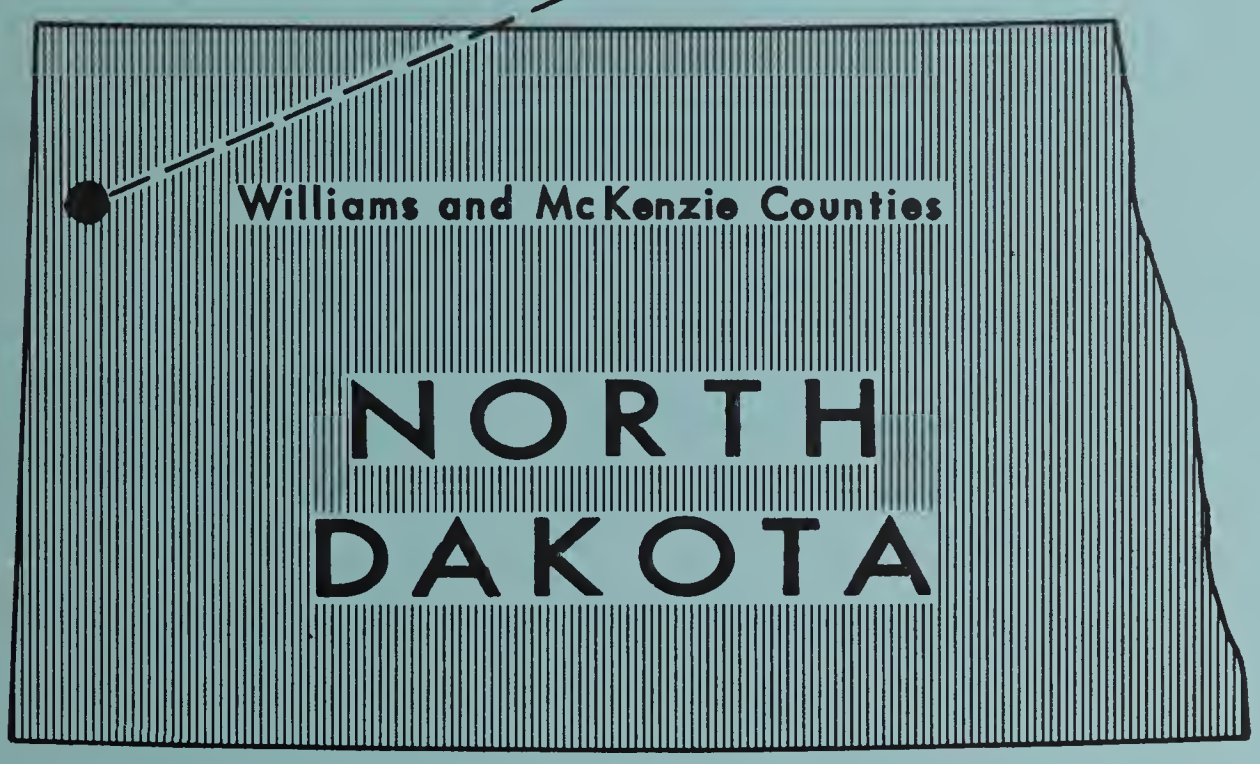
SUMMARY

Williams and McKenzie Counties Study Report



RESOURCE & POTENTIAL RECLAMATION EVALUATION

Williams and McKenzie Counties Study Report
Published July 1983

The Federal Coal Management Program has been designed as an interagency cooperative effort to meet national energy objectives.

Williams and McKenzie Counties Study Report was prepared through the efforts of the U.S. Department of the Interior, principally the Bureau of Land Management and Bureau of Reclamation. The study effort began in 1981 and was concluded in 1983 with the publication of this report.

The areas described in this report have been tentatively determined to be potential Federal coal development areas. The purpose of the report is to provide information on the areas' reclamation potential, should coal development occur. This report will assist managers in making final Federal coal leasing decisions.

Limited copies of the report are available from:

Bureau of Land Management
Montana State Office
222 N. 32nd Street
Billings, MT 59107

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Prepared jointly by the Bureau of Land Management and Bureau of Reclamation

16. Abstract The purpose of this investigation was to collect baseline data for establishing reclamation objectives and lease stipulations. The area of study, located in northwestern North Dakota, is situated in the glaciated Missouri Plateau section of the Great Plains Physiographic Province. The topography of the area is predominantly flat to gently rolling uplands which are locally dissected along drainages. Bedrock exposed in the area consists of the Sentinel Butte or Tongue River Members of the Paleocene Fort Union Formation. Pre-Pleistocene to Holocene gravel terraces, Pleistocene glacial deposits, and Holocene loessal and alluvial deposits locally mantle the bedrock in the area. Twelve fairly persistent lignite beds were penetrated by drilling in the area. These are the R-, Y-, B-, G-, Pittsley, Tyrone, Blacktail, Avoco, Williston, Judson (H-bed), I- or J-, and Mormon beds. Soil/overburden samples from 20 representative drill holes were evaluated for suitability as plant media in reconstructed profiles. Most of the materials were rated as limited suitability or unsuitable due to textural limitations, high exchangeable sodium percentage, moderate salinity, and/or moderately high levels of manganese or nickel. Suitable materials generally included the surface soil (6-18"), a few tills, and selected sedimentary strata which were medium textured, nonsaline, and nonsodic. X-ray diffraction analyses were performed on about 200 overburden samples. Illite and random mixed-layer clays, together, generally comprised 75-90% of the clay fraction. Kaolinite and chlorite were also common constituents, but averaged only 10% and 5%, respectively, of the clay fraction. Other minor constituents included quartz, carbonate, and feldspar.

17. Document Analysis a. Descriptors

0510 Environmental Surveys
0807 Coal Deposits
1407 Reclamation

b. Identifiers/Open-Ended Terms

North Dakota, reclamation, physiography, geology, overburden, x-ray diffraction

c. COSATI Field/Group

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RESOURCE AND POTENTIAL RECLAMATION EVALUATION OF WILLIAMS AND MC KENZIE COUNTIES STUDY NORTH DAKOTA

INTRODUCTION

Recent energy shortages have forced our society to seek new domestic energy sources. Attention has focused on the immense quantities of low sulfur coal that lie within the Rocky Mountain and Northern Great Plains regions. It is the responsibility of the Department of the Interior, principally the Bureau of Land Management, to assist in meeting these energy demands and, at the same time, provide sound reclamation guidelines so that the disturbed lands are restored to an acceptable condition.

PURPOSE

The purpose of this report is to provide baseline information for establishing reclamation objectives and lease requirements. Data is given on geology and overburden. Background information is also provided on area physiography.

LOCATION

The Williams and McKenzie Counties Study is located in northwestern North Dakota. Plate 1 shows the general location of the study area. Four smaller areas were selected within the two county area for overburden studies. These include the Hanks, Sand Creek, Williston, and Tobacco Garden Study Areas. The four study areas include a total of 1,037 full or partial sections as shown on Plate 2. Federal and State coal ownership is interspersed in the study areas, as shown on Plates 3 through 6. The majority of surface ownership in these areas is private. Only a limited amount is controlled by the Federal government as shown on Plates 7 through 10.

The original study area (Beaver Creek) was intended to be a comprehensive study of a portion of the present "Williston Study Area". The investigations program was to include drilling and testing samples from 25 core holes. At the commencement of the program, however, the emphasis of the study was changed to an overview of several study areas. These studies eventually included the completion of 27 core holes.

PHYSIOGRAPHY

The Williams and McKenzie Counties Study is situated in the glaciated Missouri Plateau section of the Great Plains Physiographic Province. The topography of the area is predominantly flat to gently rolling uplands which are locally dissected near drainages. Closer to Lake Sakakawea, dissection increases to a point where rugged badland topography is prevalent. Portions of the area, especially in the northwest, are characterized by knob and kettle topography.

Much of the area, especially north of the Missouri River, is mantled with deposits from continental ice sheets. The uplands are covered with till and boulders and the major valleys are often filled with glaciofluvial outwash. Sedimentary strata of the Fort Union Formation are exposed along deeply-incised

drainage valleys and, especially south of the Missouri River, at higher elevations in the uplands. Resistant scoria (baked coal and shale) outcrops occur throughout this study area. These outcrops appear as thin, remnant "caps" over the sloping uplands. Maximum relief in the area is approximately 640 feet.

Shallow, underfit streams such as the Little Muddy, White Earth, and Tobacco Garden Rivers and Beaver and Stony Creeks drain into Lake Sakakawea (Missouri River). Generally, drainage is accomplished through a well integrated dendritic system; however, numerous fresh and saline lakes occur in the poorly drained topography to the northwest.

GEOLOGY

The Williams and McKenzie Counties Study is located in the Williston Basin. This basin is a synclinal structure extending from South Dakota into Canada, a distance of about 500 miles.

Bedrock exposed in the study areas consists of the Tongue River Member of the Fort Union Formation of Paleocene Age. Pre-Pleistocene to Holocene gravel terrace deposits, Pleistocene glacial deposits, and Holocene loessal and alluvial deposits mantle the bedrock in the area.

Approximately 12 fairly persistent lignite beds were penetrated by drilling in the area. These 12 major lignite beds, from oldest to youngest, are: (1) R-bed; (2) Y-bed; (3) B-bed; (4) G-bed; (5) Pittsley; (6) Tyrone; (7) Blacktail; (8) Avoca; (9) Williston; (10) Judson (H-bed); (11) I- or J-bed; and (12) Mormon.

Engineering property tests performed on bedrock materials similar to those in the Williams and McKenzie Counties Study revealed that shear strengths are low. Slides can develop adjacent to high walls in surface mines, and saturated alluvial deposits and uncemented siltstones and fine-grained sandstones will readily erode and flow into excavations.

Excavation slopes will vary between minesites and will be dependent on exposure time, moisture conditions, material types, and depth of cut.

After disturbance, an increase of about 25 percent will occur in the volume of the overburden. Some areas of the surface will actually be higher in elevation after mining. Settlement will then occur for several years after reclamation until the materials reach a stable condition.

Three types of instability are common on reclaimed coal-mined areas in the Northern Great Plains. They are: (1) areawide settling, (2) localized collapse, and (3) piping. Each form of instability is affected by certain variables in the postmining landscape. These variables include the physical and chemical characteristics of the overburden, the method and equipment used in stripping and contouring operations, and the season when these activities occur. One or more of these types of landscape instabilities may occur on reclaimed land in the Williams and McKenzie Counties Study Area.

Weathering tests were not conducted on samples from the Williams and McKenzie Counties Study Area; however, results from the Rattlesnake Butte Study Area, located 90 miles to the south, indicated that freezing-thawing caused more weathering or breakdown than wetting-drying. The study also indicated that the

materials weather at different rates, which will require various methods of handling, storing, and processing.

A study of the seismic history of the region indicates that minor damage could result to structures from earthquake shocks.

No significant paleontological finds were observed in the study area.

OVERBURDEN SUITABILITY FOR REVEGETATION

Overburden samples from 20 representative Bureau of Reclamation drill holes were evaluated as to their suitability for use as a planting medium for revegetation.

Complete laboratory analyses, including selected trace element determinations, were performed on the samples by Bureau of Reclamation laboratories in Bismarck, North Dakota, Boise, Idaho, and Denver, Colorado. In addition, x-ray diffraction analyses were performed on approximately 200 of the samples in order to identify the major clay mineral types occurring in the various overburden materials.

The suitability criteria listed in Table 1 were applied to the laboratory data in order to place the overburden materials into one of three categories: Suitable, Limited Suitability, or Unsuitable.

Three distinct material types comprised the overburden in 20 representative drill holes from the Hanks, Sand Creek, Williston, and Tobacco Garden Study Areas. These were topsoil/subsoil, glacial till and/or outwash, and soft sedimentary beds.

Glacial till of variable depth occurred below the soil material in all but one of the drill holes. The till was underlain by the sedimentary beds, all belonging to the Sentinel Butte Member of the Paleocene Fort Union Formation.

Only a small percentage of the overburden materials were rated suitable for use as planting media. These materials commonly included the surface soil (1-2 feet) in each drill hole, as well as a few of the till materials and selected sedimentary strata. The latter typically consisted of sandstones, silty sandstones, or sandy siltstones/shales. The suitable materials were medium textured, nonsaline, and nonsodic. They could be selectively stripped and utilized as either topsoil or subsurface material in reconstructed profiles.

Many of the subsoil, till, outwash, and sedimentary materials were placed in the limited suitability category due to moderately fine or moderately coarse texture and/or moderate salinity (4-12 mmhos/cm). In addition, some of these materials had moderately high exchangeable sodium percentages or contained moderate levels of manganese or nickel. The limited suitability materials are undesirable for use as topsoiling material; however, they could be utilized as subsurface material in reconstructed profiles, preferably below 2 to 3 feet of medium textured, nonsaline, and nonsodic material.

A significant percentage of the overburden materials were rated unsuitable for use as planting media. Most of these materials consisted of sedimentary beds which were fine or coarse textured and/or contained high percentages of exchangeable sodium. A number of these materials were also moderately saline and/or contained moderately high levels of nickel or manganese. In addition to

the sedimentary beds, several outwash zones were rated unsuitable due to very coarse texture. The unfavorable physical and chemical characteristics of these materials make them undesirable for use as planting media. They should be selectively placed well below the plant rooting zone in reconstructed profiles.

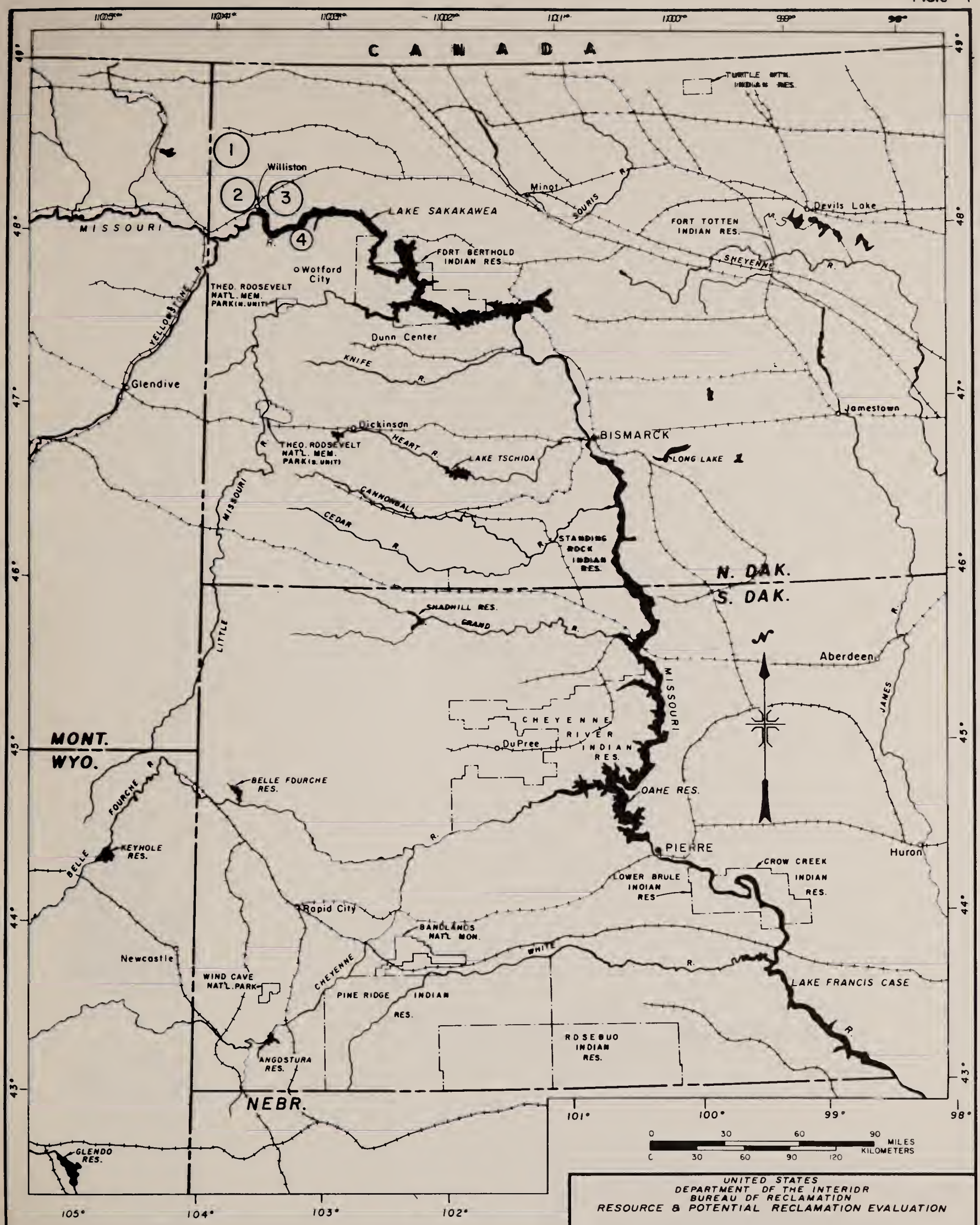
Approximately 200 overburden samples from 14 Bureau of Reclamation drill holes were selected for x-ray diffraction analysis. The purpose of this testing was to differentiate the major clay types comprising the overburden materials. Sample materials consisted of soil (subsoil), glacial till, shales, siltstones, and sandstones.

Illite and random mixed layer clays were the dominant types comprising the overburden materials. Together, they generally constituted 75 to 90 percent of the clay fraction.

The smectite clay group, of which montmorillonite is a species, was only distinguished in one shale sample and three sandstone samples. However, it was the dominant type in these samples, comprising 97 to 100 percent of the clay fraction.

Kaolinite and chlorite were relatively common constituents in the overburden samples, but they only constituted about 10 percent and 5 percent, respectively, of the clay fraction.

Other minerals occurring to a minor extent included quartz, carbonate, and feldspar.



(1) HANKS STUDY AREA

(2) SAND CREEK STUDY AREA

(3) WILLISTON STUDY AREA

(4) TOBACCO GARDEN STUDY AREA

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RESOURCE & POTENTIAL RECLAMATION EVALUATION

NORTH DAKOTA, SOUTH DAKOTA, MONTANA & WYOMING

GENERAL LOCATION MAP

DESIGNED F. CALCAGNO SUBMITTED

DRAWN S. STARCEVICH RECOMMENDED

CHECKED E.J.T. APPROVED

BILLINGS, MONTANA JUNE 1983 1305-600-377

R. 103 W. R. 102 W. R. 101 W. R. 100 W. R. 99 W. R. 98 W.

T. 160 N.

T. 159 N.

R. 97 W. R. 96 W. R. 95 W.

T. 58 N.

T. 57 N.

T. 56 N.

T. 55 N.

T. 54 N.

T. 53 N.

T. 52 N.

HANKS

HANKS

SAND CREEK

WILLISTON

WILLISTON

TOBACCO GARDEN

Boundary of Plates 3, 7 & 13

Boundary of Plates 5, 9 & 15

Boundary of Plates 4, 8 & 14

Boundary of Plates 6, 10 & 16

N

6 0 6 12

SCALE OF MILES

ALWAYS THINK SAFETY

UNITED STATES
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RESOURCE AND POTENTIAL RECLAMATION EVALUATION

WILLIAMS AND McKENZIE COUNTIES STUDY
NORTH DAKOTA

LOCATION MAP

DESIGNED F. CALCAGNO FIELD APPROVAL

DRAWN S. STARCEVICH TECHNICAL APPROVAL

CHECKED APPROVED

BILLINGS, MONTANA JUNE 1983 1305-600-378

R103W R102W R101W

T 59 N

T 58 N

T 57 N

DIVIDE COUNTY

WILLIAMS COUNTY

SHERIDAN COUNTY

MCKENZIE COUNTY

HANKS

Grenora

Williston

Fortuna

Alamo

Zahl

Lake Zahl National Wildlife Refuge

Missouri River

Gladys

MATCH LINE DWG. NO. 1305-600-380

SASKATCHEWAN, CANADA
NORTH DAKOTA

1 SHEET 1 OF 4

MONTANA
NORTH DAKOTA

1 2 3 4

INDEX MAP

EXPLANATION

Study Areas

MINERALS OWNED BY THE FEDERAL GOVERNMENT

All Minerals

Coal Only

Other

2 1 0 1 2 3 4
SCALE OF MILES

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WILLIAMS AND McKENZIE COS. STUDY
NORTH DAKOTA

MINERALS OWNERSHIP MAP

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CHECKED APPROVED

BILLINGS, MONTANA MAY 1983
SHEET 1 OF 4

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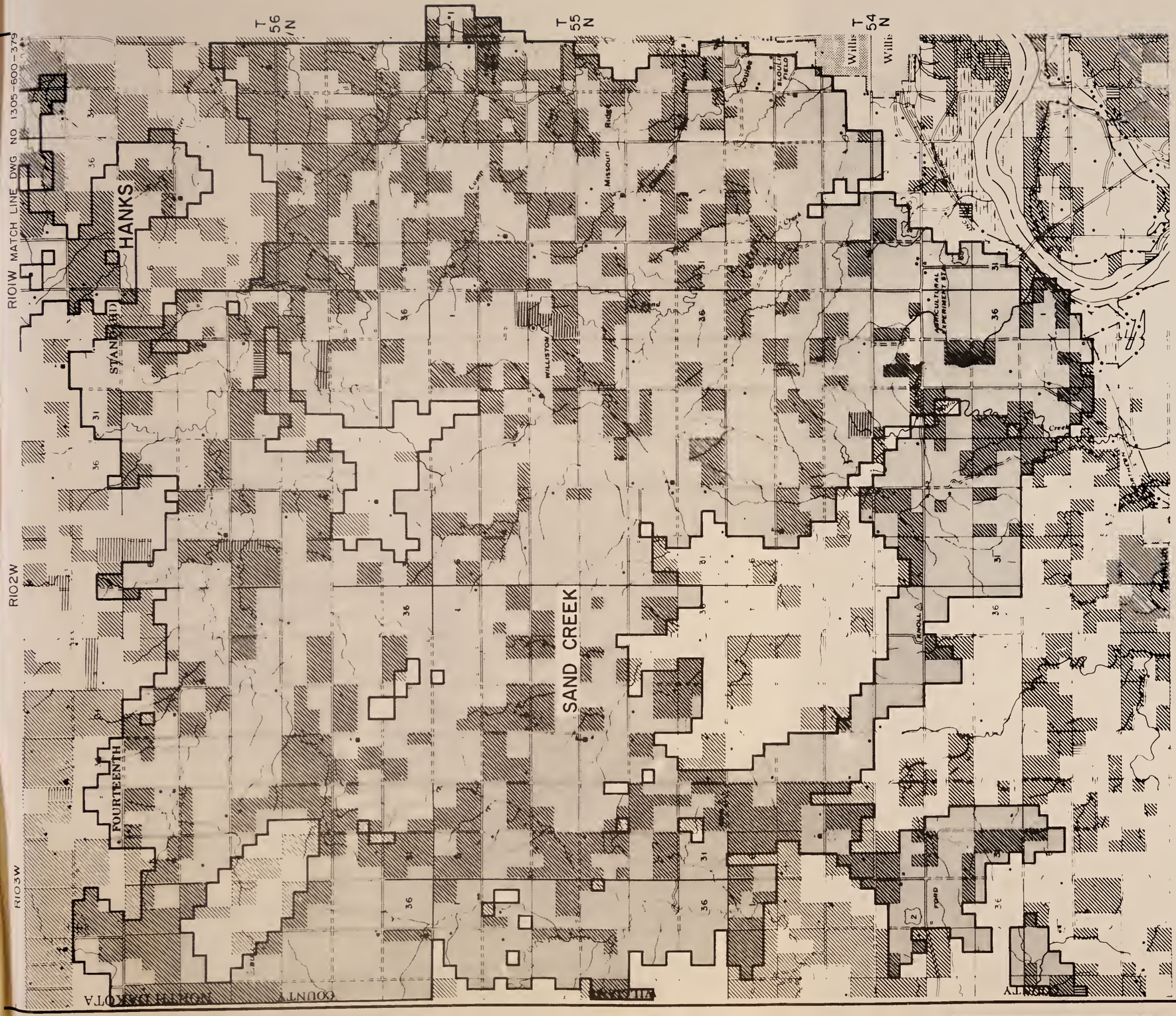

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All Minerals

Coal Only

Other

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SCALE OF MILES

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MINERALS OWNERSHIP MAP

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DRAWN S. STARCEVICH	TECHNICAL APPROVAL -
CHECKED	APPROVED -

BILLINGS, MONTANA MAY 1983
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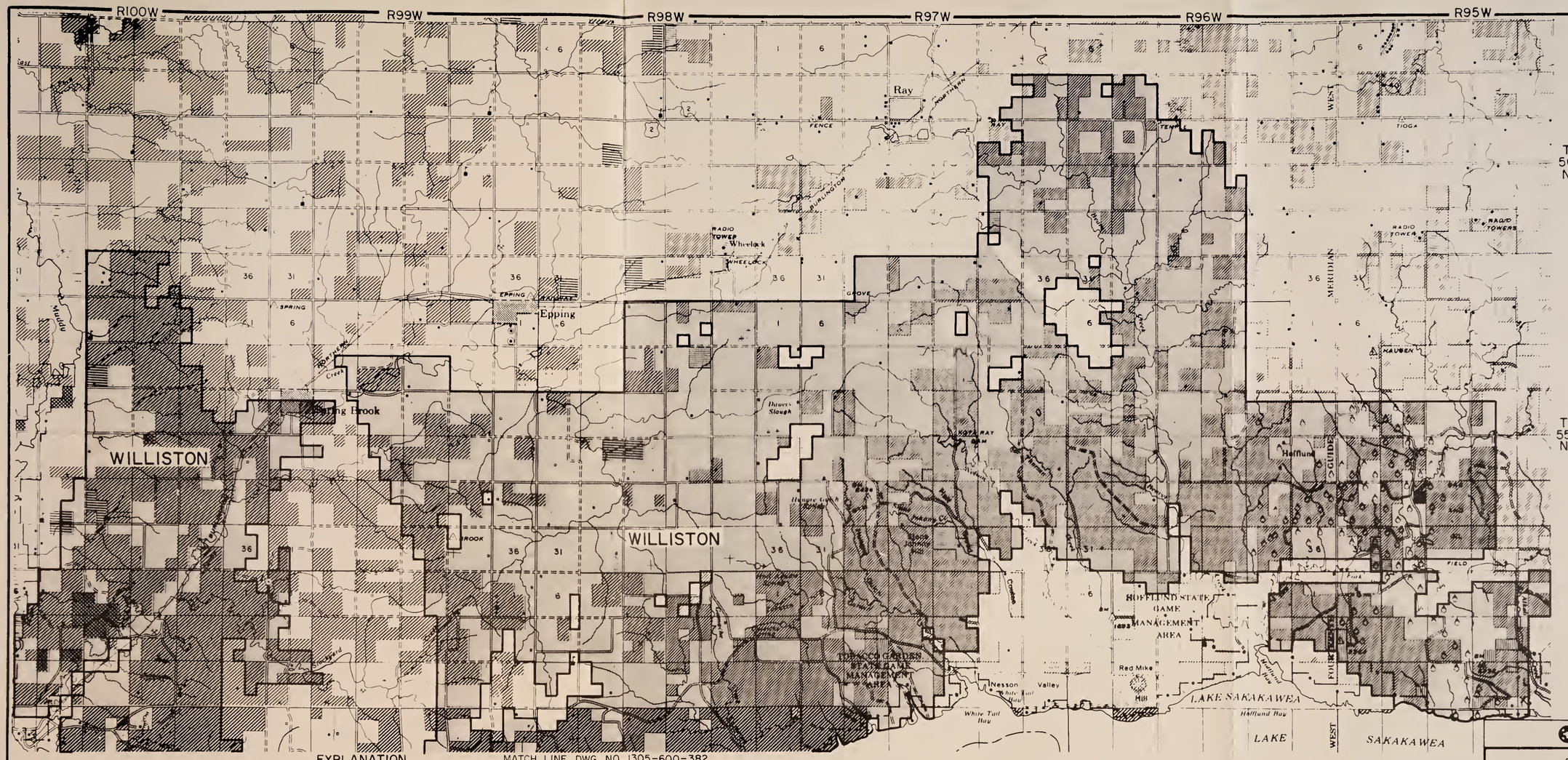

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MINERALS OWNERSHIP MAP

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DRAWN S. STARCEVICH — TECHNICAL APPROVAL
CHECKED — APPROVED

BILLINGS, MONTANA MAY 1983
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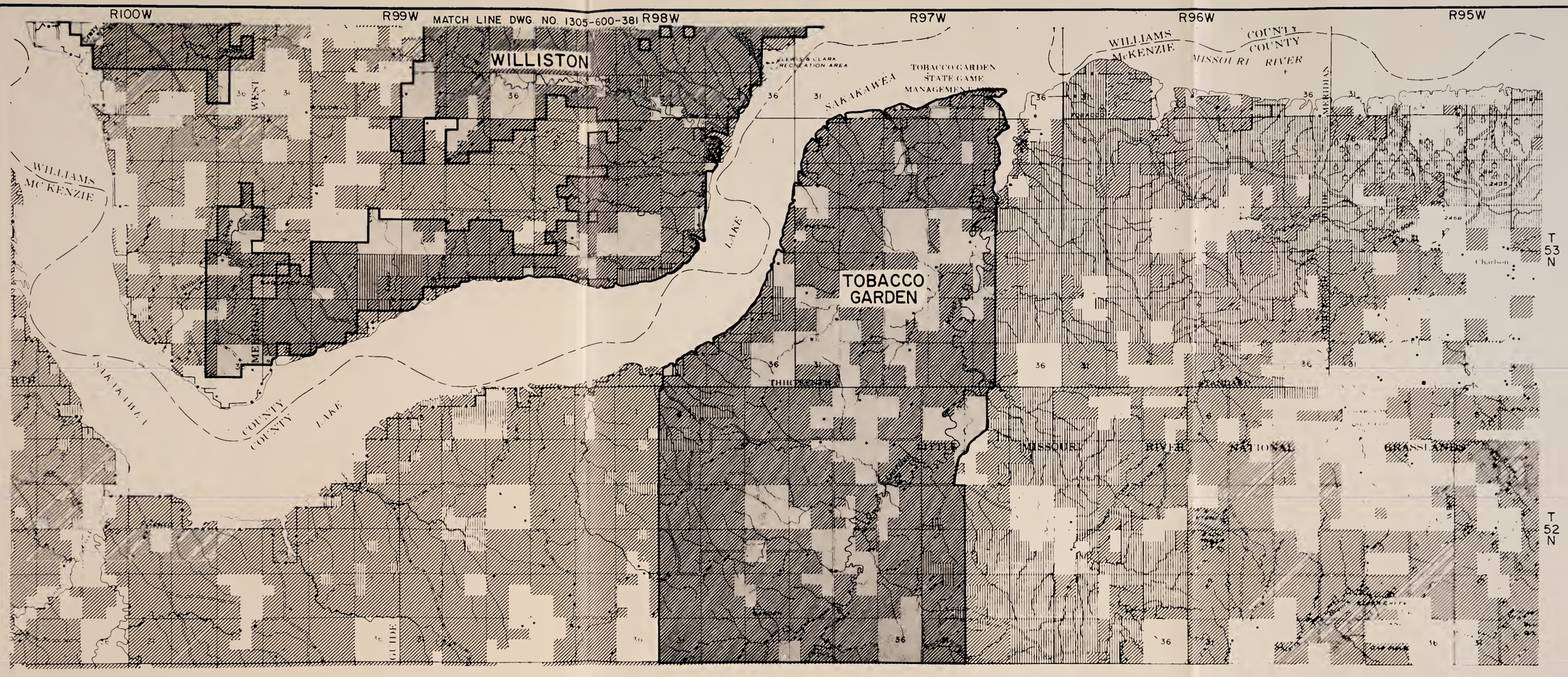

EXPLANATION

Study Areas

MINERALS OWNED BY THE FEDERAL GOVERNMENT

All Minerals

Coal Only

2 1 0 1 2 3 4
SCALE OF MILES

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MINERALS OWNERSHIP MAP

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DRAWN S. STARCEVICH	TECHNICAL APPROVAL
CHECKED	APPROVED

BILLINGS, MONTANA MAY 1983
SHEET 4 OF 4

1305-600-382

R103W R102W R101W

DIVIDE
WILLIAMS
Grenora
BURLINGTON NORTHERN INC
Hanks
HOWARD
LAKE ZAHL NATIONAL WILDLIFE REFUGE
Zahl
HANKS
Cottonwood
Pats
Coulee
Creek
GLADYS
WILLIAMS
COUNTY
T 59 N
T 58 N
T 57 N
SCALE OF MILES 2 1 0 1 2 3 4
MATCH LINE DWG. NO. 1305-600-384

SASKATCHEWAN, CANADA
NORTH DAKOTA
Fortuna
1 SHEET 1 OF 4
DIVIDE COUNTY
WILLIAMS COUNTY
Grenora
Alamo
MONTANA
NORTH DAKOTA
1
2
3
4
Williston
MISSOURI RIVER
INDEX MAP

LAND STATUS LEGEND

- Private
- State
- Public Domain
- National Forest
- Wildlife Refuge
- Bankhead-Janes L.U. Lands
- Military Reservation and Military Withdrawal
- Miscellaneous

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NORTH DAKOTA

SURFACE OWNERSHIP MAP

DESIGNED F CALCAGNO FIELD APPROVAL
DRAWN S STARCEVICH TECHNICAL APPROVAL
CHECKED APPROVED

BILLINGS, MONTANA MAY 1983
SHEET 1 OF 4

1305-600-383

LAND STATUS LEGEND

- Private
- State
- Public Domain
- National Forest
- Wildlife Refuge
- Bankhead-Jones L.U. Lands
- Military Reservation and Military Withdrawal
- Miscellaneous

2 1 0 1 2 3 4
SCALE OF MILES

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SURFACE OWNERSHIP MAP

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DRAWN S. STARCEVICH — TECHNICAL APPROVAL —
CHECKED — APPROVED —

BILLINGS, MONTANA — MAY 1983
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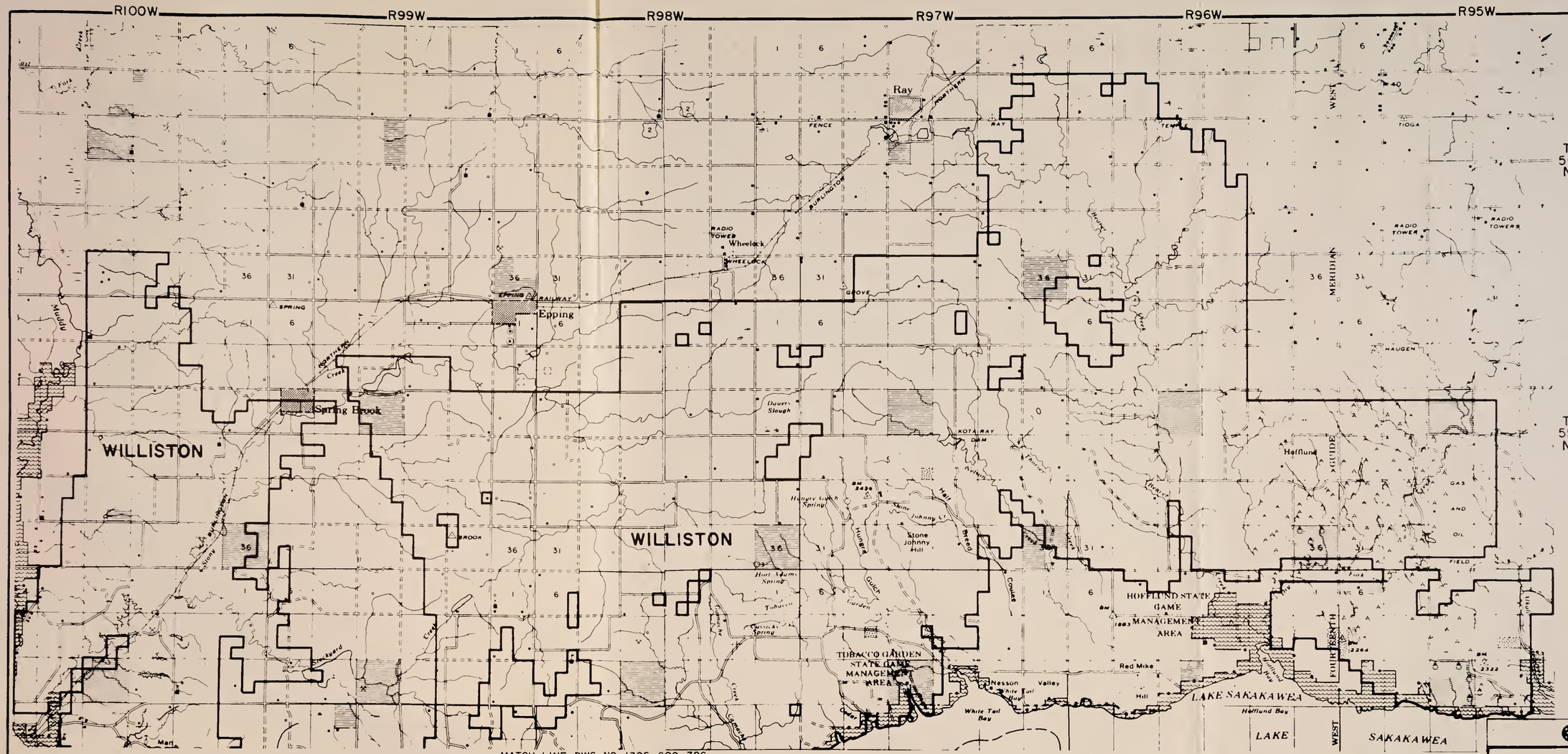

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BILLINGS, MONTANA MAY 1983
SHEET 3 OF 4

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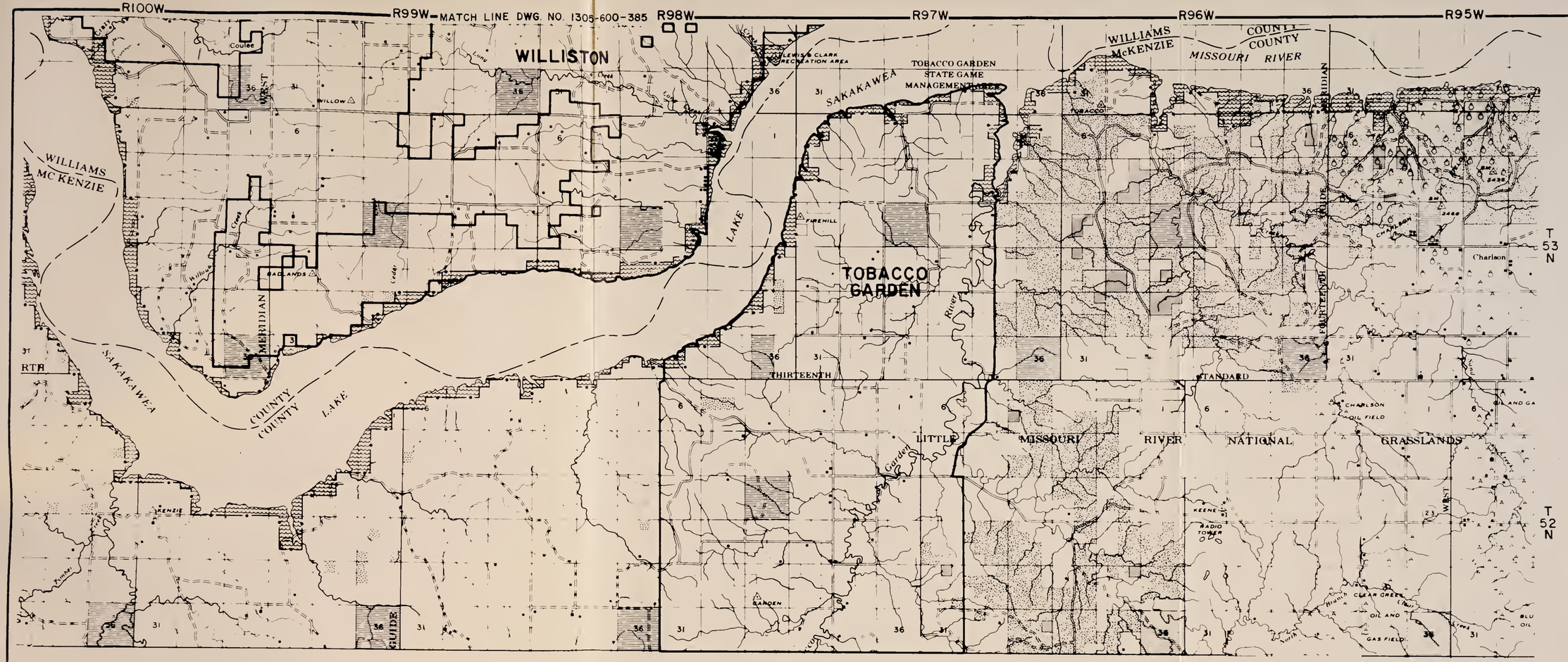

LAND STATUS LEGEND

- Private
- State
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2 1 0 1 2 3 4
SCALE OF MILES

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1305-600-386

Table 1

Criteria Used to Determine Suitability of Overburden Material
For Use as Plant Media in Revegetation[1/]

Parameter	Methodology	Suitable	Limited Suitability	Unsuitable
Texture	Pipette method plus sand sieving	FSL, VFSL, L, SiL, SCL	LFS, SL, CL, SiCL, SC	S, LS, SiC, C
Electrical Conductivity (mmhos/cm)	Saturation extract/conductivity bridge	<4	4-12	>12
pH	Saturated paste/glass electrode	6.0 - 8.4	5.0 - 6.0; 8.4 - 9.0	<5.0; >9.0
Sodium Adsorption Ratio (SAR)	Calculate: $Na/\sqrt{(Ca+Mg)/2}$; Ca, Mg, and Na in meq/l	<6	6-9 heavy textures 6-12 medium and coarse textures	>9 - heavy textures >12 - medium and coarse textures
Exchangeable Sodium Percentage (ESP)	Ammonium acetate extraction; calculate: Na/CEC x 100%	<5	5-15	>15[2/]
Boron (mg/l)	Hot water extraction/carmine method	<5		>5
Selenium (mg/l)	Hydride generation; flameless AA	<2		>2
Molybdenum (mg/l)	Ammonium oxalate extraction, flameless AA or N_2O flame AA - 5000	<1		>1
Copper (mg/l)	DTPA extraction; AA	[3/]		[3/]
Manganese (mg/l)	DTPA extraction, AA	<60		>60
Zinc (mg/l)	DTPA extraction; AA	<40		>40
Lead (mg/l)	DTPA extraction; AA	10-15 (pH <6) 15-20 (pH >6)		15 (pH <6) 20 (pH >6)
Cadmium (mg/l)	DTPA extraction; AA	<1		>1
Nickel (mg/l)	DTPA extraction; AA	2-3		>3
Mercury (mg/l)	Extraction by H_2SO_4; flameless AA (quartz cell)	<0.5		>0.5
Iron (mg/l)	-		Not Established	
Nitrate-Nitrogen (mg/l)	-		Not Established	

1/ Applicable only to reclamation study areas in Montana and North Dakota.
2/ Rate 2:1 - Clay texture poor if >10, sand texture if >20.
3/ Suspect level not established - an excessive consumption of molybdenum through ingestation of vegetation may be toxic to animals. This concern is directly related to the Cu:Mo ratio in the plant tissue.

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