearing in Bismarck, the Soil Conservation Service personnel presented cost figures for some experimental leveling of spoils piles in the Velva and Beulah areas. These plots were leveled using dozers at the commercial rate and their figures were \$139 per acre for the Velva project and \$196 per acre for the Beulah project. If larger areas were to be leveled, cost per acre could be cut somewhat, but it would probably still be in excess of \$100 per acre for the Velva area and around \$150 per acre for the Beulah area.

At this public hearing, a Soils Conservation Service representative also presented cost figures for tree planting of 10 cents per tree for hand planting and 2 cents per tree for machine planting. The cost for machine planting was later questioned by Forestry Extension Service and Game and Fish Department personnel who said that 6 cents per tree for the cost of machine planting would be a more realistic figure.

The matter of tax revenues was brought up at the public hearings also. Mr. Kane, representing the Knife River Coal Mining Company, stated that taxes were generally higher on coal company lands than on surrounding agricultural lands and that no mined out areas had been turned back to the counties by the mining companies. His tax statements regarding valuations were challenged by Mr. Moore, County Engineer for Mercer County, who subsequently sent us plats showing the valuations for the land in Mercer County around the North American, Knife River and Truax-Traer Mines. These plats generally showed that the North American and Knife River lands were assessed at rates quite similar to surrounding agricultural lands, but that the Truax-Traer lands were assessed at about double that of surrounding agricultural lands.

The question of tax yield from Game and Fish Department lands was also brought up. Mr. Stuart stated that his department pays taxes at a rate of 1 per cent of valuation less improvements for their lands.

## RECOMMENDATIONS

There are a number of solutions to the spoils piles problems which have been suggested during these investigations. The range of solutions would vary from allowing previous voluntary practices to continue to strict laws pertaining to rehabilitation. Previous voluntary practices have not resulted in very satisfactory rehabilitation practices, but the threat of laws pertaining to this subject has led some mining companies to come up with suggested rehabilitation plans and some of these have already been implemented. The question then is whether current programs are adequate for the present, and if not, is legislation necessary to rehabilitate the spoils piles areas.

Some people would like to see the spoils piles restored to their original state previous to mining. This would involve removing the topsoil first, then stripping and mining, then leveling and replacing the topsoil. Such a program would be very expensive. An alternative to this would be to continue present stripping practices, but to level the spoil areas to a gently rolling topography. Estimated costs of such rehabilitation are \$100 plus per acre for leveling. Since the land has an average value of \$50 per acre previous to mining and would certainly be less productive after leveling due to loss of topsoil and compaction during leveling, there is some question as to the economic feasibility of such rehabilitation. Furthermore, state laws prohibit corporations from engaging in farming so the coal companies could not restore the spoil areas to agricultural lands and then farm them themselves. Another consideration is that in some cases the mining companies do not own the land themselves, but merely lease it, paying royalties to the landowner. However, if such a course of action were chosen, legislation is needed to resolve the spoils piles problems.

An alternative solution suggested by the North Dakota Game and Fish Department and endorsed by several of the mining companies is to use the spoil pile areas for wildlife habitat. Inspection tours of the Custer and Wilton Mine game management areas revealed satisfactory survival rates for the plantings that have been done in those areas, as well as use of these areas by waterfowl, upland game and deer. The Knife River Coal Mining Company is on record as favoring a voluntary revegetation program and as an indication of good faith initiated such a program in the Beulah area in the spring of 1964. Their program does not involve any leveling and although the purpose of their program would be to provide wildlife habitat, they did not consider the question of land ownership after rehabilitation. They have recommended a controlled experimental planting period of about three years, after which they would expect to develop a program of revegetation to be applied throughout their spoil bank areas.

Mr. Arthur Schultz, representing the Extension Service of North Dakota State University, recommended that the spoils bank areas be leveled enough to permit the use of farm type equipment even if these lands are to be planted to trees and

used as wildlife habitat. A Soils Conservation service representative presented cost figures at the public hearing in Bismarck for hand and machine planting of trees, and then estimated a savings of about \$60 per acre for machine planting. Costs of such rehabilitation would again be a factor for consideration, and if the land were to be leveled enough for farm type tree planting equipment to be used, some legislation would be needed to provide a regulatory agency to enforce compliance with such regulations as might be deemed necessary.

Dr. Limstrom, of the United States Forest Service, Central States Forest Experiment Station, Columbus, Ohio, visited some of the North Dakota spoils bank areas in June, 1964. He stated that it has been their experience in the spoils bank areas of the central states that trees have better growth and survival rates on areas which have not been leveled and that hand planting of trees is the general practice in those areas. He also suggested that North Dakota could well afford an experimental period. This period might be used to evaluate the voluntary programs set up by the mining companies and might also include an experimental program by some government agency. Such a project should experiment with re-vegetation of leveled and unleveled areas for comparisons of growth and survival rates and cost figures should be maintained so that economic feasibility can be considered. Voluntary planting programs of the mining companies should be inspected to see what their survival and growth rate experience is. If such a program were set up the logical agency to supervise the project would seem to be the Game and Fish Department since the purpose would be to provide wildlife habitat. It would be expected that they would cooperate with the Forest Extension Service as they have previously been doing on numerous projects.

The arguments advanced in favor of using these lands for wildlife habitat may be summed up as follows:

- 1) The area affected by strip mining to date is not very large,
- 2) The state has lost large areas of wildlife habitat to the reservoirs along the Missouri River and elsewhere,
- 3) Costs of such a program of rehabilitation would not be so high as to threaten the competitive position of the lignite mining industry.

If wildlife habitat were chosen as the proper use for the spoils bank areas, at least for the present time, then the wisest course of action might be to postpone any legislation on the subject until results from present voluntary experimental projects can be more fully evaluated.

This course of action would also allow a period of time for evaluation of Basin Electric's plan of restoring the land to a "gently rolling topography". Their program should be amenable to experimentation in returning the land to agricultural usage.

In summary it is our recommendation that no legislation is necessary at the present time. However, we would recommend that an experimental program supervised by the North Dakota Game and Fish Department be initiated, so as to promote a continuing evaluation of this problem and to be ready with answers if the acreage being disturbed should increase to a point where it is of greater significance to the economies of the affected areas and to the state as a whole.

APPENDIX "A"

SENATE CONCURRENT RESOLUTION "N-N"

(Trenbeath, Kisse)

REHABILITATION OF STRIP MINE LANDS

A concurrent resolution directing the State Geological Survey to study methods of rehabilitating lands disrupted by strip coal mining operations.

WHEREAS, the amount of coal taken from strip mines within the state during past years has been quite substantial; and

WHEREAS, development of the industries of the state, particularly the industry of electrical energy production, will call for increased strip coal mining operations in the future; and

WHEREAS, strip mining operations involve the removal of large quantities of earth and other materials in order that coal veins may be exposed and removed; and

WHEREAS, the failure to properly rehabilitate lands disturbed by strip mining operations can result in leaving a topography which may be unsanitary, unsafe, and unsightly, as well as being an economic waste to the state through the inability to subsequently utilize the land for any beneficial purposes;

NOW, THEREFORE, BE IT RESOLVED BY THE SENATE OF THE STATE OF NORTH DAKOTA, THE HOUSE OF REPRESENTATIVES CONCURRING THEREIN:

That the State Geological Survey is hereby directed to study the problem of the leveling and rehabilitation of lands disturbed by strip coal mining operations, with a view both toward what action has been taken to rehabilitate such lands in the past and what may be done in the future to assure the maximum utilization of such lands by the owners thereof and by the state, and to make such recommendations as may be necessary to the Thirty-ninth Legislative Assembly; and

BE IT FURTHER RESOLVED, that the Geological Survey shall be authorized to secure the assistance of any state department, agency, board or commission, or the employees thereof, including, but not limited to the State Forester, Soil and Water Conservation Commissions, Coal Mine Inspector, and Game and Fish Department, as well as private coal mine operators and any agencies and Departments of the Federal Government.

Filed March 15, 1963.