SD EForm - 0457 V2

Department of Environment and Natural Resources
Minerals and Mining Program
Joe Foss Building
523 East Capitol Avenue
Pierre, South Dakota 57501-3181
Telephone: (605) 773-4201 Fax: (605) 773-5286

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

APPLICATION FOR MINING/MILLING PERMIT
Pursuant to SDCL 45-6B: Relating to The Extraction and Processing of Minerals in Operations Affecting More Than 10 Acres Per Year and/or Removing Over 25,000 Tons Per Year

Name of Operator: Cold Spring Granite Company

General Office Address:
17482 Granite West Road
Cold Spring, MN 56320

Telephone:
(320) 685-3621

Local Address:
14983 485th Ave.
Milbank, South Dakota

Telephone:
(605) 432-9389

Name and Address of Surface Owner: (Enter additional owners on last page)
Cold Spring Granite Company
17482 Granite West Road
Cold Spring, MN 56320

Name and Address of Mineral Owner: (Enter additional owners on last page)
Cold Spring Granite Company
17482 Granite West Road
Cold Spring, MN 56320

Legal Description of Affected Land:
See Attachment

County: Grant

Name and Address of Operator's Legal Resident Agent (if out-of-state corporation):
C.T. Corporation System
310 S. Coteau St.
Pierre, SD 57501

Minerals to be Extracted and, if Applicable, Milled:
Granite

Proposed Starting Date: When Permit is granted

Proposed Completion Date: 2062

Size of Area to be Worked at Any One Time (acres):
7.8

Estimated Working Days Per Year:
312

Estimated Tonnage Mined Per Year
245520

Estimated Duration of Operation (years):
50

Estimated Tons of Ore Per Year:
61380

Reclamation Type:
Wildlife Habitat Area

Overburden/Waste Tons Per Year:
184140

Source of Legal Right to Enter and Initiate Operations: Attach Copy

☐ Lease ☐ Letter ☐ USFS Permit

Source of Legal Right to Dispose of Tailings: Attach Copy

☐ Lease ☐ Letter ☐ USFS Permit

INSTRUCTIONS (Reference SDCL 45-6B)

This Application Must be Accompanied by:

1. A Narrative Description of Methods of Mining and Milling to be Employed as Per Section 6 (8).
2. A Reclamation Plan Pursuant to Section 7.
3. A Map of the Affected Area Pursuant to Section 10.
4. A Fee of $1,000 ($50,000 for precious metals, coal, or unaium) Pursuant to Section 14.
5. A List of the Names and Addresses of the Landowners of the Affected Land.

Before a Hearing on the Permit May be Conducted by the the SD Board of Minerals and Environment, the Applicant Must Submit the Following Materials:

1. Certified Mail Receipts Confirming Mailing of Notice to all Surface Owners and Lessees Pursuant to Section 17.
2. A Copy of the Affidavit of Publication of Notice Pursuant to Section 16.
3. Proof of Filing a Copy of the Application with the Register of Deeds Pursuant to Section 15.
4. Surety in an Amount to be Determined by the Department Pursuant to Section 20.
5. A copy of Instruments of Consultation From All Surface Landowners, if Different than the Owner of the Minerals Pursuant to Section 12 and 13.

STATE OF Minnesota

COUNTY OF Stearns

On this 4 day of May,

20 16, before me personally appeared

Steve Chouanard

who acknowledged himself to be the Engineer (Title)

for Cold Spring Granite Company (Operator)

that he is authorized to execute the Application for Mining/ Milling Permit for the purposes contained therein.

Renae J. Hemmesch
Notary Public

My Commission Expires: 1/31/18

SEAL

RENAE J. HEMMESCH
NOTARY PUBLIC - MINNESOTA
My Comm. Exp. Jan. 31, 2018

Applicant hereby affirms that the mining and milling will be conducted pursuant to SDCL 45-6B, or any regulations promulgated thereunder; that he will grant access to the Board of Minerals and Environment or its agents to the area under application from the date of the application and during the life of the permit as is necessary to assure compliance with SDCL 45-6B.

I declare and affirm under the penalties of perjury that this claim (petition, application, information) has been examined by me, and to the best of my knowledge and belief, is in all things true and correct.

Signature

Environmental Engineer
Title

5/4/2016
Date

FOR DEPARTMENT USE ONLY

DATE APPROVED: BOND AMOUNT: PERMIT NUMBER:

Chairman, SD Board of Minerals & Environment

SD EForm - 2088LD V1

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

STATE OF SOUTH DAKOTA

BEFORE THE SECRETARY OF

THE DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

IN THE MATTER OF THE APPLICATION OF)
Large Permit - Cold Spring Granite Co.) CERTIFICATION OF APPLICANT
STATE OF Minnesota)
COUNTY OF Stearns)

I, _____, the applicant in the above matter after being duly sworn upon oath hereby certify the following information in regard to this application:

I have read and understand South Dakota Codified Law Section 1-40-27 which provides:

"The secretary may reject an application for any permit filed pursuant to Titles 34A or 45, including any application by any concentrated swine feeding operation for authorization to operate under a general permit, upon making a specific finding that:

(1) The applicant is unsuited or unqualified to perform the obligations of a permit holder based upon a finding that the applicant, any officer, director, partner, or resident general manager of the facility for which application has been made:

(a) Has intentionally misrepresented a material fact in applying for a permit;

(b) Has been convicted of a felony or other crime involving moral turpitude;

(c) Has habitually and intentionally violated environmental laws of any state or the United States which have caused significant and material environmental damage;

(d) Has had any permit revoked under the environmental laws of any state or the United States; or

(e) Has otherwise demonstrated through clear and convincing evidence of previous actions that the applicant lacks the necessary good character and competency to reliably carry out the obligations imposed by law upon the permit holder; or

(2) The application substantially duplicates an application by the same applicant denied within the past five years which denial has not been reversed by a court of competent jurisdiction. Nothing in this subdivision may be construed to prohibit an applicant from submitting a new application for a permit previously denied, if the new application represents a good faith attempt by the applicant to correct the deficiencies that served as the basis for the denial in the original application.

All applications filed pursuant to Titles 34A and 45 shall include a certification, sworn to under oath and signed by the applicant, that he is not disqualified by reason of this section from obtaining a permit. In the absence of evidence to the contrary, that certification shall constitute a prima facie showing of the suitability and qualification of the applicant. If at any point in the application review, recommendation or hearing process, the secretary finds the applicant has intentionally made any material misrepresentation of fact in regard to this certification,

consideration of the application may be suspended and the application may be rejected as provided for under this section.

Applications rejected pursuant to this section constitute final agency action upon that application and may be appealed to circuit court as provided for under chapter 1-26."

I certify pursuant to 1-40-27, that as an applicant, officer, director, partner, or resident general manager of the activity or facility for which the application has been made that I; a) have not intentionally misrepresented a material fact in applying for a permit; b) have not been convicted of a felony or other crime of moral turpitude; c) have not habitually and intentionally violated environmental laws of any state or the United States which have caused significant and material environmental damage; (d) have not had any permit revoked under the environmental laws of any state or the United States; or e) have not otherwise demonstrated through clear and convincing evidence of previous actions that I lack the necessary good character and competency to reliably carry out the obligations imposed by law upon me. I also certify that this application does not substantially duplicate an application by the same applicant denied within the past five years which denial has not been reversed by a court of competent jurisdiction. Further;

"I declare and affirm under the penalties of perjury that this claim (petition, application, information) has been examined by me, and to the best of my knowledge and belief, is in all things true and correct."

Dated this 23 day of May, 2016.

Steve Chouinard
Applicant (print)

Applicant (signature)

Subscribed and sworn before me this 23rd day of May, 2016.

Notary Public (signature)

My commission expires: 1/31/20

LEAH ANN SUESS
NOTARY PUBLIC-MINNESOTA
My Comm. Exp. Jan. 31, 2020
(SEAL)

PLEASE ATTACH ANY ADDITIONAL INFORMATION NECESSARY TO DISCLOSE ALL FACTS AND DOCUMENTS PERTAINING TO SDCL 1-40-27 (1) (a) THROUGH (e). ALL VIOLATIONS MUST BE DISCLOSED, BUT WILL NOT AUTOMATICALLY RESULT IN THE REJECTION OF AN APPLICATION

Legal Description

Lot Two (2) and Lot Three (3) of Cold Spring-Dakota Granite Addition located in Government Lot Four (4) and the East Half of the Southwest Quarter (E½ SW¼) of Section Seven (7), Township One Hundred Twenty (120) North, Range Forty-seven (47) West of the 5th P.M., Grant County, South Dakota;

Department of Environment and Natural Resources
Minerals and Mining Program
Joe Foss Building
523 East Capitol Avenue
Pierre, South Dakota 57501-3182
Telephone: (605) 773-4201 Fax: (605) 773-5286

MINING/MILLING
OPERATING & RECLAMATION PLAN

Operator's Name: Cold Spring Granite Company

Permit Number: _____

In preparing the Operating and Reclamation Plan, please address each item in detail, referring to SDCL 45-6B as needed. Attach additional pages if extra space is needed.

1) Describe the proposed method of mining, and if applicable, milling to be employed:

A) Contour basis for the mining -

See Attachment

B) Depth to which and the direction in which mining will proceed -

See Attachment

C) Proposed disposition of mine spoil and tailings -

See Attachment

D) Method of blasting and control -

See Attachment

2) Provide a narrative description of the types of reclamation the operator proposes to achieve in the reclamation of the affected land (e.g. return to cropland, pasture, building sites, recreational area, forest planting, etc. Refer to SDCL 45-6B-7 and 45-6B-45):

See Attachment

3) What is the reason for choosing the above methods of reclamation?

See Attachment

4) Itemize the amount of acreage accorded to each of the reclamation types described in Number 2:

See Attachment

5) How will the reclamation plan be implemented to meet the reclamation standards which are described in SDCL 45-6B-37 through 45-6B-46 (Refer to these sections in 45-6B):

45-6B-37 Grading -

See Attachment

45-6B-38 Removal of Refuse -

See Attachment

45-6B-39 Revegetation -

See Attachment

45-6B-40 Topsoil Storage -

See Attachment

45-6B-41 Surface and Groundwater Protection -

See Attachment

45-6B-42 Highwall Reduction -

See Attachment

45-6B-43 Erosion Control/Weeds -

See Attachment

45-6B-44, 45 Type of Reclamation -

See Attachment

45-6B-46 Reclamation Timetable -

See Attachment

6) Provide a detailed description of how the intended reclamation methods described above will rehabilitate the affected land. This description shall include, but is not limited to, restoration of the natural vegetation, wildlife, water, air, and soil:

See Attachment

7) Provide a statement describing the location of proposed reservoirs, tailings ponds, tailings disposal sites, dams, dikes, and diversion canals. Denote such locations on the map required under SDCL 45-6B-10.

See Attachment

8) Describe what provisions will be made for the stripping and storage of overburden and topsoil:

See Attachment

9) Describe the methods to be used in returning the overburden and topsoil during reclamation, and describe when this activity will take place:

See Attachment

10) Describe the post-closure plan for mine waste disposal facilities required under SDCL 45-6B-5 (5):

See Attachment

11) What is the expected cost of implementing the proposed reclamation work (cost per acre/ total cost)?

See Attachment

12) Provide a statement which describes any characteristics of the affected land of historic, archaeologic, geologic, scientific, or recreational significance which are known to the applicant:

See Attachment

In addition to addressing the above items, please attach the following items to the Reclamation Plan:

1) A standard soil survey of the affected land prepared by the local Conservation District (paid for by the applicant).

2) A vegetation survey report on the affected land prepared by the local Conservation District (paid for by the applicant), including a description of the dominant species present, approximate size, and density.

3) A reclamation report prepared by the local County District Conservationist giving his recommendations and guidelines concerning how the area should be revegetated. This report should include a recommended seed mixture.

4) A wildlife survey report on the affected land prepared by the Department of Game, Fish, and Parks (paid for by the applicant), including a description of the dominant species of wildlife inhabiting the area.

5) A post reclamation map showing the anticipated physical appearance of the reclaimed mine, and portraying the outline of the proposed final land use for each portion of the reclaimed land.

6) The baseline water quality and water-level data for the area (the Department shall designate what parameters should be tested for after on-site inspection, and the applicant shall use testing methods as approved by the Department).

I declare and affirm under the penalties of perjury that this claim (petition, application, information) has been examine by me, and to the best of my knowledge and belief, is in all things true and correct.

Operator's Signature: _____

Title: Environmental Engineer Date: 5/4/2016

Application For

Large Scale mining Permit

With

South Dakota Department of Environment and Natural Resources

Minerals and Mining Program

Land exchange with Dakota Granite near Permit Area 8, Carnelian 2

Quarries located near Milbank, South Dakota

Applicant:

Cold Spring Granite Company

17482 Granite West Road

Cold Spring, MN 56320

320-685-4808

74:29:02:02 and SDCL 45-6B-4: Local Zoning Requirements.

A letter from Grant County Zoning and Planning is included in this report and it says all requirements have been met by Cold Spring Granite. All necessary paper work has been filed for the land exchange.

74:29:02:03 and SDCL 45-6B-6(2) and (3) Surface and Mineral owners.

The owner of the expansion area is the Cold Spring Granite Company. Cold Spring Granite is the only owner of the property. Adjacent property owners can be seen on a large permit 200 ft. border map later in the report.

45-6B-6 (8) A description of the method of mining and, if applicable, milling to be employed which shall include, if applicable

74:29:02:04. Mining and milling methods

(1) This mining permit application is about a parcel of land exchanged on Map 1, Plat Map. Cold Spring Granite is transferring 6.2 acres to Dakota Granite. Cold Spring Granite Company is adding 7.8 acres to the current mining operation. This area that is added has been part of Dakota Granite's mining operation for many years. At most 61,380 tons of usable granite could be mined from the new area per year. The tonnage is estimated by if the 4.25 acres of land is taken down 20 ft. per year. That is unlikely because of the location of the area on the border of Dakota Granite's property. The mining will continue in Permit area 8 and all conditions for that permit will be used to cover this new 7.8 acres.

The equipment used in the quarry hole covered by Permit 8 is a loader, drill rig, rock buggy and a couple of wire saws. The process for extraction of granite is basic and does not contain much blasting. The holes are drilled with the drill rig; wire is sent through the holes and hooked to the wire saw. The wire saw cuts the block of granite loose. The loader then comes in and removes the block. The rock buggy is a support vehicle.

Due to the land exchange, the permit boundary is being expanded and modified per the requirements of **ARSD 74.29.03.02(2)**

Sand will be removed from the expansion area and stockpiled north of the current Carnelian 2 Quarry operation. The stockpile will be needed for the next 10 years. If any stockpile is available at reclamation it will be spread over the areas needed and seeded. The stockpile area will be graded and seeded.

a) Contour basis for the mining operation. 74:29:02:04 (2)

The new permit area will be incorporated into the current permit area that borders the new area. The existing permit area, permit 8, Carnelian 2 will be used to gain access to the new area, after the overburden has been removed. The current

quarry consists of a large drive-in system with the saw building to the west side. The new area will have the overburden striped and piled along the north, west, and, east side of the area. The pile of overburden will cover about 3.55 acres and be a natural barrier to the north, west, and east. The granite will be removed from new area, from the south quarry hole until it is level with the current ledge. Maps depicting the premining contours and proposed postmining topography is provided.

b) Depth to which and the direction in which the mining will proceed-74:29:02:04 (3)

The current quarry hole is over a hundred feet deep. The new quarry area will have the granite removed from the south by the south side ramp in permit area 8. Granite is quarried in benches, each being approximately 20 feet thick. The granite will be removed in this new area as needed in these 20 foot ledges. It could take 50+ years before the new area is level with existing quarry floor. No area will be exhausted and deemed mined out prior to final termination of the operation. The limits of the granite deposit are infinite as we know them today. Maps for representing the cross-section of premining and postmining land surface are in report.

c) Proposed disposition of mine spoil and tailings. 74:29:02:04 (4)

There are no ore stockpiles or tailings dams associated with this operation. The grout from this new area will be hauled by dump truck to permit area 8, Carnelian 1. At this area, Fisher's Sand and Gravel is crushing the current grout pile. All grout will be dumped here for the life of the quarry. Map of Fishers sand and gravel is available.

74:29:02:04 (5) A stability analysis for all critical earth structures;

All earth structures around the permit area are on solid granite. The blasting is in such small amounts and only happens about once a month. No stability is going to be lost do to granite removal in the expansion area.

d) Method of blasting and control-74:29:02:04 (6)

With the advancement of technology in wire saws the use of blasting has been greatly diminished. Blasting only occurs about once a month. If any blasting is used it is small blast to loosen up the overburden. The overburden is then removed with a loader or track hoe. We control the affects of the blast by using small amounts of explosives and making sure all employees know of a coming blast with an alarm system. All explosives are kept in sealed containers that are blocked by large pieces of granite.

45-6B-6(10), ARSD 74:29:02:05 Timetables

The expansion area is next to a much larger permit area. The expansion area will be mined until the granite is exhausted or is deemed to be unusable. The expansion

area will stay open and operation until the larger quarry area is exhausted of usable granite. That could be over a hundred years away. At that time the expansion with the larger quarry area will be reclaimed as a wildlife area.

45-6B-7. Reclamation plan--Contents. The reclamation plan shall be based on provision for, or satisfactory explanation of, all general requirements for the type of reclamation proposed to be implemented by the operator. Reclamation is required on all affected lands except as provided in §§ 45-6B-8 and 45-6B-9. The reclamation plan shall include:

1) A description of the types of reclamation the operator proposes to achieve in the reclamation of the affected land, why each was chosen, and the amount of acreage accorded to each.

The expansion area will be reclaimed as a Wildlife Area. The reason that this was chosen is because the larger permit area No. 8 will be reclaimed as a Wildlife Area. The whole 7.8 acres of the expansion area will be reclaimed as a Wildlife Area.

2) A standard soil survey of the affected land prepared by the local conservation district, paid for by the applicant, or if not available, a comparable soil survey prepared by a competent person.

A soil survey was conducted on the quarry expansion area in 1983 when it was owned by Delano Granite. The soil survey was conducted by Cy Zierden and was assisted by Odell Greene of the Soil Conservation Service. The expansion area has been part of a quarry since the survey. That report is included in this report.

3) A vegetative survey of the affected land prepared by the local conservation district, paid for by the applicant or prepared by a competent person, including a description of the dominant species of vegetation present, approximate size and density.

A vegetative survey was also conducted in 1983 by Cy Zierden and Odell Greene of the Soil Conservation Service. A copy of that survey is included in this report.

4) A preliminary wildlife survey of the affected land conducted by the Department of Game, Fish and Parks, paid for by the applicant, or conducted by a competent person approved by that department. Such survey shall include a description of the dominant species of wildlife inhabiting the area. The operator shall abide by any reasonable restrictions subject to review and approval by the Board of Minerals and Environment at the request of the operator concerning riparian habitat or threatened or endangered species as notified by that department. Restrictions concerning riparian habitat for mining operation activities are limited to such habitat located within one hundred feet of each stream bank. Further, restrictions concerning riparian habitat may include temporarily diverting the stream flow, bank restoration, and revegetation of the riparian habitat area.

A wildlife survey was conducted on the expansion area on December 14, 1982 by Arlo Hasse. He found no endangerment of wildlife in the expansion area. He also did not see any potential for future wildlife problems. Another wildlife survey was

conducted by Stan Michals of the Department of Game, Fish, and Parks on January 22, 2016. He concluded that the existing survey data are still pertinent. He did want the quarry operator to update the permit to include Dakota Skippers and Poweshiek Skipperling. These were found to be on the Endangered Species list and do have critical habitat in South Dakota. No species data indicates that they are in the expansion area. A copy of this can be found later in this report.

5) A statement of any characteristics of the affected land of historic, archaeological, geologic, scientific, or recreational significance which are known to the applicant. 74:29:02:06

In March 12, 1990, Kerry Lippincott from the South Dakota State Historical Society reviewed the expansion area. He found nothing of archeological or historical significance about the site. He stated that mining may proceed as planned. A copy of this can be found later in this report. Being that the expansion area was in a previous permit area no geological, scientific, or recreational significances are known.

74:29:02:09,SDCL 45-6B-10 Permit Are Boundary-Map requirements.

A map is included later in this report.

6) A description of how the reclamation plan will be implemented to meet the requirements of §§ 45-6B-37 to 45-6B-46, inclusive;

Revegetation 45-6B-39, ARSD 74:29:02:10, ARSD 74:29:07:06

The expansion area is on the north side of the existing quarry and will have very little area to revegetate. Most of the expansion area will be under water as the quarry fills with water to make a wildlife habitat area. The remaining edge area will be about 3.55 acres. This area already had a vegetative plan that was set up in 1983 by Odell Greene for Delano Granite Inc. This seeding plan and record is provided later in this report. Coldspring wishes to use the same seeding plan for Permit Area No. 8 for the expansion area, because it surrounds the expansion area. In 1990 the area Soil Conservation Service Agent, Mr. Odell Greene, had examined the seeding plan for permit area No. 8 and made recommendations for plant selection, seed mixtures and planting rates per acre. Based on recommendations by Mr. Greene in 1983, a native grass seeding mixture will be used. This will include 20% Switch Grass, 60% Little Blue Stem, and 20% Side Oats Grama. Tree species will include 50% Cottonwood and 50% Norway pine on 14 foot centers. The area Conservation Officer, Mr. Arlo Haase, also examined the plan and provided a letter of recommendation available later in this permit. Coldspring plans on using its current vegetative plan because test plots have been set up and approved by the DENR. Recent changes have been made because of suggestions by the NRCS.

ARSD 74:29:07:06. Revegetation must meet the following general requirements.

1) **Vegetative species and composition must be appropriate for the post mining land use. The species of vegetation to be used must be described in the**

reclamation plan, indicating the composition of seed mixtures and plant types and the seeding and planting rates per acre. Vegetative species and composition must be selected in consultation with the local conservation district, the landowner, and the department of game, fish, and parks if wildlife habitat is included as a post mining land use. Introduced, naturalized, or nonnative plant species may be used only if they are suitable for the post mining land use and are approved by the board;

2) **A reference area may serve as a basis for comparatively measuring reclamation success. Reference areas must meet the following requirements:**

a. **Be large enough to make comparisons.** The area that was set up for the test plot was 100 feet by 100 feet and served as the test plot for all three quarries and the expansion area.

b. **Be located in areas where they will not be affected by future mining while serving their designated use.** The test plot is on top of a small grout pile to the east side of Quarry No. 1 that will be set aside for 10 years for this purpose.

c. **Be managed in a way that will not cause significant changes in the cover, productivity, species diversity, and composition of the vegetation.** The test plot was not disturbed for 10 years other then in June to monitor the growth.

d. **Be representative of the post mining land use.** The test plot will be constructed and vegetated in accordance with the standard reclamation plan of the application for permit 8 and the expansion area.

3) **Seeding and planting must be done in accordance with accepted agricultural practices. Affected lands shall be seeded during the first normal period of favorable planting conditions after final topsoil preparation, unless an alternative plan is approved. Any rills or gullies that would preclude successful establishment of vegetation or achievement of the post mining land use must be removed or stabilized.** As areas become available for final reclamation, the seedbed will be prepared and planted in the spring of the year. The trees will be planted after the grasses have had two growing seasons to become established. Rills and gullies will be removed before revegetation begins.

7) A description of how the reclamation plan will rehabilitate the affected land. This description shall include, but not be limited to, natural vegetation, wildlife, water, air, and soil;

The expansion area will be planted with native grasses and trees as described in **45-6B-39**. The natural vegetation will provide stability for the soil and provide a natural food source for wildlife. The water allowed to fill in the quarry hole will provide habitat for fish, birds and other aquatic animals. That will then provide a food source for other wildlife. With the grasses, trees, and water on the site it will provide cleaner air as well as helping to limit dust.

8) A map of all of the proposed affected land by all phases of the total scope of the mining operation. It shall indicate the following:

(a) The expected physical appearance of the area of the affected land; and
Map 2, Site Map

(b) Portrayal of the proposed final land use for each portion of the affected land;
Map 3, Reclamation Map

9) The baseline water quality and water level of all areas of aquifers potentially affected by the proposed mining operation. The Department of Environment and Natural Resources may designate, from the parameters set forth below, which parameters must be provided. The applicant shall use testing methods designated by the department: 74:29:02:07

The existing quarry next to the expansion area has been in operation for close to 50 years and has not had a negative effect on the water quality. The expansion area would not change this. In 1990 Cold Spring tested the water in the quarry next to the expansion area. Cold Spring Granite tested once a quarter for a year. The testing determined that the quarrying of granite left no harmful material in the ground water. This testing can be seen at the end of this report.

10) The location of proposed reservoirs, tailings ponds, tailings disposal sites, dams, dikes, and diversion canals;

No reservoirs, tailings ponds, tailings disposal sites, dams, dikes and diversion canals will be used in the expansion area. In the expansion area the natural inflow of water through the granite will be allowed to flow into the adjacent Carnelian #2 Quarry. In this quarry area the dewatering water will be pumped out through a diversion pipeline. This was approved in a 2003 technical revision.

11) Provisions for the stripping, storage, and, if required, the replacement of the overburden and topsoil;

The use of topsoil and overburden is discussed above **in 45-6B-38** and **45-6B-40.**

12) The estimated cost of implementing and completing the proposed reclamation. 74:29:02:08

The estimated cost of reclamation was based on the reclamation cost estimate that was done for Permit area 8, which is adjacent to the expansion area. The

expansion area will need reclamation on 3.55 acres of ledge. The rest of the area will be under water. The expansion area will need to be graded and sloped with topsoil. After the site prep is done Native grasses will be planted. After the native grasses are established trees will be planted every 14 feet on center or about 1,000 per acre. That cost came to about $1010 per acre in 1990. With the cost of inflation that cost came to about $1840.19 per acre. That cost times 3.55 acres comes to an estimated $6532.68 for reclamation of the expansion area. In the land exchange Cold Spring is giving up 6.2 acres. That ledge that Cold Spring would have had to reclaim comes to 1 acre. So if you minus an acre from the total cost it comes to about $4692.5.

ARSD 74.29.03.02 (2). New permit application required. A new permit application is required for major modifications. Major modifications include the following:

(1) The addition of proposed affected land not within the approved permits area. The new land in the exchange is outside of the permit boundary.

(2) The expansion of the boundaries of the permit area. The boundary of the permit will be expanded in areas and lessened in others do to the land exchange with Dakota Granite.

(3) A change in the overall post mining land use of the affected land. No change will happen in the post mining land use.

(4) A change in the permit which may adversely affect surface or groundwater. No change in the permit will adversely affect surface of ground water.

(5) The initiation of milling capabilities, excluding crushers. No milling capabilities will be initiated in this new area.

ARSD 74:29:07:02. Minimizing of Adverse impacts

1) There are no mine operation facilities in the 7.8 acre expansion area and the land was already disturbed in the past. A buffer zone around the quarry will be established to prevent erosion and surface disturbance.
2) The expansion area soils will be removed gradually as production is needed so to have as little soil disturbance as possible.
3) The expansion area will have a 3.55 buffer zone around the edge of the quarry that will be gradually sloped from the quarry edge. That will provide visual screening from the road and adjacent land.
4) This permit expansion area will have no more impact on surface and ground water. The expansion area is already near permit area 8, which has no affect

on surface and ground water. The 3.55 acre buffer zone will prevent surface water from entering the quarry hole and that will prevent groundwater contamination.

5) Cold Spring Granite has fences and gates for the existing quarry and Dakota Granite has the same set up for their side of the affected area.
6) No impacts on wildlife will be felt because this expansion area is near an active quarry where little wildlife is present. Stan Michals, from the Department of Game, Fish and Parks, in a 1-22-16 letter indicated the surveys for the initial permitting areas are still pertinent. Since the time of the first permit two species have been added to the Endangered Species Act of 1973. The Dakota Skipper and Poweshiek Skipperling are endangered species that may be located in this area of Grant County. No species occurrence data is available for the expansion area
7) All locations of waste dumps, spoil piles, topsoil stockpiles will be included on Map 1, site map. Being that this area connected to Permit area 8, all waste will be controlled the same as they are for the larger quarry area.
8) All mine waste will be hauled to site 1 and crushed by Fishers sand and Gravel.
9) The expansion area will have a slope for the buffer zone that will blend in with the country side and be compatible with the surrounding land use which is granite quarries.
10) The integration of the mine operations planning with the reclamation plan will be easily done because the expansion area is only 7.8 acres and Coldspring is losing 6.2 acres. That is only 1.6 acres added to the reclamation plan. The expansion area will be covered for reclamation by large scale permit 8.

ARSD 74:29:07:17 and SDCL 45-6B-9 Underground mines

There are no underground mining areas connected to the granite quarry.

SDCL 45-6B-8 previously mined lands

The locations of such mining activity existed prior to July 1, 1971.

SDCL 45-6B-32 Grant of permit if application in compliance with law—grounds for denial. The Board of Minerals and Environment shall grant a permit to an operator if the application complies with the requirements of this chapter and all applicable local, state and federal laws. The board may not deny a permit, except for one or more of the following:

1. **The application is incomplete or the surety has not been posted**

The surety is set up for Permit 8 for $674,021. That should cover the new boundary area set up by this permit.

2. **The applicant has not paid the required fee;**

The fee is included in with the mine permit application.

3. **Any part of the proposed mining operation, the reclamation program, or the proposed future use is contrary to the laws or regulations of this state or the united States:**

Cold Spring Granite has designed this quarry operation to comply with the laws and regulations of the state of South Dakota and the United States.

4. **The mining operation will adversely affect the stability of any significant, valuable and permanent man-made structures located within 200 ft. of the affected land, except where there is an agreement between the operator and the persons having an interest in the structure that damage to the structure is to be compensated for by the operator:**

The only significant, valuable, and permanent man-made structures located within 200 ft. of the affected area, belong to the other quarry operator. An understanding exists between Cold Spring Granite and Dakota Granite that should Cold Spring Granite cause any damage to Dakota Granite's equipment of structures; Cold Spring Granite will compensate Dakota Granite for such damage.

5. **The mining operation would be in violation of any county zoning or subdivision regulations**

Cold Spring Granite, at the time when they applied for a large mining permit 8, requested and received a letter from Grant County Commissioners stating that to the best of their knowledge, we are in compliance with all county ordinances' and requirements. On January 11, 2016 Grant County Planning and Zoning office sent a letter to Coldspring stating that Cold Spring Granite Company is in compliance with Grant County Zoning Regulations. It also stated that the Plat Recording was completed in the Register of Deeds Office on 12-15-2015 for the land exchange between Dakota Granite and Cold Spring Granite.

6. **The proposed mining operation and reclamation cannot be carried out in conformance with the requirement of 45-6B-35**

The proposed mining operation and reclamation can be carried out in the land exchange area with the conformance requirements because the existing permit covers the area and meets the requirements. The expansion area can be reclaimed in conformance with the requirements.

7. **The Operator is currently found to be in violation of the provisions of this chapter with respect to any mining operation in this state.**

Cold Spring Granite has no current violation of the provisions of this chapter with respect to any of its operation in South Dakota.

8. **The land is unsuitable for a mining operation, as determined pursuant 45-6B-33:**

SDCL 45-6B-33. As pursuant to ARSD 74:29:02:01, each section of this statute needs to be addressed.

SDCL 45-6B-33 Unsuitable land – No permit issued. No permit may be issued for the mining operation proposed on unsuitable land. Land is unsuitable if the following conditions cannot be satisfactory mitigated:

The land in the land exchange area is suitable for mining operation since is has already been part of a mining permit.

1. **Reclamation of the affected land pursuant to the requirements of this chapter is not physically or economically feasible:**

The land around this site can and will be reclaimed, along with the rest of the quarry covered under permit 8.

2. **Substantial disposition of sediment in stream or lake beds, landslides, or water pollution cannot feasibly be prevented;**

If granite is removed from this area the spoils and sludge from the wire saws will be removed and placed on the Grout pile for the reclamation plan. All water used in sawing flows to a holding area and is pumped to holding ponds to let sediment settle out of the water.

3. **The adverse effects of the proposed mining operation on the historic archeological aspects of affected or surrounding land outweigh the benefits of the proposed mining operation:**

Under **ARSD 74:29:10:01**: since the 7.8 acre expansion area is already within the permit boundaries of Dakota Granites mine permit, it is exempt from special, exceptional, critical, or unique lands determination requirements. There are no known historic or archaeological aspects on the affected or surrounding land. In March 12, 1990, Kerry Lippincott from the South Dakota State Historical Society reviewed the expansion area for Dakota Granites Large Permit. He found nothing of archeological or historical significance about the site. He stated that mining may proceed as planned. A copy of this can be found later in this report. The area in question was researched and cleared.

4. **The proposed mining operation will result in the loss or reduction of long-range productivity of aquifer, public and domestic water wells, watershed lands, aquifer recharge areas or significant agricultural areas.**

Operations have been ongoing in this area for some 70 years with no adverse affects to any water supplies. The expansion area added for this permit will not add anymore water use to the site. When the operation stops in 100 years, the quarry hole will fill with water from natural precipitation and will become a reservoir of water in the area. The post mining land use will have the potential to benefit the surrounding area during periods of drought.

5. **The biological productivity of the land is such that the loss would threatened or endangered species of wildlife indigenous to the area:**

A Wildlife survey was conducted on the expansion area on Dec. 14, 1982 by Mr. Arlo Haase, the conservation officer of the area. He found no endangerment to wildlife and did not see future wildlife problems in the expansion area. The local wildlife that surrounds this area and could possibly travel through the expansion area includes whitetail deer, pheasant, partridge, cottontail rabbits, jack rabbits, red fox, raccoon, mink and a variety of birds including robins, blue jays, blackbirds, crows and swallows.

In a 1-22-16 letter from Stan Michals of the South Dakota Department of Game, Fish, and Parks, Stan agrees with the initial permit survey. He does however state that two new endangered species could have critical habitat in Grant County. Species occurrence data is not available for the expansion area. With the expansion area being in an existing permit area for many years there is no chance that these endangered species use this area as critical habitat.

6. **The Board finds that any probable adverse socioeconomic impacts of the proposed mining operation outweigh the probable beneficial impacts of the operation.**

The large scale expansion area is very small so no socioeconomic impacts will be felt. Cold Spring Granite is gaining 7.8 acres and is losing 6.2 acres. The actual gain is only 1.6 acres to the existing quarry. This small area will have no adverse impact on the area. The quarry operation has been around for 70 years and has greatly benefited the surrounding communities.

SDCL 45-6B-35 Mining operations–Applicable law. Every operator to whom a permit is issued pursuant to the provisions of this chapter may engage in the mining operation upon the affected lands described in the permit. Upon the performance of the subject to 45-6B-36 to 45-6B-46, inclusive with respect to such lands.

A Narrative description of the measures to be taken to comply with the operating and reclamation requirements of SDCL 45-6B-37 through 45-6B-46, ARSD 74:29:02, and ARSD 74:29:06 through ARSD 74:29:08.

Grading: SDCL 45-6B-37, ARSD 74:29:07:03, and ARSD 74:29:07:04

Top soil excavated from the will be stored in a stockpile area in permit 8. A stockpile area is shown on Site map 2 in the Northeast corner. Of the 7.8 acres of the expansion, 4.25 acres will be removed and that area will be quarried and later let fill with water to reclaim as wildlife area. The remaining 3.55 acres will be used as a 70 foot buffer on the North, Ease, and West end. The edge will be graded for a gradual slope away from the Quarry edge. Top soil with be spread from the storage area for reclamation. Large Blocks of Granite will be placed along the edge to prevent erosion and create a safety barrier.

Sand will be removed from the expansion area and stockpiled north of Carnelian #2 and can be seen on Site Map 2. The sand stockpile will be needed for around 10 years. If all the stockpile is not used it will be seeded to prevent erosion. At reclamation the Sand will be spread were needed. The area of the stockpile will be graded and then reseeded.

ARSD 74:29:07:03 Grading and Backfilling—Necessity

1) **Public Safety and welfare;** The expansion area will be incorporated into the reclamation plan of permit area 8. The area will be reclaimed as a wildlife area and allowed to naturally fill the rain water. The area around the quarry

hole will be protected by the placement of a barricade of granite blocks. This is designed to alert everyone entering the area that a hazard exists. Fencing is already in place around the exciting quarry edge along the roadside. Since the expansion area is in the middle of the two permitted area, it is already guarded. Barricades of granite will be placed by the edge of the expansion area.

2) **Technical and economic feasibility;** It would not be technically feasible to backfill an area when the areas around it are going to be filled with water.
3) **Surface and Mineral Ownership;** Cold Spring Granite Company will continue ownership throughout the reclamation process.
4) **Land use requirements;** The expansion area does not have special land requirements.
5) **Pollution potential;** The expansion area will be reclaimed as a wildlife area and will add a source of clean water to the area. No pollution potential exists with this reclamation plan.
6) **Mineral resources value;** Cold Spring Granite will continue to mine until it is not economically feasible to mine. At that point the mineral value will be so low so the reclaimed wildlife area will be more valuable.

ARSD 74:29:07:04. Grading and backfilling, criteria.

1) **All reclaimed Slopes and slope combinations must meet the Following requirements:**
    a. **Be visually and functionally compatible with the configuration of the surrounding area;** The edge of the quarry near the expansion area will be covered with topsoil and grasses planted. When the quarry fills with water the wildlife area will be a desirable contrast to the farmland in the area.
    b. **Be suitable for the Post mining Use;** The intended post mining land use will be a wildlife habitat area. Since the edges will be planted and have a granite barrier for safety, the area will provide wonderful habitat for fish, waterfowl and other water animals.
    c. **Be structurally stable;** Being that the quarry walls are solid granite and there is very little slope towards the quarry it is extremely structurally sound. The granite barrier will also prevent edges collapsing into the quarry hole.
    d. **For fill slopes or other slopes composed of unconsolidated material, not exceed the angles of repose;** The edges of the expansion area will be sloped from the quarry edge back 70 feet to the permit boundary. All soils not usable from the quarry area will be pushed with a bulldozer along the 70 foot buffer area. It will be grading to have a

gradual slope back to the Quarry hole. It will act as a natural visual buffer and seeded to prevent erosion. It will be about 3.55 acres of the expansion area.

2) **All grading, backfilling, and topographic reconstruction must control erosion and sedimentation, protect areas outside the affected land from slides or other damage, and minimize the need for long-term maintenance. Erosion control measures must be implemented during all phases of construction, operation, reclamation, and closure. Detailed plans indicating dimensions, location, spacing, and design of erosion control techniques are required;**

The expansion area is in the middle of permitted mines and no erosion will leave the permitted areas. The erosion control measures are already in place and the detailed plans are covered by permit area 8. The expansion area will have a 3.55 buffer area around the edge of the Quarry area. The edge will be sloped back at a gradual slope to prevent erosion. Topsoil will be spread and seed will be planted to prevent erosion during operation and final reclamation. Granite blocks will also be placed along edge to prevent erosion.

3) **All grading, backfilling, and topographic reconstruction must be completed as soon as feasible after mining ceases. The operator shall establish reasonable timetables consistent with good mining and reclamation practices;** As the quarry is being developed the usable sand and topsoil will be removed and stockpiled elsewhere. The unusable soil will be spread throughout the 70 foot buffer around the Quarry Hole. It will be graded to have a natural slope back to the quarry. After all the soil is removed from the quarry hole the buffer area with have topsoil spread and seeded too prevent erosion. This reclamation will take place throughout the mine life. The final reclamation process will begin in the expansion area at the same time as in Permit area 8. The reclamation timetable states that reclamation will begin as soon as the quarry has been exhausted of all usable granite. At this time it is not feasible to identify any date for this work to be done. When it starts it will be a 3 year process of reclamation. The first year will be building removal and grading of quarry edge then seeding of quarry edge. It will be closely monitored for the next 2 years then trees will be planted. It will be yearly checked after that for 10 years.

4) **Depressions for the accumulation of water are not allowed unless they are consistent with the approved post mining land use;** The post mining land use will be a wildlife habitat area and the water will be allowed to fill up the existing quarry and expansion area.

5) **Original drainage must be preserved as much as possible. Alternative drainage may be approved by the board if it is functionally compatible with and complements the prevailing hydrologic balance of the surrounding area;** The original drainage in the area has not been changed. The new expansion area or the original quarry area has not affected the original drainage.

6) **When high wall reduction or elimination is not proposed, the applicant must provide justification demonstrating that such reduction or elimination is impossible, impractical, or aesthetically undesirable. If they are not eliminated, all high walls must be stabilized;** The high wall cannot be reduced because it is part of the natural ground and trying to reduce it would only destabilize a larger area then just the quarry. Being that the expansion area within the quarry is going to be a wildlife habitat area the high wall will not be a factor. The quarry will fill with water and will not be seen. Also the granite barrier along the edge will work as a natural guard from going over the high wall.

74:29:06:01. Presubmission conference -- Determination of post mining land use. The area of the expansion being so small at only 1.6 acres after the loss of 6.2 acres, it was determined that the reclamation will be covered by permit 8. The expansion area edge will be graded and covered with topsoil then planted with native seeds in the spring. The larger part of the expansion area will be under water in the wildlife habitat area.

74:29:06:02. General requirements for determination of reclamation type. For all reclamation types the applicant must present a management plan for the purpose of determining the reclamation type that does the following:

(1) Demonstrates that the affected land has the capability of meeting reclamation criteria in chapter 74:29:07. The expansion area is small when you considered it is only 1.6 acres gained and will easily meet reclamation criteria.

(2) Demonstrates that the post mining land use is compatible with surrounding land uses. Since the expansion area is surrounded by other quarries that are going to be made into Wildlife habitat area it only makes since that it does too. Farmland is what surrounds the quarries at this time and a wildlife habitat area will be good for wildlife and also supplies an emergency source of water if needed by local farmers.

(3) Details support and maintenance activities required for successful implementation. Test reclamation plots were set up and have been growing for 10 years. They can be found below in **Revegetation ARSD 74:29:07:06 section 3.**

(4) Includes assurance that the proposed post mining land use meets the following requirements:

(a) Is obtainable according to data on expected need and market. The quarry will not shutdown as long as there is a market for the product and it is feasible to extract it.

(b) Is supported by commitments from public agencies where appropriate. Local wildlife conservation officer gave support for the reclamation plan. He committed on the wildlife that would benefit from the wildlife habitat area.

(c) Is practicable on the basis of private financial capability for completion of the proposed operation. Cold Spring Granite Company has put up bond that demonstrates its ability to take on the financial responsibility of the reclamation.

(d) Is planned pursuant to a schedule attached to the reclamation plan that integrates the mining operation and reclamation with the post mining land use. No reclamation plan can be scheduled for the expansion area. The area is located in a quarry that could run for 100 more years.

(e) Is consistent with existing state and local land use plans and programs. The state and county government agencies understand the reclamation plan for the expansion area.

(f) Is of a beneficial use. A wildlife area is more than just beneficial to wildlife. It is a place of recreation for locals and can be used as an emergency source of water for local farmers and residents.

74:29:06:03 Economic study required for determination of future mineral exploration and development as reclamation type. The amount of granite in the expansion area is not that great. The economical impact of these 4.25 acres that will be mined cannot determine the future reclamation plan. The amount of usable granite throughout the quarry site cannot be determined at this time because it is not feasible giving the size of the granite deposit.
74:29:06:04 Alternative post mining land use. The only post mining land use considered for this property is wildlife habitat area, so this does not apply to the expansion area.

Disposal of Refuse: SDCL 45-6B-38, ARSD 74:29:07:05, and ARSD 74:29:07:13.

The non-usable granite, called grout will be minimal in the expansion area. If there is any grout produced it will be hauled over to the grout pile by Permit 8, Carnelian 1 and crushed by Fishers Sand and Gravel. The disposal of trash and other waste materials will be handled with the waste materials accumulated from the large scale permit area 8 that is adjacent to the expansion area. The trash disposal facilities for the expansion area will be located near the office on the South side of the Permit area near 150th street. This area can be seen on Map 2, site map.

Topsoil Salvage: SDCL 45-6B-40 and 74:29:07:07.

74:29:07:07. Topsoil management. In addition to the requirements of SDCL 45-6B-40, topsoil must be managed as follows:

1) **All salvageable topsoil or other suitable material must be removed from the areas of affected land before the land is disturbed. The board may authorize topsoil to remain on areas where minor disturbances associated with construction and installation activities will occur, such as light-use roads, signs, utility lines, fences, and monitoring stations, provided that the minor disturbances will not adversely affect the soil resource.** The topsoil from the expansion area will be stockpiled before the sand, gravel and clay is removed. The topsoil that can be salvaged is the entire 7.8 acre expansion area seen on Map 2, Site Map. During reclamation the area where topsoil would be reapplied by estimation would be about 3.55 acres. It will be about 154,640 square foot area with a topsoil application depth of about 6 inches. 2864 cubic yards of topsoil will be needed for reclamation of this area. With about 6292 cubic yards of topsoil being removed from the expansion area, there will be more than needed at final reclamation for the expansion area.

2) **Where long-term disturbances will occur, the board may authorize the temporary distribution of a portion of stockpiled topsoil or other suitable material to enhance stabilization of affected lands during periods of interim reclamation and temporary cessation of operations under the following conditions.** The area of expansion is in a quarry that runs year round and does not have temporary cessation of operations.

    a. **The topsoil or subsoil capacity and productive capabilities are not diminished by the distribution or can be restored.** Topsoil piles are not distributed in this area because it is under operation.

    b. **The topsoil is protected from erosion.** Topsoil used in the expansion area will be protected from erosion by the granite barrier.

c. **The topsoil will be available for final reclamation.** Topsoil from the expansion area will be stored at a different location in the Northeast corner of permit area 8. The location of topsoil stockpile will be at Map 2, Site map.

3) **The board may require topsoil or other suitable material to be analyzed by the operator prior to replacement to determine if fertilizer or other soil amendments are necessary to establish and sustain the required vegetation.** The initial removal of topsoil will go into a long term stockpile for final reclamation. Should the board determine a need to analyze this soil prior to final use, the process will be done.

4) **Topsoil stockpiles must be marked with legible signs containing letters not less than six inches high in sufficient locations to clearly identify stockpiles. Such signs must be in place from the time stockpiling begins**. The topsoil would be added to the pile for permit 008. A granite block with metal signs and letters six inches high will be placed on all four sides of the topsoil pile. The pile is expected to be approximately 300 feet wide by 200 feet long and 25 feet high. The blocks and metal signs will be durable to withstand the 50 to 100 year duration of these operations. Stockpile location will be shown on Map 2, site map.

5) **Topsoil or other suitable material shall be distributed as necessary to establish and sustain the required vegetation. The reclamation plan must contain an estimate of topsoil necessary to complete reclamation.** The Topsoil removed from the expansion area will be more than enough to cover the ledges. 7.8 acres of topsoil will be removed and stockpiled. Of those 7.8 acres only 3.55 acres of topsoil will be needed to reclaim the edges. The rest of the area will be allowed to fill with water. All topsoil is piled in the large scale permit area 8.

6) **If excess topsoil is present, the board may approve the use of the excess for reclamation purposes elsewhere.** Based on the numbers from expansion area, there will be excess topsoil available.

7) **Trees, large rocks, and other waste material which may hinder redistribution of topsoil must be separated from the topsoil before stockpiling;** All Trees, large rocks, and other waste material will be removed before the topsoil is stockpiled for future reclamation. A large amount of topsoil will come from the expansion area.

8) **If the amount of topsoil necessary for reclamation does not exist on the affected land, other suitable material such as subsoil may be used as a topsoil substitute if it can be demonstrated that the material is capable of establishing and sustaining the required vegetation. If other suitable materials are used in lieu of**

topsoil, they must be managed in accordance with all topsoil requirements in this section and with the following:

a. Topsoil substitute stockpiles must be segregated from topsoil stockpiles and signed as substitute topsoil stockpiles. Based on the estimates of topsoil available and need, no substitute material will be needed.

b. In addition to soil analyses, the board may require test plots to determine the suitability of topsoil substitutes as a plant-growing medium. No substitute soils will be needed, abundant amount of topsoil available.

Hydrologic Balance: SDCL 45-6B-41, ARSD 74:29:02:11, ARSD 74:29:07:08 through ARSD 74:29:07:12, and ARSD 74:29:07:27.

Since this area was already adjacent to existing quarries it would have no affect on the water in the area. No streams or wetlands are affected by the expansion area. Mining in the expansion area will have no affect on the hydrological balance.

1) A Water resources report is provided later in the report that has all the information required. The report was completed for large permit area 27 that the expansion area was a part of. Also provided is water sampling that was done by Cold Spring Granite. The results of the testing show no affects on the ground water.
2) A geological report is provided later in this permit application that has representative geologic cross sections. The report was completed for large permit area 27 that the expansion area was a part of.
3) A map is provided later in the report that shows all water resources within 200 feet of the Expansion area.
4) No wells are located within 200 feet of the expansion area. A map is provided that shows the nearest well location.

9) A drainage, erosion and sedimentation control plan was set in place for the large permit area 8. This plan will cover the expansion area.

74:29:02:12 Map requirements for large scale mining operations

All maps provided will have the requirements.

Sides, Subsidence or Damage Protection: SDCL 45-6B-42 and ARSD 74:29:07:16.

Since this expansion area is already located on the border of two permitted quarry areas this is covered. Cold Spring Granite Company has chain link or barbed wire fence and a gate located in place along the township road with signs warning people to stay out, "Danger". Granite blocks were also placed around the perimeter of the quarry to form a barricade. Signs will be posted every 500 feet warning people to "Keep Out". As far as the Dakota Granite's property in the area, it should fall under Dakota Granite's jurisdiction and permit.

Spoil Piles, Weeds: SDCL 45-6B-43, ARSD 74:29:07:14, and ARSD 74:29:07:15.

The expansion area will be adjacent to a Cold Spring Granite quarry that currently controls two noxious weeds. The same weed control method will be used for the expansion area as it is for the original quarry area. The two noxious weeds are identified as Canadian Thistle and Leafy Spurge. Any infestation of either of these weeds will be controlled by spraying with an appropriate chemical during the spring emergence. This will be followed by mowing as needed during the summer before the plants go to seed. Additional chemical control will be applied during the late summer as needed to control late growth.

Landowner Consultation, reclamation Type Development: SDCL 45-6B-44 and ARSD 74:29:06.

The proposed reclamation plan for this area is a natural wildlife area that will fill with water. The reclamation plan for Permit 8 will be used for this 7.8 acre area. All adjacent landowners were contacted and it was approved with permit 8. Dakota Granite will be sent a copy of the large permit application before it is submitted; a certified mail return receipt will be submitted.

Reclamation Choices, Operators Requirements: SDCL 45-6B-45, ARSD 74:29:07:18 through ARSD 74:29:07:26 and ARSD 74:29:07:01.

The choice of reclamation for the expansion area is wildlife habitat area. All operator requirements for this permit area will be covered by Cold Spring Granite Company. The expansion area will be reclaimed at the same time as the larger permit area.

Reclamation Timetable, Planting not required under certain conditions, Concurrent Reclamation: SDCL 45-6B-46 and ARSD 74:29:08.

This area is not scheduled for reclamation in the next year and a half. The area is many years away from being in a position for any reclamation to be completed. At this time it is not feasible to identify any date for this work to be done.

74:29:08:01. Requirements for concurrent reclamation. The expansion area is next to large permit area 8 so no reclamation can be conducted before the larger quarry is shutdown and ready for reclamation.

74:29:08:02. Requirements for interim reclamation. The expansion area is next to large permit area 8 so no reclamation can be conducted before the larger quarry is shutdown and ready for reclamation.

74:29:08:03. Requirements for final reclamation. The expansion area cannot have final reclamation done until the other quarry is ready to have final reclamation. Reclaiming the expansion area first would have an adverse affect on other mining operations.

74:29:08:04. Disturbance to avoid requirements -- Board order. Since the expansion area is next to the existing large quarry area, this does not apply.

Post closure Plan: SDCL 45-6B-91

The post closure plan for this area would be incorporated with the post closure plan for permit area 8. Since this area is smaller and connects to permit 8 all reclamation would be done whenever permit area 8 is done. The post closure plan for Area 8 is Wildlife Habitat area and will be planted and monitored like the test plots mentioned above in Section **ARSD74:29:07:06.**

1) **Treatment of Tailings.** This does not apply to this site
2) **Operation of monitoring systems.** Cold Spring Granite will fence the area and allow vegetation to become established. Revegetation will be monitored and followed like the test plots for Area 8 in Section Revegetation above. Any erosion problems or lack of vegetation will be taken care of. Efforts will be to stabilize the erosion and reseed the area to help with vegetation growth.
3) **Inspection and Maintenance activities to ensure compliance with all applicable reclamation, design, and operating criteria.** Cold Spring Granite will monitor revegetation success and any erosion concerns well the reclamation is taking place.

4) **Procedures for maintaining the final cover and controlling erosion and fugitive dust.** Erosion and none vegetative areas will be monitored and corrected throughout the reclamation process.

Critical Resources: SDCL 45-6B-92

Since the area in question has been part of a mining permit for over 50 years, there are no new critical resources that would be affected.

1. Wildlife: Little wildlife would be living in expansion area. It has been mentioned in other sections of the report that two endangered species might have critical habitat in Grant County. No data shows they are in the expansion area and with current mining operations it is unlikely any wildlife live in the expansion area.
2. Aquatic Resources: No water flows naturally into the area.
3. Vegetation: Plant life living in the expansion area is very minimal and the endangered species are not known to be present in the expansion area.
4. Water: No drinking water is affected by this area.
5. Visual Resources: The area is in along the back side of a quarry hole so it does not cause any visual constraint
6. Soils: Most of the soil from this area will be removed and topsoil will be stockpiled.
7. Cultural Resources: Nothing is of any historical or cultural significance.
8. Air Quality: There are no homes or recreational areas near the quarry. There are only more quarries and farm fields.
9. Noise: There are no homes or recreational areas near the quarry. There are only more quarries and farm fields.
10. Land designated as special, exceptional, critical, or unique: This expansion area borders permit area 8 and that had no special land designations.

74:29:07:01. General requirements for all reclamation types. All mining operations must comply with the general requirements in §§ 74:29:07:02 to 74:29:07:17, inclusive, and with the following requirements:

(1) Reclamation must rehabilitate the affected land to a condition that meets the selected post mining land use. The post mining land use for the

expansion area is wildlife habitat. The edge of the expansion area will be planted with native plants and monitored for years.

(2) All reclamation activities are subject to the concurrent, interim, and final reclamation requirements of chapter 74:29:08. The location of the expansion area makes so that there will be no interim reclamation.

(3) All reclamation required by the approved reclamation plan must be completed prior to final and full bond release. All reclamation will be completed soon after the quarry is closed.

74:29:07:08. Hydrologic balance -- Water quality. To minimize disturbances to the prevailing hydrologic balance of the affected land and adverse effects on the quality and quantity of surface water and groundwater, both during and after the mining operation and during reclamation, the following requirements must be met:

(1) South Dakota water rights laws and regulations must be complied with. The expansion area complies with all water rights laws as do the other permit areas

(2) South Dakota water quality laws and regulations must be complied with. The expansion area will comply with all water quality laws as do the other permit areas.

(3) Dredge and fill laws in sections 401 and 404 of the Federal Clean Water Act as they existed on February 1, 1987, must be complied with. No dredging or filling will take place in the expansion area.

(4) Temporary or large sedimentation, erosion, or drainage control structures must be removed after affected lands have been vegetated and stabilized, if required by the reclamation plan. All man-made erosion control measures will be removed from the expansion area as soon as it reaches full reclamation.

(5) Permanent diversion structures must be designed not to erode during the passage of the approved design precipitation event. The large granite barriers used in the expansion area to control erosion will not erode do to any precipitation event.

(6) Unchannelized surface water must be diverted around the operation as necessary to minimize pollution and erosion and to protect the operation and downstream water users who have prior water rights. No surface water is close enough to the expansion area to cause any pollution downstream.

74:29:07:09. Surface runoff diversions. Surface runoff diversions must meet the following general requirements:

(1) In soils or other unconsolidated material, the sides of diversion ditches may be no steeper than two horizontal to one vertical. The sides and, in ditches carrying intermittent discharges, the bottom must be stabilized by seeding with grasses or other methods specified in the reclamation plan as soon as practicable. There are no diversion ditches near the expansion area.

(2) In rock, the sides of diversion ditches must be stable. There are no diversion ditches near the expansion area.

(3) Rock riprap, concrete, geosynthetic liners, geosynthetic filter media, soil cement, or other methods must be used where necessary to prevent erosion. Erosion control in the expansion area is controlled by granite barriers.

(4) Culverts or bridges must be installed where necessary to allow access. No culverts or bridges are needed in the expansion area.

(5) Diversion ditches must be constructed to minimize hazards to humans, wildlife, or livestock. There are no diversion ditches near the expansion area.

(6) Surface runoff diversions around milling or processing facilities using potentially toxic chemicals or materials must be capable of carrying the flow from the six-hour probable maximum precipitation event without causing erosion. There are no diversion ditches near the expansion area and no milling or toxic chemicals.

(7) All other surface water diversions must be capable of carrying a minimum of the two-year six-hour precipitation event without causing erosion. There are no diversion ditches near the expansion area.

(8) Diversion ditches may not discharge on topsoil storage areas, spoil, or other unconsolidated material such as newly reclaimed affected lands. There are no diversion ditches or topsoil storage areas in the expansion area. There are no storage areas in the expansion area.

74:29:07:10. Diversions of intermittent and perennial streams. Permanent or temporary diversions of intermittent and perennial streams on affected lands must meet the following general requirements:

(1) Spoil, topsoil, or other unconsolidated materials may not be pushed into or placed within 10 feet of the banks of a perennial or intermittent stream or in a location which may subject them to bankfull flooding except during the construction of the diversion as approved in the permit. There are no perennial or intermittent streams located in or near the expansion area.

(2) The banks of a diverted perennial or intermittent stream must be stabilized and vegetated with approved species as soon as practicable. There are no perennial or intermittent streams located in or near the expansion area.

(3) The banks and channel of a diverted perennial or intermittent stream must be protected where necessary by rock, geosynthetic liners, geosynthetic filter media, riprap, or similar measures to minimize erosion and degradation of water quality. Permanent diversions must be designed and constructed to prevent erosion and to carry flow consistent with the flow produced by stream's original width, depth, shape, and gradient. There are no perennial or intermittent streams located in or near the expansion area.

(4) The board may not permit mining on the flood plain of a perennial or intermittent stream if it would cause the uncontrolled diversion of the stream during bankfull periods. There are no perennial or intermittent streams located in or near the expansion area.

(5) Channel and flood plain diversions must be designed to prevent erosion during the passage of the approved design precipitation event. Cross-sections and other hydrologic data for the existing stream above, below, and within the diversion area must be used to determine the flow capacities, channel configuration, and shape of the diversion. Such design information must be included in the reclamation plan. The expansion area is not in a channel and flood plain. No diversions happen in or near the expansion area.

(6) The water quality of a diverted intermittent or perennial stream must meet surface water quality standards in chapter 74:51:01. There are no perennial or intermittent streams located in or near the expansion area.

74:29:07:12. Roads and railroad spurs. Constructed or upgraded roads and railroad spurs are affected land from the location where they provide exclusive service to the mining operation and must be covered by the reclamation bond. They must meet the following general requirements:

(1) When feasible, roads and railroad spurs must not be constructed within riparian zones. No roads or railroad spurs were built for the expansion area. All roads were constructed before the expansion area was purchased.

(2) Roads within riparian zones must be constructed so that negative effects on streams are minimized; No roads or railroad spurs were built for the expansion area. All roads were constructed before the expansion area was purchased. No streams are located near the access roads to the expansion area.

(3) Roads or railroad spurs within the riparian zone of a coldwater permanent fishery designated pursuant to chapter 74:51:02 or 74:51:03 may be subject to the requirements of §§ 74:29:07:29 to 74:29:07:32, inclusive. No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

(4) Streams must be crossed at or near right angles unless contouring down to the stream bed will result in less potential stream bank erosion. Ford entrances and exits must be constructed to minimize erosion and prevent water from flowing down the roadway. No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

(5) Drainage control structures must be used as necessary to control runoff and to minimize erosion, sedimentation and flooding. When used, drainage control structures must be installed as road construction progresses. No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

(6) Culverts must be installed at prominent drainage ways. Culverts must be protected from erosion by rock, concrete, riprap, or other approved means. Culverts and drainage pipes must be constructed and maintained to avoid plugging, collapsing, or erosion at inlets and outlets. No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

(7) Trees and vegetation may be cleared only to the width necessary to maintain slope stability and to serve traffic needs. No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

(8) Access and haul road drainage structures must be routinely maintained. No roads were built for the expansion area. All existing roads are maintained for use in the main quarry site.

(9) Other transport facilities and utilities must be constructed and maintained to control degradation of water quality and quantity. No transport facilities and utilities were constructed for the expansion area.

(10) An applicant may request in writing to the board that a road or railroad spur be permitted to remain unreclaimed if the surface landowner or a local, state, or federal agency has requested that the road or spur remain unreclaimed and agrees to be responsible for future maintenance. The operator must furnish proof of such a request. No surety is required for reclamation of such a road or spur and reclamation of the road or spur is not required if the request is approved by the board. . No roads or railroad spurs were built for the expansion area. This does not apply to the expansion area.

74:29:07:13. Buildings and structures. All buildings and structures constructed, used, or improved by the operator must be dismantled and removed unless it can be demonstrated to the board's satisfaction that they will be consistent with the approved post mining land use. There are no buildings in the expansion area and none will be built. This does not apply to the expansion area.

74:29:07:14. Spoil. Spoil on all affected land must meet the following general requirements:

(1) Except where diversions are approved by the board, all spoil must be located to avoid blocking intermittent or perennial drainages. Ephemeral drainages may be blocked if the engineering and environmental methods used for dealing with runoff control and sedimentation is approved by the board. There are no drainages in the expansion area and all grout will be removed by dump truck and hauled over to permit area 1, where it will be crushed by Fishers Sand and Gravel.

(2) If permanent spoil dumps are approved by the board, the board may require the operator to demonstrate the long-term stability of the dumps through geotechnical stability analyses conducted by a registered professional engineer competent in the field of geotechnical analysis. No spoil dumps will be located in or near the expansion area.

(3) The board may require the operator to analyze spoil material to determine if it will be a source of water pollution. If the spoil material may be such a source the operator must describe proposed procedures for mitigating the condition. No spoil dumps will be located in or near the expansion area.

(4) All spoil material that is determined to be toxic or acid-forming or that will prevent reestablishment of vegetation on the reclaimed land surface must be properly disposed of during the mining operation unless such materials occur naturally on the land surface. No spoil dumps will be located in or near the expansion area.

74:29:07:18. Requirements for specific types of reclamation. The requirements in §§ 74:29:07:19 to 74:29:07:27, inclusive, apply to the specific type or types of reclamation selected pursuant to SDCL 45-6B-45. These requirements are to be used to develop, when practicable, a multiple-use reclamation plan.

The individual who develops the reclamation plan must be competent in the management and planning of the specific type or types of reclamation selected. The expansion area will be a wildlife habitat area. The 70 feet of quarry edge will be graded and planted with native grasses and trees. It will be monitored for 10 years along with the existing permit area. The individual who developed the reclamation plan used the help of the South Dakota, Game, Fish and Parks officer and the local Soil Conservation Service Agent, Mr. Odell Greene. With their help and the test plots study area, the Cold Spring Granite employee was able to develop the reclamation plan.

74:29:07:22. Wildlife habitat. The following requirements apply to wildlife habitat as an approved post mining land use:

(1) Reclamation shall be directed toward optimizing habitat diversity for game and nongame species. The surrounding unaffected land must be considered in determining habitat diversity goals. The local South Dakota Conservation Officer, Mr. Stan Michals was consulted on wildlife species. Mr. Michals agreed with the original survey that was done on the larger permit area. He added that two endangered species might have critical habitat in Grant County. These species were not considered for the reclamation plan. As for plant diversity in 1983 Mr. Odell Greene was consulted from the Soil Conservation District. He provided the seed mixture for the reclamation found above in section **ARSD 74:29:07:06.**

(2) The applicant must identify the wildlife species to benefit from the proposed reclamation. The local wildlife that surrounds this area and could benefit from the reclamation of the expansion area includes whitetail deer, pheasant, partridge, cottontail rabbits, jack rabbits, red fox, raccoon, mink and a variety of birds including robins, blue jays, blackbirds, crows and swallows. Stan Michals also indicated that the

Dakota skippers and Poweshiek Skipplerling are two endangered species that might have habitat in Grant County. These species might benefit from the reclamation of the expansion area.

(3) The affected land must be revegetated with native trees, shrubs, forbs, grasses, or other approved alternative vegetation. Revegetation composition, spacing, and arrangement must be based on consultation with the department of game, fish and parks or on an approved reference area. Woody species and understory vegetation shall be planted at rates which can reasonably be expected to yield densities appropriate for the designated wildlife species. Mr. Odell Greene was consulted from the Soil Conservation District. He provided the seed mixture for the reclamation found above in section **ARSD 74:29:07:06.** The native grasses will be planted first then after 3 years of growth trees and scrubs will be planted.

(4) Alternative wildlife habitat reclamation objectives shall be developed in consultation with the department of game, fish and parks and approved by the board. The size of the expansion area is so small it makes it so alternative wildlife habitat reclamation objectives are not needed.

(5) Sites to be reclaimed for recreational fisheries must provide suitable habitat for the selected fish species. The site will not be designated as specifically a recreational fishery

(6) Surface impoundments to be reclaimed for recreational fisheries must have at least 25 percent of the bottom at a minimum depth of 20 feet to ensure sufficient water during drought, limit growth of undesirable weeds, and reduce the potential for winterkill. The site of the expansion area will not be designated as specifically a recreational fishery.

(7) Streams to be reclaimed for recreational fisheries must have a baseline study prepared by an individual who is competent in the field of fisheries management which addresses faunal, floral, and channel characteristics and is approved by the department of game, fish, and parks. Streams to be reclaimed for recreational fisheries must be reconstructed so that they provide suitable habitat for the selected fish species. Reclamation must achieve to the extent possible the premining pool to riffle ratio, width-to-depth ratio, and stream bed particle sizing and sorting ratio, unless modifications to enhance the stream habitat are approved by the department of game, fish and parks and the department. Reclamation techniques such as stream bank stabilization and

revegetation, construction of wing deflectors, k-dams, or other management techniques may be incorporated into the reclamation plan and must have the approval of the department, the department of game, fish and parks, and the board. No streams in the expansion area so this does not apply.

(8) Sites to be reclaimed for recreational fisheries must have safe bank access. The site will not be designated as specifically a recreational fishery

(9) Reclamation is complete when the following conditions are met:

(a) The surviving vegetation species composition is capable of supporting the wildlife species identified as those to benefit from the proposed reclamation. The local wildlife authorities were consulted to make sure the reclamation plan benefits native species.

(b) The understory cover is adequate to control erosion. Grasses will be planted as described in section (3) above.

(c) Stream fisheries approximate or exceed the baseline condition of the stream or that of the approved reference area. The site will not be designated as specifically a recreational fishery

(6) Surface impoundment fisheries meet the post mining land use as described in the approved reclamation plan. The site will not be designated as specifically a recreational fishery

74:29:07:27. Permanent surface impoundment. The following requirements apply to a permanent surface impoundment as an approved post mining land use:

(1) Dams must be designed to contain and, if necessary, pass the design precipitation event. All dam designs must be reviewed and approved by the division of water rights. The expansion area is not considered a dam and neither does the permit area next to it. This does not apply.

(2) If necessary to prevent failure, dams must contain an overflow notch and spillway. Overflow notches and spillways must be riprapped with rock, concrete, or other suitable materials to prevent erosion. The expansion area is not considered a dam and neither does the permit area next to it. This does not apply.

(3) Slopes around surface impoundments, unless otherwise approved by the board, may not exceed two to one, except from five to ten feet below the

expected water line where slopes may not exceed three to one. If a swimming area is proposed, the slope, unless otherwise approved by the board, may be no steeper than five to one throughout the area proposed for swimming. All slopes around surface impoundments must be graded and contoured to minimize hazards to humans, livestock, and wildlife. The slopes around the expansion area will be graded before final reclamation. The edges will have granite barriers to prevent accidental falls by people or wildlife.

(4) The board may require the operator to determine if sources of water contamination within the impoundment exist. Such sources must be treated to prevent contamination of the impounded water. The source of water for the expansion area with be ground water or rain water and should not contain any contamination.

(5) Surface impoundments intended for use as recreational fisheries or recreation areas must meet the applicable requirements of § 74:29:07:23. The site will not be designated as specifically a recreational fishery.

(6) Reclamation is complete when the intended use of the surface impoundment has been attained and all other requirements of the reclamation plan have been met. Reclamation will start immediately after shutdown and will be completed within 3 years of shutdown.

Large Permit Application Added items

Certification of Application Form: A copy is found in this application.

SDCL 45-6B-15: A copy of the letter can be found in the application.

SDCL 45-6B-37, ARSD 74:29:07:04 (1)(d), (2), and (7), and ARSD &4:29:07:27(3):

The final slope along the quarry edge in the expansion area will be a 25% grade or a 4 to 1. There are no plans to allow swimming in the quarry after reclamation. It is to be a wildlife habitat area. The area outside the Expansion area will be protected from slides like all other ledges along the permit area 8, Carnelian 2. The ledges will have a slight grade and will have large granite blocks placed along the ledge to prevent erosion. These blocks also act as a natural safety barrier. The landforms created by grading are a nice flat area with a slight slope. This will compatible with the surrounding area because it is all flat farm fields.

SDCL 45-6B-39, ARSD 74:29:07:06(1), and ARSD 74:29:07:22(3) :

Included later is a letter from Grant County NRCS stating that the seed mix in the revegetation section of the Large permit application is acceptable for the expansion area. A copy of a letter from Stan Michals of the Department of Game, Fish, and Parks is also included later in this report. It states that the seed mix is acceptable for the post mine land use of wildlife habitat area.

SDCL 45-6B-41, ARSD 74:29:02:11(1)(2)(9) and (10) and ARSD 74:29:07:04(2):

A copy of water sampling done in 1990 for Permit area 8 is included in this report. The testing was done for a year and never found any harmful effects on the ground water. A copy of a Water resource survey is also included. It shows information that can help characterize the hydrologic system in the area. A representative geologic cross-section of the expansion area is included with the Water resources report.

Since the expansion area is only 7.8 acres it will be covered under permit area 8. The basic drainage, erosion and sedimentation control plan for the expansion area is covered by Permit Area 8. There will be a slight grade on the ledges and large granite barriers will be placed to control erosion. Also native seed will be planted to prevent erosion. No chemicals will be used in the expansion area. No milling will be taken place in the expansion area. No spill contingency plan is needed for the expansion area.

SDCL 45-6B-42 and ARSD 74:29:07:16:

There will be no subsidence in the expansion area. No mining will be done below the surface so there will be no chance for cave-ins. The expansion area is on solid granite that we are not sure how far it goes into the ground. There is no chance the area will sink into the ground.

SDCL 45-6B-43 and ARSD 74:29:07:15:

A copy of a letter from Nathan Mueller of Grant County Weed Department is included later in this application. It states that the weed control plan for the expansion area is in compliance with Grant County Weed Department mandated practices.

SDCL 45-6B-44:

A copy of the certified mail receipt is included later in this application.

SDCL 45-6B-46:

Most of the expansion area will not be revegetated because the quarry will fill with water and be considered a lake. A large piece of the expansion will be under water. About 4.25 acres will be under water. The remaining 3.55 acres will be sloped and seeded. There will be no permanent grout piles generated from the expansion area

because it will be crushed in permit Area 8, Carnelian 1, by Fishers Sand and Gravel. The ledge area in the expansion are will be revegetated with the approved seed mix.

SDCL 45-6B-92(1) , (2), (3), and (6):

The expansion area is in the middle of 2 permit areas and only 7.8 acres. Most of that will be under water at the time of quarry reclamation. It is not critical deer winter range now because it is in a fenced area and it is a non wooded area that is not good winter deer habitat. It will not be critical at the time of reclamation because 4.25 acres will be under water and the remaining 3.55 acres is not enough for deer to winter range on.

No cold water fisheries will be in the expansion area. If fish happen to be in the quarry after reclamation it will be a natural occurrence.

There are no Riparian zones or Wetlands located in the expansion area.

The soils in the expansion area are not highly erosive or have low revegetation potential. The area is level ground on the north side of current quarry area. Revegetation will start as soon as the quarry edge is sloped back from the quarry expansion area. The revegetation will help control erosion along with Granite barriers.

ARSD 74:29:06:02(4) (a) and (e):

The reclamation type is obtainable according to the expected need in the area because it has been approved in the past. The reclamation plan that covers permit area 8 will also cover the expansion area. That plan has been approved by the Department of Game, Fish, and Parks and SD DENR.

The reclamation plan is consistent with existing state and local land use plans because it has been approved for the much larger permit area 8. All plans for the expansion area have been approved already for permit area 8.

ARSD 74:29:07:01(2) and ARSD 74:29:08:02:

The topsoil salvaged from the expansion area is small and is stockpiled in permit area 8. The topsoil in this area has interim reclamation. The soil is seeded with the approved seed mix to prevent erosion. Blocks of granite were also placed around this area to prevent erosion.

ARSD 74:29:07:02(7):

There will be no waste or spoil disposal in the expansion area. It will all be hauled to Fishers crushing site with all other grout from permit area 8. Fisher's sand and Gravel Map shows the location of this disposal site.

GRANT COUNTY *SOUTH DAKOTA*

PLANNING AND ZONING OFFICE
210 East 5th Avenue
Milbank, SD 57252-2499
Phone: 605-432-7580
Fax: 605-432-7515

January 11, 2016

Cold Spring Granite Company
RE: Plat Inspection

Dear Sirs:

Based upon the information provided for review, it appears that the Cold Spring Granite is in compliance with Grant County Zoning Regulations.

1. Taxes were paid on the entire parcel and the plat brought to Planning and Zoning Office.
2. Engineer's information was included:
   Proprietor's Certificate, Treasurer's Certificate, Surveyor's Certificate, Director of Equalization Certificate, Grant County Planning and Zoning Certificate, Grant County Commission Resolution, Register of Deed's Certificate- mylar, Plat Map Siting
3. The plat will be placed on the agenda of the next meeting of the Planning and Zoning Board. The meeting was held on December 7, 2015.
4. After P&Z approval, the plat is placed on the agenda of the next meeting of the Grant County Commissioner's. County Commissioners the meeting was held on December 15, 2015 by resolution 2015-37.
5. Plat Recording was completed in the Register of Deeds Office on 12-15-2015

All paperwork appears to be in order to complete the process and no further information is needed by Planning & Zoning in Grant County.

If you have questions, please call: 605-432-7580

Sincerely,

Krista Atyeo-Gortmaker
Grant County Planning & Zoning Officer

22108-00

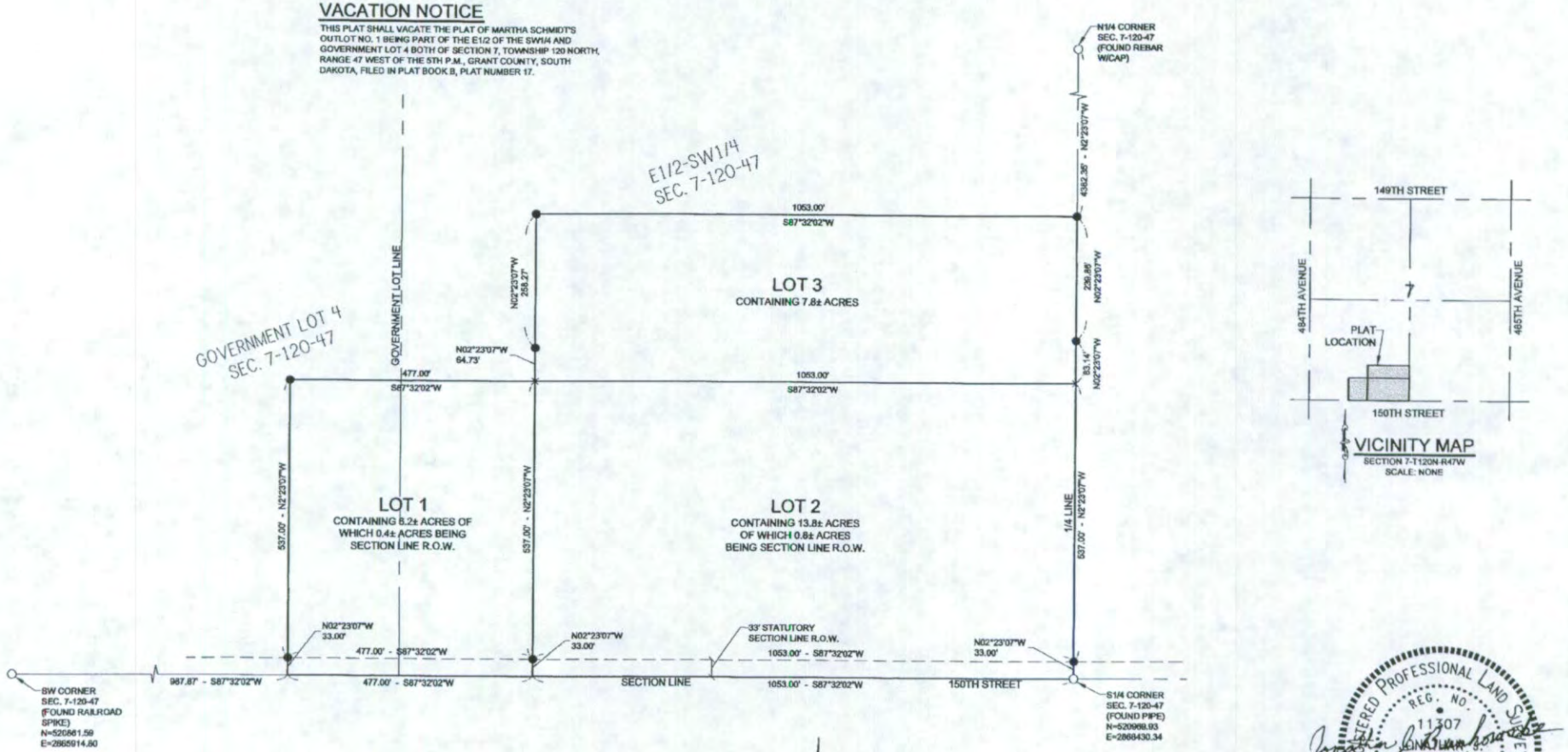
PLAT OF

LOTS 1, 2 AND 3 OF COLD SPRING-DAKOTA GRANITE ADDITION,

LOCATED IN GOVERNMENT LOT 4 AND THE E1/2-SW1/4 OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA

VACATION NOTICE

THIS PLAT SHALL VACATE THE PLAT OF MARTHA SCHMIDT'S OUTLOT NO. 1 BEING PART OF THE E1/2 OF THE SW1/4 AND GOVERNMENT LOT 4 BOTH OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA, FILED IN PLAT BOOK B, PLAT NUMBER 17.



VICINITY MAP
SECTION 7-T120N-R47W
SCALE: NONE

GEODETIC BEARING
SCALE: 1" = 200'

LEGEND

- ○ MONUMENT FOUND
- ● MONUMENT SET THIS SURVEY (5/8" REBAR WITH STAMPED PLASTIC CAP #11307)
- × CORNER FALLS IN QUARRY PIT AND WAS INACCESSIBLE AT THE TIME OF THE SURVEY

HORIZONTAL DATUM: NAD 83 (2007)

PROJECTION:
SOUTH DAKOTA STATE PLANE COORDINATES NORTH ZONE (4001)

BASIS OF BEARING: GEODETIC NORTH

ALL DIMENSIONS SHOWN ARE IN TERMS OF U.S. SURVEY FEET

REGISTERED PROFESSIONAL LAND SURVEYOR
REG. NO. 11307
JONATHAN J. BUNKOWSKE
11/1/15
SOUTH DAKOTA

PREPARED BY:
BANNER ASSOCIATES, INC.
MILBANK, SOUTH DAKOTA
(855) 323-6342
NOVEMBER 2015

Document #
STATE OF SOUTH DAKOTA COUNTY OF GRANT-ss
Recorded this _____ day of _____, A.D., 20_____
at _____o'clock ____ .M., Plat Case_____ Plat No. _____
Register of Deeds

SHEET 1 OF 2

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

SURVEYOR'S CERTIFICATE

I, Jonathan J. Bunkowske, a Professional Land Surveyor in the State of South Dakota, do hereby certify that I did, on or before **JULY 30, 2015**, at the request of the owner(s) listed hereon, survey a portion of that parcel of land described as **THE SW1/4 AND MARTHA SCHMIDT'S OUTLOT NO. 1 OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA,** and platted the same as shown on the above plat.

The same shall hereafter be known and described as **LOTS 1, 2 AND 3 OF COLD SPRING-DAKOTA GRANITE ADDITION, LOCATED IN GOVERNMENT LOT 4 AND THE E1/2-SW1/4 OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA.**

I have surveyed the tract of land shown, and to the best of my knowledge and belief, said plat is an accurate representation of said survey.

Dated this 11th day of November 20 15.

REGISTERED PROFESSIONAL LAND SURVEYOR · REG. NO. 11307 · JONATHAN J. BUNKOWSKE · 11/11/15 · SOUTH DAKOTA

Jonathan J. Bunkowske
Professional Land Surveyor
Registration No. 11307

Banner Associates, Inc.
803 South Dakota St.
Yankton, South Dakota 57252
Telephone 1-800-323-6342

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

CERTIFICATE OF OWNER

We, **DAKOTA GRANITE COMPANY AND COLD SPRING GRANITE COMPANY,** hereby certify that we did authorize and do join in and approve the above survey and plat, and that the said tract of land is free of any encumbrance, and that the development of this land shall conform to all existing applicable zoning, subdivision and erosion and sediment control regulations.

THIS PLAT SHALL VACATE THE PLAT OF MARTHA SCHMIDT'S OUTLOT NO. 1 BEING PART OF THE E1/2 OF THE SW1/4 AND OF GOVERNMENT LOT 4 BOTH OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA, FILED IN PLAT BOOK B, PLAT NUMBER 17.

IN WITNESS WHEREOF, I HAVE HEREUNTO SET MY HAND AND SEAL THIS _____ DAY OF _____, 20____.

_____
DAKOTA GRANITE COMPANY

_____
COLD SPRING GRANITE COMPANY

ACKNOWLEDGMENT OF OWNER

STATE OF _____ }
COUNTY OF _____ } SS

On this day, before me, the undersigned, a Notary Public, within and for the State and County aforesaid, personally appeared **DAKOTA GRANITE COMPANY** known to me to be the person(s) who executed the foregoing Certificate of Owner, and acknowledged to me that they executed the same.

IN WITNESS WHEREOF, I HAVE HEREUNTO SET MY HAND AND SEAL THIS _____ DAY OF _____, 20____.

_____
Notary Public

My Commission Expires _____

ACKNOWLEDGMENT OF OWNER

STATE OF _____ }
COUNTY OF _____ } SS

On this day, before me, the undersigned, a Notary Public, within and for the State and County aforesaid, personally appeared **COLD SPRING GRANITE COMPANY,** known to me to be the person(s) who executed the foregoing Certificate of Owner, and acknowledged to me that they executed the same.

IN WITNESS WHEREOF, I HAVE HEREUNTO SET MY HAND AND SEAL THIS _____ DAY OF _____, 20____.

_____
Notary Public

My Commission Expires _____

COUNTY PLANNING COMMISSION CERTIFICATE

Approval of **LOTS 1, 2 AND 3 OF COLD SPRING-DAKOTA GRANITE ADDITION, LOCATED IN GOVERNMENT LOT 4 AND THE E1/2-SW1/4 OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA,** is hereby granted by the County Planning Commission on this _____ day of _____, 20____.

_____
Chairman, County Planning Commission
Grant County, South Dakota

COUNTY COMMISSION RESOLUTION

It was moved by _____, seconded by _____, motion carried that the **LOTS 1, 2 AND 3 OF COLD SPRING-DAKOTA GRANITE ADDITION, LOCATED IN GOVERNMENT LOT 4 AND THE E1/2-SW1/4 OF SECTION 7, TOWNSHIP 120 NORTH, RANGE 47 WEST OF THE 5TH P.M., GRANT COUNTY, SOUTH DAKOTA,** as described above and hereon be approved and accepted and the Chairman is hereby instructed to endorse on such plat this resolution and to certify the same.

_____
Chairman, Board of Commissioners,
Grant County, South Dakota

DIRECTOR OF EQUALIZATION

I, _____, Director of Equalization, Grant County, South Dakota, do hereby certify that a copy of the above plat has been filed at my office.

_____
Director of Equalization,
Grant County, South Dakota

COUNTY TREASURER'S CERTIFICATE

I, _____, Treasurer of Grant County, South Dakota, do hereby certify that all taxes which are liens upon the land shown in the above plat, as shown by the records in my office, have been paid in full.

_____
Treasurer
Grant County, South Dakota

REGISTER OF DEEDS

STATE OF _____ }
COUNTY OF _____ } SS

Filed for record this _____ day of _____, 2015 at _____ o'clock ____.m., and recorded in book of Plats _____ on page _____ therein.

_____
Register of Deeds
Grant County, South Dakota

PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY	DESCRIPTION
	TOTAL AFFECTED AREA
	SURFACE MINE LAND DISTURBED
	PERMIT BOUNDRY
	HAUL ROADS
	BUILDINGS / STRUCTURES
	FENCING
	RECLAIMED AREAS 4.1 Acres
	Trash Disposal
	Topsoil Stockpile Area
	Topsoil Stockpile Area

SCALE

0 250 500 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Site Map 2	Drawn By: SC
SCALE see above	Date Drawn:5-4-16
Checked BY:	

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 305-V			
503	520706.69, 2863269.5	Nail Above Stone	
504	520861.62, 2865914.83	Nail Above Stone	

Milbank #3 Quarry
48369 150 St.
Milbank, SD 57252, Grant County

45.2086 N, 96.5250 W
T120N, R48W, NE 1/4 Sect. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.

BOUNDRY 2
PERMIT No. 373 (Site 3)

PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA
	Area Gained by Land Exchange.....7.8 Acres
	Area Lost do to land Exchange.....6.2 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	TOTAL AFFECTED AREA.....80.5 Acres
	SURFACE MINE LAND DISTURBED.....57.6 Acres
	PERMITTED AFFECTED BOUNDRY.....70.9 Acres
	PERMIT BOUNDRY.....175.8 Acres
	PROPERTY LINE.....176.3 Acres
	HAUL ROADS
	BUILDINGS / STRUCTURES
	FENCING
	Topsoil removal area
	Trash Disposal
	Topsoil Stockpile Area

SCALE

N

0 250 500 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING™
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Revised Permit Boundary #4 Drawn By: SC
SCALE see above Date Drawn:5-4-16
Checked BY:

PERMANENT REFERENCE POINTS

CTL 305-V
503 520706.69, 2863289.5 Null Above Stone
504 520861.62, 2863914.63 Null Above Stone

Milbank #3 Quarry
48369 150 St.
Milbank, SD 57252, Grant County

45.2066 N, 96.5250 W
T120N, R49W, NE 1/4 Sec. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP; PROJECTION: "NAD83 / South Dakota North (ft)"; DATUM; VERTICAL DATUM; GEOCOS "Geographic Coordinate System"; SPHEROID; "GRS 1980"
SURVEY CERTIFICATE (for property lines) : Completed on 8-24-1994 by Don and updated 10-22-08 for State Plane Coordinate System.
BOUNDRY 2
PERMIT No. 173 (Site 3)
PREVIOUS DRAWING: P-011

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA
	200 foot buffer
	200 feet buffer area items
	Creek
	Dakota Granite adjoining land Parcel # 02.47.07.3003 Parcel # 02.47.07.3002
	Abosnd well, not within 200feet
	No Buildings within 200 feet
	No Power and Communication lines within 200 feet
	No Roads within 200 feet
	HAUL ROADS
	BUILDINGS / STRUCTURES
	FENCING
	RECLAIMED AREAS.....4.1 Acres
	Trash Disposal

SCALE

N

0 250 500 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing—Site Map 5 Drawn By: SC

SCALE see above Date Drawn:5-4-16

Checked BY:

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JUN 27 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 305-V
503 520706.69, 2863289.5 Nail Above Stone
504 520861.62, 2865914.83 Nail Above Stone

Millbank #3 Quarry
46369 150 St.
Millbank, SD 57252, Grant County

45.2086 N, 96.5250 W
T120N, R48W, NE 1/4 Sect. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)" VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.
BOUNDRY 2
PERMIT No. 373 (Site 5)
PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA
	Quarry hole edge
	Elevations
	little elevation changes Slight drop in elevation to north of property.

SCALE

N
0 100 200 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Premining Site topography Drawn By: SC
SCALE see above Date Drawn:5-19-16
Checked BY:

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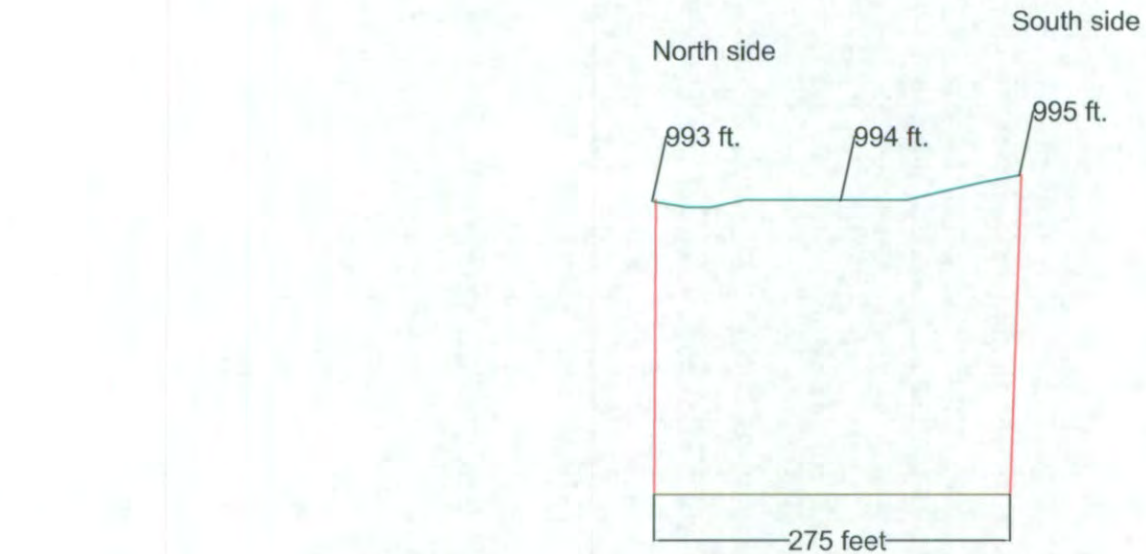
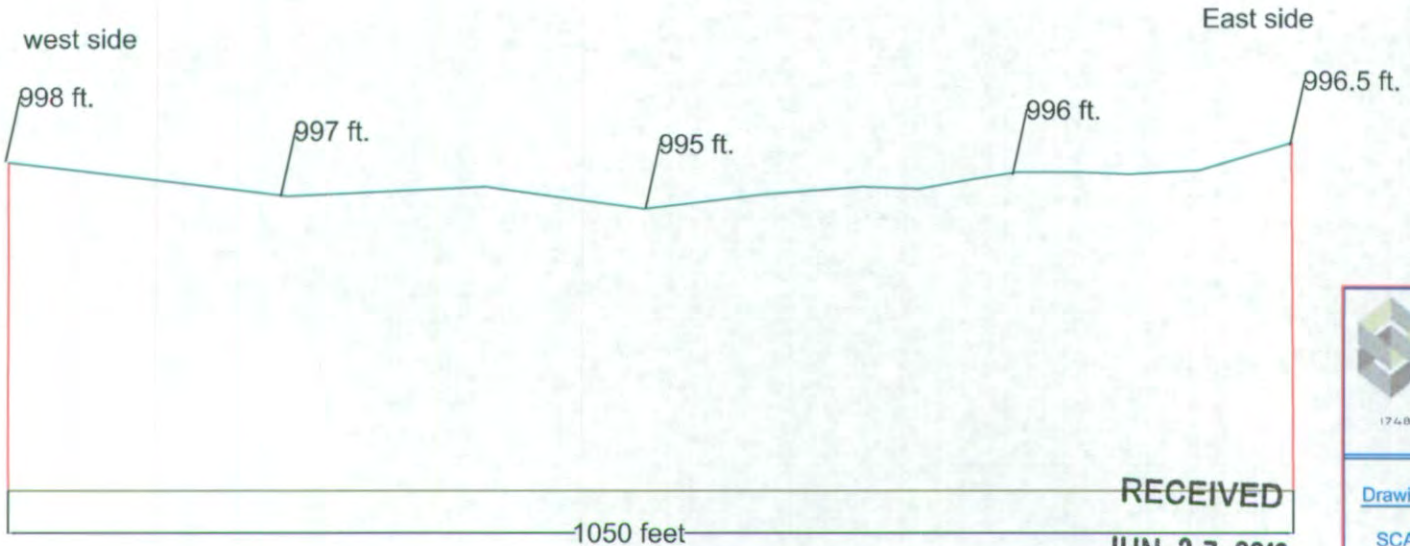
MINERALS & MINING PROGRAM





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JUN 27 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 305-V

503	520706.69, 2863269.5	Nail Above Stone
504	520861.82, 2865914.83	Nail Above Stone

Millbank #3 Quarry
46369 150 St.
Millbank, SD 57252, Grant County

45.2086 N, 96.5250 W
T120N, R48W, NE 1/4 Sec. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)" DATUM: "NAD83"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.

BOUNDARY 2
PERMIT No. 373 (Site 3)

PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA EDGE
	TOPSOIL
	GROUND

SCALE

NTS

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

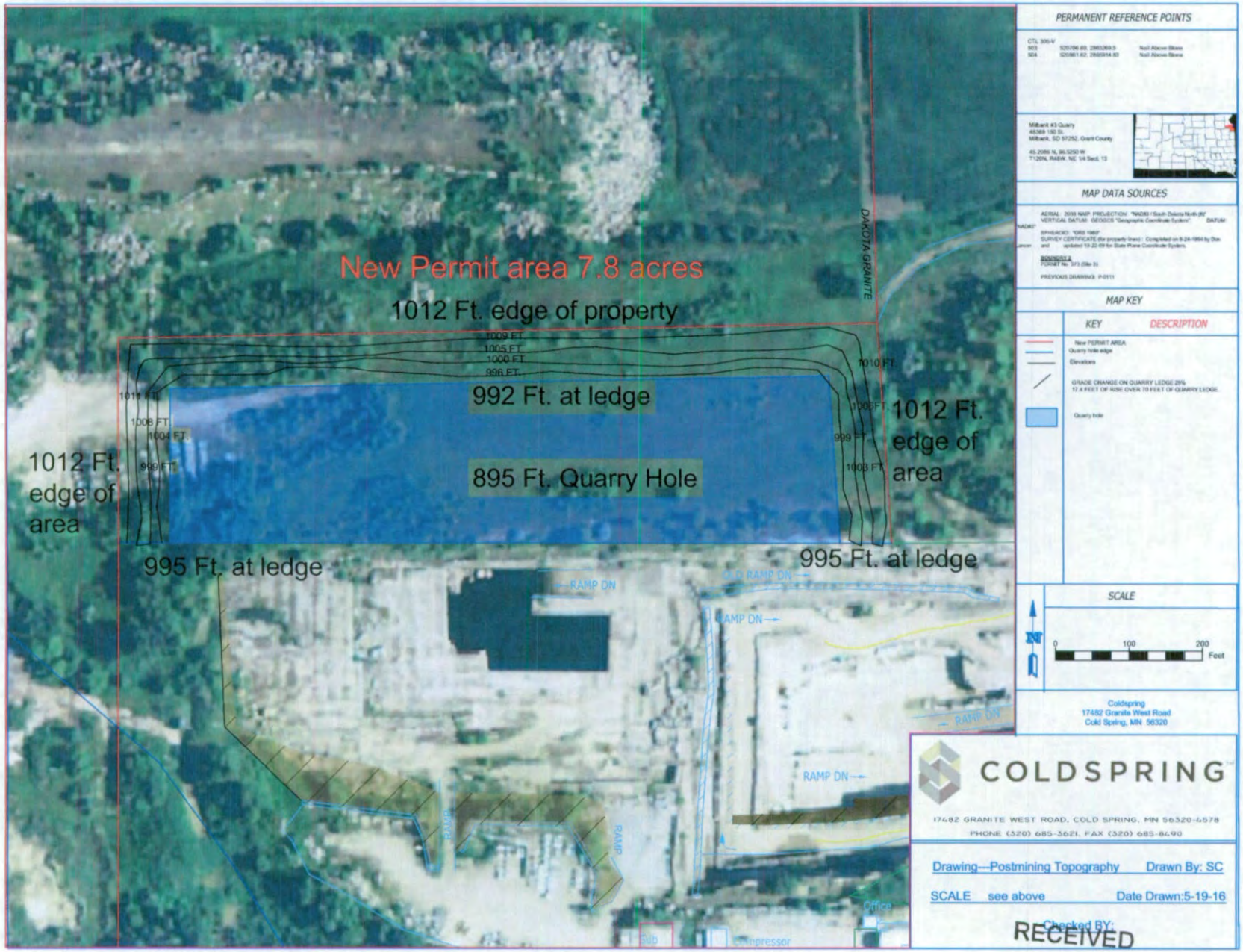
COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Premining Cross Section Map Drawn By: SC

SCALE see above Date Drawn:5-19-16

Checked BY:



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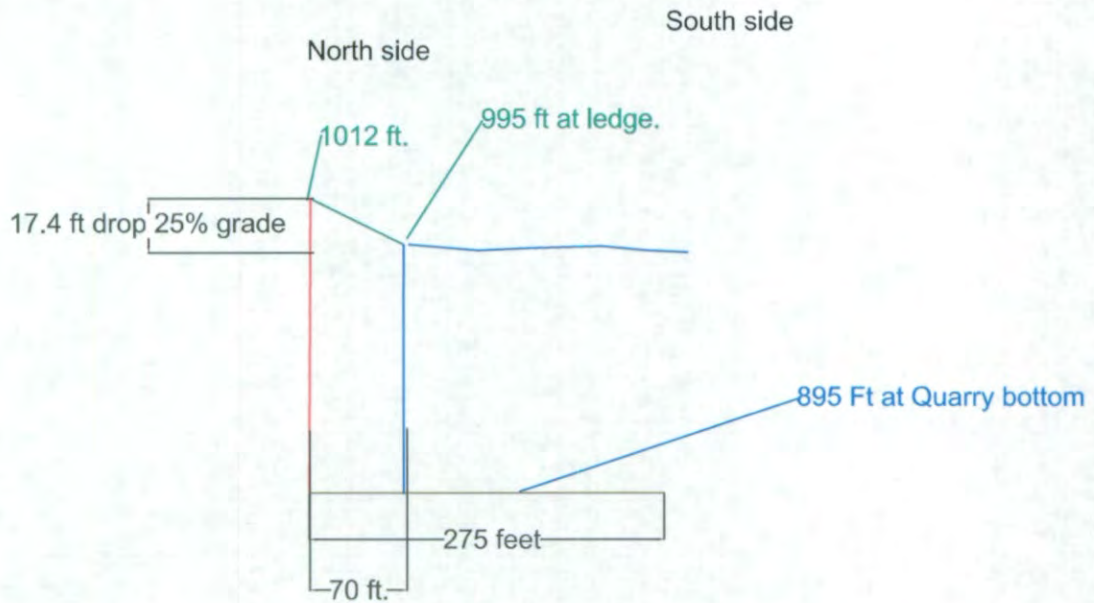
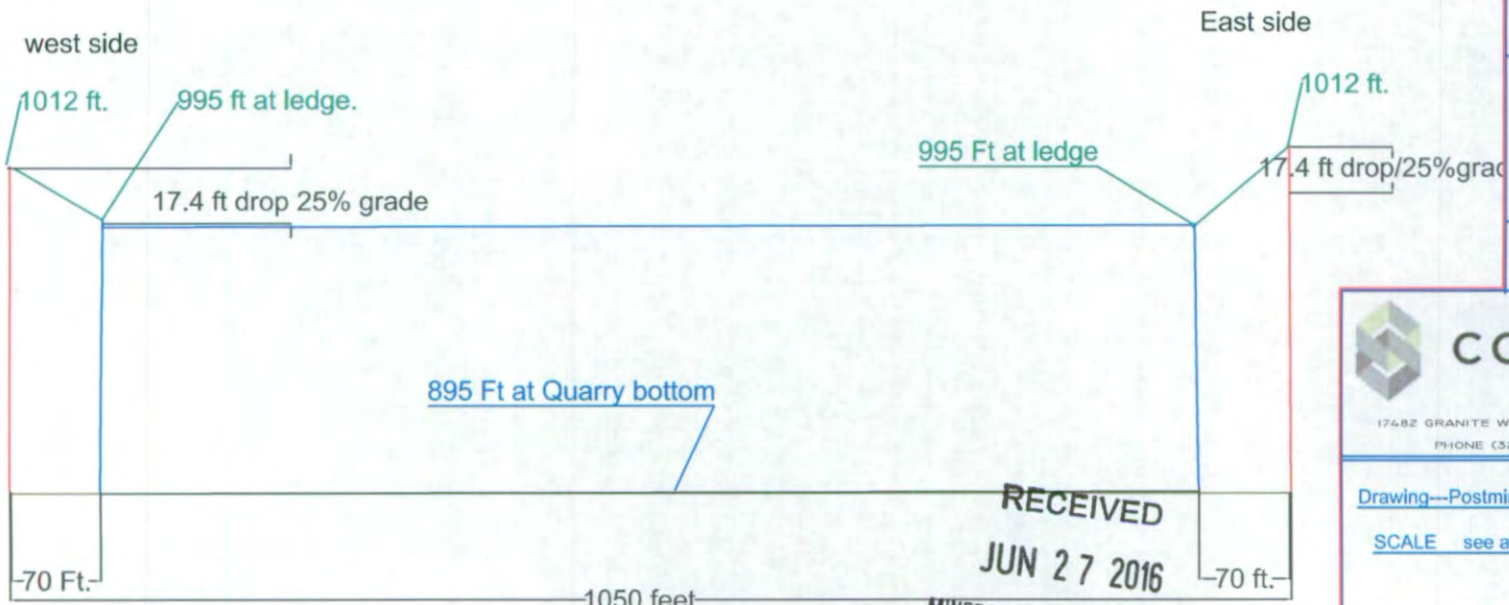
JUN 27 2016

MINERALS & MINING PROGRAM





RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 305-V
503 520706.69, 2863269.5 Nail Above Stone
504 520861.62, 2865914.83 Nail Above Stone

Millbank #3 Quarry
48369 150 St.
Millbank, SD 57252, Grant County

45.2086 N, 96.5250 W
T120N, R48W, NE 1/4 Sect, 13

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.
BOUNDRY 2
PERMIT No. 373 (title 3)
PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	NEW PERMIT AREA EDGE
	TOPSOIL
	GROUND
	WATER LEVEL AND QUARRY LEDGE
	EXPANSION AREA DISTANCES

SCALE

N

NTS

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Postmining Cross Section Map Drawn By: SC

SCALE see above Date Drawn:5-19-16

Checked BY:

PERMANENT REFERENCE POINTS

CTL 305-V
503 520706.68, 2963268.5 Nail Above Stone
504 520661.62, 2965814.83 Nail Above Stone

Millbank #3 Quarry
46365 150 St.
Millbank, SD 57252, Grant County

45.2066 N, 96.5250 W
T120N, R48W, NE 1/4 Sect. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP. PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM:
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Bonnell updated 10-22-99 for State Plane Coordinate System.
BOUNDARY
PERMIT No. 313 (Div I)
PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	RECLAIMED AREAS / PLANTED TREES
	New PERMIT Boundary
	Old PERMIT Boundary
	Area Gained by Land Exchange ..... 0.2 Acres
	Area Lost do to land Exchange ..... 2.1 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	PERMITTED BOUNDRY ..... 70.8 Acres
	TOTAL AFFECTED AREA ..... 56.1 Acres
	SURFACE MINE LAND DISTURBED ..... 42.2 Acres
	HAUL ROADS
	BUILDINGS / STRUCTURES
	FENCING
	Topsoil Removal Area
	Topsoil storage
	Grout Piles
	Trench Disposal

SCALE

0 500 1000 Feet

N

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

MAP - GROUT PILE Drawn By: SC

SCALE see above Date Drawn:5-22-16

Checked BY:

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

DEPARTMENT OF GAME, FISH, AND PARKS
Division of Wildlife – Regional Office
4130 Adventure Trail
Rapid City, South Dakota 57702-0303

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

January 22, 2016

Dakota Granite
Attn. Jason Redmond
48391 150th Street
PO Box 1351
Milbank, SD 57252

Coldspring
Attn. Steven R. Chouanard
17482 Granite West Road
Cold Spring, MN 56320-4578

Subject: Dakota Granit, Cold Spring Granite Mine Permit Applications

Gentlemen:

This letter is in response to your requests for information on fulfilling both large and small scale permit application requirements for wildlife surveys: SDCL 45-6B-54(8). Your permit application submittals result from Cold Spring Granite and Dakota Granite exchanges of previously permitted parcels in Grant County. Both parcels have GFP preliminary wildlife survey data from initial permits efforts. GFP review of that data indicates existing surveys are still pertinent for the new permitting effort.
Mine permitting also requires description of critical resource as found in SDCL 45-6B-92(1). This section of your permit application may need updating. Since the initial permitting effort, the United States Fish and Wildlife Service has listed the Dakota skippers (Hesperia dacotae) and Poweshiek skipperling (Oarisma poweshiek) as threatened under the Endangered Species Act of 1973. Additionally, the Fish and Wildlife Service has designated about 19,900 acres of critical habitat in Minnesota, North Dakota and South Dakota. Species occurrence data is not available for your specific project area but potential habitat exists in native prairie in Grant County. Please make this addition to your company's permit applications. Please be free to contact me with any wildlife related questions regarding your mining operations.
Thank you and good luck.

Sincerely,

Stan Michals
Energy and Minerals Coordinator

Cc: E. Holm (SD/DENR)

Office (605) 394-2589 E-mail stan.michals@state.sd.us

South Dakota
Department of
Game, Fish and Parks

Division of Parks & Recreation

August 21, 1989

Mr. Don Sieger
Cold Spring Grnaite Company
202 South Third Avenue
Cold Spring, MN 56320

Dear Don:

The following information covers the requirements of wildlife habitat as the post-mining land use for your three granite quarry sites near Milbank, SD. These quarries are locatied more specifically as follows:

Carnelian No. 1 located on a portion of the North 1/2 of Section 17, T120N, R47W and the SW 1/4 of Section 8, T120N, R47W.

Carnelian No. 2 located on a portion of the South 1/2 of Section 7, T120N, R47W.

Carnelian No. 3 located on a portion of the North 1/2 of Section 13, T120N, R48W.

The wildlife species present on these lands and surrounding lands include whitetail deer, pheasant, partidge, cottontail rabbit, jack rabbit, red fox, raccoon, mink, and a variety of birds including robins, blue jays, blackbirds, crows, and swallows.

The Company plan to create a habitat suitable for the species noted above is realistic. Since the overall land area is relatively small, these species will naturally populate the affected areas without a stocking program.

Cold Spring Granite Company's plan to vegetate the disturbed land area with a mixture of alfalfa, wheat grass and sweet clover is acceptable. Trees of red pine, black locust, and popple shall be planted on a 10' X 10' staggered spacing. Local shrubs and forbs will invade the lands from the surrounding area and establish a natural density.

The vegetation plan noted above shall be applied to all nearly horizontal land areas that have been disturbed excluding the sides of the grout piles. These sides may be left as broken granite rock without soil, sand, or gravel on them. The size fraction of the final surface should be made of blocks ranging in size from 1 to 3 feet.

I see no endangerment of these species of wildlife by a quarry operation, nor do I see any problem in the future with a quarry type of operation.

Sincerely,

Arlo A. Haase

Arlo A. Haase
Wildlife Conservation Officer
Department of Game, Fish & Parks
PO Box 404
Milbank, SD 57252

SOUTH Dakota

Department of Game, Fish and Parks

Division of Game and Fish

December 14, 1982

Mr. Cy Zierden
Delano Granite Inc.
Big Stone City, S. Dak.

Dear Mr. Zierden:

I have recieved your request for a wildlife statement for the renewal of, and conversion of, your mining permit No. 27. The location being in E½ of SW¼, Sec. 7, Township 120, Range 47 W Grant County, South Dakota.

Wildlife species present include Whitetail deer, pheasant, partridge, cottontail and jack rabbit, red fox and raccoon.

I see no endangerment of these species of wildlife by your present operation, nor do I see any problem in the furure with a quarry type operation.

Sincerely,

Arlo A. Haase

Arlo A. Haase
Wildlife Conservation Officer
Milbank, S. Dak. 57252

SOUTH DAKOTA

SOUTH DAKOTA STATE HISTORICAL SOCIETY
State Archaeological Research Center

August 10, 1990

Mr. Eric Holm
Office of Minerals and Mining, DWNR
Joe Foss Building
Pierre, SD 57501-3181

Dear Mr. Holm,

This letter is in relation to the special, exceptional, critical or unique land determination for the conversion of Field Granite's small scale mining permit to a large scale permit in the E1/2 SW1/4 Section 7, T120N, R47W Grant County. My March 12th, 1990 letter to Mr. Gary Zitzlsperger of Field Granite indicated that the permit expansion should be permitted unless prehistoric or historic features or artifacts were encountered. Cultural resource surveys have been conducted on adjacent and adjoining pieces of property within the same topographic setting without identifying any cultural resources. Therefore it seems quite unlikely that any cultural resources would be found on the property under consideration. However there is a possibility that buried materials might be uncovered if any ground disturbing activities were to take place. The standard cultural resource survey is only concerned with surface exposures, so it seemed unreasonable to require a survey in an area of low potential. But it also seemed prudent to add the requirement if any materials were encountered after quarrying had begun. Therefore the standard disclaimer was inserted in the permit approval from this office.

Considering that cultural resource surveys have been conducted in the near vicinity and that the results of such surveys were negative I have no problems with the conversion from a small scale to large scale mining permit for Field Granite within the defined boundaries of the permit.

If you have any questions or would like additional information, please call me.

Sincerely,

Kerry Lippincott, PhD

P.O. Box 5005 2425 East St. Charles Street Rapid City, SD 57709-5005
Department of Education and Cultural Affairs - Office of History

Appendix

DEPARTMENT OF GAME, FISH, AND PARKS
Division of Wildlife – Regional Office
4130 Adventure Trail
Rapid City, South Dakota 57702-0303

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

May 20, 2016

Coldspring
Attn. Steven Chouanard
17482 Granite West Road
Cold Spring, MN 56320-4578

RE: ARSD 74:29:07:06. Revegetation

Dear Steve,

This is in response to your request for agency approval of both the reclamation seed mixture and tree species for the quarry expansion permit. South Dakota Department of Game Fish, and Parks finds the previously approved native grass seeding mixture and tree species appropriate to achieve the post mine land use at the mine expansion area. Please contact me with any reclaimation mixture or tree species change that may result from contact with the local Natural Resources Conservation Service. Also,contact me with your questions or concerns at any of the numbers listed below.
Good luck.

Sincerely

Stan Michals

Energy and Minerals Coordinator
SD/Game, Fish and Parks
Office (605)394-2589
Fax (605)394-1793
Stan.Michals@state.sd.us

CC: E. Holm SD/DENR

United States Department of Agriculture

NRCS

Natural Resources Conservation Service
1102 S DAKOTA ST
MILBANK SD 57252-2707

Phone: (605) 432-6570 Ext. 3

June 17, 2016

Coldspring
Attn: Steven Chouanard
17482 Granite West Road
Cold Spring, MN 56320

Re: Seed plan

Mr. Chouanard,

I looked at the seed plan. I can let you know the seed plan will work, however it would not meet NRCS standards.

When it comes to the tree plan I strongly suggest you use another tree besides green ash since the green ash borer could be an issue in the future. Another thing is I suggest that you use 14 foot spacing instead of the 20 foot.

If you have, any questions call me at the above telephone number.

Sincerely,

Dale J. Thiel
Soil Conservationist
Grant County NRCS

To whom it may concern:

Cold Spring Granite has been and continues to be in compliance with Grant County Weed Department mandated weed control practices.

Cold Spring Granite makes use of Chemical, Mechanical and Bio-Control methods as the need dictates.

In ongoing cooperation Cold Spring Granite consults with Grant County Weed Department when questions or concerns arise.

If you are in need of additional information contact:

Grant County Weed Department

210 E. 5th Ave.

Milbank,SD 57252

Ph.# 605-432-1489

Nathan Mueller Grant County Weed Supervisor

South Dakota Department of Environmental and Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Attn: Eric Holm
Natural Resources Engineer III
Mineral and Mining Program

Dear Eric:

Cold Spring Granite Company has applied for a Large Scale Mining Permit to operate dimension stone quarries east of Milbank. A copy of this application has been placed in the Grant County, South Dakota, courthouse for Public review.

Sincerely,

_____

DAKOTA GRANITE

48391 150th Street • PO Box 1351 • Milbank, SD 57252
Phone 605-432-5580 • 800-843-3333 • Fax 605-432-6155 • 800-338-5346
dakota@dakgran.com • www.dakotagranite.com

To Whom It May Concern,

I received the large permit application from Cold Springs Granite on June 20, 2016. All information and maps were included in the application. If you have any questions about the application please contact me at 605-432-5580.

Sincerely,

Jason Redmond

Jason Redmond
48391 150th St.
Milbank, SD 57252

VEGETATION SURVEY REPORT

FOR

DELANO GRANITE INC. (North)

Cy Zierden

Assisted by:

Odell Greene
District Conservationist
Soil Conservation Service
Milbank, South Dakota

In Cooperation With:

Grant County Conservation District

January 3, 1983

USDA-SCS

CONSERVATION PLAN MAP

SD-CPA-31B
11-80
File Code CPA-

Owner Delano Granite Inc. Operator Same

County Grant State South Dakota Date 1-3-83

Approximate acres 26 Approximate scale 8" = 1 mile

Cooperating with Grant County Conservation District

N

Plan identification Photo number 179-5R

Assisted by Odell Greene USDA Soil Conservation Service

USDA-SCS

SD-CPA-1
12/81

SYMBOLS ON CONSERVATION PLAN MAP FOR INTERPRETING FEATURES ON YOUR LAND

SPECIAL SYMBOLS

Farm, ranch, or other operations boundary - - - - - - - -

Ownership boundary - - - - - - - - - -

Field or land use boundary - - - - - -

Land capability, range, or woodland site boundary - - - - - - -

Range condition boundary - - - - - - - - - - - -

Range condition - - - - - - - - - - - - EC, GC, FC, PC
(Excellent, Good, Fair, Poor)

Public road - - - - - - - - - - - - -

Private road - - - - - - - - - - - - -

Field number - - - - - - - - - - - - - (2)

Field acreage - - - - - - - - - - - - - 320 A.

Inclusion tie - - - - - - - - - - - - -

Special purpose plantings (label) - - - - - - WILDLIFE

CONSERVATION PRACTICE SYMBOLS

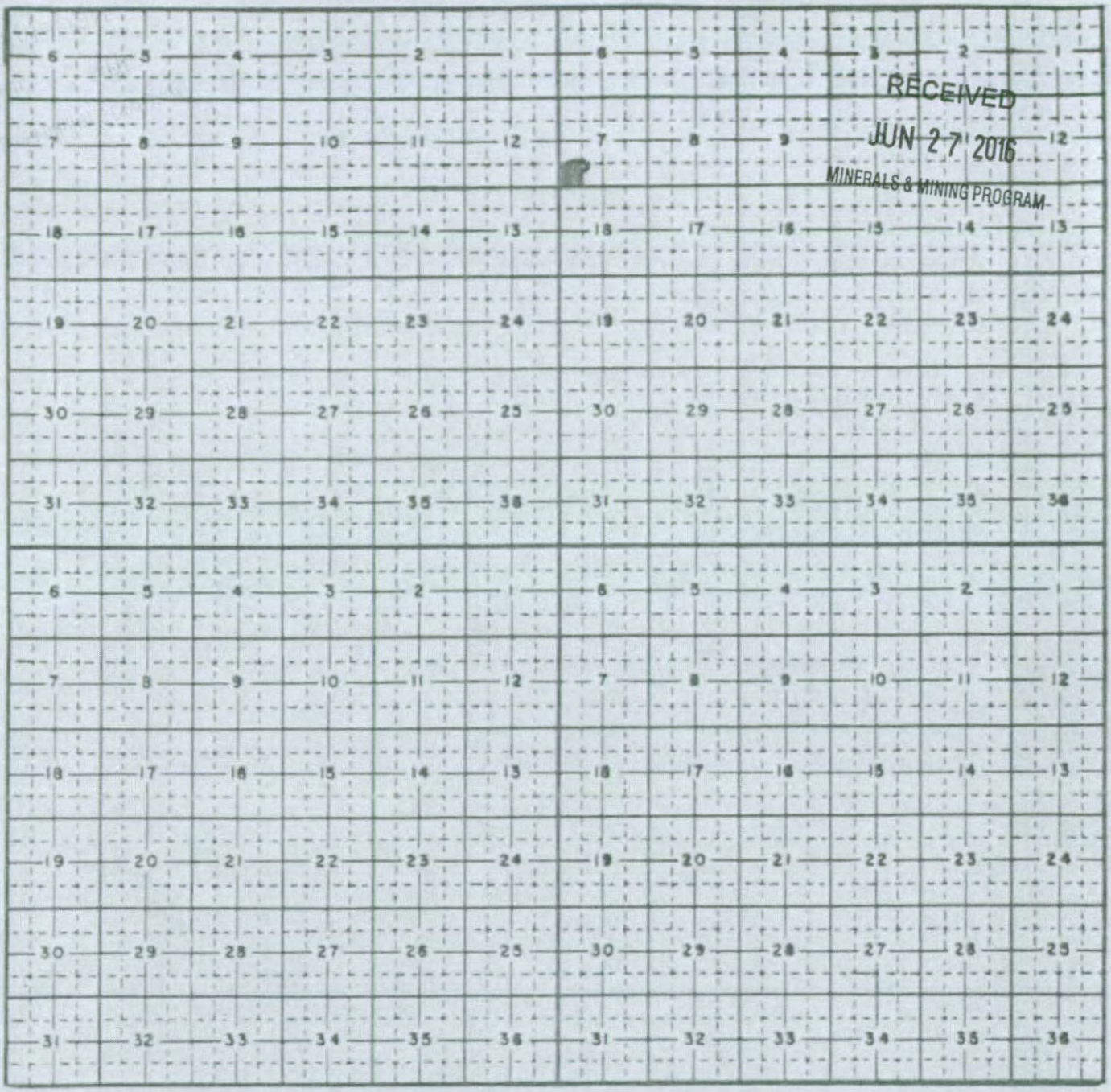
	PLANNED	APPLIED
Fence		
Shelterbelt		
Stream bank protection		
Dike or levee		
Pipeline		
Flume or syphon		
Canal (label)	CANAL CANAL	CANAL CANAL
Irrigation ditch		
Diversion		
Drainage or open drain		
Closed or tile drain		
Terrace		
Vegetative waterway		
Division box or turnout		
Add other symbols		

	PLANNED	APPLIED
Diversion or spreader dam		
Check dam or gully plug		
Drop structure		
Dam and reservoir		
Dugout		
Stock pond		
Spring development		
Spring and trough		
Trough		
Well (label)	WELL	WELL
Windmill		
Windmill and trough		
Water tank (label)	WATER TANK	WATER TANK
Pump		

Delano Granite Inc

SD-CONS-2
10/69

TWP _____ RGE _____ TWP 12 S RGE 47 W



TWP _____ RGE _____ TWP _____ RGE _____

FENCE

RESERVOIR

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-CONS-5
10-75
FILE CODE CONS-14-5

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

INVENTORY & EVALUATION
OF LAND, WATER, AND RELATED RESOURCES

REQUESTED BY Delano Granite Inc. LOCATION SW¼ SW¼ 7, 120 - 47

ASSISTED BY Odell Greene DATE 1-3-83

* ☒ INDIVIDUAL ☐ GROUP ☐ UNIT OF GOVERNMENT

SITUATION: Delano Granite Inc. requested a Vegetation and Seeding Survey for the purpose of renewing their present mining permit, located in SW corner of section 7, T 120N - R 47W in Grant County, South Dakota.

SUGGESTED SOLUTION(S) The site was visited by Odell Greene of the Soil Conservation Service, Milbank, South Dakota. The site is presently being mined for granite. Around the site are granite piles, a drainage ditch and other mining byproducts. There are also grasses such as brome grass and little blue grass. Trees of green ash, cottonwood and elm are scattered over different parts of the area.

Recomendation for seeding: see SD CPA 4

* *Check appropriate category*

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

SD-CPA-4
Rev 8/82

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

SEEDING PLAN AND RECORD

Cooperator Delano Granite Inc. Cons. District Grant County

Program _____ Practice No. _____ Practice Name: Tame Grass seeding

CI or Referral No. _____ Seeded by: Operator

	PLANNED	APPLIED
Field No. (s) or Section-T&R	1	
1 - Seedbed Preparation	Full	
2 - Seeding Equipment	Special Drill	
3 - Acres	26	
4 - Date Planted	Spring	
5 - Range Site or Pasture Group	Reclaim mine	
6 - Protection Provided	Defer	

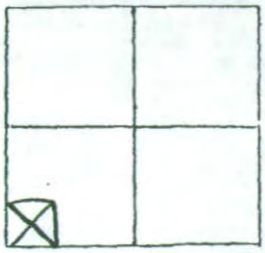
PLANNED

Seed Species	a: Variety or Seed Source	b: PLS lbs/ac for Full (100%) Seeding	c: % Desired in Mixture	d: PLS lbs/ac Needed (c x d)	e: Acres to be Seeded	f: Total PLS lbs Needed (e x f)
Alfalfa	Local	6.5	50%	3.3	26	86
Brome	Local	9.5	50%	4.8	26	125

SEEDING APPLIED

Seed Species	h: Variety or Seed	i: Purity %	j: Germination %	k: Pounds Bulk Seeds Planted	l: Acres Certified	m: PLS Actual lbs Planted (i x j x l)

LOCATION MAP



N
T 120
R 47
S 7

Planning Assistance by: Odell Greene 1-3-83
(Name and Date)

Field Planting check by: _____
(Name and Date)

Recheck of Quantities by: _____
(Name and Date)

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service

SD-CPA-4
Rev 8/82

SEEDING PLAN AND RECORD

Cooperator Delano Granite Inc. Cons. District Grant County

Program _____ Practice No. _____ Practice Name: Native Grass Seeding

CI or Referral No. _____ Seeded by: Operator

	PLANNED	APPLIED
Field No. (s) or Section-T&R	1	
1 - Seedbed Preparation	Full	
2 - Seeding Equipment	Special Drill	
3 - Acres	26	
4 - Date Planted	June	
5 - Range Site or Pasture Group	Shallow	
6 - Protection Provided	Defer	

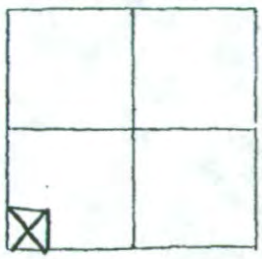
PLANNED

a Seed Species	b Variety or Seed Source	c PLS lbs/ac for Full (100%) Seeding	d % Desired in Mixture	e PLS lbs/ac Needed (c x d)	f Acres to be Seeded	g Total PLS lbs Needed (e x f)
Big Blue Stem	Local	8.0	40%	3.2	26	83
Switch Grass	Local	4.0	30%	1.2	26	31
Side Oats Grama	Local	5.0	30%	1.5	26	39

SEEDING APPLIED

h Seed Species	i Variety or Seed	j Purity %	k Germination %	l Pounds Bulk Seeds Planted	m Acres Certified	n PLS Actual lbs Planted (i x j x l)

LOCATION MAP



N
T 120
R 47
S 7

Planning Assistance by: Odell Greene 1-3-83
(Name and Date)

Field Planting check by: _____
(Name and Date)

Recheck of Quantities by: _____
(Name and Date)

POUNDS OF GRASS SEED; BULK MATERIAL REQUIRED
TO YIELD ONE POUND OF PURE LIVE SEED

% Purity	Percent Germination														
	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25
100	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.7	1.8	2.0	2.2	2.5	2.9	3.3	4.0
95	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.8	1.9	2.1	2.3	2.6	3.0	3.5	4.2
90	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.5	2.8	3.2	3.7	4.5
85	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	1.3	2.6	3.0	3.4	3.9	4.7
80	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.3	2.5	2.8	3.2	3.6	4.2	5.0
75	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.7	3.0	3.3	3.9	4.5	5.3
70	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.6	2.9	3.2	3.7	4.2	4.8	5.7
65	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.6	2.8	3.1	3.4	3.9	4.4	5.1	6.2
60	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.0	3.3	3.7	4.2	4.8	5.5	6.6
55	1.9	2.0	2.1	2.3	2.4	2.6	2.8	3.0	3.3	3.6	4.1	4.6	5.2	6.1	7.3
50	2.1	2.2	2.3	2.5	2.7	2.9	3.1	3.3	3.6	4.0	4.5	5.0	5.7	6.7	8.0
45	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.7	4.1	4.5	5.0	5.6	6.4	7.4	8.9
40	2.6	2.8	3.0	3.2	3.3	3.7	3.9	4.2	4.6	5.0	5.6	6.3	7.2	8.3	10.0
35	3.0	3.2	3.4	3.6	3.9	4.2	4.4	4.8	5.2	5.7	6.4	7.2	8.2	9.5	11.4
30	3.5	3.7	3.9	4.2	4.5	4.8	5.1	5.5	6.1	6.7	7.4	8.3	9.5	11.1	13.3
25	4.2	4.5	4.7	5.0	5.3	5.7	6.2	6.6	7.3	8.0	8.9	10.0	11.4	13.3	16.0
20	5.3	5.6	5.9	6.3	6.7	7.1	7.7	8.3	9.1	10.0	11.1	12.5	14.3	16.7	20.0

GENERAL SEEDING RECOMMENDATIONS AND CONDITIONS:

SEEDBED PREPARATION - Seedbed should be disked or field cultivated to a depth of approximately 3 inches to reduce grass and weed competition. Harrow or cultipack to firm up seedbed before seeding. The seedbed shall be firm and free, or very nearly free, of all competing vegetation and is not subject to erosion.

SEEDING - Seed should be placed approximately 1/2" deep with good seed to soil contact. The best method of seeding is with a drill that can control seeding depth and has press pack after seeding. Seeding rates for broadcast seeding should be increased by 30-50% over normal rates.

PROTECTION PROVIDED (Code to other side)

Erosion(E): Only if erosion is a problem, seed into the dead mulch cover from a previously seeded protective crop. No companion crop should be seeded. All critical area seedings should be properly mulched after seeding, especially the 4:1 or steeper slopes.

Weed Control (WC): Weeds, volunteer crops and companion crops where permitted will be mowed before they begin to produce seed heads, or begin to compete for moisture, before July 1. This may mean several mowings. REMOVE WINDBREAKS OR THICK LAYERS OF WEEDS FROM THE SEEDING. If spraying is necessary, consult County Extension Agent for specific information regarding kind of herbicide and proper use. Observe precautionary measures.

Deferment(D): Those plantings designed for grazing will be deferred from grazing one full growing season following planting for tame grasses and will be continuously protected to the end of the second growing season for native grasses. Following the period of specified protection the grazing of thin or partial stands may require special judgement and management to obtain full stands.

* *

NOTE: A heel imprint 1/2 inch deep or less indicates a firm seedbed.

South Dakota
Department of Game, Fish and Parks

Division of Wildlife
Sigurd Anderson Building
445 East Capitol
Pierre, South Dakota 57501-3185
(605) 773-3384

January 26, 1983

Mr. W. H. Harris
Office of Minerals and Mining
Water and Natural Resources
Joe Foss Building
Pierre, SD 57501

Dear Mr. Harris:

The Department of Game, Fish and Parks does not object to the following mining reclamation plans:

Harlan Opperman, E. 50 acres of SW¼ of Section 15, Township 97 North, Range 72 West Gregory County

W. E. Bartholow and Sons Construction Company, SE¼ of Section 10, Township 108 North, Range 63 West Jerauld County

Harold L. Boyle, E½NW¼ of Section 7, Township 7 North, Range 5 East Meade County

Dakota Granite Company, NE¼, NE¼ Section 13, Township 120 North, Range 48 West Grant County

Dakota Granite Company, NW¼SW¼ of Section 18, Township 120 North, Range 47 West Grant County

Dakota Granite Company, NW¼,NE¼ of Section 17, Township 120 North, Range 47 West Grant County

#21 Delano Granite, Inc. E½, SW¼ Section 7, Township 120 North, Range 47 West Grant County

Delano Granite, Inc. S½NE¼ and NE¼NE¼ and Outlots 1 and 2 of Section 13, Township 120 North, Range 48 West less Outlots A, B, C, D, E, F, G, 3, 4, and 5 and 12.15 acre plot, Grant County

POUNDS OF GRASS SEED; BULK MATERIAL REQUIRED
TO YIELD ONE POUND OF PURE LIVE SEED

% Purity	Percent Germination 95	90	85	80	75	70	65	60	55	50	45	40	35	30	25
100	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.7	1.8	2.0	2.2	2.5	2.9	3.3	4.0
95	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.8	1.9	2.1	2.3	2.6	3.0	3.5	4.2
90	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.5	2.8	3.2	3.7	4.5
85	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.1	1.3	2.6	3.0	3.4	3.9	4.7
80	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.3	2.5	2.8	3.2	3.6	4.2	5.0
75	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.7	3.0	3.3	3.9	4.5	5.3
70	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.6	2.9	3.2	3.7	4.2	4.8	5.7
65	1.6	1.7	1.8	1.9	2.1	2.2	2.4	2.6	2.8	3.1	3.4	3.9	4.4	5.1	6.2
60	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.0	3.3	3.7	4.2	4.8	5.5	6.6
55	1.9	2.0	2.1	2.3	2.4	2.6	2.8	3.0	3.3	3.6	4.1	4.6	5.2	6.1	7.3
50	2.1	2.2	2.3	2.5	2.7	2.9	3.1	3.3	3.6	4.0	4.5	5.0	5.7	6.7	8.0
45	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.7	4.1	4.5	5.0	5.6	6.4	7.4	8.9
40	2.6	2.8	3.0	3.2	3.3	3.7	3.9	4.2	4.6	5.0	5.6	6.3	7.2	8.3	10.0
35	3.0	3.2	3.4	3.6	3.9	4.2	4.4	4.8	5.2	5.7	6.4	7.2	8.2	9.5	11.4
30	3.5	3.7	3.9	4.2	4.5	4.8	5.1	5.5	6.1	6.7	7.4	8.3	9.5	11.1	13.3
25	4.2	4.5	4.7	5.0	5.3	5.7	6.2	6.6	7.3	8.0	8.9	10.0	11.4	13.3	16.0
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* *

NOTE: A heel imprint 1/2 inch deep or less indicates a firm seedbed.

Albert Swenson, NE¼NW¼ of Section 16, Township 109 North, Range 51 West Brookings County

South Dakota Division of Highways as follows:

North 1,000 feet NE¼ of Section 1, Township 127 North, Range 78 West Campbell County

E½, SW¼ of Section 20, Township 119 North, Range 67 West Faulk County

N½, NW¼ of Section 8, Township 119 North, Range 49 West Grant County

NW¼,NW¼ of Section 1, Township 121 North, Range 77 West Walworth County

NE¼ of Section 32, Township 123 North, Range 78 West Walworth County

SE¼NE¼ and NE¼, SE¼ of Section 25, Township 15 North, Range 19 East Ziebach County

Ervin E. Schimkat, NE¼,SE¼ of Section 20, Township 100 North, Range 53 West Turner County

Butte County Highway Department, N½SW¼ of Section 8, Township 8 North, Range 4 East Butte County

Sincerely,

David McGuigan
Habitat Staff Specialist

DM/sh

SOUTH Dakota
Department of Agriculture

DIVISION OF CONSERVATION
Anderson Building, Room 322 • Pierre, South Dakota 57501
Phone 605/773-3258

February 10, 1983

Wm. H. Harris
Exploration and Mining Program
Dept. of Water & Natural Resources
Foss Building

Dear Bill:

We have reviewed the following applications for a permit to mine:

1) S.D. Div. of Highways, SE¼ NE¼ and NE¼ SE¼ 25,T15N-R19E, Ziebach County
2) S.D. Div. of Highways, NE¼ 32-T123N-R78W, Walworth County
3) S.D. Div. of Highways, NE¼ NW¼ 1-T121N-R77W, Walworth County
4) S.D. Div. of Highways, N½ NW¼ 8-T119N-R49W, Grant County
5) S.D. Div. of Highways, E½ SW¼ 20-T119N-R67W, Faulk County
6) S.D. Div. of Highways, N1000' NE¼ 1-T127N-R78W, Campbell County
7) Albert Swenson, NE¼ NW¼ 16-T109N-R51W, Brookings County
8) Delano Granite, Inc.,S½ NE¼ & NE¼ NE¼ 13-T120N-R48W, Grant County
9) Delano Granite, Inc.,E½ SW¼ 7-T120W-R47W, Grant County
10)Harlan Opperman, E 50ac. SW¼ 15-T97N-R72W, Gregory County
11)Harold L. Boyle, E½ NW¼ 7-T-7N-R5E, Meade County
12)W.E. Bartholow & Son, SE¼ 10-T108N-R63W, Jerauld County
13)Dakota Granite Co., NW¼ NE¼ 17-T120N-R47W, Grant County
14)Dakota Granite Co., NW¼ SW¼ 18-T120N-R47W, Grant County
15)Dakota Granite Co., NE¼ NE¼ 13-T120N-R48W, Grant County

We note that applications no. 5 and 6 contain seeding recommendations from the conservation districts, but we did not see operator statements that the areas will be reseeded. We also note that no. 11, 12, 13, 14, and 15 had no input from the local districts at the time of mailing (January 19).

Thanks for the opportunity to review.

Sincerely,

Keith L Harner

Keith L. Harner
DIVISION OF CONSERVATION

KLH/ah

FIELD GRANITE INTERNATIONAL

SOIL SURVEY

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

SD--CONS-31A
5/75

SOIL MAP

Owner Delano Granite Inc. Operator SAME

County Grant State South Dakota

Soil survey sheet(s) or code No.(s) #25 Approximate scale 3.2=1Mi.

N

Prepared by U.S. Department of Agriculture, Soil Conservation Service cooperating with Grant County Conservation District

INTERPRETIVE GROUPING	LAND USES AND SOILS INFORMATION ON YOUR OPERATING UNIT
Soils Pf	Gravel pit - This map unit consists of open excavations, 5 to 30 feet deep, from which overburden sand and gravel have been removed. The areas of this unit are irregular in shape and range from 2 to 50 acres in size. Slopes are uneven and broken; they range from nearly level at the bottom of the pit to nearly vertical at the rim. In some pits, the bottom is covered with water. The bottom of pits typically is sand and gravel, but in some pits the sand and gravel have been removed and granite rock is exposed. Mounds of overburden consisting of loamy soil material are on the edge of the pits. The bottom and sides of the pits support little or no vegetation. Annual weeds grow on the mounds of overburden.

* *

SOUTH DAKOTA

STATE GEOLOGICAL SURVEY

E. P. Rothrock, State Geologist

REPORT OF INVESTIGATIONS

No. 20

THE GEOLOGY

OF

GRANT COUNTY, SOUTH DAKOTA

By

E. P. Rothrock

University of South Dakota
Vermillion, S. Dak.

June 1934

Reprint January 1952

* *

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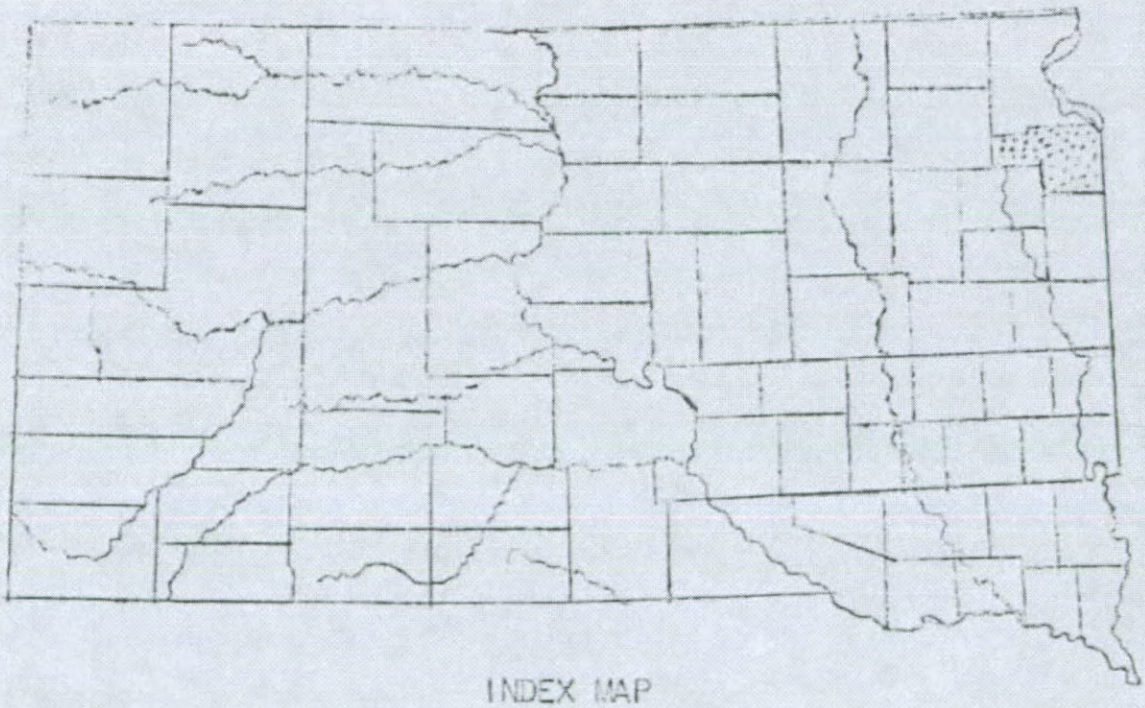
TABLE OF CONTENTS, CONTINUED

THE GEOLOGY OF GRANT COUNTY,

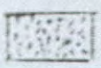
SOUTH DAKOTA

By

E. P. Rothrock



INDEX MAP

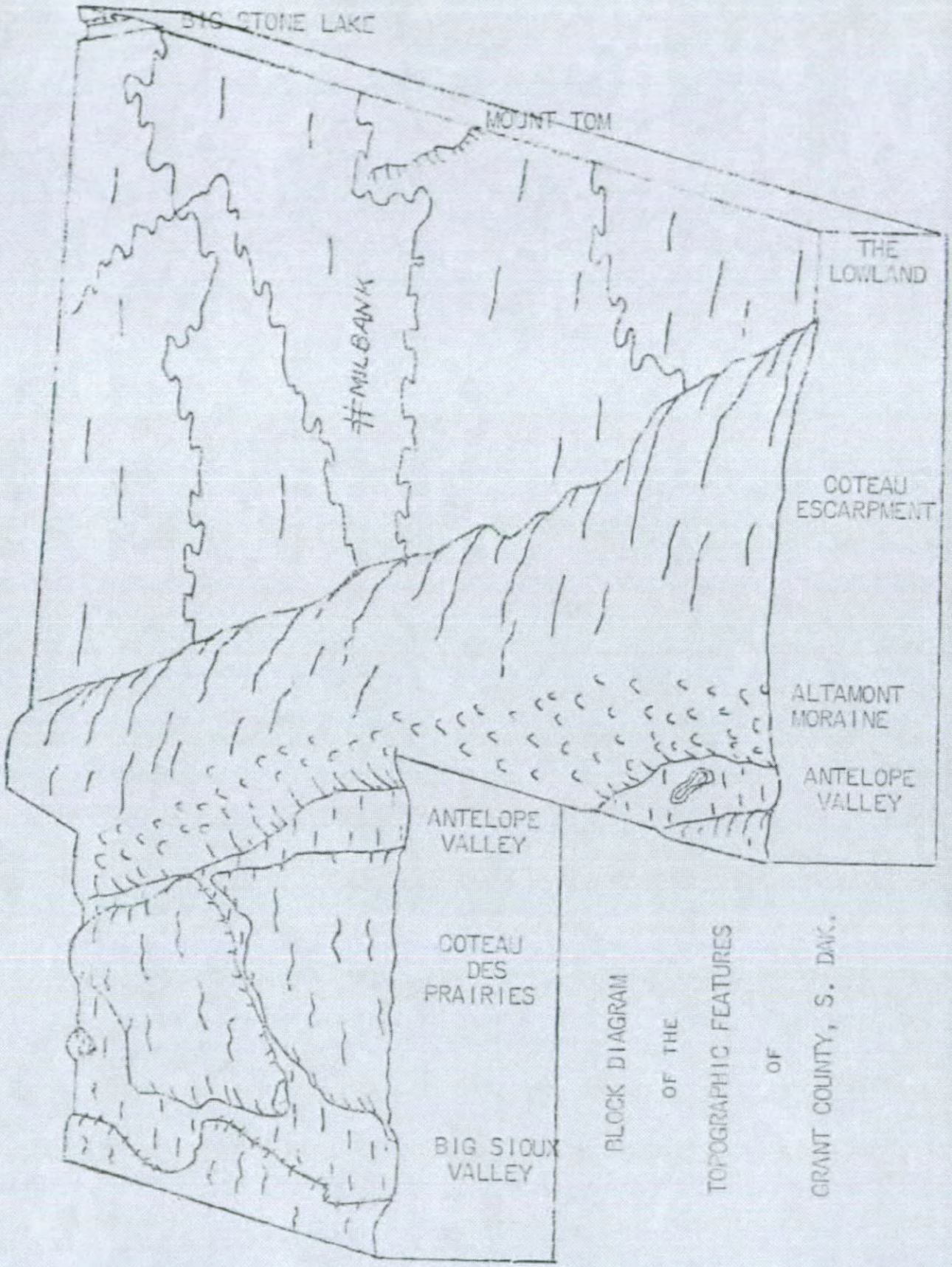
 Shaded area indicates location of Grant County.

I. LOCATION AND AREA

GRANT COUNTY OCCUPIES ABOUT 689 SQUARE MILES IN THE NORTHEASTERN CORNER OF SOUTH DAKOTA AT THE FOOT OF LAKE BIG STONE WHICH TOUCHES ITS NORTHEASTERN CORNER. ITS EASTERN BOUNDARY IS THE EASTERN BOUNDARY OF THE STATE AND THE OTHER THREE ARE ARBITRARILY SURVEYED LINES LAID OUT TO CORRESPOND WITH THE TOWNSHIP AND SECTION LINES OF THE LAND SURVEY.

ITS SHAPE IS VERY IRREGULAR COMPARED TO THAT OF ITS NEIGHBORS TO THE SOUTH AND WEST WHICH ARE MATHEMATICAL RECTANGLES RIGIDLY LAID OUT. GRANT COUNTY ALSO MIGHT HAVE ASSUMED A RECTANGULAR SHAPE HAD NOT THE NORTHEASTERN CORNER OF CODINGTON COUNTY SHOULDERED INTO ITS TERRITORY ON THE SOUTHWEST, LEAVING A NARROW STRIP AND REMOVING THE SIX TOWNSHIPS NECESSARY TO COMPLETE A RECTANGLE. THUS, GRANT COUNTY IS THE ONLY ONE IN SOUTH DAKOTA WHICH CAN BOAST OF A PANHANDLE. THIS PANHANDLE, TEN MILES IN WIDTH, PROJECTS FROM THE WESTERN SIDE OF THE MAIN BODY OF THE COUNTY FOR A DISTANCE OF SEVENTEEN MILES. THE MAIN BODY OF THE COUNTY, HOWEVER, IS NEARLY SQUARE, TWENTY-ONE MILES FROM EAST TO WEST AND TWENTY-FOUR MILES FROM NORTH TO SOUTH. THESE DIMENSIONS GIVE THE COUNTY THE SHAPE OF A STEW PAN WITH A SHORT STUBBY HANDLE, AND ILLUSION HEIGHTENED BY THE OFFSET OF THE NORTHERN BOUNDARY LINE, WHERE IT CROSSES INTO THE SISSETON INDIAN RESERVATION, NARROWING THE BACK OF THE HANDLE AND CAUSING THE RIM OF THE PAN TO PROJECT SOME THREE MILES TO THE NORTH.

WITHIN THIS COUNTY THERE IS AN INTERESTING VARIETY OF GEOLOGIC AND GEOGRAPHIC CONDITIONS, SOME OF WHICH CAN BE USED TO ADVANTAGE. AT THE REQUEST OF THE MILBANK CHAMBER OF COMMERCE, THEREFORE, THE STATE GEOLOGIST AND DR. W. V. SEARIGHT MADE A RECONNAISSANCE SURVEY OF THESE FEATURES THE RESULTS OF WHICH ARE CONTAINED IN THIS REPORT. THE FIELD WORK WAS DONE DURING THE MONTH OF AUGUST, 1933, AND INFORMATION WAS ADDED BY WELL DRILLERS OF THE COUNTY, MEMBERS OF THE MILBANK CHAMBER OF COMMERCE AND OTHER CITIZENS WHO FREELY GAVE MUCH THAT IS CONTAINED HEREIN. SPECIAL MENTION SHOULD BE MADE OF MESSRS. W. S. GIVEN, MARTIN MORLEY, AND MARVIN LEE, ALL OF MILBANK, WITHOUT WHOSE AID MUCH OF THE DATA WOULD OTHERWISE HAVE BEEN UNAVAILABLE.



BLOCK DIAGRAM OF THE TOPOGRAPHIC FEATURES OF GRANT COUNTY, S. DAK.

II. THE SURFACE

LIKE THE PEOPLE OF SCOTLAND, THE CITIZENS OF GRANT COUNTY MIGHT BE DIVIDED INTO TWO CLASSES. THE LOWLANDERS AND THE HIGHLANDERS, FOR THE COUNTY CAN BE DIVIDED INTO TWO VERY DISTINCT PARTS: AN EASTERN LOWLAND PLAIN WITH A SURFACE AS FLAT AS THE PROVERBIAL FLOOR, AND A WESTERN HIGHLAND WHOSE UNDULATING AND HILLY SURFACE LIES NEARLY A THOUSAND FEET ABOVE THIS PLAIN. THESE TWO SECTIONS, SO DIFFERENT IN ELEVATION AND TOPOGRAPHY, MEET AT THE BASE OF A GREAT SCARP WHICH TRENDS DIAGONALLY ACROSS THE COUNTY FROM NORTHWEST TO SOUTHEAST, DIVIDING IT INTO TWO NEARLY EQUAL PARTS.

THE LOWLAND

SURFACE:

THE MOST STRIKING CHARACTERISTIC OF THE LOWLAND IS ITS FLATNESS. HOUSES, TREES, HAYSTACKS AND TELEPHONE POLES STAND OUT PROMINENTLY ABOVE THE HORIZON AND CAN BE SEEN FOR DISTANCES OF SEVERAL MILES. HIGHWAYS STRETCH AWAY TO A VANISHING POINT IN THE FAR DISTANCE. THE SLIGHT UNDULATIONS ARE RARELY MORE THAN A FEW FEET IN HEIGHT. ALONG THIS PLAIN A FEW LOW MORAINIC RIDGES RISE ABOVE THE GENERAL SURFACE AND THE EASTERN PARTS OF THE VALLEYS OF WHETSTONE AND YELLOW BANK CREEKS AND BIG STONE VALLEY FORM THE ONLY DEPRESSIONS OF NOTE.

THE WESTERN EDGE OF THE PLAIN IS SHARPLY MARKED BY THE BASE OF THE GREAT ESCARPMENT (CALLED LOCALLY THE DAKOTA HILLS) WHICH PASSES ABOUT A MILE WEST OF REVILLO, TRENDS NORTHWESTWARD PASSING TWO MILES TO THE WEST OF TWIN BROOKS, AND CROSSES THE NORTH LINE OF THE COUNTY ABOUT FOUR MILES EAST OF THE SISSETON INDIAN RESERVATION LINE. FROM THIS LINE THE PLAIN STRETCHES EASTWARD INTO MINNESOTA AND NORTHWARD INTO ROBERTS COUNTY. IT SLOPES TO THE NORTHEAST AT THE RATE OF ABOUT FOURTEEN FEET PER MILE, A SLOPE TOO GENTLE TO BE READILY DETECTED BY THE NAKED EYE. IN FACT, IT APPEARS TO BE REVERSED WHEN TRAVELING WESTWARD DUE TO AN OPTICAL ILLUSION CAUSED BY THE GREAT ESCARPMENT OF THE DAKOTA HILLS.

ELEVATIONS FURNISHED BY THE ENGINEERING DEPARTMENTS OF THE RAILROADS, WHICH CROSS THIS COUNTY, AND COMPUTED FROM THE PROFILES FROM THE STATE HIGHWAY ENGINEER'S OFFICE BRING OUT THIS

SLOPE VERY PERCEPTIBLY. AT THE WESTERN EDGE OF THE PLAIN IN BOTH THE NORTHERN AND SOUTHERN PARTS OF THE COUNTY AN ELEVATION OF 1300 FEET IS REACHED. THE UPLAND IN THE VICINITY OF BIG STONE LAKE HAS AN APPROXIMATE ELEVATION OF 1050 FEET OR A TOTAL DROP OF 250 FEET IN A DISTANCE OF APPROXIMATELY SIXTEEN MILES. THE FOLLOWING ELEVATIONS ARE GIVEN BY THE RAILROAD ENGINEERS AND REPRESENT THE ELEVATION OF THE TRACK IN FRONT OF THE STATION IN THE CITIES MENTIONED:

TWIN BROOKS	1266 FEET
REVILLO	1208 FEET
ALBEE	1180 FEET
MILBANK	1142 FEET
BIG STONE CITY	1000 FEET

THE LOWEST POINT IN THE STATE IS THE WATER LEVEL OF BIG STONE LAKE. THIS LAKE LIES IN A DEEP TROUGH CUT IN NEARLY A HUNDRED FEET BELOW THE SURFACE OF THE PLAIN. THE SEA LEVEL ELEVATION OF THE WATER IN NORMAL SEASONS AVERAGES 967 FEET.

DRAINAGE:

MOST OF THE PLAIN IS UNDRAINED AND SHOWS THE CHARACTERISTIC SWELLS AND SWALES OF A RECENTLY GLACIATED SURFACE. THE FEW STREAMS WHICH CROSS THE SURFACE WANDER AIMLESSLY EASTWARD AND FINALLY ENTER THE MISSISSIPPI DRAINAGE BY WAY OF THE MINNESOTA RIVER. THE CHANNELS OF MOST OF THESE STREAMS DO NOT AVERAGE TEN FEET IN DEPTH AND FROM A SHORT DISTANCE ARE USUALLY DISTINGUISHED FROM THE PLAIN ONLY BY THE LINE OF TREES WHICH FOLLOWS THE CHANNEL. THE EXCEPTIONS TO THIS RULE ARE THE LOWER PARTS OF THE WHETSTONE AND YELLOW BANK CREEKS, WHICH LIE IN DEEPLY CUT VALLEYS. MOST OF THE RAIN WHICH FALLS ON THE PLAIN IS HELD IN THE SWAMPS AND SMALL PONDS WHICH DOT THIS LOWLAND. ONLY TWO NATURAL WATER BODIES ARE LARGE ENOUGH TO BE DESIGNATED AS LAKES. THE LARGEST IS BIG STONE LAKE, THE TIP END OF WHICH BORDERS THE NORTHEASTERN CORNER OF THE PLAIN FOR TWO MILES. THE SECOND IS LAKE ALBERT, A SHALLOW GLACIAL LAKE SIX MILES EAST OF MILBANK, WHICH WAS DRY AT THE TIME OF THIS INVESTIGATION (1933). A LAKE COVERING APPROXIMATELY ONE-HALF SQUARE MILE HAS BEEN FORMED AT MILBANK BY PLACING A DAM IN THE SOUTH FORK OF WHETSTONE CREEK.

MILBANK MORAINE:

THIS NAME IS USED TO DESIGNATE FIVE SHORT, NARROW RIDGES, WHICH RISE SHARPLY OUT OF THE PLAINS TO HEIGHTS OF TWENTY TO

THIRTY FEET. MOST OF THEM AVERAGE ABOUT A QUARTER OF A MILE IN WIDTH. THE NAME MILBANK WAS USED HERE TO DISTINGUISH THESE MORAINIC RIDGES FROM THOSE THAT WILL BE DESCRIBED LATER BECAUSE THE NORTHERNMOST RIDGE LIES A MILE NORTHWEST OF THE CITY OF MILBANK. ALL THE RIDGES ARE FORMED OF BOULDER CLAY DUMPED AT THE EDGE OF AN ICE SHEET WHICH WAS HALTED TEMPORARILY ALONG THE LINE THEY NOW OCCUPY. THEY TREND IN A NORTHWEST-SOUTHEAST DIRECTION FORMING A LINE THAT IS NEARLY STRAIGHT. THE NORTHERN-MOST RIDGE AT MILBANK IS ABOUT TWO MILES LONG AND LIES IN THE POSITION JUST INDICATED, NORTHWEST OF MILBANK. THE SECOND RIDGE IS ABOUT A MILE LONG AND LIES THREE MILES SOUTH AND ONE MILE EAST OF MILBANK, WHILE THE THIRD STARTS FOUR AND A QUARTER MILES SOUTH AND ONE MILE EAST OF MILBANK AND IS NEARLY CONTINUOUS FOR FIVE MILES. THE LAST RIDGE RISES TWO MILES EAST OF ALBEE (THREE MILES SOUTH OF THE END OF THE ONE JUST MENTIONED), AND TRENDS SOUTHEASTWARD FOR NEARLY TWO MILES WHERE IT IS FINALLY LOST IN THE SURROUNDING PLAIN. THESE RIDGES ARE NOT LARGE OR CONSPICU-OUS FEATURES OF THE TOPOGRAPHY BUT SERVE TO BREAK THE UNIFORMITY OF THE PLAIN.

ANTELOPE AND BIG STONE MORAINES:

THE MOST STRIKING FEATURE OF THE ENTIRE LOWLAND IS BIG TOM, MOUNT TOM, OR THE MOUNT TOM RANGE, AS IT IS VARIOUSLY CALLED. AS SEEN FROM THE HIGHWAY, BETWEEN MILBANK AND BIG STONE, BIG TOM APPEARS TO BE A GREAT ROUND TOP MOUNTAIN RISING BOLDLY ABOVE THE SURROUNDING PLAINS. THE LACK OF ALL VEGETATION EXCEPT SHORT GRASS AND LOW BRUSH GIVES IT A BALD APPEARANCE, WHICH IS ESPECIALLY NOTICEABLE DURING THE DRYER PARTS OF THE YEAR. IN REALITY BIG TOM IS A RIDGE ENDING ABRUPTLY IN THE BALD KNOB TO WHICH THE NAME IS USUALLY APPLIED. IT LIES IN THE GREAT BEND OF THE YELLOW BANK RIVER, FOUR MILES SOUTH OF LAKE ALBERT. FROM THIS POINT IT TRENDS ABOUT THIRTY DEGREES EAST OF SOUTH, CROSSING THE STATE LINE INTO MINNESOTA IN THE NORTHEAST CORNER OF VERNON TOWNSHIP THREE MILES FROM ITS NORTHERN EXTREMITY. THE RANGE IS VERY STEEP SIDED AND IS COMPOSED LARGELY OF MEDIUM TO COARSE GRAVEL. IN GRANT COUNTY IS CONSISTS OF THREE LARGE PEAKS OR BOSSES SEPARATED BY SADDLES SIXTY-FIVE FEET DEEP. THE ENTIRE RIDGE, INCLUDING THE SADDLES, IS COVERED WITH SMALLER GRAVEL KNOLLS. ITS WIDTH IS NOT MORE THAN HALF A MILE AND THIS MAKES ITS HUNDRED OR MORE FEET OF HEIGHT APPEAR MORE CONSPICUOUS THAN IT WOULD IF THE SAME DIMENSIONS SPREAD OVER A WIDER TERRITORY.

THE SOUTHERN END OF THE RIDGE, IN LAC QUI PARLE COUNTY, MINNESOTA, IS KNOWN LOCALLY AS THE ANTELOPE HILLS AND, THEREFORE, THE NAME ANTELOPE MORAINE WAS GIVEN TO THE ENTIRE RIDGE YEARS AGO BY DR. T. C. CHAMBERLAIN.[1]

THE BIG STONE MORAINE IS THE NAME GIVEN TO SOME ROUGH TOPOGRAPHY WHICH BREAKS THE UPLANDS ABOUT HALF WAY BETWEEN BIG STONE LAKE AND THE NORTH FORK OF WHETSTONE RIVER. IT CONTINUES SOUTHEASTWARD ON THE EAST SIDE OF LAKE ALBERT TO THE MINNESOTA BOUNDARY. NORTH OF THE MAIN WHETSTONE RIVER IT IS A NARROW BELT SCARCELY HALF A MILE WIDE, COMPOSED OF HUMMOCKY TOPOGRAPHY WITH A RELIEF OF FIFTEEN TO TWENTY FEET. THIS PART OF THE MORAINE DOES NOT MAKE A CONSPICUOUS FEATURE ON THE LANDSCAPE. SOUTH OF THE WHETSTONE RIVER THE MORAINE WIDENS TO ABOUT TWO MILES AND IS CHARACTERIZED BY A HUMMOCKY SURFACE WITH A RELIEF OF FIFTEEN TO TWENTY-FIVE FEET. THE TOTAL AREA COVERED BY THIS SORT OF TOPOGRAPHY DOES NOT EXCEED EIGHT OR TEN SQUARE MILES. DR. FRANK LEVERETT INCLUDES THIS TOPOGRAPHY WITH THE BIG STONE MORAINE, WHICH HE TRACED AROUND THE SOUTHERN END OF LAKE BIG STONE FROM FARTHER EAST IN MINNESOTA.[2]

THE COTEAU DES PRAIRIES

THE HIGHLANDS IN THE WESTERN HALF OF GRANT COUNTY ARE PART OF THE DIVIDE BETWEEN THE VALLEYS OF THE JAMES AND RED RIVERS. THIS DIVIDE HAS LONG BEEN KNOWN AS THE COTEAU DES PRAIRIES. THE NAME WAS FIRST USED FOR THIS REGION BY PROFESSOR WILLIAM H. KEATING, WHO SAW THE HIGHLANDS WHILE TRAVELING WITH AN EXPLORING PARTY THROUGH MINNESOTA IN 1883.[3] THE FIRST DESCRIPTION OF THEM WAS PUBLISHED BY AN ENGLISH GEOLOGIST, G. W. FEATHERSTONHAUGH, WHO SAYS, "THE COTEAU DES PRAIRIES . . . IS A VERY BROAD RIDGE OF LAND, DIVIDING THE WATERS TRIBUTARY TO THE MISSOURI FROM THOSE WHICH DISCHARGE THEMSELVES INTO THE ST. PETERS AND INTO THE RED RIVER OF LAKE WINNEPEG".[4] DR. T. C. CHAMBERLIN DESCRIBES IT AS FOLLOWS: "THE COTEAU DES PRAIRIES ... CONSISTS OF AN A SHAPED PLATEAU, THE APEX OF WHICH LIES ABOUT FORTY MILES WEST OF LAKE TRAVERSE AND ATTAINS A MAXIMUM ELEVATION OF A LITTLE OVER 2000 FEET ABOVE SEA LEVEL. THIS PROMONTORY STANDS BOLDLY FORTH 600 TO 800 FEET ABOVE THE PLAINS WHICH SKIRT IT ON THE EAST, NORTH AND WEST. . . . THE SIOUX VALLEY LIES BETWEEN THE

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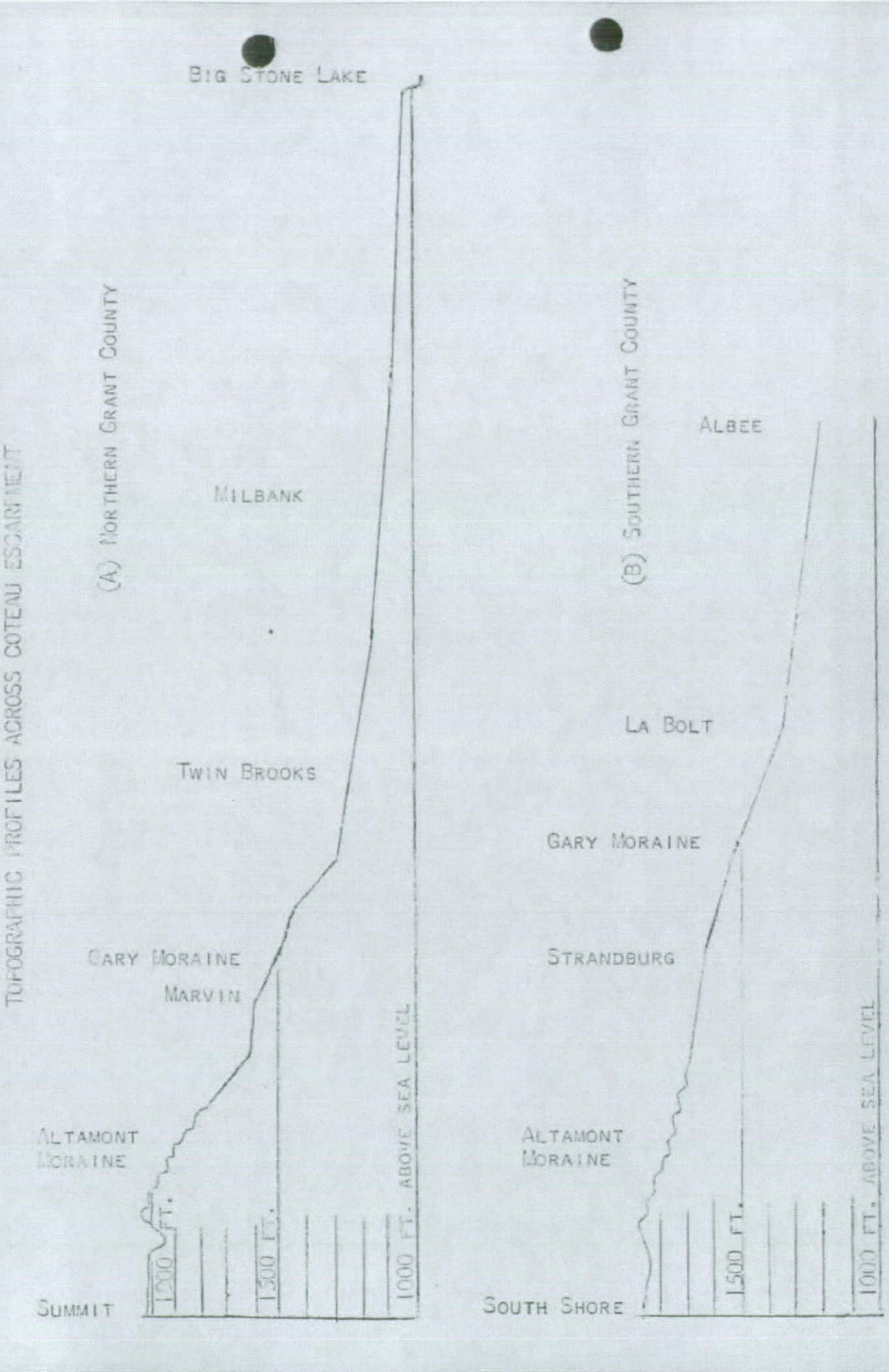
1. CHAMBERLIN, T. C., U.S. GEOLOGICAL SURVEY THIRD ANNUAL REPORT, PP. 389, 393, 1883.
2. LEVERETT, FRANK, U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 161, P. 105, 1932.
3. SEE VOL. I OF THE GEOLOGICAL SURVEY OF MINNESOTA, P. 6, 1880.
4. SEE VOL. I OF THE GEOLOGICAL SURVEY OF MINNESOTA, P. 62, 1880.


TOPOGRAPHIC PROFILES ACROSS COTEAU ESCARPMENT
(A) NORTHERN GRANT COUNTY
BIG STONE LAKE
MILBANK
TWIN BROOKS
GARY MORAINE
MARVIN
ALTAMONT MORAINE
SUMMIT
1000 FT.
1500 FT.
1000 FT. ABOVE SEA LEVEL
(B) SOUTHERN GRANT COUNTY
ALBEE
LA BOLT
GARY MORAINE
STRANDBURG
ALTAMONT MORAINE
SOUTH SHORE
1500 FT.
1000 FT. ABOVE SEA LEVEL

ARMS OF THIS TOPOGRAPHICAL A THOUGH ITS DEPRESSION IS NOT EQUAL TO THAT OF THE GREATER VALLEYS ON THE EXTERIOR."[1]

THE SURFACE OF THE COTEAU IN GRANT COUNTY LIES AT AN ELEVATION OF APPROXIMATELY 1900 FEET ABOVE SEA LEVEL, 600 FEET HIGHER THAN THE LOWLAND PLAIN. CERTAIN POINTS ON IT RISE 100 FEET ABOVE THIS AVERAGE, THE HIGHEST POINT MEASURED BEING ALONG THE HIGHWAY NEAR THE CITY OF SUMMIT WHERE AN ELEVATION OF 2008 FEET WAS RECORDED. THE HILLS THROUGH WHICH THE HIGHWAY PASSES RISE TWENTY OR THIRTY FEET HIGHER MAKING THIS SECTION OF GRANT COUNTY AS HIGH AS ANY PART IN THE STATE EAST OF THE MISSOURI RIVER. THE MEASURED DIFFERENCE IN ELEVATION BETWEEN THIS HIGH REGION AND BIG STONE LAKE IS 1041 FEET, GIVING GRANT COUNTY THE DISTINCTION OF HAVING NOT ONLY THE LOWEST POINT IN THE STATE, BUT ALSO OF HAVING THE GREATEST RELIEF OF THE PLAINS COUNTIES OF SOUTH DAKOTA.

THE FACE OF THE COTEAU IS A BOLD EAST FACING ESCARPMENT, KNOWN LOCALLY AS THE DAKOTA HILLS. AT THE NORTHERN END IT RISES FROM THE PLAIN AT THE AVERAGE RATE OF ONE HUNDRED FEET PER MILE, BUT FLATTENS OUT TO A SLOPE OF ABOUT FORTY FEET PER MILE IN THE SOUTHERN PART OF THE COUNTY. VIEWED FROM THE THE LOWLAND IT APPEARS TO BE AN ENORMOUS HILL EXTENDING BOTH NORTH AND SOUTH AS FAR AS THE EYE CAN SEE. LOOKING EASTWARD FROM ITS SUMMIT, THE LOWLAND STRETCHES AWAY FAR BENEATH INTO THE MISTY DISTANCE AS THOUGH VIEWED FROM AN AEROPLANE. THIS ESCARPMENT CAN BE FOLLOWED SOUTHWARD THROUGH DEUEL COUNTY WHERE IT LEAVES THE STATE AT GARY AND FINALLY ENDS IN COTTONWOOD AND WATONWAN COUNTIES, MINNESOTA. IT CAN BE FOLLOWED NORTHWARD THROUGH ROBERTS COUNTY AND INTO NORTH DAKOTA WHERE IT JOINS THE PEMBINA ESCARPMENT WHICH CROSSES THAT STATE. THIS ESCARPMENT, THEREFORE, IS ONLY A SMALL PART OF A TOPOGRAPHIC FEATURE WHICH IS SEVERAL HUNDRED MILES LONG. IT STARTS IN SOUTHWESTERN MINNESOTA AND ENDS IN SOUTHERN CANADA.

THE CHARACTERISTIC SURFACE OF THE COTEAU IS ROUGH, BUT THERE ARE CONSIDERABLE AREAS WHERE GENTLE SLOPES AND SMOOTH FIELDS OCCUR. PART OF THIS TOPOGRAPHY IS DUE TO STREAM EROSION AND PART TO GLACIAL DEPOSITION.

THE LOWER HALF OF THE SLOPE IS DEEPLY TRENCHED BY STREAM VALLEYS WHICH FORM THE HEADWATERS OF THE STREAMS CROSSING THE LOWLAND. A MULTITUDE OF SMALL STREAMS WHICH FINGER BACK INTO THE ESCARPMENT, FORMING FAN-LIKE PATTERNS THAT CONVERGE AT THE BASE OF THE SLOPE, MAKE THE HEADWATERS OF WHETSTONE AND THE

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1. CHAMBERLIN, T. C., U.S.G.S. 3RD ANN. REP., P. 390, 1883.

NORTH AND SOUTH FORKS OF YELLOW BANK RIVERS. MOST OF THESE VALLEYS ARE OUT TO A DEPTH OF THIRTY TO SIXTY FEET AND THEIR BLUFFS ARE SO ABRUPT THAT TRAVEL IS DIFFICULT. MANY SECTION LINE ROADS ARE NOT OPEN IN THIS PART OF THE SLOPE, AND IT IS OFTEN NECESSARY TO FOLLOW VERY ROUND ABOUT ROUTES IN ORDER TO AVOID IMPASSABLE VALLEYS.

ALTAMONT MORAINE:

ALONG THE CREST OF THIS ESCARPMENT LIES A GREAT TERMINAL MORAINE KNOWN AS THE ALTAMONT MORAINE. IT IS SIMILAR TO THE MORAINES ERRATICKED ON THE LOWLAND IN THAT IT IS A BELT OF HILLY COUNTRY, BUT ITS SURFACE IS MUCH MORE ROUGH AND IT IS MUCH LARGER. IT EXTENDS THE ENTIRE LENGTH OF THE RIDGE IN GRANT COUNTY AND VARIES FROM TWO TO FOUR MILES IN WIDTH.

THE STONY HILLS, TWENTY TO FIFTY FEET HIGH, SURROUND KETTLE-LIKE HOLLOWS, MANY OF THEM CONTAINING SWAMPS AND PONDS. BOATING LAKE AND TWIN LAKES, NEAR THE NORTHERN BOUNDARY OF THE COUNTY, ARE THE LARGEST OF THESE KETTLE LAKES. THEY CAN BE SEEN FROM U. S. HIGHWAY NO. 12, ABOUT HALF A MILE EAST OF THE WESTERN EDGE OF THE MORAINE.

ANOTHER KETTLE LAKE LARGE ENOUGH TO RECEIVE A NAME IS KNOWN AS MYERS LAKE AND LIES FIVE MILES SOUTH AND ONE MILE WEST OF MARVIN. SO ROUGH IS THE SURFACE OF THIS MORAINE THAT FEW ROADS TRAVERSE IT AND LITTLE CROP FARMING IS CARRIED ON. THIS IS BY FAR THE LARGEST MORAINIC SURFACE IN THE COUNTY, AND, IN FACT, IN THIS PART OF THE STATE.

GARY MORAINE:

ABOUT HALF WAY DOWN THE ESCARPMENT A SECOND BELT OF MORAINIC TOPOGRAPHY OCCURS. FROM MARVIN NORTHWARD IT IS VERY CONSPICUOUS AND COVERS A STRIP OF COUNTRY ONE-HALF TO ONE MILE IN WIDTH. THE KNOBS ARE NOT SO HIGH NOR THE KETTLES AS DEEP AS ARE THOSE OF THE ALTAMONT MORAINE, BUT THE HILLS ARE SUFFICIENTLY ROUGH TO MAKE IT A DIFFICULT COUNTRY IN WHICH TO TRAVEL, AND SUFFICIENTLY STONY TO PREVENT CROP FARMING ON A LARGE SCALE. SOUTHEAST OF MARVIN THE MORAINE DISAPPEARS AS A TOPOGRAPHIC BELT, BUT HERE AND THERE SMALL KNOBBY HILLS AND PATCHES OF VERY STONY MOUNDS OCCUR WHICH TRACE THE CONTINUATION OF THIS BELT INTO DEUEL COUNTY WHERE IT JOINS THE MORE CONSPICUOUS MORAINE AT GARY.

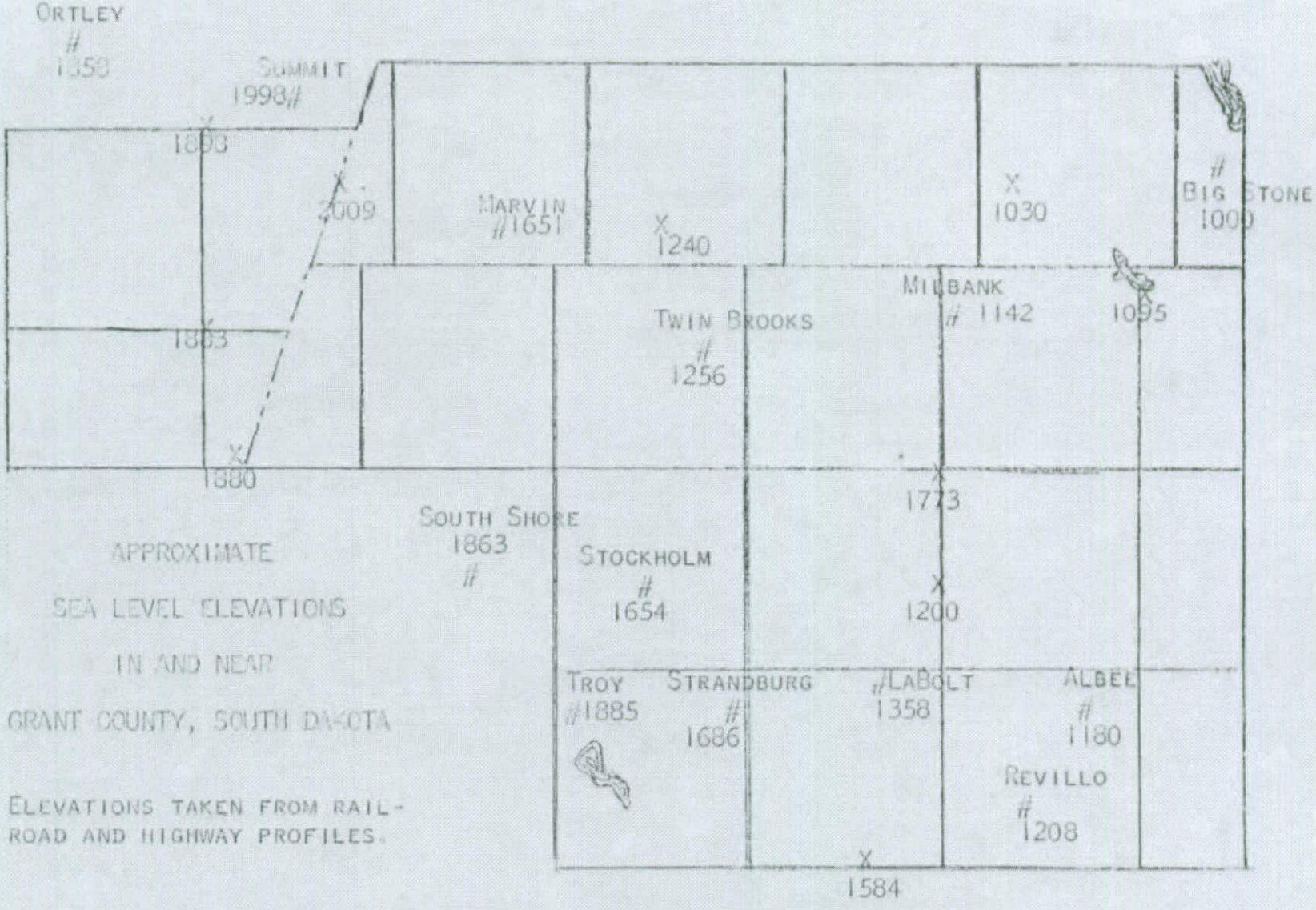
THE UPLAND:

THIS PART OF THE COTEAU OCCUPIES THE PANHANDLE OF GRANT COUNTY AND ABOUT A THIRD OF THE SOUTHWEST CORNER OF TROY TOWNSHIP IN THE SOUTHWEST CORNER OF THE COUNTY. ITS SURFACE IS THE PRODUCT OF ICE AND TORRENTS OF WATER WHICH CAN BEST BE CHARACTERIZED AS A GENTLY ROLLING TOPOGRAPHY CUT BY GREAT FLAT-BOTTOMED, GRAVEL FILLED VALLEYS. THIS CONTRASTS SHARPLY WITH THE SURFACE OF THE ESCARPMENT FOR THE ROUGH TOPOGRAPHY HAS GIVEN WAY TO LONG GENTLE SLOPES, LOW SMOOTH HILLS AND WIDE OPEN, GENTLE VALLEYS. SWAMPS AND LAKES ARE UNKNOWN EXCEPT IN GRAVEL CHANNELS. THE CHANNELS, THEREFORE, FORM THE MOST CONSPICUOUS FEATURES OF THIS UPLAND.

THE LARGEST OF THESE CHANNELS IS THE ANTELOPE VALLEY WHICH HAS BEEN TRACED FROM CLEAR LAKE, IN DEUEL COUNTY, THROUGH GRANT COUNTY TO A POINT NORTH OF SUMMIT ON THE NORTHERN BOUNDARY OF GRANT COUNTY. IT IS A GREAT OPEN VALLEY ONE TO THREE MILES WIDE, WHICH LIES IMMEDIATELY IN FRONT OF THE ALTAMONT MORAINE. IN FACT, ITS SURFACE IS DUE TO WASHING OF GRAVEL FROM GLACIAL ICE WHOSE FRONT STOOD AT THE SITE OF THE ALTAMONT MORAINE. THE VALLEY CONTAINS SEVERAL LAKES, BUT ONLY ONE LARGE ONE, CROOKED LAKE, LIES IN GRANT COUNTY. THE SOUTHERN END OF THE VALLEY IN THE VICINITY OF TROY HAS AN ELEVATION OF 1885 FEET ABOVE SEA LEVEL, WHILE THE NORTHERN END, IN THE VICINITY OF SUMMIT, HAS AN ELEVATION OF 1923 FEET.

THE ANTELOPE VALLEY HAS TWO CHANNELS LEADING FROM IT TO THE GREAT CHANNEL OF THE BIG SIOUX VALLEY; ONE AT SUMMIT, WHICH FLOWS NORTH AND WEST TO THE BIG SIOUX CHANNEL SOUTH OF ORTLEY, IN ROBERTS COUNTY, AND A SECOND WHICH HEADS WEST OF TWIN LAKES AND FLOWS DIAGONALLY ACROSS THE CENTER OF THE PANHANDLE. THE BIG SIOUX CHANNEL WAS THE MASTER DRAINAGE DURING GLACIAL TIMES AS IT IS TODAY, AND IS THE LONGEST OF THE GRAVEL CHANNELS. IN THE GRANT COUNTY PORTION OF THE COTEAU THIS CHANNEL VARIES IN WIDTH, BEING WIDEST AT THE POINT WHERE THE TRIBUTARY CHANNELS ENTER IT AND NARROW BETWEEN TRIBUTARIES. THE MAXIMUM WIDTH IS ABOUT THREE MILES AND THE MINIMUM ABOUT A HALF MILE.

THE FLOOD PLAINS AND SWAMPY LANDS OF THESE CHANNELS OCCUPY THIRTY-EIGHT SQUARE MILES OR ABOUT THIRTY PER CENT OF THE TOTAL AREA OF THE COTEAU UPLAND.



APPROXIMATE

SEA LEVEL ELEVATIONS

IN AND NEAR

GRANT COUNTY, SOUTH DAKOTA

ELEVATIONS TAKEN FROM RAIL-ROAD AND HIGHWAY PROFILES.

III. SOME GEOGRAPHICAL FACTORS

A DETAILED DESCRIPTION OF THE GEOGRAPHY OF GRANT COUNTY IS NOT WITHIN THE SCOPE OF THIS INVESTIGATION, BUT A FEW PERTINENT FACTS WHICH BEAR ON THE USABILITY OF THE REGION WILL BE MENTIONED.

Access

GRANT COUNTY HAS READY ACCESS TO ALL POINTS IN ITS IMMEDIATE NEIGHBORHOOD. THERE IS NO NATURAL BARRIER TO HIGHWAY OR RAILWAY CONSTRUCTION EITHER WITHIN THE COUNTY OR TO THOSE LEADING INTO IT FROM WITHOUT. BIG STONE LAKE LIES IN THE EXTREME NORTHEASTERN CORNER OF THE COUNTY AND, THEREFORE, DOES NOT PREVENT TRAVEL. IN FACT, IT HAS BEEN A BENEFIT IN THAT IT HAS FORCED A TRANSCONTINENTAL RAILROAD AND A NATIONAL HIGHWAY TO CROSS THE COUNTY. THE GREAT ESCARPMENT OF THE DAKOTA HILLS IS ONLY A SMALL BARRIER TO TRUCKS AND PASSENGER TRAFFIC, WHICH CROSS IT READILY ON HIGHWAYS RUNNING BOTH NORTH AND SOUTH AND EAST AND WEST. MOST OF THE RAILROAD TRAINS CROSS IT WITHOUT EXTRA POWER. SOME OF THE LONGEST TRAINS ON THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD, HOWEVER, USE TWO ENGINES BETWEEN MILBANK AND SUMMIT.

GRANT COUNTY IS A PART OF THE HINTERLAND OF MINNEAPOLIS AND ST. PAUL TO WHICH CITIES THE THREE RAILROADS SERVING THE COUNTY LEAD. THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD TRAVELS THROUGH THE NORTHERN HALF OF THE COUNTY, PASSING THROUGH SUMMIT, MARVIN, TWIN BROOKS, MILBANK AND BIG STONE CITY AND OFFERING TRANSPORTATION BETWEEN THE TWIN CITIES AND ABERDEEN.

THE SOUTHERN END OF THE COUNTY IS SERVED BY THE GREAT NORTHERN RAILROAD WITH STATIONS AT ALBEE, LA BOLT AND STOCKHOLM. IT CONNECTS THIS PART OF THE COUNTY WITH THE TWIN CITIES ON THE EAST AND WATERTOWN, SOUTH DAKOTA ON THE WEST. THE GREAT NORTHERN RAILROAD IS PARALLELED, A FEW MILES TO THE SOUTH, BY THE MINNEAPOLIS AND ST. LOUIS RAILROAD WITH STATIONS AT TROY, STRANDSBURG AND REVILLO. IT GIVES THE SAME OUTLETS AS THE GREAT NORTHERN. THE PANHANDLE IS THE ONLY PART OF THE COUNTY WHICH IS NOT CROSSED BY A RAILROAD, BUT AN EXCELLENT HIGHWAY AND WELL GRADED SIDE ROADS GIVE EXCELLENT ACCESS TO THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD AT ORTLEY AND SUMMIT TO THE NORTH, AND ALSO TO THE RAILROADS AT WATERTOWN TO THE SOUTH.

HIGHWAYS AND GOOD ROADS ABOUND, COVERING ALL PARTS OF THE COUNTY. THE ONLY EXCEPTIONS BEING THE BELT OF ROUGH COUNTRY IN THE ALTAMONT MORAINE AND SMALL AREAS IN THE LOWER HALF OF THE ESCARPMENT WHERE THE HILLS OF THE GARY MORAINE AND THE SHARPLY CUT VALLEYS MAKE NORTH-SOUTH TRAFFIC DIFFICULT.

SOILS

A DETAILED SURVEY OF THE SOILS OF GRANT COUNTY HAS BEEN MADE BY THE U. S. BUREAU OF SOILS AND ITS RESULTS ARE AVAILABLE TO THE PUBLIC. NO REPETITION OF THIS INFORMATION WILL BE ATTEMPTED HERE, EXCEPT THE GENERALIZATION THAT ALL SOILS ARE OF GLACIAL ORIGIN, AND THEREFORE OF HIGH FERTILITY. SILT, LOAM AND CLAY SOILS ARE CHARACTERISTIC. "THE UPLAND SOILS ARE CHARACTERIZED BY THREE DISTINCT LAYERS, OR HORIZONS, WHICH, FOR CONVENIENCE, ARE GIVEN THE DESIGNATIONS A, B, AND C. THESE MAJOR LAYERS MAY BE SUBDIVIDED ACCORDING TO LOCAL VARIATIONS, BUT THE THREE GENERAL DIVISIONS ARE ALWAYS PRESENT. IN CULTIVATED AREAS, THE SURFACE LAYER, KNOWN AS THE A HORIZON, IS DARK COLORED TO A DEPTH VARYING FROM TEN TO FOURTEEN INCHES. IN THE VIRGIN SOIL THIS SURFACE HORIZON HAS TWO LAYERS WHICH HAVE THE SAME COLOR, BUT DIFFER SLIGHTLY IN STRUCTURE. THE UPPER LAYER IS VERY FINELY GRANULAR, SILTY, OR SINGLE-GRAINED. THE GRANULES ARE UNIFORM IN COLOR THROUGHOUT THE LAYER, AND THE MATERIAL DOES NOT CHANGE COLOR WHEN CRUSHED. THE UPPER TWO-INCH LAYER IS USUALLY SOD. THE LOWER PORTION OF THE A HORIZON, WHICH BEGINS AT A DEPTH OF SIX OR EIGHT INCHES, IS SLIGHTLY MORE COMPACT AND CRUMBLES INTO GRANULAR MASSES, THE GRANULES BEING LARGER THAN IN THE UPPER PART.

"THE NEXT LAYER IS THE UPPER PART OF THE B HORIZON. IT IS NEARLY ALWAYS HEAVIER IN TEXTURE THAN THE HORIZON ABOVE, BEING OFTEN A HEAVY CLAY. THIS MATERIAL IS RATHER COMPACT, BUT IT BREAKS INTO ANGULAR FRAGMENTS LARGER IN SIZE THAN THE GRANULES IN THE A HORIZON. THE TRUE COLOR OF THESE PARTICLES IS BROWN, BUT THE DARK COLORED ORGANIC MATTER HAS BEEN CARRIED DOWN FROM ABOVE AND DEPOSITED OVER THEM AS A COATING. THE DARK COLOR DECREASES DOWNWARD AS THE CONTENT OF ORGANIC MATTER BECOMES LESS. THIS LAYER IS USUALLY FROM TEN TO FIFTEEN INCHES THICK.

"THE LOWER PART OF THE B HORIZON IS COLORED GRAYISH BROWN OR GRAYISH YELLOW WITH A FAINT OLIVE TINGE, AND HAS SPOTS OF LIGHT GRAY OR WHITE LIME CARBONATE SCATTERED THROUGH IT. THE

LIME MAY ALSO BE PRESENT AS SMALL CONCRETIONS, AS COATINGS ALONG THE BREAKAGE PLANES, AND AS DEPOSITS IN SMALL ROOT CHANNELS, ANIMAL BURROWS AND WORMHOLES. THE MATERIAL CONSTITUTING THE LOWER LAYER OF THE B HORIZON BREAKS UP INTO SOFT CLODS. THIS LAYER VARIES FROM EIGHT TO SIXTEEN INCHES IN THICKNESS, AND IT IS APPARENTLY A ZONE OF LIME ACCUMULATION, SINCE IT CONTAINS A HIGHER PERCENTAGE OF CARBONATE THAN THE A HORIZON AND SEEMS TO CONTAIN MORE LIME CARBONATE THAN THE HORIZON BELOW IT.

"THE DEEPER UNDERLYING LAYER, THE C HORIZON, CONSISTS OF THE PARENT MATERIAL WHICH HAS BEEN BUT LITTLE ALTERED BY WEATHERING. ITS COLOR IS GRAYISH YELLOW WITH A SLIGHT OLIVE TINGE. USUALLY LIME CARBONATE IS PRESENT UNIFORMLY THROUGHOUT THE MASS. THE MATERIAL IS USUALLY SILTY IN CHARACTER, STRUCTURELESS, AND BREAKS INTO SOFT CLODS.

"UPLAND SOILS WHICH HAVE REACHED THE STAGE OF DEVELOPMENT JUST DESCRIBED ARE SHOWN . . . AS TYPES OF THE BARNES AND MOODY SERIES."[1]

FOR MORE DETAILED INFORMATION ON GRANT COUNTY SOILS THE READER IS REFERRED TO THE PUBLICATION ON THE BUREAU OF SOILS.

CLIMATE

THE CLIMATE OF GRANT COUNTY IS BEST BROUGHT OUT BY A STUDY OF THE FOLLOWING TABLES WHICH ARE TAKEN FROM A RECORD KEPT AT MILBANK FOR THE U. S. WEATHER BUREAU. GRANT COUNTY IS A TYPICAL INLAND COUNTY AND SO SHARES WITH THE REST OF SOUTH DAKOTA AND WESTERN MINNESOTA A TYPICAL CONTINENTAL CLIMATE, CHARACTERIZED BY RAPID CHANGES AND EXTREMES. COLD WINTERS, HOT SUMMERS, CHANGES FROM A HOT OR WARM SPELL TO A COOL OR FRIGID SPELL WITHIN A DAY OR TWO ARE COMMON. THE FOLLOWING TABLES BRING OUT CERTAIN FACTS: THE AVERAGE ANNUAL TEMPERATURE SINCE 1890 HAS BEEN 42.8 DEGREES FAHRENHEIT. THE AVERAGE JANUARY TEMPERATURE HAS BEEN 11.9 DEGREES FAHRENHEIT AND THE AVERAGE TEMPERATURE DURING JULY HAS BEEN 70.8 DEGREES FAHRENHEIT. ON THE HOTTEST SUMMER DAY THE MERCURY REACHED 105 DEGREES FAHRENHEIT, AND ON THE COLDEST WINTER DAY RECORDED IT REACHED 35 DEGREES BELOW ZERO FAHRENHEIT. THE GROWING SEASON VARIES FROM 97 DAYS TO 169 DAYS, AVERAGING 138 DAYS OR APPROXIMATELY FOUR MONTHS AND A HALF.

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1. WATKINS, W. I. AND PIERRE, W. H., SOIL SURVEY OF GRANT COUNTY, SOUTH DAKOTA, U.S. DEPARTMENT OF AGRICULTURE, BUREAU OF SOILS, 1927.

THE RAINFALL IS NOT HEAVY COMPARED WITH RAINFALL IN EASTERN STATES, BUT AVERAGES 23 INCHES A YEAR WHICH IS SUFFICIENT TO GROW CROPS, ESPECIALLY SINCE MORE THAN HALF OF IT FALLS DURING THE SUMMER MONTHS. DURING DRY SEASONS, HOWEVER, THE ANNUAL PRECIPITATION HAS FALLEN TO 12.71 INCHES, BUT THIS HAS OCCURRED ONLY ONCE IN THE FORTY-FOUR YEARS THE RECORD HAS BEEN KEPT, AND FOR SIX YEARS IT HAS SHOWN AN ANNUAL PRECIPITATION OF OVER THIRTY INCHES. THE MAXIMUM OF THIRTY-FIVE INCHES FELL IN 1905.

EXTREMES, HOWEVER, ARE THE EXCEPTION AND THE NORMAL CLIMATE HAS A BRACING TEMPERATURE, NEITHER OPPRESSIVELY HOT IN SUMMER NOR SEVERELY COLD IN WINTER. MOISTURE AND TEMPERATURE ARE SO WELL BALANCED THAT CROP FAILURES ARE RARE.

PRECIPITATION, ANNUAL AND AVERAGE AMOUNTS (IN INCHES AND HUNDREDTHS)

MILBANK, GRANT COUNTY, SOUTH DAKOTA

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL
1890	0.00	0.60	1.00	0.27	1.54	10.53	0.86	1.53	1.45	1.35	0.30	0.45	19.88
1891	0.06	0.25	1.20	1.86	1.90	3.04	1.44	0.55	0.78	0.67	0.40	0.56	12.71
1892	0.07	1.41	0.52	3.99	8.09	2.91	3.80	6.33	0.13	0.27	0.55	0.73	28.80
1893	1.26	1.36	2.16	1.37	2.14	1.38	2.07	2.05	0.00	0.78	0.33	0.95	15.85
1894	0.65	T.	2.51	3.73	0.50	2.12	T.	0.76	1.70	2.28	0.10	T.	14.35
1895	0.20	0.60	0.30	2.50	1.93	3.56	2.63	0.40	1.50	0.00	1.20	0.00	14.82
1896	0.45	1.05	0.50	5.95	4.70	3.08	1.04	2.21	1.70	2.09	0.60	0.54	23.91
1897	1.10	1.30	1.40	2.15	2.05	4.60	3.92	0.63	1.68	0.82	0.25	0.15	20.05
1898	0.00	0.52	0.90	1.03	3.36	3.52	2.73	2.58	0.95	2.96	0.40	0.00	18.95
1899	0.13	0.27	0.67	1.59	3.97	4.22	2.28	7.00	0.42	1.77	0.53	0.17	23.02
1900	0.25	0.65	2.50	0.83	1.00	1.54	3.65	5.26	3.28	0.94	0.42	0.35	20.64
1901	0.30	0.30	2.27	2.28	1.03	3.73	1.59	0.99	6.68	1.37	0.40	0.55	21.49
1902	0.30	0.30	1.37	0.72	3.73	2.63	2.04	2.70	0.11	1.29	1.04	1.50	17.73
1903	0.55	0.30	1.23	1.84	4.09	2.30	7.50	3.66	5.04	2.10	0.16	0.49	29.76
1904	0.18	0.90	0.67	2.25	1.85	1.58	3.22	3.42	1.67	2.54	T.	0.82	22.10
1905	0.60	0.15	0.52	1.25	7.35	8.60	5.27	3.55	2.17	3.00	2.85	T.	35.31
1906	0.41	0.07	1.89	2.72	6.29	6.55	2.93	5.22	2.38	3.61	1.13	0.77	33.97
1907	2.50	0.70	1.15	0.73	3.83	6.06	1.76	1.63	1.58	0.91	0.14	1.01	22.00
1908	0.47	4.04	2.53	4.00	5.42	4.70	1.47	1.86	2.05	1.81	2.60	2.55	33.50
1909	0.71	1.34	0.15	0.53	4.80	1.46	2.18	3.45	1.55	2.96	0.74	2.80	22.67
1910	0.80	0.65	0.35	2.12	0.43	3.33	1.91	3.36	0.81	2.62	0.28	0.40	17.08
1911	1.42	0.45	0.37	2.12	1.52	3.84	3.18	3.08	3.19	3.70	1.28	0.65	24.08
1912	0.21	0.07	0.57	4.40	3.62	.94	5.58	3.09	1.87	0.38	0.28	0.52	22.53
1913	0.61	0.68	1.83	2.32	3.97	0.89	3.11	3.41	1.92	1.36	1.17	0.11	21.58
1914	1.32	0.41	1.37	3.01	3.20	8.24	2.39	3.87	2.45	2.13	T.	0.60	29.01
1915	0.60	1.76	3.06	4.12	5.13	5.78	3.27	1.33	2.16	2.64	0.25	0.49	30.59
1916	2.85	0.39	1.20	2.72	4.07	5.04	1.42	5.18	1.80	0.67	0.10	0.72	26.16
1917	1.64	1.25	3.09	1.81	1.16	3.06	2.09	1.70	3.78	1.56	0.16	0.69	22.19
1918	2.10	1.62	2.71	2.17	3.85	2.95	1.64	2.31	0.30	1.93	2.15	2.19	25.92
1919	0.16	1.51	0.88	3.49	2.63	7.23	2.05	0.81	1.08	1.49	2.74	0.86	24.93
1920	1.09	0.53	4.69	2.30	2.69	0.63	2.28	2.04	2.37	1.31	2.28	1.34	32.55
1921	0.22	0.20	2.65	2.21	1.21	2.64	3.30	2.48	4.80	0.44	3.89	0.26	24.30
1922	1.94	3.19	0.66	1.92	2.52	1.11	1.26	1.84	1.35	1.23	4.76	0.53	22.31
1923	2.59	1.29	1.12	2.79	2.52	2.68	1.54	1.21	2.08	0.49	0.52	0.41	19.24
1924	0.55	0.90	3.05	2.70	1.19	5.12	0.95	5.47	2.45	1.13	0.10	0.35	23.96
1925	0.85	0.25	0.31	1.92	0.89	7.40	1.91	1.79	2.20	0.80	0.72	T.	19.04
1926	1.20	0.10	0.70	0.58	3.07	1.73	4.94	5.97	3.15	1.28	1.21	1.42	25.35
1927	0.33	0.46	1.91	3.02	2.93	2.73	3.86	2.31	0.82	1.66	1.55	3.40	24.98
1928	0.50	0.33	0.15	1.37	0.62	3.01	3.81	4.30	1.43	2.43	0.89	0.10	18.94
1929	1.81	1.37	1.48	3.07	2.02	0.61	4.91	1.56	4.20	2.30	0.25	0.80	24.38
1930	0.65	1.08	0.12	0.90	2.60	2.81	4.64	1.66	1.14	1.48	2.45	T.	19.58
1931	0.10	0.75	1.01	1.06	5.42	1.76	1.40	2.47	1.21	1.87	1.55	0.57	19.17
1932	0.77	0.02	2.05	3.85	2.68	5.11	2.50	2.08	1.65	2.16	1.20	0.42	24.49
1933	0.69	0.68	0.73	1.43	2.62	2.22	2.29	2.17	2.03	0.02	0.23	0.53	15.63
AVE.	0.80	0.82	1.40	2.25	3.0.	3.75	2.71	2.76	1.98	1.60	1.00	0.71	22.92

WEATHER STATION AT MILBANK, GRANT CO., S. DAK.

TEMPERATURE (DEGREES FAHRENHEIT)				FROST DATA			
YEAR	HIGHEST	LOWEST	ANNUAL MEAN	YEAR	LAST KILLING FROST IN SPRING	FIRST KILLING FROST IN AUTUMN	LENGTH GROWING SEASON
1900	102	-25	46.8*	1890	MAY 5	OCT. 17	165
1901	107	-26	44.6	1891	MAY 4	OCT. 3	152
1902	100	-30	43.8	1892	MAY 22	OCT. 7	138
1903	96	-25	....	1893	.....	SEPT. 16	...
1904	101	...	44.3*	1894	MAY 19	.....	...
1905	95	-31	42.4	1895	MAY 20	SEPT. 28	131
1906	101	-26	42.8	1896	APR. 21	SEPT. 11	143
1907	96	-35	40.0	1897	JUNE 6	SEPT. 17	103
1908	99	-25	43.4	1898	MAY 2	OCT. 5	156
1909	97	-25	41.3	1899	MAY 13	SEPT. 29	139
1910	98	-20	43.6	1900	MAY 4	SEPT. 17	136
1911	102	-26	42.0	1901	JUNE 7	OCT. 3	118
1912	97	-34	41.2	1902	MAY 10	SEPT. 12	125
1913	100	-22	42.7	1903	JUNE 11	SEPT. 16	97
1914	98	-28	42.56	1904	MAY 15	SEPT. 21	129
1915	89	-29	42.4	1905	MAY 1	OCT. 16	168
1916	99	-32	40.0	1906	MAY 8	SEPT. 30	145
1917	105	-33	38.8	1907	MAY 27	SEPT. 25	121
1918	98	-28	45.7	1908	MAY 6	SEPT. 28	145
1919	101	-30	43.3	1909	MAY 10	OCT. 12	155
1920	97	-21	42.7*	1910	JUNE 2	SEPT. 12	102
1921	98	-22	46.6	1911	MAY 13	OCT. 19	159
1922	100	...	40.1*	1912	MAY 16	SEPT. 26	133
1923	96	-20	45.6	1913	MAY 6	SEPT. 19	136
1924	94	-30	42.9	1914	MAY 15	OCT. 14	152
1925	99	-22	44.8	1915	MAY 18	OCT. 5	140
1926	105	-22	43.6	1916	MAY 3	SEPT. 15	135
1927	94	-23	42.0	1917	MAY 6	OCT. 6	153
1928	99	-28	43.3	1918	MAY 14	SEPT. 17	126
1929	104	-37	41.0	1919	MAY 7	OCT. 10	156
1930	102	-30	43.7	1920	APR. 28	SEPT. 30	155
1931	108	-18	....	1921	MAY 15	OCT. 3	141
1932	99	...	46.61*	1922	APR. 26	OCT. 12	169
1933	104	-27	44.2	1923	MAY 12	OCT. 5	146
				1924	MAY 24	OCT. 6	135
				1925	MAY 25	SEPT. 21	119
AVE.			42.8	1926	MAY 22	SEPT. 24	125
				1927	APR. 23	SEPT. 28	158
				1928	.....	SEPT. 23	...
* ELEVEN MONTHS AVERAGE				1929	MAY 20	SEPT. 18	121
				1930	MAY 24	SEPT. 27	126
				1931	MAY 22	SEPT. 24	125
				1932	APR. 27	SEPT. 29	155
				1933	APR. 27	OCT. 8	163
				AVE.	MAY 13	SEPT. 28	138

LATEST DATE OF KILLING FROST IN SPRING - JUNE 11.
EARLIEST DATE OF KILLING FROST IN AUTUMN - SEPT. 11.

IV. GEOLOGY

The Bedrock

IF A GIANT KNIFE COULD CUT A VERTICAL SLICE OUT OF THE COUNTY THE BED ROCK WOULD APPEAR LIKE THE LAYERS OF A GREAT CAKE. AT THE BASE WOULD BE A FOUNDATION OF GRANITE AND ON THIS WOULD LIE A SERIES OF SANDSTONES, SHALES, AND LIMESTONES OF MARINE ORIGIN, PILED LAYER ON LAYER TO A THICKNESS OF SEVERAL HUNDRED FEET. OVER THE MARINE ROCK IS SPREAD A SHEET OF LOOSE BOULDER CLAY AND SAND, OF GLACIAL ORIGIN. IN DISCUSSING THE GEOLOGY, THEREFORE, THREE NATURAL DIVISIONS CAN BE MADE: THE ROCKS OF THE BASEMENT FOUNDATION, THOSE OF OCEANIC ORIGIN, AND THOSE OF THE GLACIAL DRIFTS. THIS THREEFOLD DIVISION HOLDS NOT ONLY FOR THE MANNER BUT FOR THE TIME OF THEIR FORMATION. THE FOUNDATION ROCK WAS FORMED AT AN EARLY DAY IN THE KNOWN HISTORY OF THE EARTH DURING WHAT IS CALLED THE ALGONKIAN ERA. AFTER A GREAT LAPSE OF TIME THE STRATIFIED MARINE ROCKS WERE FORMED. THIS TIME OF THEIR FORMATION IS KNOWN AS THE CRETACEOUS PERIOD. AFTER A SECOND GREAT LAPSE OF TIME, THE GLACIAL DRIFTS WERE SPREAD OVER THE ENTIRE COUNTY DURING THE PLEISTOCENE EPOCH. AN UNDERSTANDING OF THE RELATIONSHIPS OF THESE THREE GROUPS OF ROCKS WILL THROW CONSIDERABLE LIGHT ON THE ECONOMIC POSSIBILITIES OF THE COUNTY AND THEY WILL THEREFORE BE DESCRIBED IN SOME DETAIL.

The Granite Foundation:

ROCKS OF THIS FOUNDATION OUTCROP ONLY IN A SMALL AREA BETWEEN MILBANK AND BIG STONE, WHERE THEY APPEAR AS SMOOTH BOSSES OF ROCK IN THE SHALLOW VALLEYS OF THE CREEKS. THE WESTERNMOST OUTCROP LIES FIVE MILES EAST AND ONE AND ONE-HALF MILES SOUTH OF MILBANK, (SECTION 13, T. 120 N., R. 48 W.). FROM THIS POINT THE GRANITE CAN BE FOLLOWED EASTWARD FOR THREE MILES, (SECTION 17, T. 120 N., R. 47 W.). A HALF DOZEN QUARRIES HAVE OPENED IN THIS AREA. A SECOND OUTCROP LIES AT THE BOTTOM OF THE VALLEY OF WHETSTONE CREEK, A MILE SOUTHWEST OF BIG STONE CITY, (S. W. CORNER, SECTION 17, T. 121 N., R. 46 W.), AND IS REPORTED AS THE FOUNDATION FOR THE RAILROAD BRIDGE, ONE-QUARTER MILE WEST OF THE OUTCROP, TWENTY-SEVEN FEET BELOW THE BED OF THE CREEK.

IT ALSO OUTCROPS IN MINNESOTA, IN THE BOTTOM OF THE MINNESOTA RIVER VALLEY, A MILE EAST OF THE STATE LINE AND A MILE SOUTH OF

BIG STONE CITY. THIS OUTCROP EXTENDS OVER AT LEAST [illegible] MILES OF THE VALLEY BOTTOM. SINCE THE ROCK IN ALL THESE OUTCROPS IS THE SAME, IT IS SAFE TO ASSUME THAT THIS GRANITE UNDERLIES AT LEAST THIRTY SQUARE MILES IN THE NORTHEASTERN PART OF GRANT COUNTY. IN DRILLING WELLS ON THE LOWLAND, GRANITE HAS BEEN STRUCK AS FAR EAST AS MILBANK AND AS FAR SOUTH AS ALBEE. AS NO SAMPLES WERE AVAILABLE FROM THESE WELLS, IT IS NOT POSSIBLE TO TELL WHETHER THE GRANITE OF THE DRILLERS IS THE SAME AS THAT OF THE OUTCROPPING AT THE QUARRIES, BUT IT IS CERTAIN THAT IT IS A SIMILAR ROCK AND A PART OF THE BASEMENT ON WHICH THE MARINE ROCK LIE. IT WILL BE POSSIBLE TO STRIKE A SIMILAR BASEMENT ROCK IN ALL PARTS OF THE COUNTY IF DRILLING IS CARRIED TO A SUFFICIENT DEPTH.

THE ROCK IS A GRANITE, BEING COMPOSED OF APPROXIMATELY 60% DARK RED FELDSPAR BELONGING TO THE ORTHOCLASE GROUP, 25% CLEAR QUARTZ, 15% BIOTITE MICA. THIS MINERAL COMPOSITION GIVES THE ROCK A RICH DARK COLOR WHICH IS WELL DESCRIBED BY ITS TRADE NAME, MAHOGANY GRANITE. THE ROCK IS MEDIUM TO COARSE IN TEXTURE, GRAINS AVERAGING ONE-HALF TO ONE INCH IN DIAMETER. PEGMATITE STRINGERS OR VEINS ARE COMMON IN WHICH CRYSTALS FROM THREE TO FOUR INCHES ACROSS HAVE BEEN MEASURED. MOST OF THESE VEINS ARE SMALL, HOWEVER, SELDOM EXCEEDING TEN INCHES IN WIDTH.

ON WEATHERED SURFACES A DISTINCT GRAIN CAN BE SEEN. THIS WAS NOTED BY THE EARLY EXPLORERS IN THE REGION WHO CALLED THE GRANITE IN THE MINNESOTA VALLEY, NEAR BIG STONE, GNEISSIC GRANITE.[1] THE SAME ROCK HAS BEEN CLASSIFIED AS A GNEISS.[2] IN THE GRANT COUNTY OUTCROPS THE GRAIN IS CAUSED IN PART BY A ROUGH ORIENTATION OF CRYSTALS AND IN PART BY THE SEGREGATION OF FELDSPAR AND BLACK MICA. IT IS NOT VISIBLE IN THE FRESH ROCK BUT IS BROUGHT OUT AS FINE LINES OR LAMINATIONS UPON PARTIAL WEATHERING. THE STRIKE OF THE GRAIN IS EAST-WEST AND IT DIPS TO THE NORTH AT AN ANGLE OF FIFTY DEGREES. THE ROCK TAKES A HIGH POLISH AND IS MUCH PRIZED AS AN ORNAMENTAL STONE.

THIS GRANITE IS OF VOLCANIC ORIGIN; THAT IS, IT WAS FORMED BY THE FREEZING OF AN ENORMOUS MASS OF MOLTEN ROCK WHICH NEVER REACHED THE SURFACE OF THE EARTH. ITS COARSE CRYSTALS SHOW THAT IT COOLED VERY SLOWLY, PROBABLY DUE TO THE FACT THAT IT WAS A

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1. "IMMENSE MASSES OF GRANITE ALL QUASI-STRATIFIED, IN LAMINAE ABOUT AN INCH BROAD." FEATHERSTONHAUGH, G.W., A CANOE VOYAGE UP THE MINNAY SOTOR, VOL. I, PAGE 35, LONDON, 1847.
2. HALL, C. W., "THE GNEISSES, GABBRO SCHISTS, AND ASSOCIATED ROCKS OF SOUTHWESTERN MINNESOTA," U.S. GEOL. SURV. BULLETIN 157, P. 41.

PART OF AN ENORMOUS MASS OF LIQUID ROCK. AT LEAST THIRTY SQUARE MILES, AND PROBABLY THREE TIMES THAT AREA, IS UNDERLAIN BY THE GRANITE IN GRANT COUNTY AND THE SAME ROCK CAN BE TRACED FOR MANY MILES DOWN THE MINNESOTA RIVER VALLEY IN MINNESOTA. SUCH ENORMOUS MASSES OF VOLCANIC ROCK ARE KNOWN IN A NUMBER OF PLACES AND ARE USUALLY ASSOCIATED WITH THE MOST ANCIENT ROCKS VISIBLE AT THE EARTH'S SURFACE. NO FIGURES CAN BE GIVEN FOR THE DEPTH OF THE GRANITE. ONE QUARRY HAS PENETRATED IT TO A DEPTH OF 100 FEET, BUT IF THE THICKNESS CORRESPONDS TO THE KNOWN THICKNESS OF OTHER GREAT BODIES OF GRANITE WITH SIMILAR HORIZONTAL EXTENT, IT SHOULD BE MEASURED IN HUNDREDS OR POSSIBLY EVEN THOUSANDS OF FEET.

IT IS NOT LIKELY THAT THE BASEMENT ROCK UNDER THE ENTIRE COUNTY IS EXACTLY LIKE THAT EXPOSED IN THE OUTCROP, BUT IT WOULD RESEMBLE IT IN BEING A VERY HARD, DENSE ROCK AND WOULD CONTAIN OTHER MASSES OF VOLCANIC MATERIAL. IT PROBABLY CONTAINS A GREAT DEAL OF BANDED OR LAMINATED ROCK SUCH AS GNEISSES, SCHISTS AND SLATES, AND MAY ALSO CONTAIN QUARTZITE.

THE AGE OF THE ROCK IN MINNESOTA RIVER VALLEY OF MINNESOTA IS GIVEN AS PRE-CAMBRIAN BECAUSE OF THEIR RESEMBLANCE TO KNOWN PRE-CAMBRIAN ROCK FARTHER NORTH IN MINNESOTA. SINCE THE OUTCROPS IN GRANT COUNTY ARE CONTINUOUS WITH THOSE IN THE MINNESOTA VALLEY, IT IS SAFE TO ASSIGN THEM ALSO TO THE PRE-CAMBRIAN GROUP.

THE OUTCROPS IN THE MINNESOTA VALLEY ARE LISTED UNDER THE HEADING OF PRE-CAMBRIAN ROCK IN THE DESCRIPTION GIVEN BY HALL.[1] NO EVIDENCE IS GIVEN FOR THE AGE ASSIGNED, HOWEVER. THE SAME ROCKS ARE ASSIGNED TO THE ARCHEAN GROUP BY THE EARLY WISCONSIN GEOLOGISTS. IN A REPORT ON THE GEOLOGY OF BIG STONE AND LAC QUI PARLE COUNTIES, WISCONSIN, DATED 1884 AND PUBLISHED IN 1901, WARREN UPHAM MAKES THE FOLLOWING STATEMENT. "THE ROCK THAT UNDERLIES THESE COUNTIES BELONGS TO THE ARCHEAN, COVERED MORE OR LESS BY A NONCONFORMABLE LATER COATING OF CRETACEOUS. THE FORMER ARE EXPOSED ALONG THE MINNESOTA VALLEY FROM ORTONVILLE SOUTHEASTWARDLY TO MARSH LAKE, AND ON TO THE SHORES OF LAC QUI PARLE."[2] IN LATER PUBLICATIONS THE AGE IS GIVEN AS ALGONKIAN.[3] THIS MAKES THEM CONSIDERABLY YOUNGER THAN THE ARCHEAN, BUT STILL LEAVES THEM IN THE PRE-CAMBRIAN.

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1. HALL, C. W., U.S. GEOLOGICAL SURVEY BULLETIN 157, P. 38. 1899.
2. UPHAM, WARREN, THE GEOLOGY OF MINNESOTA, MINNESOTA GEOLOGICAL AND NATURAL HISTORY SURVEY VOL. VI, PLATE 29.
3. DARTON, N. H., GEOLOGY AND UNDERGROUND WATERS OF SOUTH DAKOTA, U.S. GEOLOGICAL SURVEY WATER SUPPLY PAPER 227, PLATE I, 1909.

AS THERE ARE NO BEDROCK EXPOSURES IN GRANT COUNTY EXCEPT THOSE OF THE GRANITE, IT IS IMPOSSIBLE TO DETERMINE ITS AGE BY ITS RELATION TO THE SURROUNDING BEDROCK, NOR WILL ITS EXTENT THROW LIGHT ON THE SUBJECT FOR LARGE GRANITIC MASSES ARE TO BE FOUND IN BOTH ARCHEAN AND ALGONKIAN ROCKS. THE TENDENCY HAS BEEN, HOWEVER, TO PLACE THE ROCKS FARTHER SOUTH IN THE YOUNGER GROUP, HENCE THE BIG STONE GRANITE IS HERE CLASSED AS ALGONKIAN.

THESE ROCKS ARE AMONG THE MOST ANCIENT EXPOSED IN THE ENTIRE STATE. THEY ARE ROUGHLY CONTEMPORANEOUS WITH THE QUARTZITE EXPOSED IN THE VICINITY OF SIOUX FALLS, AND THE SCHISTS, GNEISSES, AND GRANITES WHICH MAKE THE CORE OF THE BLACK HILLS.

THE SURFACE OF THE ALGONKIAN ROCKS:

THE GRANITE SURFACE SLOPES VERY GRADUALLY TOWARD THE WEST ACCORDING TO THE REPORTS OF WELL DRILLERS. IT HAS BEEN STRUCK SIX MILES WEST OF THE OUTCROP AT A DEPTH OF 456 FEET. IN MILBANK IT WAS STRUCK IN WELLS AT DEPTHS OF 280 TO 300 FEET. FIVE MILES SOUTH OF MILBANK IT IS REPORTED 220 FEET BELOW THE SURFACE. A WELL NINE MILES SOUTH OF MILBANK STRUCK IT AT A DEPTH OF 240 FEET. THE SOUTHERNMOST GRANITE IS REPORTED ONE AND ONE-HALF MILES EAST OF ALBEE, TEN MILES SOUTH OF THE QUARRIES, WHERE IT WAS STRUCK 125 FEET UNDERGROUND.

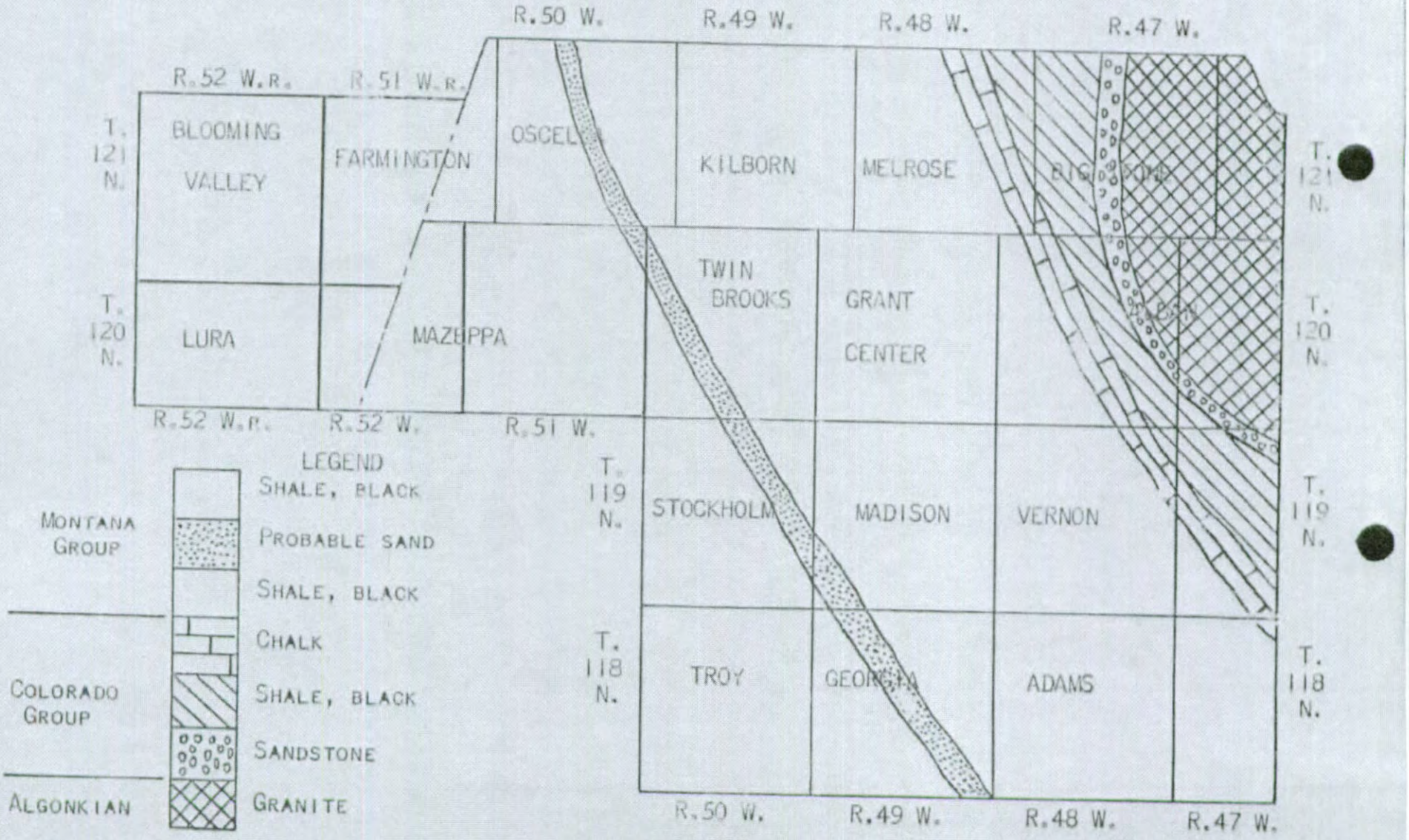
WHEN THESE DEPTHS ARE COMPUTED TO SEA LEVEL ELEVATIONS, THEY SHOW THAT THE SURFACE HAS AN APPROXIMATE ELEVATION OF 1000 FEET AT BIG STONE LAKE, 1100 FEET AT THE QUARRIES, 880 FEET AT MILBANK, 700 FEET ONE MILE WEST OF MILBANK, 800 FEET NINE MILES SOUTH OF MILBANK, AND 1100 FEET ONE AND ONE-HALF MILES EAST OF ALBEE. IN OTHER WORDS, THE SURFACE SLOPES WESTWARD AT A VERY LOW ANGLE, THE MAXIMUM SLOPE IN THIS REGION BEING 66 FEET PER MILE. ALTHOUGH THE GRANITE HAS NOT BEEN REACHED IN ANY WELLS DRILLED WEST OF THOSE MENTIONED, IT IS PROBABLE THAT THE SURFACE WILL BE ENCOUNTERED AT SEA LEVEL ELEVATIONS OF BETWEEN 500 AND 1000 FEET, UNDER THE ENTIRE COUNTY.

THE MARINE ROCKS

THE CHIEF CHARACTER OF MARINE ROCKS IS THEIR STRATIFICATION. THEY LIE LAYER UPON LAYER, LIKE HUGE BLANKETS OR RUGS PILED ONE UPON THE OTHER. THE LAYERS ARE MADE OF SAND, CLAY OR LIME DEPENDING UPON THE PART OF THE SEA IN WHICH THEY WERE FORMED, AND

GRANT COUNTY, SOUTH DAKOTA

APPROXIMATE DISTRIBUTION OF BEDROCK FORMATIONS
UNDER THE GLACIAL DRIFTS



THE KINDS OF MATERIAL WHICH WERE SUPPLIED.

IN GRANT COUNTY MARINE ROCK HAS BEEN ENCOUNTERED IN WELLS ONLY. IN NO PLACE ARE THEY EXPOSED AT THE SURFACE. THAT THEY ARE OCEAN FORMED IS ATTESTED BY THE FACT THAT "SNAIL SHELLS" (CEPHALOPODS) ARE REPORTED FROM THEM IN THE VICINITY OF MILBANK. FISH TEETH WHICH CAME FROM "BLUE CLAY" IN A WELL TWO MILES EAST OF ALBEE WERE SHOWN BY THE DRILLER WHO SAVED THEM. SMALL BITS OF PYRITE (FOOL'S GOLD), WHICH WERE ENCOUNTEDED IN THE BLUE CLAY OF THESE WELLS WERE ALSO SEEN, AND THE ROCK ITSELF WAS EXPOSED IN A DUG WELL NEAR MILBANK. THIS BLACK SHALE LOOKED VERY MUCH LIKE THE BLACK SHALE FOUND IN THE ROCKS OF THE CRETACEOUS SYSTEM IN OTHER PARTS OF THE STATE.

MANY WELLS HAVE BEEN DRILLED ON THE LOWLAND AND QUITE A NUMBER HAVE GONE DEEP ENOUGH TO AFFORD CONSIDERABLE VALUABLE INFORMATION ON THE CHARACTER OF THE BEDROCK. THE WELLS BETWEEN MILBANK AND TWIN BROOKS HAVE STRUCK WATER AT SEVERAL HORIZONS AND THE COMBINATIONS OF THEIR RECORDS SHOW THE FOLLOWING SUCCESSION OF STRATA:

30 TO 50 FEET	GLACIAL DRIFT. BOULDER CLAY.
75 TO 100 FEET	BLUE SHALE.
2 TO 5 FEET	CHALK ROCK. THESE THICKNESSES MENTIONED IN LOGS AS THOSE AT WHICH WATER FLOWS WERE OBTAINED; TOTAL THICKNESS NOT AVAILABLE.
200 TO 300 FEET	BLUE SHALE.
- - - - - - - - -	SAND. ARTESIAN WATER SAND.

MR. MARTIN MORLEY, A WELL DRILLER OF MILBANK, DESCRIBES THE GENERAL SECTION BETWEEN THERE AND TWIN BROOKS AS FOLLOWS:

AT A DEPTH OF 125 TO 185	CHALK ROCK.
AT A DEPTH OF 330 FEET	SAND FOLLOWED BY BOX CLAY. (BLACK SHALE)
AT A DEPTH OF 350 FEET	SAND FOLLOWED BY BOX CLAY.
AT A DEPTH OF 385 FEET	SAND.

PYRITE CAP ROCKS OCCUR ON THE LOWER SAND, AT LEAST LOCALLY.

A WELL DUG ONE MILE EAST OF MILBANK, WHICH WAS BEING CLEANED AT THE TIME OF THIS INVESTIGATION (1933), GAVE THE ONLY CHANCE FOR THE INSPECTION OF THE BEDROCK IN THE COUNTY. THIS WELL DISPLAYS THE FOLLOWING SECTION:

	42 FEET	CLAY; TYPICAL GLACIAL DRIFT.
	8 FEET	SAND; FINE GRAINED, DARK COLORED, HUMUS AND SPLINTERS OF WOOD FOUND IN IT. COARSER PEBBLES AND SMALL BOULDERS AT THE BASE. LARGEST BOULDER ENCOUNTERED WAS A FOOT IN DIAMETER. THIS IS A WATER SAND, BUT THERE IS SUFFICIENT CLAY IN IT TO MAKE IT MOLD SLIGHTLY IN THE HAND. THE GLACIAL BOULDERS (ONE GRANITE) AND THE UNMINERALIZED WOOD SHOW THIS TO BE A GLACIAL DEPOSIT.
PLEISTOCENE		
	5 TO 6 FEET	BLACK GUMMY CLAY WITH LAMINATED BEDDING MUCH LIKE PIERRE SHALES. IN THIS SAME MATERIAL "SNAILS" (CEPHALOPODS) WERE FOUND IN THE NORTHEASTERN PART OF MILBANK AT FORTY ODD FEET BELOW THE SURFACE.
CRETACEOUS		

THE CHALK

THIS ROCK, A SOFT VARIETY OF LIMESTONE, IS WELL KNOWN TO THE LOCAL DRILLERS IN GRANT COUNTY AND IS DESCRIBED AS A WHITISH, CHALKY MATERIAL. IT IS REPORTED IN A NUMBER OF WELLS IN THE VICINITY OF MILBANK AND TWIN BROOKS WHERE IT FURNISHES A FLOW OF WATER. THOUGH NOT AN ARTESIAN WATER SUPPLY, IT FURNISHES VERY GOOD PUMP WELLS. CHALK ROCK IS ALSO ABUNDANT IN THE GLACIAL DRIFTS OF THE COUNTY, AND MAY HAVE COME FROM BEDROCK OF THIS SAME FORMATION NOT FAR AWAY. ONE CHALK PEBBLE FROM THE DRIFT CONTAINED A SPECIMEN OF OSTREA CONGESTA, THE TYPE FOSSIL OF THE NIOBRARA FORMATION.

THE CHALK LIES AT A DEPTH OF 125 TO 130 FEET BELOW THE SURFACE, WHICH IS AN ELEVATION OF ABOUT 1100 FEET ABOVE SEA LEVEL. THE RECORDS OF ARTESIAN WELLS WERE NOT SUFFICIENTLY DETAILED TO NOTE THE PENETRATION OF THE CHALK, PROBABLY BECAUSE THEY WERE DRILLED FOR FLOWING WATER AND LITTLE ATTENTION WAS PAID TO WATER HORIZONS WHICH WOULD NOT FLOW.

THE WELLS PRODUCING FROM THIS LEVEL LIE IN A BELT WHICH TRENDS NORTHWEST-SOUTHEAST AND PARALLELS THE BASE OF THE COTEAU A FEW MILES TO THE WEST. MOST OF THE COUNTRY EAST OF THE BELT

IS SERVED BY SHALLOW WELLS WHICH DO NOT ENTER THE BEDROCK. IT IS, THEREFORE, IMPOSSIBLE TO SAY HOW FAR THE CHALK MAY EXTEND IN THIS DIRECTION. IT IS ENTIRELY MISSING IN THE GRANITE AREA AND PROBABLY IS ERODED IN THE NORTHEASTERN CORNER OF THE COUNTY SINCE THE SURFACE HERE LIES AT A LOWER ELEVATION THAN THAT AT WHICH THE CHALK OCCURS IN THE WELLS. NO WELLS HAVE BEEN DRILLED ON THE COTEAU TO A SUFFICIENT DEPTH TO REACH THIS HORIZON, BUT CHALK ROCK SHOULD UNDERLIE ALL OF THE COUNTY WEST OF THE BELT IN WHICH THE WELLS OCCUR.

THE ARTESIAN SAND:

IN THE MILBANK-TWIN BROOKS AREA, AN ARTESIAN FLOW IS OBTAINED FROM A SANDSTONE WHICH LIES 200 TO 250 FEET BELOW THE CHALK. THESE WELLS ARE ABOUT 300 FEET DEEP IN THE VICINITY OF MILBANK, 500 FEET NEAR TWIN BROOKS AND 200 FEET NEAR THE NORTH COUNTY LINE, EIGHT MILES NORTH OF TWIN BROOKS. THE SAND LIES AT AN ELEVATION OF ABOUT 700 TO 800 FEET ABOVE SEA LEVEL NEAR TWIN BROOKS. SEVEN MILES TO THE NORTH, THE ARTESIAN SAND, WHICH IS PROBABLY THE SAME, LIES ABOUT 100 FEET HIGHER.

IT IS PROBABLE THAT THIS SAND UNDERLIES THE NORTHEASTERN AND THE SOUTHEASTERN PORTIONS OF THE COUNTY, BUT IS CUT OUT IN THE VICINITY OF THE GRANITE OUTCROPS. ITS FURTHEST EXTENSION SOUTH OCCURS AT REVILLO WHERE FLOWING WELLS ARE ENCOUNTERED IN A SAND LYING ABOUT 1000 FEET ABOVE SEA LEVEL. IT IS NOT POSSIBLE TO CORRELATE THIS SAND POSITIVELY WITH THE ARTESIAN SAND ABOUT TWIN BROOKS FOR THERE IS A GAP OF ABOUT EIGHT MILES IN WHICH NO DATA IS AVAILABLE, BUT THE ELEVATION OF THE SAND AND THE NEARNESS OF THE KNOWN GRANITE SURFACE SUGGESTS IT IS THE SAME. THE FOLLOWING LOG OF THE RAILROAD WELL DRILLED AT REVILLO WAS FURNISHED THROUGH THE COURTESY OF MR. G. E. LOVERING, ASSISTANT CHIEF ENGINEER FOR THE MINNEAPOLIS AND ST. LOUIS RAILROAD COMPANY.

LOG OF M. AND ST. L. RAILROAD, REVILLO, SOUTH DAKOTA.
DRILLED JUNE, 1900. TESTED 7,500 GAL.
PER HOUR. ELEVATION: 1208 FT.

POSSIBLE CORRELATION		
GLACIAL DRIFT	40 FEET	YELLOW CLAY
	25 FEET	SAND
	115 FEET	BLUE CLAY
CRETACEOUS	15 FEET	FINE SAND
	31 FEET	COARSE SAND AND GRAVEL

A WELL, ONE MILE NORTH OF ALBEE, GAVE THE FOLLOWING LOG ACCORDING TO THE DRILLER. LOCATION: S. E. CORNER, SECTION 35, T. 119 N., R. 48 W.

30 FEET	GLACIAL DRIFT.
180 FEET	BLUE CLAY, NOT STICKY; CONTAINS FOOL'S GOLD.
5+ FEET	FINE SAND; GAVE GOOD WATER, BUT COULD NOT PUMP IT.

NOTE: A WELL ONE-HALF MILE NORTH MADE A GOOD PUMP WELL FROM THIS SAME SAND.

AT ALBEE A "FINE WHITE SAND" GIVES WATER AT A DEPTH OF 90 FEET OR A SEA LEVEL ELEVATION OF 1100 FEET. THE LOGS OF THE WELLS AS REPORTED GIVE:

GLACIAL DRIFT	40 FEET	CLAY
PROBABLY CRETACEOUS	-------	WATER SAND. WATER NOT GOOD, NOR IS SUPPLY DEPENDABLE.
	50 FEET	BLUE CLAY
	-------	FINE WHITE SAND. PLENTY OF FRESH WATER; NOT SALINE TO TASTE, BUT DOES HAVE SLIGHT TASTE OF IRON.

THE SEA LEVEL ELEVATION OF THIS SAND AND THE CHARACTER OF THE WATER CORRESPOND TO THAT OF THE CHALK NEAR TWIN BROOKS. THE MATERIAL, HOWEVER, IS REPORTED AS WHITE SAND, AND NO CUTTINGS WERE AVAILABLE FOR IDENTIFICATION. A MILE EAST OF ALBEE GRANITE IS REPORTED AT 125 FEET.

THE AGE OF MARINE ROCKS:

THE PRESENCE OF CHALK ROCK AND THE FISH TEETH INDICATE THAT THE BEDROCK OF THE LOWLAND IS OF CRETACEOUS AGE. BEYOND THIS LITTLE CAN BE SAID. THE CUSTOM OF CALLING ALL ARTESIAN SANDS NEAR THE BASE OF THE CRETACEOUS STRATA THE DAKOTA SANDSTONE WAS FOLLOWED BY DARTON. IN SPEAKING OF THE ARTESIAN HORIZONS IN GRANT COUNTY, HE SAYS, "IT HAS BEEN PROPOSED THAT THE BASAL BED IS THE DAKOTA SANDSTONE, BUT POSSIBLY IT IS THE BENTON."[1] THE

1. DARTON, N. H., U.S. GEOL. SURV. WATER SUPPLY PAPER 227, P. 103, 1909.

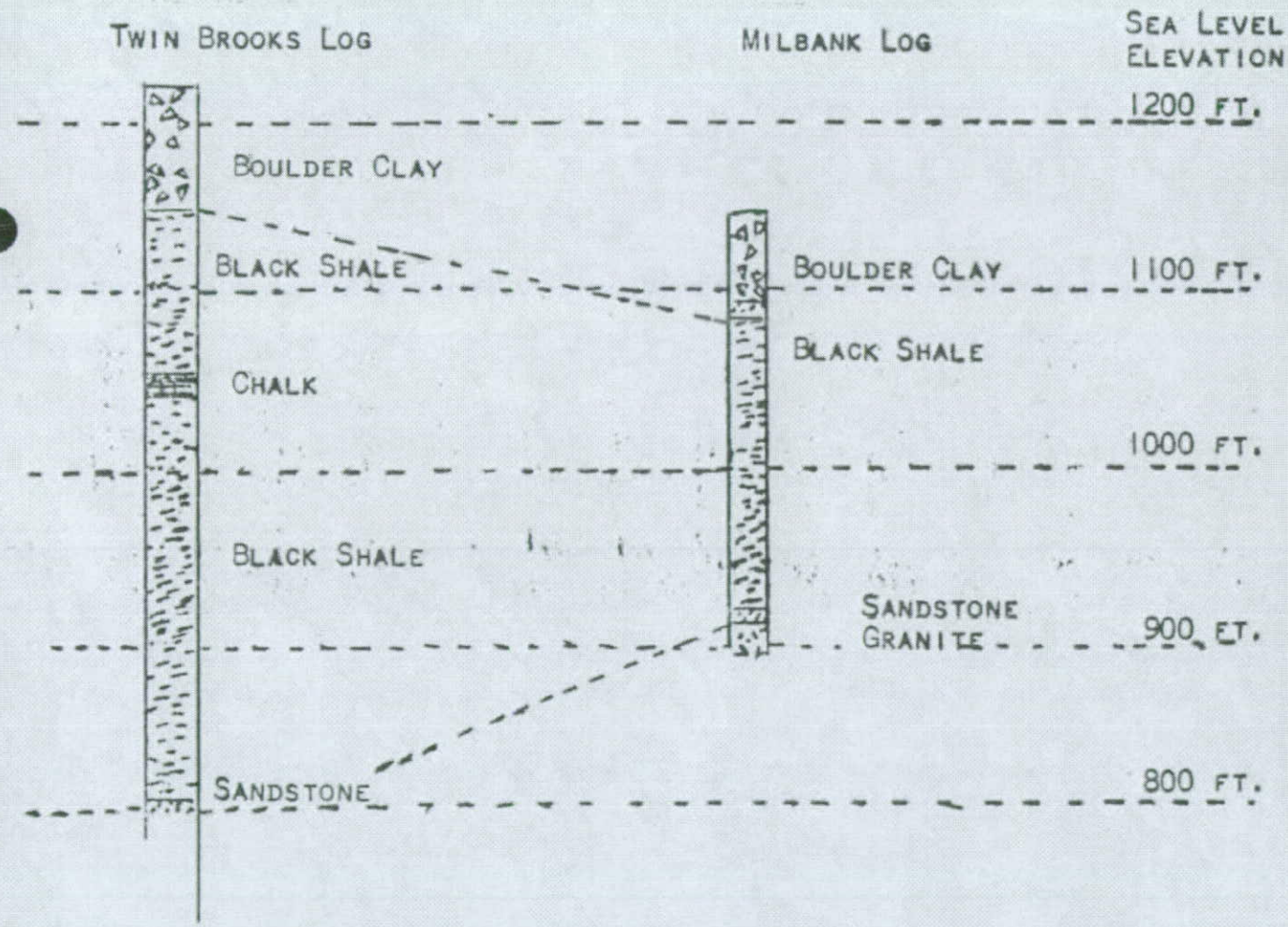
GENERALIZED SECTIONS

FROM

WELL LOGS

BETWEEN

TWIN BROOKS AND MILBANK



CHALK SUGGESTS A CORRELATION WITH THE NIOBRARA, ESPECIALLY SINCE ONE DRIFT PEBBLE HELD A SPECIMEN OF THE INDEX FOSSIL, OSTREA CONGESTA. CHALK OCCURS IN THE PIERRE FORMATION, HOWEVER, ALONG THE MISSOURI RIVER AND ALSO IN THE GREENHORN FORMATION IN THE LOWER BIG SIOUX VALLEY. THE DETERMINATION OF THE EXACT AGE OF THESE BEDS MUST AWAIT A PALEONTOLOGICAL CORRELATION, BUT IT IS A SAFE ASSUMPTION THAT THE BEDROCK OF THE LOWLAND BELONGS IN THE LOWER PART OF THE CRETACEOUS SYSTEM.

THESE ROCKS OVERLAP THE OLD GRANITE SURFACE FROM THE WEST. THE CONTACT IS NOWHERE TO BE SEEN, BUT LIES BETWEEN MILBANK AND THE GRANITE OUTCROP FOUR MILES EAST OF THE CITY.

The Bedrock of the Coteau:

NO BEDROCK IS EXPOSED ON THE COTEAU AND THE WATER SUPPLIES ARE FROM SHALLOW WELLS FOR THE MOST PART. FOR THIS REASON THERE IS VERY LITTLE SATISFACTORY INFORMATION AS TO THE CHARACTER OF THE ROCK UNDERLYING THIS PART OF THE COUNTY.

A LINE OF WELLS, WELL UP ON THE COTEAU SLOPE, AND TRENDING NORTHWEST-SOUTHEAST THROUGH STRANDBURG AND STOCKHOLM, GAVE NO SATISFACTORY INFORMATION, EXCEPT THAT THEY ALL DREW WATER FROM A HORIZON LYING BETWEEN 1400 AND 1500 FEET. IN SOME CASES THESE WERE FLOWING WELLS; IN OTHERS WATER HAD TO BE PUMPED. THE SOUTHERNMOST WELL IN THIS LINE IS A 315-FOOT WELL, THREE AND ONE-HALF MILES SOUTH OF STRANDBURG. SEVERAL WELLS OCCUR NEAR STOCKHOLM, DRAWING WATER FROM THE SAME ELEVATION. SEVERAL FLOWING WELLS PRODUCE FROM THIS HORIZON FOUR AND ONE-HALF MILES NORTHWEST OF STOCKHOLM. THE NORTHERNMOST WELL OF THIS LINE IS KNOWN AS THE BRENNEN WELL AND LIES ABOUT THREE MILES SOUTH OF MARVIN.

INFORMATION AVAILABLE ON THE SOUTHERNMOST WELL WAS THAT IT FURNISHED AN ABUNDANT SUPPLY OF WATER AND WAS DRILLED INTO A SAND VEIN.[1] A SEVENTY-FOOT FLOWING WELL, ONE MILE SOUTHEAST OF STRANDBURG, ORIGINATED IN THE SAND AT AN ELEVATION OF ABOUT 1570 FEET.

THE BEST WELL LOG ON THE COTEAU WAS OBTAINED FROM A WELL WHICH WAS BEING FINISHED AT THE TIME OF THE INVESTIGATION. IT WAS LOCATED ONE-HALF MILE EAST OF STOCKHOLM, AND AFFORDED A GOOD COMPARISON WITH TWO OTHER WELLS DRILLED SOUTH OF STOCKHOLM. THE DRILLER, MR. IVAN KORSBURG, GAVE THE FOLLOWING LOG:

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1. THE NORBECK COMPANY. PERSONAL COMMUNICATION.

65 FEET	BLUE CLAY.
15 FEET	FINE WHITE SAND. A SAMPLE OF THIS SAND UNDER THE MICROSCOPE SHOWED IT TO BE COMPOSED ALMOST ENTIRELY OF ANGULAR FRESHLY BROKEN BITS OF QUARTZ, WELL SORTED IN SIZE.
70 FEET	BLUE CLAY. AN UNSATISFACTORY SAMPLE OF THIS MATERIAL FROM THE SLUDGE PIT DISPLAYED A GREAT DEAL OF SANDY MATERIALS STUCK TOGETHER WITH A HEAVY CLAY, BUT IT WAS IMPOSSIBLE TO ASCERTAIN WHETHER THIS WAS A MIXTURE OF CRETACEOUS SHALES AND THE WHITE SAND OR WAS GLACIAL MATERIAL.
4 FEET	COARSE GRAVEL. WATER BEARING HORIZON.

NEITHER OF THESE SAMPLES, FROM THE FIFTEEN-FOOT SAND OR THE SEVENTY-FOOT BLUE CLAY, COULD BE POSITIVELY IDENTIFIED AS BEDROCK. THE BLUE CLAY, AS IT WAS FOUND IN THE SLUDGE PIT, HAS MUCH THE CHARACTER OF SANDY GLACIAL CLAY. THIS WAS THE BEST DIRECT EVIDENCE AVAILABLE AT THE TIME OF THE EXAMINATION.

IT IS INTERESTING, HOWEVER, TO NOTE THAT THE WELLS ALONG THE FRONT OF THE COTEAU STRIKE THE WATER SAND AT A UNIFORM HORIZON WHICH DIPS SLOWLY TO THE NORTH. THREE MILES SOUTH OF STRANDBURG, THE 315-FOOT WELL PRODUCES WATER AT APPROXIMATELY 1600 FEET ABOVE SEA LEVEL, WHILE A 190-FOOT WELL ACROSS THE ROAD PRODUCES THE WATER FROM A SAND AT ABOUT 1470 FEET.

AT STOCKHOLM, SEVEN MILES NORTH OF THESE WELLS, THE UPPER SAND IS ENCOUNTERED AT AN ELEVATION OF APPROXIMATELY 1585 FEET AND THE LOWER SAND AT APPROXIMATELY 1500 FEET IN THREE WELLS NEAR THE TOWN. THREE MILES NORTHWEST OF STOCKHOLM FLOWING WELLS WERE PRODUCING FROM A SAND AT AN ELEVATION OF ABOUT 1450 FEET, WHILE ABOUT FOUR MILES NORTHWEST OF THESE, THE BRENNEN WELL DRAWS FROM A SAND AT AN ELEVATION OF 1372 FEET. THREE MILES EAST OF THE BRENNEN WELL THE LINE OF SPRINGS BREAKS OUT ON THE FACE OF THE COTEAU AT AN ELEVATION VARYING FROM 1360 TO 1425 FEET.

THE AVAILABLE DATA IS INCONCLUSIVE, BUT THERE IS A SUGGESTION IN THE CONCORDANCE OF THE LEVELS AT WHICH THESE WELLS PRODUCE. SUCH UNIFORMITY IS MOST COMMON IN MARINE SANDSTONES, WHICH IN THIS CASE WOULD BE IN THE BEDROCK. THERE IS, OF COURSE, A POSSIBILITY THAT THE CONCORDANCE IS DUE MERELY TO CHANCE AND THAT THE WELLS ARE PRODUCING FROM SEPARATE SANDS. THE REMARKABLY UNIFORM FLOW OF WATER, AND THE LACK OF ANY DECREASE DURING THE RECENT DRY SEASON, HOWEVER, STRENGTHEN THE SUGGESTION OF A BEDROCK WATER SAND.

THERE HAS BEEN SOME DIFFERENCE OF OPINION AS TO THE FORMATION OF THE COTEAUS; THE OLDER MINNESOTA GEOLOGISTS ASSERTING THAT THE COTEAUS WERE A ROCK ESCARPMENT AND THAT THE GLACIAL DRIFT COVERS IT AS A THIN VENEER. "THE ALTITUDE OF THE COTEAUS IS DOUBTLESS THUS CAUSED BY THE GREATER HEIGHT OF THE FORMATIONS, PROBABLY CRETACEOUS, UPON WHICH THESE DRIFT DEPOSITS LIE, RATHER THAN BY EXTRAORDINARY THICKNESS OF THE DRIFT BEYOND THAT WHICH IT COMMONLY HAS THROUGHOUT SOUTHWESTERN MINNESOTA. THE DEPTH THAT IS ADDED TO THE GENERAL DRIFT-SHEET BY THE ACCUMULATIONS OF THE TERMINAL MORAINES DOES NOT APPEAR TO AVERAGE MORE THAN 50 TO 75 FEET."[1] LATER GEOLOGISTS ESPECIALLY INTERESTED IN GLACIAL PHENOMENA HAVE TAKEN THE VIEW THAT THE COTEAUS WERE LARGELY DEPOSITS OF DRIFT AT LEAST IN MINNESOTA. "THE PROMINENT COTEAU DES PRAIRIES, IN THE SOUTHWESTERN PART OF MINNESOTA, WAS FOR SOME TIME INTERPRETED BY GEOLOGISTS AS OWING ITS GREAT PROMINENCE CHIEFLY TO CRETACEOUS STRATA, WHICH WERE THOUGHT TO FILL THE GAPS BETWEEN THE HIGH AREAS OF SIOUX QUARTZITE NOTED ABOVE. BUT STUDIES BY MEINZER ALONG THE COTEAU AND LATER STUDIES BY THE PRESENT WRITER HAVE SHOWN THAT THE FILLING BETWEEN THE QUARTZITE AREAS CONSISTS LARGELY OF GLACIAL MATERIAL, BORINGS HAVING BEEN PUT DOWN TO A DEPTH OF 400 TO 500 FEET WITHOUT ENCOUNTERING ROCK."[2]

THE STATEMENT BY MEINZER TO WHICH DR. LEVERETT REFERS READS IN PART AS FOLLOWS: "IT STILL SEEMS ALTOGETHER PROBABLE THAT THE ELEVATION OF THE COTEAU IS TO A LARGE EXTENT CAUSED BY OLDER FORMATIONS (THOUGH AS YET THERE IS NO PROOF OF THIS IN MINNESOTA); BUT THE WELL DATA AT HAND SHOW THAT THE AVERAGE THICKNESS OF THE DRIFT IS MUCH GREATER HERE THAN ON THE ADJACENT LOWLAND PLAIN, AND THAT SO FAR AS THIS COUNTY (LINCOLN COUNTY, MINNESOTA) IS CONCERNED A CONSIDERABLE PART OF THE HIGHER ELEVATION RESULTS FROM THIS GREATER THICKNESS. THE WELL RECORDS ALSO SEEM TO INDICATE THAT THE PRESENT MARGIN OF THE COTEAU IS DETERMINED BY THE DEPOSITS OF DRIFT, AND THAT LOCALLY THE UNDERLYING FORMATIONS ARE NO HIGHER ABOVE SEA LEVEL BENEATH THE COTEAU THAN BENEATH THE LOWLAND PLAIN."[3]

EVEN THOUGH THE DATA AT HAND DO NOT SOLVE THE PROBLEM FOR THE PORTION OF THE COTEAU IN GRANT COUNTY, IT IS OF INTEREST TO NOTE THAT THIS SECTION IS A SMALL PART OF THE ESCARPMENT WHICH HAS BEEN TRACED NORTHWARD THROUGH NORTH DAKOTA INTO SOUTHERN CANADA. THE NORTHERN END OF THE ESCARPMENT IS KNOWN TO BE ROCK

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1. UPHAM, WARREN, THE GEOLOGY OF MINNESOTA, MINNESOTA GEOLOGICAL AND NATURAL HISTORY SURVEY VOL. I, 1882, P. 601.
2. LEVERETT, FRANK, QUATERNARY GEOLOGY OF MINNESOTA AND PARTS OF ADJACENT STATES", U.S.G.S. PROF. PAPER 161, P. 11, 1932.
3. MEINZER, O. E., "GEOLOGY AND UNDERGROUND WATERS OF SOUTHERN MINNESOTA, U.S.G.S. WATER SUPPLY PAPER 256, P. 233, 1911.

CORED. THE MOST SOUTHERLY OUTCROP IS THE PEMBINA MOUNTAINS, WHICH IS THE NAME GIVEN THAT PART OF THE ESCARPMENT LYING IN NORTHERN NORTH DAKOTA, WHERE CRETACEOUS FORMATIONS OUTCROP. IT IS PROBABLY SAFE TO ASSUME, THEREFORE, THAT THE GRANT COUNTY SECTION OF THE COTEAU IS ROCK CORED, AND THAT BEDROCK WILL BE FOUND AT AN ELEVATION SEVERAL HUNDRED FEET ABOVE THAT AT WHICH IT OCCURS ON THE LOWLAND.

THE GLACIAL DRIFTS

GLACIAL DEPOSITS DOMINATE THE GEOLOGY OF GRANT COUNTY. THEY ARE SPREAD AS A MANTLE OVER THE ENTIRE COUNTY, ENTIRELY CONCEALING ALL OLDER ROCKS EXCEPT FOR THE VERY FEW SMALL OUTCROPS OF GRANITE WHICH HAVE BEEN DESCRIBED (PAGE 15). THESE DEPOSITS CONSIST OF DEBRIS LEFT BY MELTING ICE SHEETS WHICH COVERED THE COUNTY IN THE GEOLOGIC YESTERDAY, AT A TIME IN THE EARTH'S HISTORY KNOWN AS THE PLEISTOCENE EPOCH, SOMETIMES CALLED THE GREAT ICE AGE.

THESE DEPOSITS COLLECTIVELY ARE CALLED THE GLACIAL DRIFTS, AND UNDER THIS HEAD IS INCLUDED BOULDER CLAY (TILL), WHICH COMPOSES BY FAR THE BULK OF THE DEPOSITS, SANDS AND GRAVELS WASHED DOWN CHANNELS IN FRONT OF THE MELTING ICE, AND DEPOSITS OF WIND-BLOWN DUST WHICH ARE PROMINENT IN SOME OF THE SOILS OF THE COUNTY.

THREE SHEETS OF DRIFT WERE LAID OVER THE COUNTY BY THREE SUCCESSIVE ICE SHEETS, AND PARTS OF THEM STILL REMAIN, THOUGH THE LAST ICE DID MUCH TO OBLITERATE THE EARLY DRIFTS. TO GLACIAL GEOLOGISTS, THE OLDEST SHEET IS KNOWN AS THE KANSAN DRIFT SHEET, THE NEXT YOUNGER, THE IOWAN, AND THE YOUNGEST, THE WISCONSIN. THESE NAMES ARE BORROWED FROM NEIGHBORING STATES IN WHICH DRIFT SHEETS WERE BEING FORMED AT THE SAME TIME THAT THEY WERE IN GRANT COUNTY.

THE THICKNESS OF THE DRIFT VARIES IN DIFFERENT PARTS OF THE COUNTY, AND IT IS POSSIBLE ONLY TO GIVE A FEW GENERALIZATIONS HERE. ON THE LOWLAND THE DRIFT IS MUCH THINNER THAN ON THE FACE OF THE COTEAU. A STUDY OF THE WELL RECORDS GIVES AN AVERAGE OF ABOUT 50 FEET FOR THE DRIFT OF THE LOWLAND. THE FOLLOWING TABLE MAY SERVE AS A GUIDE:

MILBANK	50 FEET
TWIN BROOKS	71 FEET
MELROSE TOWNSHIP (T. 121 N., R. 48 W.)	60 TO 65 FEET
ALBEE	40 TO 60 FEET

On the Coteau the only information available was that from the well near Stockholm where the drift was at least 150 feet in depth. No information as to the thickness of the drift is obtainable on the high parts of the Coteau.

The Kansan Drift Sheet

Kansan drift is exposed in very few places in the county, the outcrops all being on the east side of the Coteau. Three of them are well up on the escarpment in the southern part of the county, and one is on the lowland north of Twin Brooks. This situation may be due to the fact that, since its formation, two glaciers have overridden the Kansan drift sheet and doubtlessly removed much of it. It is also due to the fact that the Kansan drift sheet is well concealed under drifts left by the two younger glaciers.

The best section was obtained from an exposure five miles south of LaBolt in the southwest corner of Section 35, T. 118 N., R. 49 W. At this point Highway No. 77 crosses a large stream and the road cut on both the north and south bluffs expose the drift.

Section of Kansan Drift

S.W. Corner, Section 35, T. 118 N., R. 49 W.

2 feet	Prairie soil; black to brown; scattered pebbles and 6 to 8 inch boulders.
1½ feet	"Forest soil"; ashy gray; fluffy feel; with typical columnar jointing and pseudo-lamination. This is similar in color, texture and structure to the Sangamon forest soil of Illinois.
2 feet	Sand, buff, medium grained.
5 feet	Gumbo till; very sticky; dark brown to black on outcrop, but dries to a light brown; gumbo checking on surface and typical starchy fracture on fresh material. No pebbles or boulders.
10+ feet	Dark colored drift.

ON THE COUNTY LINE TWO MILES EAST OF THE SECTION JUST DESCRIBED AND TWO AND ONE-HALF MILES SOUTHWEST OF SEVILLO, ANOTHER GOOD EXPOSURE OCCURS. THE FOREST SOILS ARE WELL DISPLAYED AND A DARK, STICKY TILL UNDERLIES IT. THE TYPICAL GUMBO, HOWEVER, IS NOT PRESENT.

SECTION OF KANSAN DRIFT

S.W. CORNER, SECTION 32, T. 118 N., R. 48 W.
ROAD CUT AT THE NORTHEAST CORNER OF ROAD INTERSECTION.

2½ FEET	PRAIRIE SOIL. SILTY WITH SOME PEBBLES AND ONE GRAVEL PATCH ACROSS WHICH SOIL HAS BEEN FORMED; BLACK AT THE TOP, GRADING INTO BROWN BELOW; TYPICAL COLUMNAR JOINTING.
1 FOOT	SAND AND FINE GRAVEL WITH PROMINENT STRATIFICATION.
1 FT. 8 IN.	"FOREST SOIL". LIGHT, ASHY GRAY, SILTY MATERIAL; ONE COMPACTED WITH COLUMNAR JOINTING; TYPICAL OF SOILS AND FULL OF ABUNDANT ROOT MARKS AND LEAF IMPRESSIONS; PSEUDO-BEDDING.
4 FEET	TILL. DARK BROWN AND STICKY; PEBBLES PRESENT, BUT NOT ABUNDANT; NO CHALK OBSERVED, BUT PROBABLY LOST BY LEACHING; DOLOMITES, IGNEOUS AND METAMORPHIC ROCK INCLUDED IN THE PEBBLES; BOTH FRESH AND ROTTEN IGNEOUS PEBBLES ARE PRESENT.

ONE MILE NORTH OF TWIN BROOKS TWO DRIFTS ARE EXPOSED IN A ROAD CUT. THE LOWER OF THESE HAS ALL THE EARMARKS OF KANSAN TILL AND THE UPPER IS EVIDENTLY THE YOUNGER WISCONSIN SHEET. AN UNDULATING CONTACT, IN THE HOLLOWS OF WHICH OCCUR SMALL PATCHES OF SAND AND GRAVEL, SEPARATES THE TWO. AT THIS POINT THE FOLLOWING SECTION WAS MEASURED.

SECTION OF KANSAN DRIFT

N.W. CORNER, SECTION 120 N., R. 50 W.

1 FT. 8 IN.	BLACK PRAIRIE SOIL. NON-CALCAREOUS; GRADING INTO:-
1 FT. 6 IN.	MORE CALCAREOUS BROWN SOIL, PARTLY LEACHED, BUT WITH SAME COLUMNAR JOINTING AS THE BLACK SOIL.

2 FT. YELLOW CALCAREOUS TILL; LIES ON WAVY SURFACE WITH STONY OR GRAVELLY SPOTS IN HOLLOWS OF THE CONTACT.

4 FT. TILL. DENSE, DARK BROWN, COLUMNAR JOINTING. STICKY BUT NOT GUMBO TILL. PARTLY LEACHED. ONE PEBBLE OF MUCH WEATHERED CHALK NOTED. VEINS AND STRINGERS OF SECONDARY CALCITE THROUGHOUT THE OUTCROP.

NOTE: THE DEGREE OF OXIDATION AND LEACHING OF THIS LOWER TILL INDICATES THAT IT IS NEAR THE TOP OF THE KANSAN DRIFT.

A FOURTH OUTCROP WAS NOTED A MILE SOUTH OF STOCKHOLM. THESE OUTCROPS ARE FAR ENOUGH APART TO SHOW THAT THE KANSAN ICE SHEET COVERED THE ENTIRE COUNTY AND ITS DEPOSITS MUST HAVE MANTLED THE ENTIRE TOPOGRAPHY BEFORE THE COMING OF THE LATER ICE SHEETS. THIS FACT IS FURTHER STRENGTHENED BY THE OCCURRENCE OF KANSAN DRIFT IN THE VICINITY OF LAKE KAMPESKA IN CODINGTON COUNTY, WEST OF GRANT COUNTY.[1]

THE IOWAN DRIFT SHEET:

THE IOWAN DRIFT IS EXPOSED ONLY IN THE PANHANDLE OF GRANT COUNTY, WEST OF THE ANTELOPE VALLEY, WHERE IT COVERS AN AREA OF LESS THAN FOUR TOWNSHIPS (BLOOMING VALLEY, FARMINGTON, LURA AND MAZEPPA). IT APPEARS AS A THIN SHEET OF TILL SPREAD OVER AN OLD, WELL-DRAINED TOPOGRAPHY. THE DRIFT DISPLAYS A SMOOTH UNDULATING SURFACE, CHARACTERIZED BY BROAD OPEN VALLEYS WITH GENTLE BLUFFS AND INDEFINITE CHANNELS. SWAMPS AND LAKES, SO ABUNDANT ON THE YOUNGER DRIFT TO THE EAST AND WEST OF THIS AREA, ARE CONSPICUOUS BY THEIR ABSENCE. THE TILL AT THE SURFACE IS NOT AS STONY AS IS THE TILL OF THE YOUNGER DRIFT. THERE ARE NO SHARP RIDGES OR HILLS OF DRIFT, SUCH AS CHARACTERIZE THE TERMINAL MORAINES OF THE YOUNGER DRIFT SHEET, AND NO GRAVEL HILLS (KAMES OR ESKERS) BREAK THE SMOOTH SURFACE OVER THE ENTIRE OUTCROP.

THESE FEATURES ARE CHARACTERISTIC OF THE IOWAN DRIFT WHERE IT OCCURS IN MINNESOTA AND IOWA.[2] THE ABUNDANT GRAVELS, CHARACTERISTIC OF IOWAN DRIFT IN OTHER PLACES, ARE NOT PRESENT IN GRANT COUNTY. LARGE DEPOSITS OF GRAVEL OCCUR IN THE BIG SIOUX VALLEY AND IN THE ANTELOPE VALLEY, BUT THESE ARE THE PRODUCTS OF THE WISCONSIN ICE SHEET.

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1. LEVERETT, FRANK, U.S. GEOL. SURV. PROF. PAPER 161, MAP ON PAGE 58, 1932.
2. LEVERETT, FRANK, U.S. GEOL. SURV. PROF. PAPER 161, PAGE 23, 1932. DARMAN, ERNEST J., FURTHER STUDIES ON PLEISTOCENE GEOLOGY OF NORTHWESTERN IOWA, ANNUAL REPORT FOR 1929, IOWA GEOL. SURV. VOL. 35, PAGE 40.

THE WISCONSIN DRIFT SHEET:

THIS SHEET OF DRIFT FORMS THE SURFACE OF MOST OF THE COUNTY, THE VARIOUS DETAILS OF TOPOGRAPHY BEING LARGELY DUE TO IRREGULARITIES IN ITS DEPOSITION. THE SMOOTH AREAS OF THE LOWLAND AND ON THE FACE OF THE COTEAU ARE WISCONSIN TILL PLAINS, OFTEN CALLED GROUND MORAINES. THE ROUGH AREAS ARE IRREGULAR PILES THE WISCONSIN DRIFT FORMED AS THE ICE FRONT HALTED IN ITS EASTWARD RETREAT. THESE ARE THE TERMINAL MORAINES OF THE GEOLOGIST.

THE WISCONSIN GLACIER MOVED INTO THE COUNTY FROM THE EAST, CLIMBED THE COTEAU HIGHLANDS TO THE APPROXIMATE LOCATION OF THE ANTELOPE VALLEY. AFTER A LONG PAUSE HERE, THE INCREASING HEAT MELTED THE ICE SO RAPIDLY THAT THE FRONT RETREATED EASTWARD FASTER THAN THE NEW ICE WAS FURNISHED BY THE GLACIER. THE FRONT THUS RETREATED EASTWARD OFF THE COTEAU AND ACROSS THE LOWLAND, HALTING THREE TIMES, BEFORE IT LEFT THE COUNTY ALL TOGETHER.

AT THE SAME TIME A TONGUE OF ICE, WHICH WAS MOVING DOWN THE JAMES VALLEY, SPREAD EASTWARD ONTO THE COTEAU AND REACHED THE EXTREME SOUTHWEST CORNER OF THE PANHANDLE OF GRANT COUNTY, WHERE IT WAS HALTED AND FINALLY RETREATED DUE TO EXCESSIVE MELTING, AS THE ICE FROM THE EASTERN LOBE HAD DONE. ONLY FIVE SQUARE MILES OF GRANT COUNTY ARE COVERED WITH THE DRIFTS OF THIS JAMES VALLEY GLACIER.

WITH THIS GENERAL PICTURE IN MIND IT WILL BE POSSIBLE TO DESCRIBE BRIEFLY THE DETAILS OF THE WISCONSIN DRIFT SHEET. FOR CONVENIENCE THEY CAN BE DIVIDED INTO MORAINIC AND OUTWASH DEPOSITS. THE FORMER WILL INCLUDE THE GROUND AND TERMINAL MORAINES WHICH ARE LARGELY BOULDER CLAY (TILL), AND THE LATTER WILL INCLUDE THE SANDS AND GRAVELS WHICH WERE DEPOSITED AT THE ICE FRONTS AT VARIOUS STAGES DURING ITS RETREAT ACROSS THE COUNTY.

ALTAMONT MORAINE:

THE EASTERN EXTENSION OF THE GLACIER IN THE JAMES VALLEY IS MARKED BY A SHARP RISE FROM THE GENTLE UNDULATIONS OF THE IOWAN DRIFT SURFACE TO A ROUGH TOPOGRAPHY WHICH COVERS SECTIONS 17, 18, 19, 20 OF TOWNSHIP 120 NORTH, RANGE 52 WEST (LURA TOWNSHIP). THIS IS A SMALL AREA BUT IS PART OF A VERY LARGE TERMINAL MORAINE WHICH EXTENDS INTO CODINGTON AND DAY COUNTIES AND HAS BEEN CALLED THE ALTAMONT MORAINE, BECAUSE IT IS THE OUTER MORAINE OF THE WISCONSIN ICE SHEET.[1]

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1. CHAMBERLIN, T. C., U.S. GEOL. SURV. THIRD ANNUAL REPORT, PP. 378-386, 393; 1883.

THE DOMINANT FEATURE OF THE WISCONSIN DRIFT IN GRANT COUNTY IS THAT PART OF THE ALTAMONT TERMINAL MORAINE WHICH WAS FORMED WHEN THE WISCONSIN ICE TONGUE, WHICH MOVED IN FROM MINNESOTA, REACHED THE TOP OF THE COTEAU ESCARPMENT. THIS GREAT MORAINE IS CHARACTERIZED BY AN EXCEEDINGLY ROUGH SURFACE IN WHICH KETTLE-LIKE HOLLOWS, CARRYING LAKES AND SWAMPS, ABOUND. THEY ARE SURROUNDED BY A MASS OF KNOBBY, BOULDER-COVERED HILLS AVERAGING 50 FEET IN HEIGHT. THIS MORAINE COVERS MOST OF TROY TOWNSHIP (T.118 N., R. 50 W.), IN THE SOUTHWESTERN PART OF THE COUNTY, AND TRENDS NORTHWEST IN A BELT TWO TO FOUR MILES WIDE, LEAVING THE COUNTY AT THE CITY OF SUMMIT. THE MORAINE FORMS THE CREST OF THE COTEAU ESCARPMENT AND RISES ABOVE THE TOPOGRAPHY BOTH EAST AND WEST OF IT. ITS ELEVATION AT SUMMIT IS APPROXIMATELY 2050 FEET WHICH IS 100 FEET ABOVE THE IOWAN DRIFT TO THE WEST. BOTH ITS SIZE AND THE LARGE AMOUNTS OF GRAVEL WHICH LINE ITS FRONT INDICATE THAT THE ICE STOOD AT THIS LOCATION FOR A LONG TIME. THIS STRONG MORAINE CAN BE TRACED CONTINUOUSLY SOUTHWARD FROM GRANT COUNTY THROUGH THE TOWN OF ALTAMONT, SOUTH DAKOTA, FROM WHICH IT DERIVES ITS NAME.

THOUGH THE ALTAMONT MORAINE REPRESENTS THE LONGEST STAND OF ICE, IT IS NOT THE EXTREME WESTWARD LIMIT OF ICE ADVANCE ALONG THE COTEAU ACCORDING TO DR. LEVERETT.[1] AN INDEFINITE MORAINE LIES IMMEDIATELY IN FRONT OF THE ANTELOPE VALLEY SOUTH OF GRANT COUNTY. THIS MORAINE IS CALLED THE BEMIS MORAINE AND REPRESENTS A STAND OF THE WISCONSIN ICE FRONT WHICH WAS OF SHORT DURATION. THE MAIN STAND WAS ALONG THE ALTAMONT MORAINE. THE BEMIS MORAINE IS DEVELOPED AS A WEAK BUT DISTINCT TOPOGRAPHIC FEATURE IN CODINGTON COUNTY WHERE IT IS REPRESENTED BY STONY KNOBS AND RIDGES AND GRAVEL HILLS SOUTH OF PUNISHED WOMAN'S LAKE. THE LANDMARK, KNOWN AS PUNISHED WOMAN'S MOUND, IS ONE OF THESE HILLS.

IN GRANT COUNTY, HOWEVER, THESE FEATURES HAVE ENTIRELY DISAPPEARED AND THE DIVISION BETWEEN THE WISCONSIN AND IOWAN DRIFT SHEETS IS VERY INDISTINCT. JUDGING FROM THE TOPOGRAPHY, THE LINE OF SEPARATION BETWEEN THESE DRIFTS IN THE PANHANDLE OF GRANT COUNTY, SHOULD BE PLACED AT THE WESTERN EDGE OF THE ANTELOPE VALLEY. A SMALL AREA OF ROUGH TOPOGRAPHY ON THE WESTERN SIDE OF THE ANTELOPE VALLEY IMMEDIATELY SOUTH OF CROOKED LAKE IS THE ONLY SUGGESTION OF THE BEMIS MORAINE IN GRANT COUNTY.

GARY MORAINE:

A SECOND MORAINE PARALLELING THE ANTELOPE MORAINE LIES TWO MILES EAST OF IT AND ABOUT 400 FEET LOWER ON THE COTEAU

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1. LEVERETT, FRANK, U.S.G.S. PROFESSIONAL PAPER 161, P. 57.

ESCARPMENT. IT IS CALLED THE GARY MORAINE BECAUSE A MORAINE WITH A SIMILAR RELATION TO THE ALTAMONT MORAINE PASSES THROUGH THE TOWN OF GARY, SOUTH DAKOTA. "THE GARY MORAINE IS NAMED BY CHAMBERLIN FROM GARY, SOUTH DAKOTA. IT IS COMBINED WITH THE ALTAMONT MORAINE IN ROBERTS AND GRANT COUNTIES, SOUTH DAKOTA, THE COMBINED BREADTH BEING SIX TO EIGHT MILES, ABOUT HALF OF WHICH PROBABLY PERTAINS TO THE GARY MORAINE."[1] IN THE NORTHERN PART OF THE COUNTY THE GARY MORAINE SHOWS AS A BELT OF DECIDEDLY ROUGH TOPOGRAPHY ALMOST A MILE IN WIDTH, AND IS EASILY TRACED THROUGH MARVIN, BUT IT BECOMES VERY INDEFINITE SOUTH OF TWIN BROOKS, AND ITS LOCATION IN THE SOUTHERN PART OF THE COUNTY CAN BE TRACED ONLY BY PATCHES OF LOW HILLS WHICH ARE COVERED BY AN UNUSUAL NUMBER OF BOULDERS.

MILBANK MORAINE:

WERE IT NOT PERSISTENT FOR SUCH A LONG DISTANCE, THE PARTS OF THE MILBANK MORAINE WOULD DOUBTLESS BE CONSIDERED AS DETAILS OF THE GROUND MORAINE RATHER THAN A TERMINAL MORAINE. THIS MORAINE OCCURS AS A LOW RIDGE RISING TWENTY TO FIFTY FEET ABOVE THE SURROUNDING PLAINS. ITS SUMMIT IS HUMMOCKY. THE MORAINE IS NOT CONTINUOUS BUT OCCURS IN RIDGES TWO TO FIVE MILES LONG AND ONE-QUARTER TO ONE-HALF MILE IN WIDTH. SINCE THESE RIDGES ALL TREND IN THE SAME DIRECTION AND LIE VERY NEARLY IN A LINE, IT IS EVIDENT THAT THEY REPRESENT A TEMPORARY HALT IN THE ICE FRONT AS IT RETREATED ACROSS THE COUNTY. THIS IS A MINOR MORAINE AND PROBABLY CANNOT BE TRACED ANY DISTANCE OUTSIDE OF GRANT COUNTY.

ANTELOPE MORAINE:

THE ANTELOPE MORAINE IS THE EASTERNMOST TERMINAL MORAINE IN GRANT COUNTY. ITS MOST CONSPICUOUS PORTION IS A HIGH RIDGE, SEVEN MILES EAST AND TWO MILES SOUTH OF MILBANK, KNOWN AS MOUNT TOM. FROM THIS BALD GRAVEL HILL, A RIDGE ONE-QUARTER OF A MILE IN WIDTH AND STANDING BOLDLY 50 TO 100 FEET ABOVE THE SURROUNDING TILL PLAIN, TRENDS SOUTHEASTWARD INTO MINNESOTA WHERE, IN THE SOUTHWESTERN PART OF LAC QUI PARLE COUNTY, IT IS GIVEN THE NAME OF THE ANTELOPE HILLS BY THE SETTLERS. FROM THIS SECTION CHAMBERLIN GAVE THE NAME ANTELOPE TO THE ENTIRE MORAINE.[2]

DR. LEVERETT SAYS, "THE NORTHWEST END OF THE DISTINCT MORAINE IS A RANGE OF GRAVELLY HILLS IN EASTERN GRANT COUNTY,

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1. LEVERETT, FRANK, OP. CIT., P. 75.
2. CHAMBERLIN, T. C., U.S. GEOL. SURVEY THIRD ANNUAL REPORT, PP. 388-394, 1883.

SOUTH DAKOTA, KNOWN AS THE MOUNT TOM RANGE, ANTICLINES FROM THE NORTH FORK OF THE YELLOW BANK RIVER TO THE SOUTH FORK, A DISTANCE OF TWO OR THREE MILES AND HAS A GENERAL WIDTH OF SCARCELY A HALF OF A MILE... IT IS A DISTINCT MORAINE FOR ONLY A SHORT DISTANCE INTO SOUTH DAKOTA, WHERE IT BECOMES MERGED WITH OTHER MORAINES."[1]

BIG STONE MORAINE:

THIS NAME WAS GIVEN BY DR. LEVERETT TO A TERMINAL MORAINE WHICH HE FOLLOWED AROUND THE SOUTHERN END OF BIG STONE LAKE FROM MINNESOTA. "IT RUNS ALONG THE SOUTHWEST SIDE OF BIG STONE LAKE IN SOUTH DAKOTA."[2] IT DOES NOT TAKE A RIDGE-LIKE FORM IN THIS REGION, BUT IS REPRESENTED BY PATCHES OF ROUGH TOPOGRAPHY WHICH LIE ON THE HIGHLAND BETWEEN LAKE BIG STONE AND THE NORTH FORK OF THE WHETSTONE RIVER.

THOUGH MOUNT TOM IS CONSIDERED THE NORTHERN END OF THE ANTELOPE MORAINE, SMALL GRAVEL OUTWASHES, KAME-LIKE HILLS AND SMALL PATCHES OF MORAINIC TOPOGRAPHY EXTENDING NORTHWARD FROM IT PAST LAKE ALBERT, CONNECT IT WITH THE BIG STONE MORAINE AT THE JUNCTION OF THE MAIN AND NORTH FORKS OF THE WHETSTONE RIVER.

GROUND MORAINES:

BETWEEN THESE FOUR TERMINAL MORAINES LIE VERY GENTLY UNDULATING DRIFT PLAINS OF THE WISCONSIN GROUND MORAINE. THE UNDULATIONS ARE SO FLAT THAT THE PLAINS GIVE THE IMPRESSION OF BEING FLAT. THIS GROUND MORAINE OFFERS AN EXCELLENT SOIL AND EASILY TILLABLE FIELDS. TO IT, THEREFORE, IS LARGELY DUE THE EXCELLENT AGRICULTURAL POSSIBILITIES OF THE COUNTY.

WISCONSIN GRAVEL DEPOSITS:

ALONG THE ENTIRE FRONT OF THE ALTAMONT MORAINE IN GRANT COUNTY, LIES A SHEET OF GRAVEL ONE TO TWO MILES IN WIDTH WHICH OCCUPIES THE DEPRESSION KNOWN AS THE ANTELOPE VALLEY. THIS SHEET OF SAND AND GRAVEL WAS WASHED INTO THE VALLEY BY WATERS FROM THE MELTING ICE WHICH SORTED THE DEBRIS THE ICE CARRIED, ACCORDING TO SIZE OF GRAIN, CARRIED THE FINE SILT AND MUD FAR AWAY AND LEFT THE COARSE SANDS AND GRAVELS BEHIND IN THE ANTELOPE VALLEY. SUCH A SHEET OF GRAVEL IS CALLED AN OUTWASH PLAIN BECAUSE IT FORMS A GENTLY SLOPING FLAT IN FRONT OF THE MORAINE.

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1. LEVERETT, FRANK, U. S. GEOL. SURV. PROF. PAPER 161, P. 103.
2. LEVERETT, FRANK, OP. CIT., P. 105.

BLOCKS OF ICE ARE SOMETIMES TRAPPED IN THESE OUTWASHES, AND SAND AND GRAVEL FILLED AROUND AND OVER THEM. AN ICE BLOCK MAY THUS BE KEPT IN COLD STORAGE UNTIL LONG AFTER THE FRONT OF THE GLACIER HAS LEFT THE REGION. WHEN THIS BLOCK MELTS, IT LEAVES A DEPRESSION IN THE GRAVELS WHICH FILLS WITH SPRING WATER FORMING A LAKE. CROOKED LAKE, SOUTH OF TROY, IS SUCH A LAKE. TWO OTHER SMALL, UNNAMED LAKES, HAVING A SIMILAR ORIGIN LIE IN THE PAN-HANDLE SECTION OF ANTELOPE VALLEY.

THE BIG SIOUX VALLEY, WHICH CROSSES THE EXTREME WESTERN PART OF THE PANHANDLE, LIES IN A BROAD GRAVEL-FILLED VALLEY WHICH SERVED AS A SPILLWAY FOR WATERS FROM THE WISCONSIN GLACIER. MUCH OF IT CAME FROM THE PART OF THE ICE FRONT WHICH LAY IN ROBERTS COUNTY THOUGH IT WAS ALSO FED BY WATERS FROM THE ICE FRONT IN THE VICINITY OF SUMMIT AND FROM THE NORTH END OF THE ANTELOPE VALLEY. ONE CHANNEL BORDERING THE ALTAMONT MORAINE AT SUMMIT, CARRIED WATER PAST THIS CITY AND EASTWARD INTO THE BIG SIOUX WHILE ANOTHER CHANNEL, BEGINNING AT THE NORTHERN END OF THE ANTELOPE VALLEY, FOUR MILES WEST OF MARVIN, CARRIED WATER DIRECTLY SOUTHWEST INTO THE SOUTHERN PORTION OF THE BIG SIOUX SPILLWAY. THE DEPOSITS OF GRAVEL FORMED IN SUCH SPILLWAYS ARE KNOWN AS VALLEY TRAINS. THE VALLEY TRAIN OF THE BIG SIOUX COVERS AN AREA OF ABOUT 25 SQUARE MILES IN GRANT COUNTY.

NEAR THE BASE OF THE COTEAU ESCARPMENT, SMALL GRAVEL PATCHES AND MINIATURE OUTWASHES ARE COMMON BUT NO GREAT VOLUME OF GRAVEL WAS DEVELOPED. SOME OF THE LARGER OF THESE DEPOSITS ARE INDICATED ON THE ACCOMPANYING MAP.

THE STAND WHICH THE ICE MADE AT THE ANTELOPE AND BIG STONE MORAINES FORMED SOME LARGE DEPOSITS IN THE EASTERN PART OF THE COUNTY. THE NORTHERN END OF THE ANTELOPE MORAINE, MOUNT TOM, IS COMPOSED OF ENORMOUS HILLS OF GRAVEL AND SMALLER HILLS CAN BE FOUND SPRINKLED OVER THE GRANITE AREA BETWEEN MOUNT TOM AND LAKE ALBERT. SOME DEPOSITS ARE ALSO TO BE FOUND ALONG THE WHETSTONE CREEK IN FRONT OF THE ANTELOPE MORAINE. THESE HILLS SHOULD BE CLASSED AS KAMES AS THEY ARE EVIDENTLY PILES OF GRAVEL FORMED BY STREAMS FLOWING OFF THE FRONT OF THE ICE.

THE GRAVEL OUTWASH FILLS THE VALLEY OF THE NORTH FORK OF WHETSTONE RIVER FROM THE NORTH COUNTY LINE TO LAKE ALBERT AND DOWN THE MAIN VALLEY OF THE WHETSTONE RIVER FROM ITS JUNCTION WITH THE NORTH FORK TO THE BIG STONE VALLEY. AT THE JUNCTION OF THE MAIN AND NORTH FORKS, THE OUTWASH COVERS A LARGER AREA THAN IT DOES FARTHER NORTH OR SOUTH, OCCUPYING NEARLY FOUR SQUARE MILES. THE OUTWASH CAN BE TRACED AROUND THE GRANITE AREA THROUGH THE BIG BEND OF THE YELLOW BANK RIVER, NORTH OF MOUNT TOM.

THE ONLY OTHER LARGE VOLUME OF GRAVEL OCCURS IN A LONG RIDGE OR ESKER TWO MILES SOUTHEAST OF REVILLO. THIS RIDGE CAN BE FOLLOWED FOR MORE THAN TWO MILES. IT IS ABOUT 500 FEET ACROSS AT THE BASE AND 30 TO 50 FEET HIGH. THIS IS THE ONLY LARGE ESKER IN GRANT COUNTY AND OWES ITS EXISTENCE TO A LARGE STREAM OF WATER WHICH FLOWED THROUGH A CREVASS IN THE GLACIER, FILLING IT WITH SAND AND GRAVEL WHICH WAS LEFT AS A RIDGE AFTER THE ICE MELTED.

THE DEPOSITS OF THE WISCONSIN GLACIER ARE THE YOUNGEST ROCKS IN THE COUNTY AND ARE THE LEAST HARDENED OF THE THREE GREAT GROUPS MENTIONED AT THE BEGINNING OF THIS DESCRIPTION. THEY CONSIST OF LOOSE GRAVEL, SAND, SILT AND CLAY WHILE THE UNDERLYING CRETACEOUS MARINE STRATA ARE COMPOSED OF SHALES, LIMESTONES, AND SANDSTONES, AND THE OLDEST OR BASEMENT ROCKS ON WHICH THE TWO OTHERS LIE ARE COMPOSED OF THE TOUGHEST AND DENSEST ROCKS KNOWN.

V. ECONOMIC GEOLOGY

THE MINERAL RESOURCES OF GRANT COUNTY INCLUDE BUILDING AND STRUCTURAL MATERIALS, WATER SUPPLIES AND SOILS.

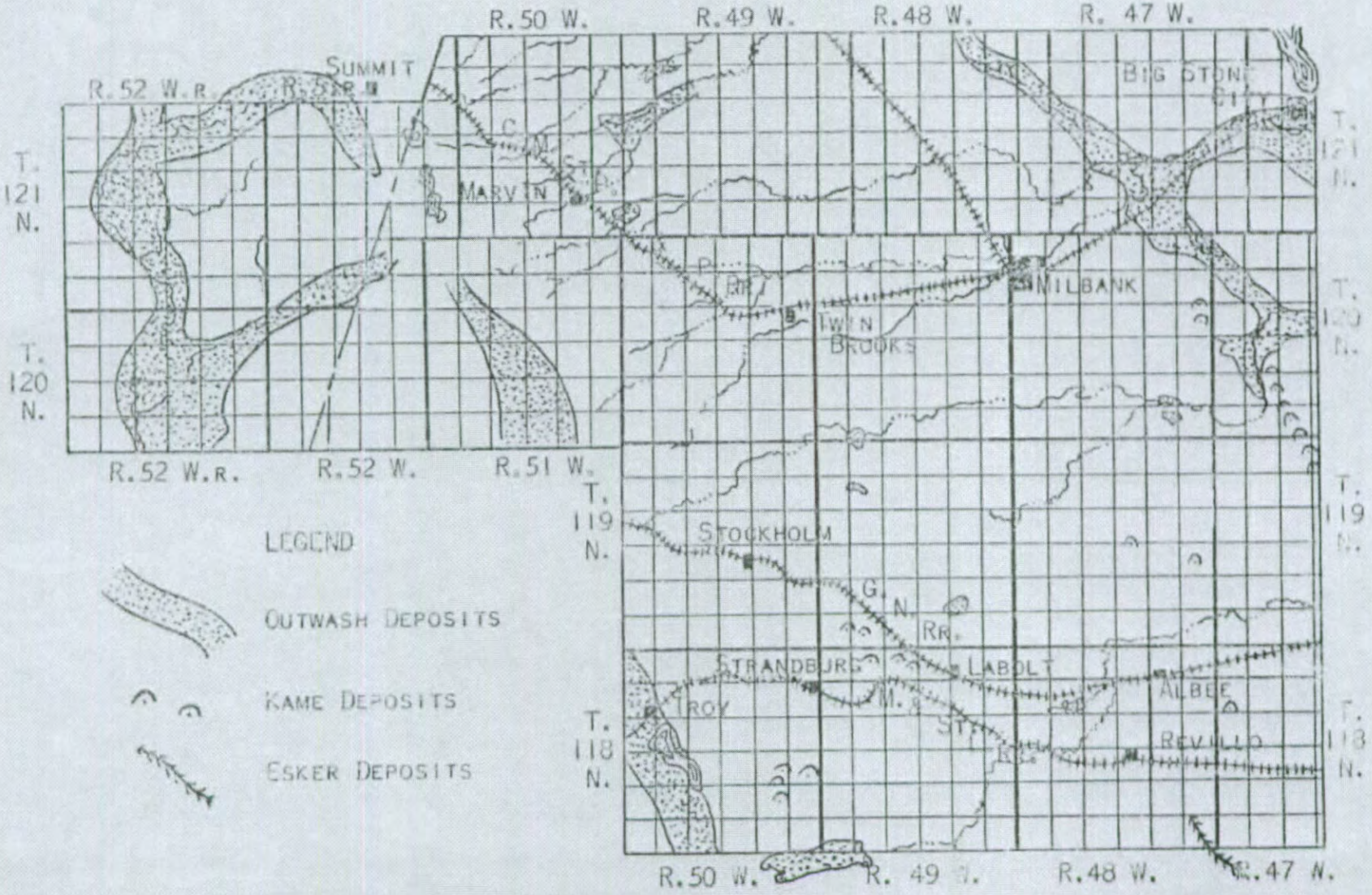
GRANITE

GLACIAL BOULDERS, OR FIELD STONES AS THEY ARE SOMETIMES CALLED, ARE ABUNDANT ESPECIALLY ON THE TERMINAL MORAINES. THEY CONTAIN A GREAT VARIETY OF ROCKS AND CAN BE DRESSED FOR BUILDING BLOCKS. THIS STONE HAS BEEN USED EFFECTIVELY IN WALLS AND SMALL BUILDINGS WHERE A VARIETY OF COLORS WAS DESIRED, BUT CAN NEVER SUPPLY MORE THAN A LOCAL MARKET BECAUSE OF THE EXPENSE INVOLVED IN COLLECTING SCATTERED BOULDERS.

THE STONE INDUSTRY IN GRANT COUNTY WILL DEPEND UPON THE DEVELOPMENT OF THE GRANITE WHICH OUTCROPS FOUR MILES EAST OF MILBANK AND HAS BEEN DESCRIBED ON PAGE 15 OF THIS REPORT. THIS GRANITE IS THE BASIS FOR ONE OF THE MOST IMPORTANT OF SOUTH DAKOTA'S MINERAL INDUSTRIES AND SHOULD CONTINUE TO HOLD THIS PLACE. THE STONE IS NOW QUARRIED FOR ORNAMENTAL STONE, BUT WILL SERVE EQUALLY WELL FOR BUILDING STONE, RIPRAP, OR CONCRETE AGGREGATE SHOULD OCCASION DEMAND. IT HAS A DARK MAHOGANY COLOR AND TAKES A POLISH WHICH MAKES IT ESPECIALLY VALUABLE AS AN ORNAMENTAL STONE. IT HAS SUFFICIENT JOINTING TO ASSIST IN THE QUARRYING, BUT THE CRACKS ARE FAR ENOUGH APART TO ALLOW THE REMOVAL OF LARGE BLOCKS. IT HAS BEEN USED EFFECTIVELY FOR SOME VERY DISTINCTIVE PUBLIC MEMORIALS, NOTABLY THE STATUTE OF PATRIOTISM BY PAUL BARTTLETT AT DULUTH, MINNESOTA AND THE LARGE COLUMNS IN THE NATIONAL CATHOLIC SHRINE AT WASHINGTON, D. C.

THE FIRST QUARRYING OF THIS STONE WAS DONE BY MR. GUST SWANSON, STONE MASON, WHO USED THE ROCK FOR TOP STONE FOR BUILDING FOUNDATIONS. REAL QUARRYING BEGAN ABOUT 1908 WHEN ROBERT HUNTER ERECTED THE FIRST LARGE DERRICK AND OPENED A COMMERCIAL QUARRY. THE FIRST DIMENSION STONE QUARRIED IN SOUTH DAKOTA WAS USED IN THE STATE CAPITOL BUILDING AT PIERRE. IN 1933 THE ORIGINAL HUNTER COMPANY WAS STILL IN EXISTENCE AND WAS OPERATING TWO QUARRIES AND A MODERN FINISHING PLANT. FOUR OTHER COMPANIES, MOST OF WHICH HAD STARTED SINCE 1920, WERE ALSO IN OPERATION. MILBANK GRANITE HAS BEEN SHIPPED TO NEARLY EVERY STATE IN THE UNION AND ALSO INTO CANADA.

SAND AND GRAVEL DEPOSITS OF GRANT COUNTY, SOUTH DAKOTA



THE VOLUME OF GRANITE IS SUFFICIENT FOR AS LARGE AN INDUSTRY AS MAY DEVELOP. THE DEEPEST QUARRY HAS PENETRATED THE ROCK TO A DEPTH OF ONE HUNDRED FEET WITH NO APPARENT CHANGE IN ITS CHARACTER. IT IS PROBABLE THAT THREE OR FOUR TIMES THIS DEPTH CAN BE REACHED IF NECESSARY. THE SMALL OUTCROPS WHERE THE QUARRIES HAVE BEEN OPENED COVER A VERY SMALL PART OF THE TOTAL AREA WHERE THE ROCK IS ACCESSIBLE. FOR APPROXIMATELY FIVE SQUARE MILES THE GRANITE IS OVERLAID BY A THIN MANTLE OF GLACIAL DRIFT WHICH CAN BE STRIPPED EASILY IF THE MARKET WARRANTS THE EXPENSE. THE OUTCROP IN THE WHETSTONE VALLEY, A MILE SOUTHWEST OF BIG STONE CITY, OFFERS ANOTHER POSSIBILITY, THOUGH THE AREA OF EXPOSED ROCK IS NOT VERY EXTENSIVE AND THE DRIFT COVER OUTSIDE OF THE VALLEY IS PROBABLY TOO THICK TO STRIP ECONOMICALLY. WITH THIS ENORMOUS VOLUME OF GRANITE AS A RESOURCE IT SHOULD BE POSSIBLE TO MAINTAIN A LARGE PRODUCTION FOR A GREAT MANY YEARS.

SAND AND GRAVEL

THE DEVELOPMENT OF THESE MATERIALS HAS NOT YET BEGUN IN GRANT COUNTY. THE GRAVELING OF HIGHWAYS HAS OPENED A FEW ROADSIDE PITS AT ADVANTAGEOUS PLACES, BUT THERE HAS BEEN NO ATTEMPT AT COMMERCIAL PRODUCTION. LARGE AMOUNTS OF GRAVEL COULD BE PRODUCED, HOWEVER, IF THE DEMAND WERE CREATED.

ALL GRAVEL IS OF GLACIAL ORIGIN, AND THE SORTING, THEREFORE, IS VERY IMPERFECT. SCREENING AND WASHING, HOWEVER, CAN OVERCOME THIS DIFFICULTY. THE PERCENTAGE OF SOFT MATERIALS, SUCH AS CHALK, SHALE, AND IRON IN THE GRAVEL IS NOT EXCESSIVELY HIGH IN MOST DEPOSITS. NEARLY ALL OF THE DEPOSITS LIE UNDER A COVER OF SILT, WHICH WILL HAVE TO BE REMOVED. THE DEPTH OF THE COVER VARIES SO MUCH THAT NO GENERALIZATION CAN BE MADE, BUT IT IS SAFE TO SAY THAT STRIPPING WILL BE NEEDED ON ALL DEPOSITS, AND MOST OF IT WILL BE THREE FEET OR MORE FOR DEPOSITS OF COMMERCIAL SIZE.

IN THE SHORT TIME AVAILABLE FOR THIS INVESTIGATION, IT WAS NOT POSSIBLE TO DETERMINE THE AMOUNTS OF GRAVEL IN THE VARIOUS DEPOSITS. A LITTLE INFORMATION WAS AVAILABLE ON THE DEPTH AND CHARACTER OF MATERIALS WHERE PITS HAD BEEN OPENED, BUT MOST OF THE DEPOSITS CONTAINED NO SUCH OPENING. THE INFORMATION AT HAND, HOWEVER, SHOWS THE YARDAGE IN SOME OF THESE DEPOSITS MUST BE RECKONED IN THE MILLIONS. THE GREAT VOLUMES AND VARIED CHARACTER OF THE DEPOSITS MAKE IT NECESSARY TO GIVE EACH A CAREFUL INVESTIGATION IF IT IS TO BE USED FOR COMMERCIAL PRODUCTION.

A SHORT DESCRIPTION OF THE LARGER DEPOSITS IS ALL THAT CAN BE ATTEMPTED IN THIS REPORT.

Coteau Gravels:

The large deposits of the Coteau offer an especially good opportunity for gravel production. These occur in three locations, namely: the Big Sioux Spillway, the Antelope Valley, and at the base of the Coteau escarpment.

The Big Sioux Spillway:

The Big Sioux Spillway probably contains the largest deposits of gravel in the county, for it extends north and south across the entire panhandle, a distance of eleven miles, and has an average width of about two miles. This spillway was the outlet for waters which flowed from the ice front while it stood over the Altamont Moraine. These waters carried enormous amounts of sand and gravel which eventually choked the spillway channel. Two tributary spillways, which are also gravel-filled, come from the Antelope Valley, trend in a southwesterly direction and join the Big Spillway. The combined area of these spillways is about twenty-four square miles. In this area gravels and sands are to be found under the flats and the swampy lowland, bordering the Big Sioux River, and also on terraces higher up on the bluff. The gravel is covered by silt in most places to a depth of several feet, but is exposed at many places by road cuts where the highways ascend from the lower flats onto the terraces. A few pits are opened and these throw some light on the thickness of the gravels.

Six feet of gravel were exposed in a pit on the north side of the county line, four miles east of Summit (S. W. Corner, Section 36, T. 122 N., R. 52 W., Res.). Seven miles south of this pit a road cut showed six to ten feet of gravel under two feet of silt cover (S.W. Corner, Section 1, T. 120 N., R. 52 W., Res.). A cut bank one and one-half miles southwest of this last pit, in the middle of the spillway, exposed eight feet of gravel, covered by four feet of silt. Six feet of gravel were also exposed on the west bank of Big Sioux Channel at the south county line. In no case was the bottom of the gravel exposed, but it is probable that its thickness exceeds ten or fifteen feet.

Antelope Valley Gravels:

The Antelope Valley, which lies in front of the Altamont Moraine, is filled with outwash. Only a small part of this outwash (11 square miles) lies in Grant County. This valley offers some excellent opportunities for gravel prospecting, however, since it is crossed at its southern end

BY THE MINNEAPOLIS AND ST. LOUIS RAILWAY WITH THE TOWN OF TROY LOCATED AT THE EASTERN EDGE OF THE OUTWASH. FEW PITS WERE OPENED AND NO OTHER OPPORTUNITIES WERE OFFERED FOR OBTAINING FIGURES FOR THE DEPTH OR CHARACTER OF THE GRAVEL. ONE EXPOSURE, TWO MILES SOUTH OF TROY, SHOWED MORE THAN SIX FEET OF GRAVEL UNDER A COVER OF ONE FOOT OF SILT.

ALONG THE SOUTH LINE OF THE COUNTY IS A LARGE GRAVEL-FILLED VALLEY, WHICH EMPTIES INTO THE ANTELOPE VALLEY AT ROUND LAKE. PART OF THIS VALLEY IS IN GRANT COUNTY, AND PART IN CODINGTON. IT IS, THEREFORE, INCLUDED WITH THE GRANT COUNTY GRAVELS. AT ITS EASTERN END A STREAM HAS CUT DEEPLY INTO THE VALLEY FILL, EXPOSING MORE THAN TWENTY FEET OF SAND AND GRAVEL.

THE NORTH END OF THE ANTELOPE VALLEY LIES IN THE PANHANDLE, AND WAS TRACED FOR ABOUT FIVE MILES FROM THE SOUTH COUNTY LINE. IT REACHES A WIDTH OF TWO MILES. GRAVEL APPEARS IN NUMEROUS ROAD CUTS, BUT NO PITS OR OTHER OPENINGS WERE DISCOVERED. IT IS SAFE TO ASSUME THAT THE GRAVEL IN THIS END WILL CORRESPOND IN DEPTH AND QUALITY TO THAT FOUND IN THE SOUTHERN SECTION, WHICH HAS JUST BEEN DESCRIBED.

GRAVELS OF THE COTEAU ESCARPMENT:

THE TERMINAL MORAINES (ALTAMONT AND GARY) CONTAIN MANY SMALL POCKETS AND HILLS (KAMES) OF GRAVEL, BUT NO LARGE DEPOSITS SUFFICIENT FOR COMMERCIAL PRODUCTION.

LARGER DEPOSITS DO OCCUR ALONG THE LOWER SLOPE AND BASE OF THE ESCARPMENT, HOWEVER. SOME OF THE LARGEST OF THESE HAVE BEEN INDICATED ON THE ACCOMPANYING GRAVEL MAP. THOUGH THEY ARE TOO SMALL FOR COMMERCIAL PRODUCTION, THEY WILL SERVE WELL FOR LOCAL USE SUCH AS CONCRETE CONSTRUCTION ON NEIGHBORING FARMS AND FOR GRAVELING LOCAL HIGHWAYS. THE THREE FOLLOWING EXAMPLES WILL GIVE AN IDEA OF THE SIZE AND CHARACTER OF THESE DEPOSITS.

(1) A SMALL OUTWASH CONTAINING 50,000 TO 100,000 CUBIC YARDS OCCURS AT THE BASE OF THE COTEAU ESCARPMENT AT THE EAST QUARTER CORNER, SECTION 14, T. 121 N., R. 50 W. A PIT OPENED IN THIS DEPOSIT SHOWED:

1 FT. BROWN SOIL COVER
10 FT. MEDIUM TO COARSE GRAVEL; MOSTLY OF HARD MATERIALS PERCENTAGE OF OVERSIZE SMALL (5-10%); SOME BOULDERS SCATTERED THROUGH THE DEPOSIT; SAND MATRIX NOT OVER 40 OR 50%.

(2) A SECOND DEPOSIT WAS OPENED ON THE NORTH BLUFF OF A TRIBUTARY TO YELLOW BANK CREEK IN SECTION 8, T. 119 N., R. 49 W. THIS WAS APPARENTLY DEPOSITED BY WATER RUNNING OFF THE COTEAU ESCARPMENT. THE TOTAL DEPOSIT CONTAINS SOME 30,000 CUBIC YARDS OF PATCHY MATERIAL, BUT A PIT FROM WHICH 4,000 OR 5,000 YARDS HAD BEEN REMOVED SHOWED THE FOLLOWING SECTION:

½ TO 2 FT.	BLACK SOIL AND SOD COVER
6 FT.	MEDIUM GRAVEL, YELLOW AND POORLY SORTED; LARGE BOULDERS ONE TO TWO FEET IN DIAMETER, ABUNDANT.
10+ FT.	YELLOW STONY TILL.

(3) ANOTHER LOCATION, TWO MILES WEST OF ALBEE IN THE NORTHEAST ONE-QUARTER SECTION 8, T. 118 N., R. 48 W., CONTAINED A VOLUME OF 10,000 TO 20,000 YARDS. IT IS A SMALL OUTWASH JUST EAST OF THE BASE OF THE COTEAU ESCARPMENT AND A SMALL PIT SHOWS THE FOLLOWING SECTION:

2 FT.	SOIL AND COVER.
6 TO 8 FT.	SAND AND GRAVEL IN ALTERNATE LAYERS; FAIRLY WELL SORTED; LITTLE OVERSIZED AND NO BOULDERS.

LOWLAND GRAVELS

WHETSTONE VALLEY GRAVELS:

THE LARGEST SAND AND GRAVEL DEPOSITS OF THE LOWLAND OCCUR IN THE EASTERN PART OF THE COUNTY AND MAY BE LOCATED ROUGHLY ALONG A LINE FOLLOWING THE NORTH FORK OF THE WHETSTONE RIVER AND PROCEEDING SOUTH ALONG THE ANTELOPE MORAINE. FROM THE JUNCTION OF THE NORTH FORK WITH THE MAIN FORK OF WHETSTONE CREEK, OUTWASH CAN BE FOLLOWED DOWNSTREAM TO ITS JUNCTION WITH THE BIG STONE VALLEY. THIS DISTRIBUTION IS DUE TO THE FACT THAT THE ANTELOPE AND BIG STONE MORAINES JOIN IN THIS REGION, AND CONSEQUENTLY FORMED A GREATER AMOUNT OF OUTWASH THAN FARTHER WEST OF THE LOWLAND. IT IS POSSIBLE THAT THE PRESENCE OF THE GRANITE SOUTH OF LAKE ALBERT AND IN THE BIG STONE VALLEY ALSO HAS SOMETHING TO DO WITH HOLDING UP THE ICE AT THIS POINT.

THE OUTWASH WHICH FILLS THE VALLEY OF NORTH FORK IS SCARCELY ONE-HALF MILE WIDE AT THE NORTH COUNTY LINE. THIS WIDTH INCREASES, HOWEVER, NEAR THE JUNCTION WITH THE MAIN VALLEY TO A

MILE AND A HALF, THE LARGEST BODY OF OUTWASH COVERING AN AREA OF ABOUT 6 SQUARE MILES. SOUTH OF THIS JUNCTION THE OUTWASH NARROWS SHARPLY AGAIN TO LESS THAN A QUARTER OF A MILE AT LAKE ALBERT. FROM THE JUNCTION, OUTWASH CAN BE FOLLOWED DOWN THE MAIN WHETSTONE VALLEY INTO THE VALLEY OCCUPIED BY BIG STONE LAKE WHERE IT JOINS GRAVEL TERRACES ON THE BLUFFS OF THE LAKE DEPRESSION. IN THIS PART OF THE WHETSTONE VALLEY, HOWEVER, THE MATERIALS OCCUR IN TERRACES ON THE VALLEY BLUFFS, WHILE IN THE VALLEY OF THE NORTH FORK AND AT THE JUNCTION, MOST OF THE GRAVEL OCCUPIES THE BOTTOMS OF THE VALLEYS OR LOW TERRACES.

THE GRAVEL REACHES A DEPTH OF MORE THAN TEN FEET IN SEVERAL OUTCROPS. NEAR THE JUNCTION OF THE TWO FORKS MENTIONED (E $\frac{1}{4}$ CORNER, SEC. 20, T. 121 N., R. 47 W.) A PIT EXPOSED TEN FEET OF GRAVEL UNDER TWO FEET OF SILT COVER. A SECOND, THREE MILES DOWNSTREAM IN THE MAIN WHETSTONE VALLEY (N.E. $\frac{1}{4}$ CORNER, SEC. 23, T. 121 N., R. 47 W.) SHOWED FIVE FEET OF SILT COVER UNDERLAID BY MORE THAN TEN FEET OF GRAVEL. AT THE BRICK PLANT ONE-HALF MILE WEST OF BIG STONE CITY, THE FOLLOWING SECTION WAS EXPOSED.

SECTION AT THE BRICK PLANT AT BIG STONE CITY

S.E.$\frac{1}{4}$, N.W.$\frac{1}{4}$, SEC. 17, T. 121 N., R. 46 W.

13 FT.	SILT. YELLOW, BANDED SOME SANDY, EVIDENTLY WATER-LAID. THESE FURNISH MATERIAL OF WHICH THE YELLOW BRICKS WERE MADE.
17 FT.	MEDIUM GRAVEL, (AVERAGING $\frac{1}{4}$ INCH) AND SAND; FAIRLY CLEAN AND COMPOSED MOSTLY OF HARD MATERIALS; NOT MUCH OVERSIZED, THOUGH ONE TO TWO-FOOT BOULDERS ARE SCATTERED THROUGH THE DEPOSITS. THE MATERIALS NOTED AS ABUNDANT AMONG THE PEBBLES WERE GRANITE-GRAY AND MAHOGANY, SCHISTS AND GNEISSES, DOLOMITES ABUNDANT, SHALE ABUNDANT IN WELL ROUNDED PEBBLES, PIPESTONE VERY SCARCE, CHALK VERY SCARCE, ONE PIECE NOTED.

NOTE: - TORRENTIAL CROSS-BEDDING INDICATES THAT THE WATER CURRENTS WHICH DEPOSITED THIS GRAVEL FLOWED EASTWARD.

KAME AND ESKER GRAVELS:

SMALL AMOUNTS OF GRAVEL CAN BE TRACED THROUGH LAKE ALBERT AND THE VALLEY WHICH CONNECTS IT WITH YELLOW BANK CREEK, BUT THESE ARE TOO SMALL FOR COMMERCIAL EXPLOITATION. THERE ARE, HOWEVER, CERTAIN HILLS OF GRAVEL WHICH ARE OF SUFFICIENT SIZE TO BE WORTH PROSPECTING. THESE HILLS ARE DOME OR BEEHIVE SHAPED. THEY VARY IN HEIGHT FROM A FEW FEET TO SEVENTY FEET, AND IN DIAMETER AT THE BASE FROM TWENTY FEET TO THREE HUNDRED FEET. THE MOST CONSPICUOUS OF THESE IS MOUNT TOM. NOT ONLY IS THIS BIG HILL MADE OF GRAVEL, BUT SAND AND GRAVEL HAVE ALSO BEEN SPREAD OUT ABOUT ITS BASE, ESPECIALLY TO THE NORTH AND WEST WHERE IT FORMS A SMALL OUTWASH SURROUNDING THE END OF THE RIDGE. GRAVEL KNOBS OCCUR OVER THE ENTIRE LENGTH OF THE ANTELOPE MORAINE IN THE COUNTY BUT APPEAR TO BE LARGER AND MORE ABUNDANT AT THE NORTHERN END.

SIMILAR BUT SMALLER HILLS ARE SCATTERED OVER THE SURFACE OF THE GRANITE OUTCROPS NORTHWEST OF MOUNT TOM. THE LARGER OF THESE HAS BEEN INDICATED ON THE ACCOMPANYING GRAVEL MAP. GRAVEL KNOBS OF THIS SORT ARE CALLED KAMES AND THOSE WHICH HAVE BEEN DESCRIBED CAN SUPPLY LARGE QUANTITIES OF GRAVEL. IF THIS MATERIAL IS CHARACTERISTIC OF THAT IN KAMES FOUND IN OTHER PARTS OF THE STATE, THE GRAVEL MAY BE PATCHY AND POORLY SORTED. BALLS AND MASSES OF CLAY MAY OCCUR IN THE DEPOSITS, ESPECIALLY THOSE ON THE END OF THE RIDGE, WHERE THE SORTING ACTION WAS NOT SO VIGOROUS AS IT WAS TO THE NORTH.

THERE IS ONLY ONE ESKER OF SUFFICIENT SIZE TO WARRANT ATTENTION HERE. IT IS A CONSPICUOUS RIDGE, TWO MILES LONG AND A FEW HUNDRED FEET ACROSS AT THE BASE. THE NORTHERN HALF LIES IN GRANT COUNTY TWO MILES SOUTHEAST OF REVILLO, AND THREE MILES WEST OF THE SOUTHEAST CORNER OF GRANT COUNTY.

THIS ESKER SHOWS THE UNDULATING CREST CHARACTERISTIC OF SOUTH DAKOTA ESKERS AND WINDS SNAKE-LIKE OVER THE TOPOGRAPHY. IT IS BROKEN INTO SEVERAL PARTS AND HAS KNOBS ON ITS CREST WHICH ARE VERY KAME-LIKE IN APPEARANCE. IT ENDS AT THE SOUTHEAST IN A GROUP OF EIGHT OR TEN LITTLE KAMES.

WHERE THE MATERIALS ARE EXPOSED, POORLY SORTED SANDS AND GRAVELS OCCUR. CLAY PATCHES AND MANY BOULDERS, ONE TO THREE FEET IN DIAMETER ARE INCLUDED. THE ENTIRE MASS IS VERY CALCARIOUS AND THE GRAVELS ARE STAINED A DEEP YELLOW BROWN BY OXIDATION OF IRON WHICH IT CONTAINS.

ON THE WHOLE THIS ESKER LOOKS LIKE A BETTER GRAVEL PROSPECT THAN IT REALLY IS. THE PATCHY CONDITION OF THE GRAVELS MAKE

THEM DIFFICULT TO EXCAVATE. THE POOR SORTING, THE OVERSIZE AND THE ABUNDANCE OF SHALE AND OTHER SOFT MATERIALS IN THE GRAVELS DOES NOT RENDER THEM OF HIGH QUALITY FOR MOST PURPOSES.

THOUGH THE TOTAL YARDAGE OF GRAVEL CONTAINED IN THE ESKER IS HIGH, THE AVAILABLE YARDAGE WILL BE COMPARATIVELY SMALL. CAREFUL PROSPECTING WILL YIELD POCKETS WHERE 5,000 TO 10,000 YARDS CAN BE EXCAVATED. PRODUCTION FROM THIS ESKER WILL BE A MATTER OF PICKING OUT ENOUGH OF THESE SMALL POCKETS TO OBTAIN THE REQUIRED AMOUNT OF GRAVEL.

CLAYS

THE EASILY ACCESSIBLE CLAYS IN GRANT COUNTY ARE OF GLACIAL ORIGIN. ALL THE DRIFTS OF THE DIFFERENT ICE SHEETS CONTAIN CLAYS WHICH MIGHT BE USED FOR BRICK OR SIMILAR PURPOSES. THE LIME CONTENT, HOWEVER, IS RATHER HIGH AND HAS A TENDENCY TO MAKE BRICK SOFT.

THE SILT OVERLYING THE GRAVELS OF THE VARIOUS OUTWASHES OFFER A BETTER SOURCE OF MATERIAL. THEY ARE MUCH BETTER SORTED, AND DO NOT CONTAIN THE PEBBLES AND SANDY MATERIAL WHICH ARE PRESENT IN THE BOULDER CLAYS. THESE SILTS HAVE BEEN USED AT BIG STONE CITY BY THE MILLER BRICK COMPANY, WHICH PRODUCES A YELLOW BRICK OF VERY GOOD QUALITY. SIMILAR SILTS COVER ALL OTHER GRAVELS IN THE WHETSTONE CREEK. THEY ARE OF VARIOUS THICKNESSES, AND DOUBTLESS COULD BE USED AT MANY PLACES. NO EFFORT WAS MADE, HOWEVER, TO DETERMINE THEIR THICKNESS OR EXTENT. THE SILTS OF THE BIG SIOUX AND ANTELOPE VALLEYS ALSO OFFER POSSIBILITES WORTH PROSPECTING.

THERE IS NO EVIDENCE THAT CLAY, SUITABLE FOR OTHER PURPOSES THAN BRICK AND TILE, WILL BE FOUND IN THE COUNTY. THOUGH THERE IS AN ABUNDANCE OF COMMON CLAYS, SPECIAL TYPES, SUCH AS FIRE CLAYS, BALL CLAY, CHINA CLAY, ETC. DO NOT OCCUR.

GOLD

GOLD HAS BEEN REPORTED FROM THE SANDS AND GRAVELS OF THIS REGION AS LONG AGO AS 1894.[1] MR. DOANE ROBINSON, FORMER STATE

---

1. TODD, J. E., SOUTH DAKOTA GEOLOGICAL SURVEY BULLETIN NO. 1, "A PRELIMINARY REPORT OF THE GEOLOGY OF SOUTH DAKOTA", P. 147, 1894.

HISTORIAN, REPORTS ITS PRESENCE NEAR GARY IN THE LAC QUI PARLE RIVER,[1] AND ATTEMPTS HAVE BEEN MADE TO MINE GOLD AT THE SOUTHERN END OF BIG STONE LAKE. IN ALL CASES THE GOLD OCCURRED IN GLACIAL GRAVELS, HAVING BEEN BROUGHT FROM VEINS OR LODES TO THE NORTHEAST. SUCH VEINS ARE KNOWN AS NEAR AS THE LAKE OF THE WOODS, AND NEAR REDWOOD FALLS, MINNESOTA.[2]

THE FINDING OF VALUABLE PLACER DEPOSITS, HOWEVER, IS VERY IMPROBABLE AS GLACIAL ICE HAS A TENDENCY TO SCATTER ITS MATERIALS TOO WIDELY. GOLD NUGGETS MAY BE FOUND FROM TIME TO TIME IN THE GRAVELS AND DRIFTS OF GRANT COUNTY, BUT SHOULD NOT AROUSE HOPE FOR AN IMPORTANT GOLD INDUSTRY.

WATER SUPPLIES

SURFACE WATER:

THE STREAMS WHICH CROSS GRANT COUNTY ARE NOT RELIABLE SOURCES OF SURFACE WATER. ALL ARE INTERMITTENT. DURING THE DRY SEASON OF 1933, EVEN THE BIG SIOUX WAS REDUCED TO POOLS AND SWAMPY PLACES IN ITS CHANNEL. WHETSTONE CREEK, THE NEXT LARGEST STREAM, WAS IN THE SAME CONDITION, AND THE SMALLER STREAMS WERE NOTHING BUT DRY CHANNELS. THIS, OF COURSE, WAS AN ABNORMAL CONDITION, BUT EVEN IN NORMAL YEARS THEY CARRY ONLY SMALL VOLUMES OF WATER. THE LARGER LAKES, HOWEVER, ARE PERMANENT. BIG STONE AND CROOKED LAKES STILL HELD WATER AT THE CLOSE OF THE HOT DRY SUMMER OF 1933, THOUGH MOST OF THE OTHERS HAD BEEN REDUCED TO MARSHES AND DRY FLATS. THESE LAKES, HOWEVER, SHOW A LOWERING OF THE SURFACE, AMOUNTING TO THREE OR FOUR FEET BELOW THE NORMAL LEVEL. THEIR WATERS ARE FRESH AND THEY WILL MAKE EXCELLENT SOURCES OF SUPPLY WHERE LAKE WATER IS NEEDED.

SPRING WATER:

SPRINGS ARE ABUNDANT ON THE FACE OF THE COTEAU AND IN THE GRAVELS AT THE BASE OF THE LARGER TERRACES IN THE LOWER END OF THE BIG STONE AND WHETSTONE VALLEYS. THE COTEAU SUPPLIES HAVE BEEN VERY STEADY, FLOWING A FAIR SUPPLY AT THE END OF THE DRY SUMMER OF 1933. SOME IDEA OF THE CHARACTER OF THE WATER MAY BE OBTAINED FROM AN ANALYSIS WHICH WAS MADE OF THE SPRING WATERS WHICH SUPPLY THE CITY OF MILBANK.

---

1. PERSONAL COMMUNICATION.
2. TODD, J. E., BULLETIN NO. 1, S. DAK. GEOL. SURVEY., P. 148, 1894.

Analysis of Milbank Spring Water

(Furnished by C. M. St. P. and P. Railroad, 1923)

Oxide	1.6	}	
Calcium		}	Total In-
Carbonate	2.7	:-	crusting
Sulphate	25.3	}	Solids
Magnesium Carbonate	11.0	}	40.6
Alkali Sulphate	1.1	}--	Non-Incrusting
Chloride	0.8	}	Solids 1.9
Total	42.5		

As re-calculated by Mr. Guy G. Frary, State Chemist, this analysis shows:

	Parts Per Million
Calcium	152.5
Magnesium	54.4
SO_4	318.9
Na (Sodium)	11.5
CO_3	162.5
Cl	13.7
Total Solids	713.5

The source of these springs has already been discussed in this report (p. 25). The uniformity of the flow and the approximate uniformity in the elevations at which the springs appear suggests a bedrock source, which may correspond with the water sands struck in some of the wells higher up on the Coteau.

No bedrock is visible, however, and if this is the source, the waters would have to percolate through a considerable thickness of glacial drift. Sand and gravel pockets, exposed on the face of the Coteau at that elevation are scarcely large enough to keep a steady flow under the dry conditions. These springs make an excellent source of supply, especially for farm installations and supplies for small towns. By combining several springs the city of Milbank was amply supplied thru the dry season of 1933.

Shallow Wells

Much of the water used in the county comes from wells less than 100 feet in depth. These are listed as shallow wells because the source of water is largely from surface supplies. In the large sand and gravel-filled valleys, such as those of the Big Sioux, Antelope, and Whetstone Valleys an abundance of good water can be found in wells less than twenty-five feet deep, which penetrate the sand and gravel fills beneath the silt cover. Water is also obtained from the contact of the drift with the underlying bedrock. In the northeastern part of the county, such wells average about sixty feet in depth, and on the lowland south of Milbank forty to fifty feet in depth. A dirty sand, which in many places carries pieces of wood and other organic matter, usually supplies the water. These waters are always hard. No analysis of them was available, but the testimony of many housewives who report difficulty using soap amply attests to its hardness. This source supplies sufficient water for farm uses in most places, but could not be used where large supplies of water were needed. Many of these wells failed during the dry summer of 1933.

Bedrock Supplies:

The bedrock water sands, which have been discussed earlier in this report (p.25) will be repeated here for the sake of clarity. In the lowland two water sands are available, the chalk rock and the artesian sandstone. Both of these sands can be encountered by drilling west of the outcrop shown on the geologic map. The chalk lies at an approximate elevation of 1150 feet. The artesian sand lies at an elevation of about 800 feet. On the lowland, therefore, the chalk should be encountered at a depth of from 100 to 150 feet, and the artesian sand from 200 to 400 feet. In order to encounter these formations beneath the Coteaus it would be necessary to add 200 to 900 feet to the figures already given. No analyses of the water from the chalk is available, but it is ordinarily described as soft. The water from the artesian wells at Revillo and Albee is described as soft and "sweet", but that from all the deep wells around Milbank and Twin Brooks is sufficiently charged with salts to give it a taste. Some describe the taste as salty and others as "pluty". An analysis of the water from the artesian well on the Peter Hublou farm, one mile north and one-half mile west of Milbank, was made by Mr. Guy G. Frary, State Chemist, in the State Chemical Laboratory, and gives the following results:

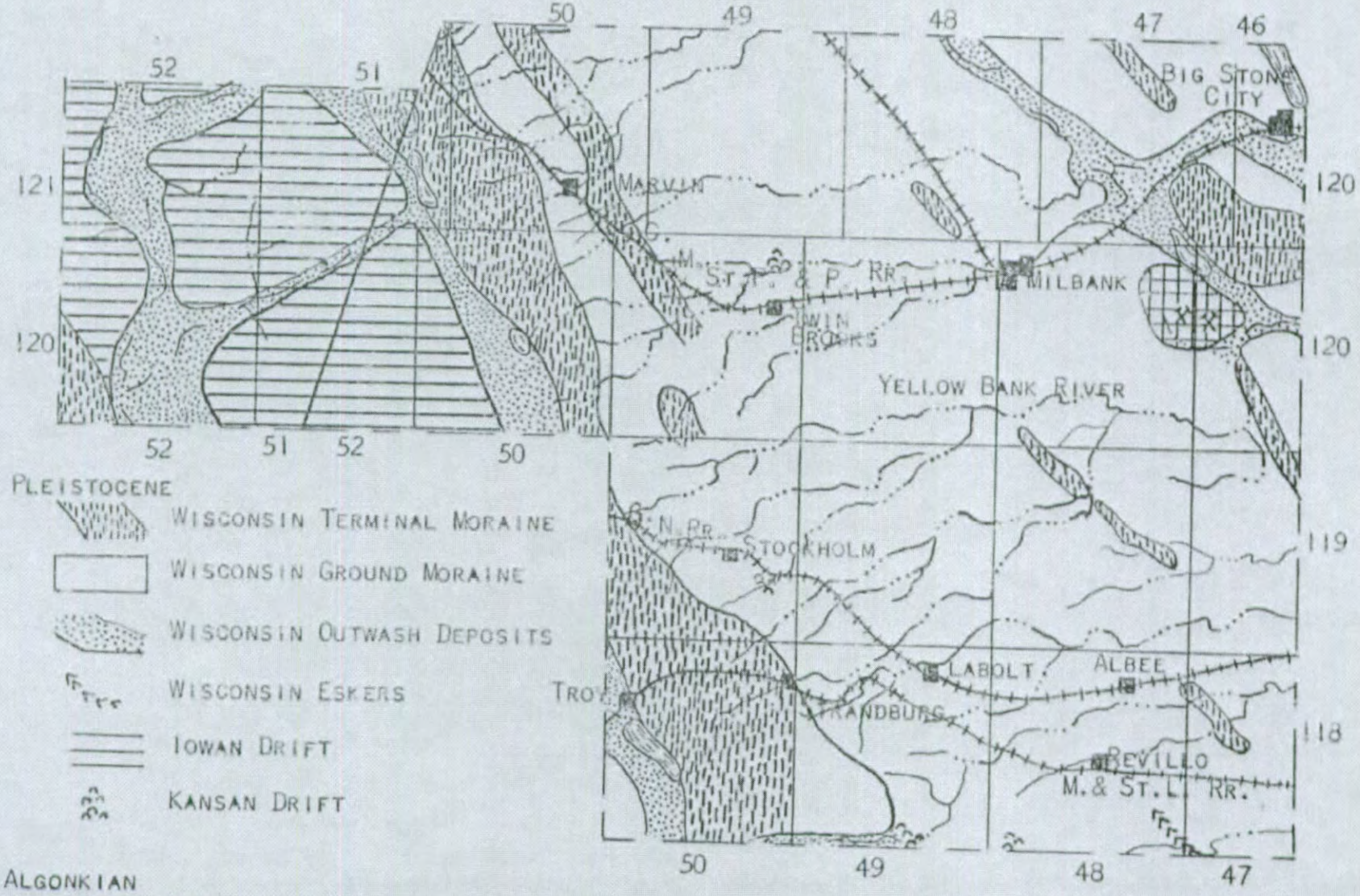
Elements	Parts per Million
Total Solids	2938.0
Silica	12.0
Iron and Aluminum	------
Calcium	27.0
Magnesium	4.36
Sulphate	1160.97
Chlorides	132.0

The low calcium and magnesium content shows that this water is not hard. In fact it is used as laundry water without breaking. The sulphate content, however, is high enough to give the water certain medicinal properties. This is probably a fair sample of the water to be encountered in the deep artesian sand in this part of the basin.

The water supplies of the Coteaus come entirely from glacial sands, with a possible exception of the springs and shallow flowing wells which occur in the lower half of the Coteau escarpment. From the information at hand it is impossible to tell whether a water bearing sandstone lies above the chalk in the Coteaus. The accordance of the water level in the springs and certain Coteau wells suggests that such a sand exists at an elevation of about 1400 feet. If so, a well on the summit of the Coteau would have to be drilled to a depth of approximately 500 or 600 feet to reach the sand. The abundance of shallow water sources in the sands of the Antelope and Big Sioux Valleys, in gravel and sand pockets of the glacial drifts, make it unnecessary to drill deep wells in this part of Grant County.

SURFICIAL GEOLOGY

GRANT COUNTY SO. DAK.



WATER RESOURCES OF CODINGTON AND GRANT COUNTIES, SOUTH DAKOTA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 89-4147

Prepared in cooperation with the

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Huron, South Dakota
1990

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

For readers who may prefer to use metric (International System) units rather than inch-pound units, the conversion factors for the terms in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
acre	4,047	square meter
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
foot per mile (ft/mi)	0.1894	meter per kilometer
gallon per minute (gal/min)	0.06309	liter per second
inch	25.4	millimeter
inch per year (in/yr)	25.4	millimeter per year
mile (mi)	1.609	kilometer
million gallons per day (Mgal/d)	0.04381	cubic meter per second
square mile (mi^2)	2.590	square kilometer

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

WATER RESOURCES OF CODINGTON AND GRANT COUNTIES, SOUTH DAKOTA

By Donald S. Hansen

ABSTRACT

The primary sources of surface water in Codington and Grant Counties are Lakes Kampeska and Pelican and numerous potholes and sloughs in western Codington County. Seasonal variations in streamflow and lake levels are directly related to seasonal variations in precipitation and evapotranspiration. Long-term lake-level fluctuations indicate correlation with departure from normal precipitation. Dissolved-solids concentrations in water from streams and lakes increase as stream discharge decreases and lake levels decline.

Seven glacial aquifers and two bedrock aquifers were delineated in Codington and Grant Counties. The areal extent of the glacial aquifers was determined to be 30 square miles for the Antelope Valley aquifer; 140 to 190 square miles for the Lonesome Lake, Big Sioux, and Revillo aquifers; 260 square miles for the Veblen aquifer; 760 square miles for the Prairie Coteau aquifer; and 840 square miles for the Altamont aquifer.

The average thickness of the glacial aquifers ranges from 21 to 63 feet. Recharge to glacial aquifers is from direct infiltration and subsequent percolation of precipitation mostly in the spring and early summer and by leakage from till. The Big Sioux and Antelope Valley aquifers generally are less than 10 feet below land surface, the Veblen aquifer averages about 52 feet below land surface, the Prairie Coteau aquifer averages 138 feet below land surface, the Lonesome Lake aquifer averages 170 feet below land surface, the Revillo aquifer averages 295 feet below land surface, and the Altamont aquifer averages 460 feet below land surface. The buried aquifers are overlaid and underlaid by till except for the Revillo and Altamont aquifers which, in most locations, lie on shale bedrock.

Discharge from glacial aquifers is by evapotranspiration where the aquifers are close to land surface; by withdrawals from domestic, stock-watering, irrigation, and municipal wells; and by outflow to nearby streams and lakes. Reported well yields are the largest (800 gallons per minute or more) from the Big Sioux, Antelope Valley, and Prairie Coteau aquifers.

Predominant chemical constituents are calcium and bicarbonate in water from the Big Sioux, Antelope Valley, Prairie Coteau, Veblen, Revillo, and Lonesome Lake aquifers. Significant concentrations of sulfate also are present in water from the Veblen and Revillo aquifers. Sodium and sulfate are predominant in water from the Altamont aquifer. Average dissolved-solids concentrations in water from the aquifers range from 350 to 2,120 milligrams per liter.

The two bedrock aquifers delineated are the Dakota and granite wash. The Dakota aquifer is at about 1,230 feet below land surface and the water level has declined 10 feet from 1958-85. Predominant chemical constituents in water from the Dakota aquifer are sodium and sulfate. The water has a dissolved-solids concentration of 1,480 milligrams per liter. The granite

wash aquifer is limited to eastern Grant County and has an average thickness of 37 feet. Predominant chemical constituents in water from the granite wash aquifer are sodium and sulfate.

The average annual water use in Codington and Grant Counties is 18.34 million gallons per day. Seventeen percent of the water used is for irrigation.

INTRODUCTION

Codington and Grant Counties encompass 1,415 mi^2 of northeastern South Dakota. Codington County and western Grant County are within the Coteau des Prairies, a highland plateau between the Minnesota River lowland to the east and the James River lowland to the west (fig. 1). Eastern Grant County lies in the western part of the Minnesota River lowland. Land-surface altitudes range from 970 ft in northeast Grant County to 2,015 ft above sea level on the crest of the coteau in northern Codington County.

Previous water-resource studies within the Big Sioux River basin were designed for a specific purpose and were completed as county water-resource investigations, ground-water simulation studies, or city water-supply studies. The studies never were intended to assess hydrologic conditions and evaluate the water-supply potential of the entire basin. As a result, water development has occurred at a rapid rate in some areas of the basin while, in other areas, development has proceeded much more slowly.

The Big Sioux basin hydrologic study, which started in 1982, is a 7-year comprehensive investigation of the water-resources of Codington, Grant, Minnehaha, Lincoln, and Union Counties to develop a hydrologic data base and subsequently to develop digital models of the Big Sioux aquifer. This report is the result of a 4-year water-resources investigation of Codington and Grant Counties.

Purpose and Scope

This report describes the results of a hydrogeologic study in Codington and Grant Counties. The study included test drilling through the glacial drift to bedrock, installation of observation wells, measurement of water levels, and chemical analysis of ground water. Figure 2 shows the test-hole and geologic-section locations and observation-well and water-quality sampling sites in Codington and Grant Counties. The wells and test holes are numbered according to the Federal land survey system (fig. 3).

This report describes: (1) The surface-water resources; (2) the extent of the major glacial outwash and bedrock aquifers; (3) the recharge to, movement, and discharge from the major glacial aquifers; and (4) the quality of the surface and ground water in Codington and Grant Counties.

Acknowledgments

The author would like to acknowledge the cooperation of residents of Codington and Grant Counties for providing information on their water wells, and of the local drilling companies for supplying test-hole information.

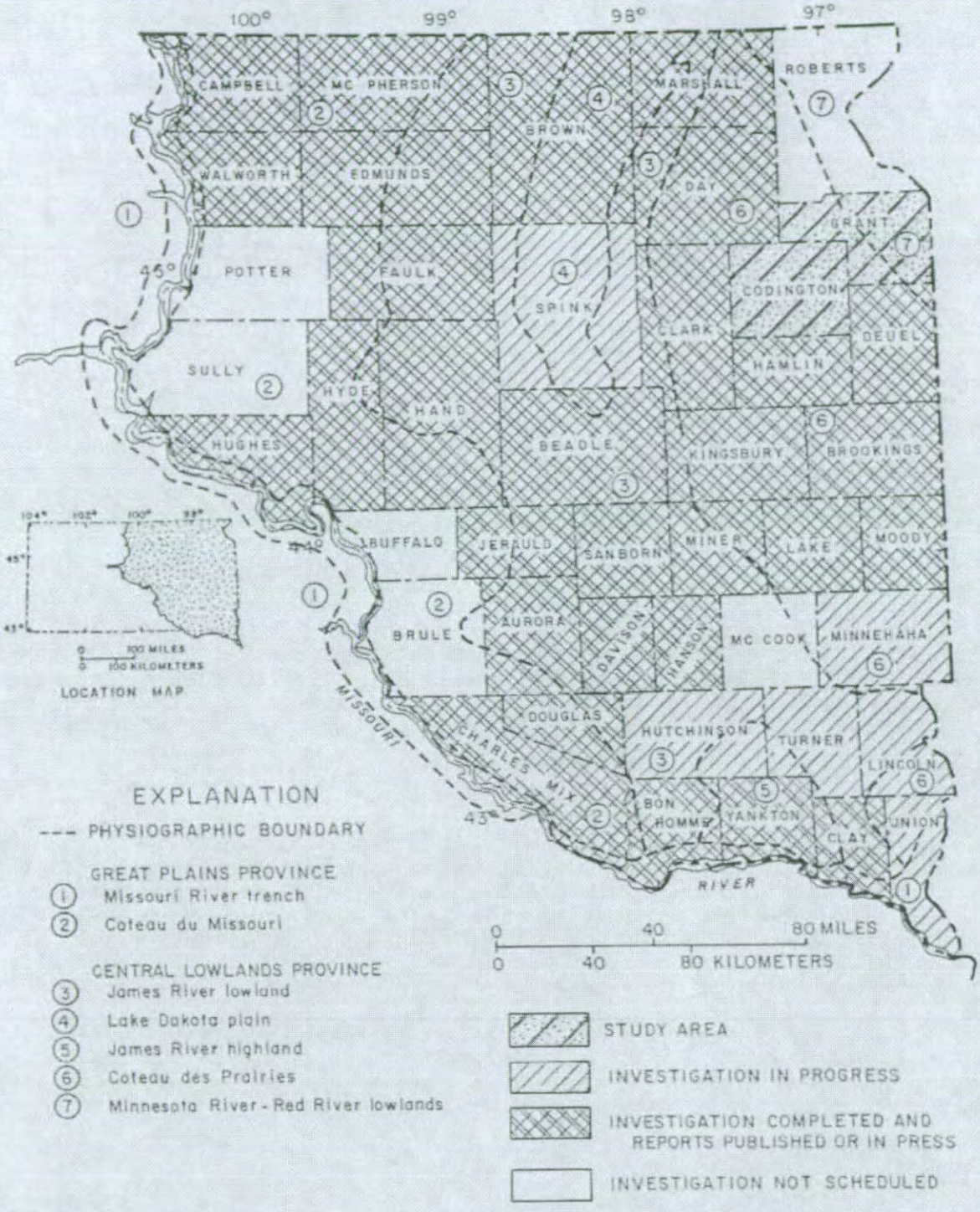


Figure 1.--Index map of eastern South Dakota showing area of this report, status of county investigations, and major physiographic divisions.

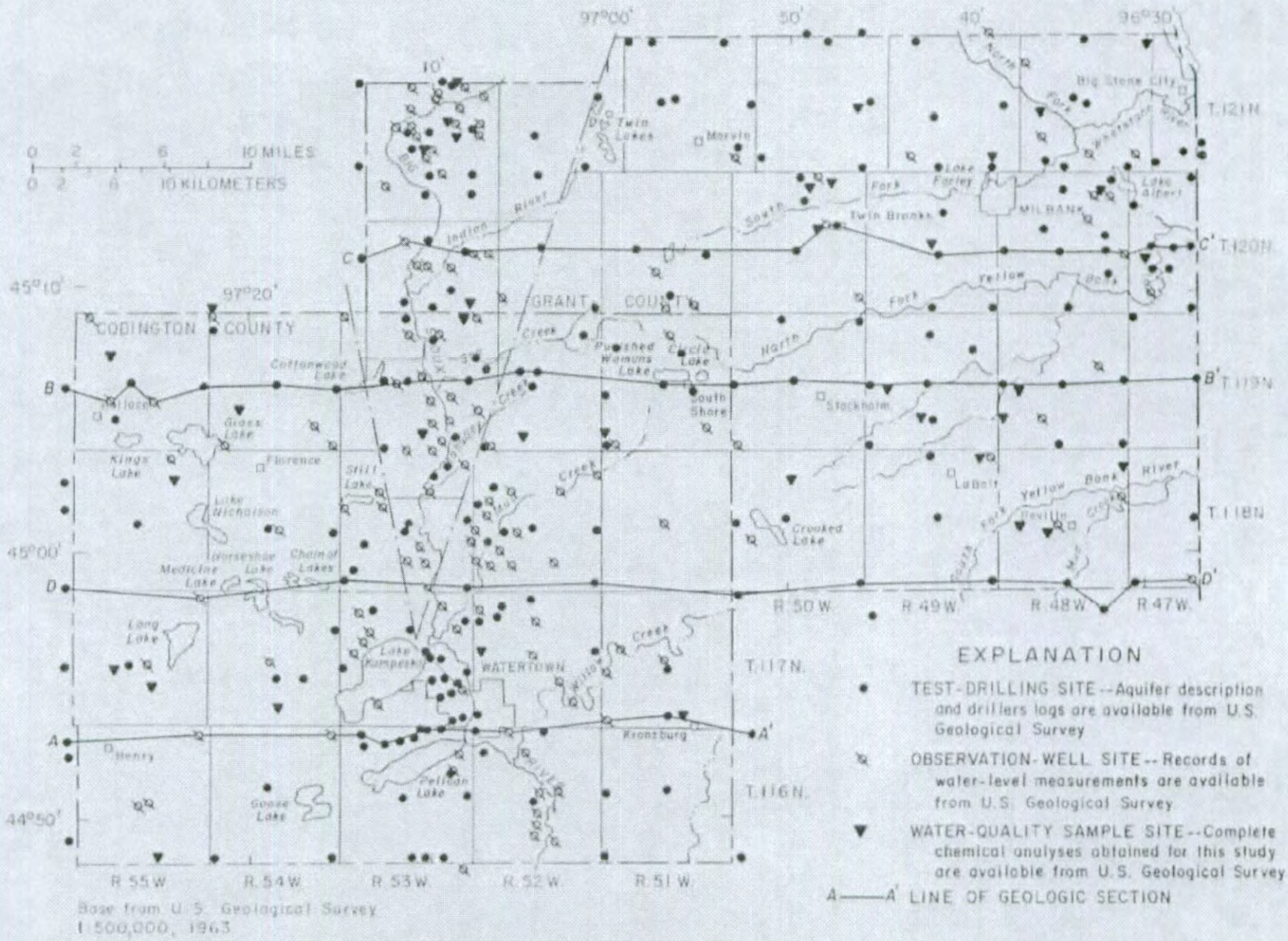


Figure 2.--Location of data sites and geologic sections in Codington and Grant Counties.

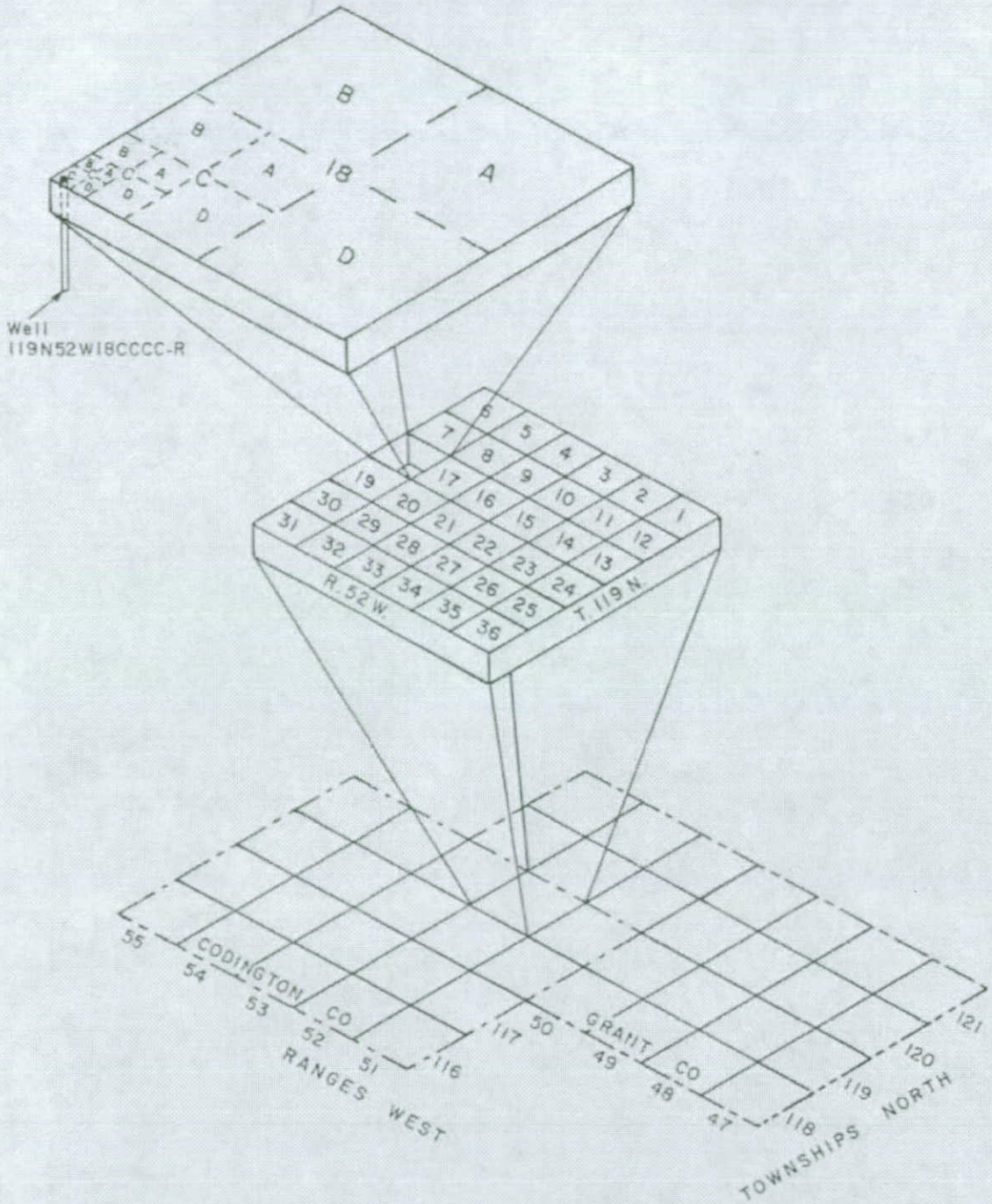


Figure 3.--Well-numbering diagram. The well number consists of township followed by "N," range followed by "W," and section number, followed by a maximum of four uppercase letters that indicate, respectively, the 160-, 40-, 10-, and 2½-acre tract in which the well is located. These letters are assigned in a counter clockwise direction beginning with "A" in the northeast quarter. A serial number following the last letter is used to distinguish between wells in the same 2½-acre tract. The last letter "R" in well designation denotes that the well is located on the Sisseton Indian Reservation.

WATER RESOURCES

The average annual precipitation at Watertown from 1951-80 was 22.3 inches (U.S. National Oceanic and Atmospheric Administration, 1987). About 75 to 85 percent of the precipitation is returned to the atmosphere by evaporation and transpiration. About 5 percent of the average annual precipitation becomes streamflow; however, this quantity may vary from year to year because of climatic variations. Ten to 20 percent of the precipitation percolates through the root zone to become ground water. In a given year, the water budget shows a change in ground-water storage that can be detected by, and calculated from, water-level changes in observation wells in the aquifers. The long-term (greater than 10 years) changes in storage are small, unless ground-water discharge to wells increases.

Drainage in eastern Codington and western Grant Counties (fig. 4) is primarily by the Big Sioux River and its tributaries. Western Codington County is poorly drained, is characterized by numerous closed-basin lakes that do not have an outlet, and is a noncontributing part of the Big Sioux River drainage basin. Drainage in eastern Grant County is well developed and consists of the North and South Forks of the Whetstone and Yellow Bank Rivers. These rivers drain into the Minnesota River. The drainage divide between the Minnesota and Big Sioux River basins is located in extreme northeastern Codington and western Grant Counties (Amundson and others, 1985). This area is characterized by numerous small lakes and potholes.

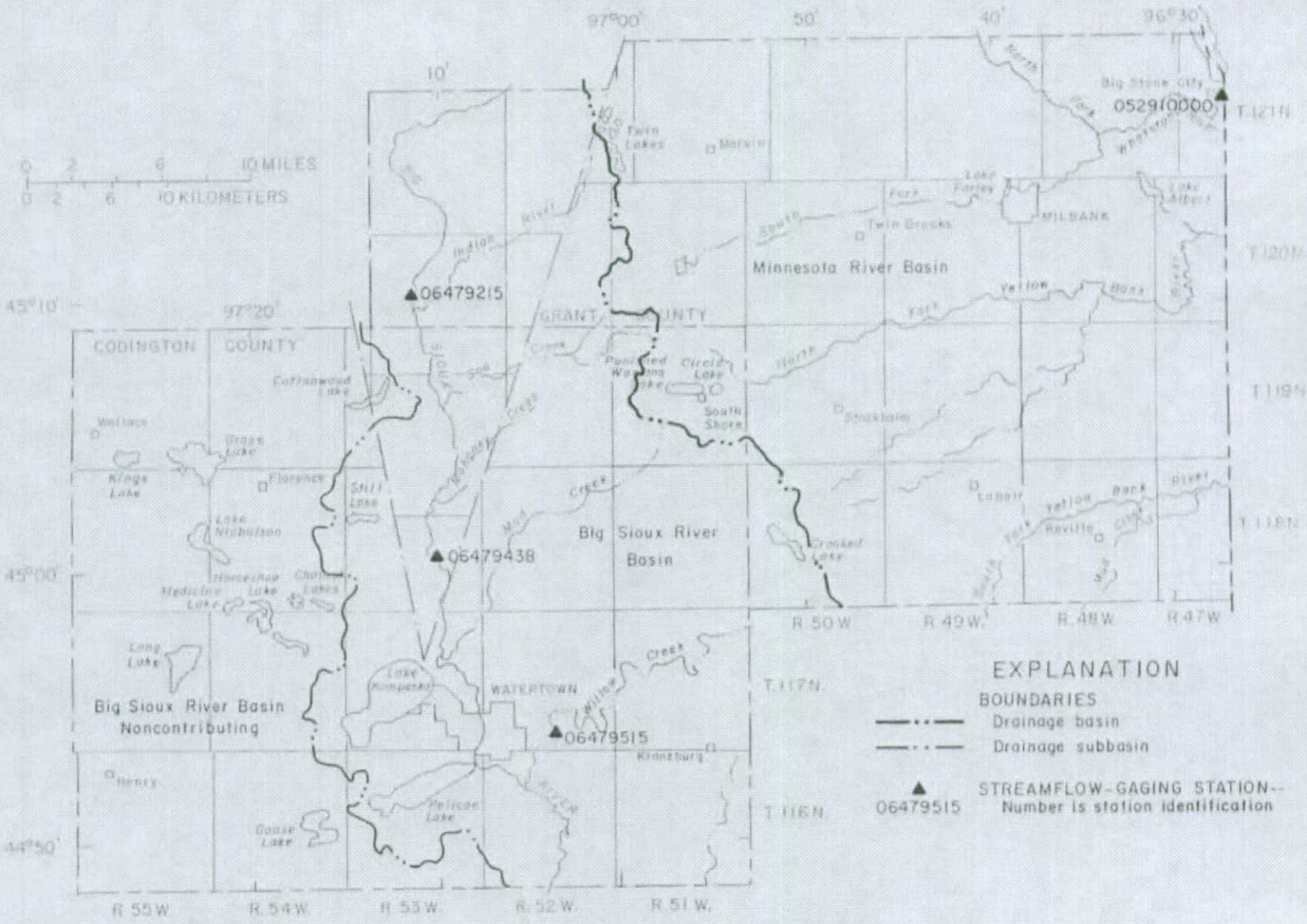
Surface Water

Streamflow

Streamflow depends on seasonal variations in precipitation, evapotranspiration, and ground-water storage. Rivers and creeks generally flow during spring and early summer because of snowmelt and rainfall runoff and because of peak storage in aquifers. Creeks and the upper reaches of the Big Sioux River in Grant County generally do not flow during late fall and winter because of: (1) Decreased runoff; (2) decreased ground-water discharge; (3) evaporation; and (4) ice formation. During years of above-normal precipitation, Willow Creek and the North and South Forks of the Whetstone and Yellow Bank Rivers may not go dry during late fall and winter. Under normal precipitation conditions, the Big Sioux River may receive 15 to 25 ft^3/s from ground water between the Grant-Roberts County line and the streamflow-gaging station on the Big Sioux River near Castlewood, located 5 mi south of the Codington-Hamlin County line. A summary of data for streamflow-gaging stations within the study area is given in table 1.

Specific conductance of water from rivers and streams varies with the volume of streamflow. Specific conductance generally decreases as stream discharge increases because of dilution from snowmelt and rainfall runoff. The observed specific conductance of water from the Big Sioux River near Watertown decreased from 650 $\mu S/cm$ (microsiemens per centimeter at 25 °Celsius) when the instantaneous discharge was 12 ft^3/s in October 1985 to 260 $\mu S/cm$ when the instantaneous discharge was 2,140 ft^3/s in March 1986.

Flooding in Grant County is unlikely because of the well-developed drainage. Valley bottoms and areas of internal drainage in western Codington County are flooded almost every year because of snowmelt and rainfall runoff. Maps of flood-prone areas adjacent to the Big Sioux River have been prepared and are available from the U.S. Geological Survey, Huron, South Dakota 57350. The flood-prone areas, shown on topographic maps at a scale of 2.5 inches to the mile, are areas that have about a 1 in 100 chance, on the average, of being inundated during any year.



Base from U.S. Geological Survey
1:500,000, 1963

Figure 4.--Drainage basins and U.S. Geological Survey streamflow-gaging stations in Codington and Grant Counties.

Table 1.--Summary of data for streamflow-gaging stations in Codington and Grant Counties

[--, not computed]

Station no.	Station name	Contributing drainge area (square miles)	Period of record (water years)	Discharge (cubic feet per second)		
				Maximum instan-taneous	Minimum daily	Average
06479215	Big Sioux River near Florence, S. Dak.[1]	67.9	1984-85	268	0	--
06479438	Big Sioux River near Watertown, S. Dak.	228	1972-85	3,720	0	21.3
06479515	Willow Creek near Watertown, S. Dak.	110	1971-85	4,040	0	15.2
05291000	Whetstone River near Big Stone City, S. Dak.	389	1932-85	6,870	0	47.0
05293000	Yellow Bank River near Odessa, Minn.[2]	398	1939-85	6,970	0	54.8

[1]Streamflow-gaging station established June 6, 1984.
[2]Streamflow-gaging station located 6 miles southeast of Big Stone City. The North and South Forks of the Yellow Bank River join 6 miles south and 5 miles east of Big Stone City.

Lakes

Lakes in Codington and Grant Counties cover about 27 mi^2, or about 3 percent of the study area. Lakes Kampeska and Pelican (fig. 4) cover about 7,600 acres and were formed by stagnant ice blocks positioned at the margin of the receding Wisconsin age glacier (J. P. Gilbertson, South Dakota Geological Survey, written commun., 1986).

Long-term records of lake-level fluctuations for Lake Kampeska indicate correlation with departure from normal precipitation (fig. 5). Lake levels rose from 1970-73, 1977-80, and 1984-86 because of above-normal precipitation. Lake levels generally declined from 1973-76 and from 1980-83 because of below-normal precipitation. In recorded history, Lake Kampeska has never been known to dry up completely (South Dakota State Lakes Preservation Committee, 1977).

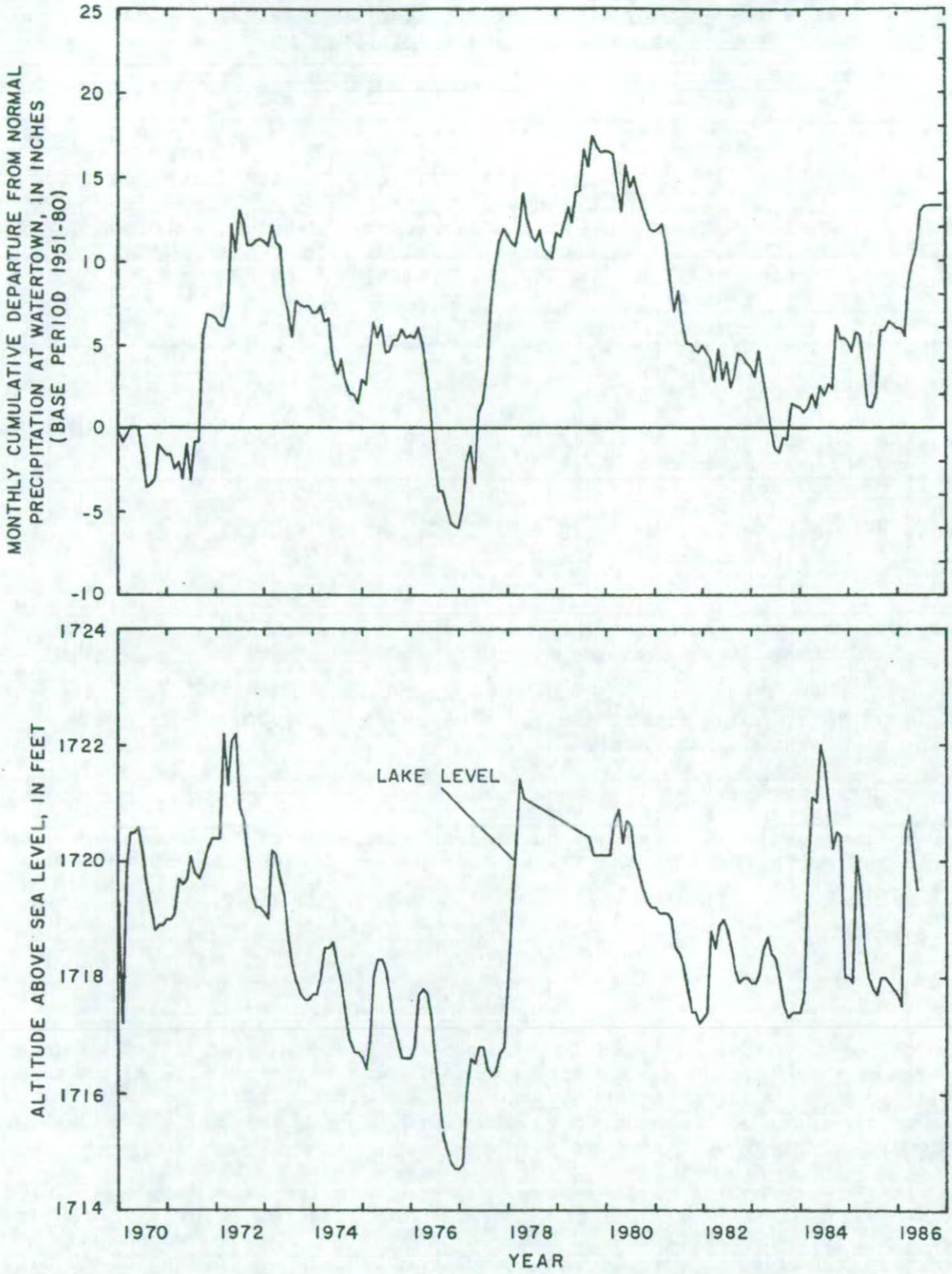


Figure 5.--Lake-level fluctuations for Lake Kampeska and monthly cumulative departure from normal precipitation at Watertown.

Table 2.--Summary of chemical analyses for selected lakes in Codington County

[Analyses based on data collected from 1964-75, State Lakes Preservation Committee, 1977. Results are average value in milligrams per liter except as indicated; --, not analyzed]

	Lakes connected to an aquifer and having an outlet		Lakes not connected to an aquifer and having no outlet		
	Kampeska	Pelican	Medicine	Nicholson	Long
Specific conductance (microsiemens per centimeter at 25 °C)	490	1,280	--	61,000	4,700
pH	8.5	8.8	8.1	9.1	8.2
Alkalinity, total	220	260	1,820	2,200	110
Dissolved solids	330	970	87,500	148,000	13,000
Dissolved calcium	44	60	590	1,400	410
Dissolved magnesium	32	100	12,000	14,000	1,200
Dissolved sodium	11	55	8,000	23,000	1,300
Dissolved potassium	10	22	1,270	1,700	190
Dissolved sulfate	68	280	57,000	99,000	9,000
Dissolved chloride	4.2	21	1,100	1,100	250
Dissolved nitrogen	.1	.1	.17	--	--
Dissolved phosphorus	1.1	<.01	1.1	--	--

The chemical quality of water in lakes is determined by the hydrologic setting of the lake and seasonal changes in precipitation. Lakes in areas of internal drainage having no outlet generally contain water that is one to two orders of magnitude higher in dissolved solids than lakes having external drainage or having good hydraulic connection with a surficial aquifer. Table 2 shows the average chemical quality of water of selected lakes in Codington County. Lakes Kampeska and Pelican are in hydraulic connection with the Big Sioux aquifer and have a total dissolved-solids concentration two orders of magnitude less than Medicine, Nicholson, and Long Lakes. Medicine, Nicholson, and Long Lakes receive recharge by overland runoff and rainfall; however, the only source of discharge is by evaporation. Dissolved-solids concentrations in water from lakes generally decrease during the spring because of dilution from snowmelt and rainfall runoff and then increase during summer and late fall because of reduced inflow and increased evaporation. Dissolved-solids concentrations in water from Medicine Lake increase with depth. Dissolved solids increase from 65,000 mg/L (milligrams per liter) at 2.5 ft to 171,000 mg/L at 7.5 ft (South Dakota State Lakes Preservation Committee, 1977).

Ground-Water Occurrence and Chemical Quality

Glacial Aquifers

Seven aquifers were delineated in Codington and Grant Counties. Hydrologic characteristics of these aquifers are given in table 3. Glacial-outwash aquifers consist of unconsolidated sand and gravel deposited by meltwaters from receding glaciers. Test drilling has shown that the aquifers are overlaid and underlaid by till. Till in Codington and Grant Counties consists of grayish-blue clay with minor amounts of sand and silt. Till in

Table 3.--Summary of the hydrologic characteristics of the major aquifers in Codington and Grant Counties

[--, not determined]

Aquifer	Areal extent (square miles)	Maximum aquifer thickness (feet)	Average aquifer thickness[1] (feet)	Range in aquifer depth below land surface (feet)	Average depth of aquifer below land surface[1] (feet)	Range of ground-water level below land surface[2] (feet)	Average water level below land surface[3] (feet)	Artesian (A) and (or) water-table (WT) aquifer	Estimated volume of water in storage[4] (acre-feet)	Range of reported well discharges[5] (gallons per minute)	Suitability[6] for irrigation
					GLACIAL AQUIFERS						
Big Sioux	150	50	24	0-12	3	-1 - 31	8	WT	350,000	50-1,100	Yes.
Antelope Valley	30	52	34	1-57	9	2 - 22	10	WT	100,000	50-800	Yes
Prairie Coteau	590	62	20	21-380	138	-2.54 - 101	33	A	1.5 million	50-1,100	Yes.
Veblen	330	155	28	1-210	52	1 - 81	29	A	700,000	10-50	Yes.
Lonesome Lake	140	98	32	200-380	270	80 - 100	90	A	430,000	10-20	Yes.
Revillo	210	150	63	105-665	295	-1 - 71	30	A	1.0 million	50-150	No.
Altamont	860	94	40	319-668	460	5 - 250	150	A	3.3 million	10-50	No.
					BEDROCK AQUIFERS						
Dakota[7]	--	--	--	>1,230(?)	--	--	--	A	--	--	No.
Granite wash	230	94	37	75-444	190	-3 - 116	22	A	650,000	10-550	No.

[1] Arithmetic mean from test-hole data.
[2] A negative number indicates feet above land surface.
[3] Arithmetic mean from observation-well data.
[4] Storage was estimated by multiplying average thickness by areal extent and multiplied by specific yield of 0.15 (Hansen, 1987).
[5] Reported data.
[6] Based on the South Dakota irrigation-water classification diagram (fig. 6).
[7] Data for aquifer available from only one well.

eastern South Dakota has a hydraulic conductivity of about 10^{-5} ft/d (Barari, 1985). The till will not yield a sufficient quantity of water to wells even for domestic use; however, locally it may contain thin, discontinuous sand and gravel lenses that reportedly yield 2 to 15 gal/min to domestic and stock-watering wells.

Water-level fluctuations in observation wells screened in the glacial aquifers, with the exception of the Altamont, are caused by seasonal changes in recharge and discharge. Water levels generally rise from February through June because recharge from snowmelt and spring rainfall is greater than discharge. Water levels generally decline from July through January because discharge from wells and evapotranspiration are greater than recharge.

Suitability of water for irrigation from the glacial aquifers may be determined by use of the South Dakota irrigation-water diagram (fig. 6) (Koch, 1983). The diagram is based on South Dakota irrigation-water standards, revised January 7, 1982, and shows the State of South Dakota's water-quality and soil-texture requirements for the issuance of an irrigation permit.

Big Sioux aquifer

The Big Sioux aquifer (fig. 7) consists of poorly to well-sorted surficial outwash that ranges from medium sand to medium gravel; it generally is less than 10 ft below land surface. The aquifer is limited to the flood plain of the Big Sioux River and its tributaries, and is underlaid by till. In most locations, the aquifer becomes coarser and more sorted with depth. The aquifer generally is under water-table conditions, except in the Lake Pelican area where the aquifer is confined by 3 to 5 ft of till. A geologic section of the aquifer is shown in figure 8.

Recharge to the aquifer is by direct infiltration and subsequent percolation of rainfall and snowmelt through the overlying 1 to 2 ft of topsoil. Recharge to the aquifer ranges from 4 to as much as 10 in/yr (Hansen, 1988). The general direction of water movement in the aquifer is to the south and toward the Big Sioux River (fig. 9), which flows from north to south. The gradient of the water-table surface generally is about 6 to 10 ft/mi. Lakes Kampeska and Pelican are connected hydraulically to the Big Sioux aquifer. During spring and early summer, lake levels commonly exceed the water level in the aquifer and, thus, the lakes recharge the aquifer. During summer and fall, when evaporation exceeds precipitation, the lake levels are less than water levels in the surrounding Big Sioux aquifer and water from the aquifer discharges to the lakes.

Discharge from the Big Sioux aquifer is by withdrawals from irrigation, domestic, municipal, and stock-watering wells; by evapotranspiration; and by ground-water discharge to lakes and the Big Sioux River. The average annual reported pumpage by irrigation and municipal wells was about 2,100 acre-ft from 1972-80 (South Dakota Department of Water and Natural Resources, written commun., 1972-80). The average annual reported pumpage by irrigation wells was 2,800 acre-ft during the drought years of 1975-77. Reported discharge from irrigation wells in the Big Sioux aquifer is as much as 1,100 gal/min.

Records of long-term water-level fluctuations in well 118N52W21BBCB show correlation with long-term trends in precipitation (fig. 10). The water-level rise during 1972, 1977-79, and 1984-86 was caused by above-normal precipitation. The decline from 1973-76 and 1980-81 was caused by below-normal precipitation.

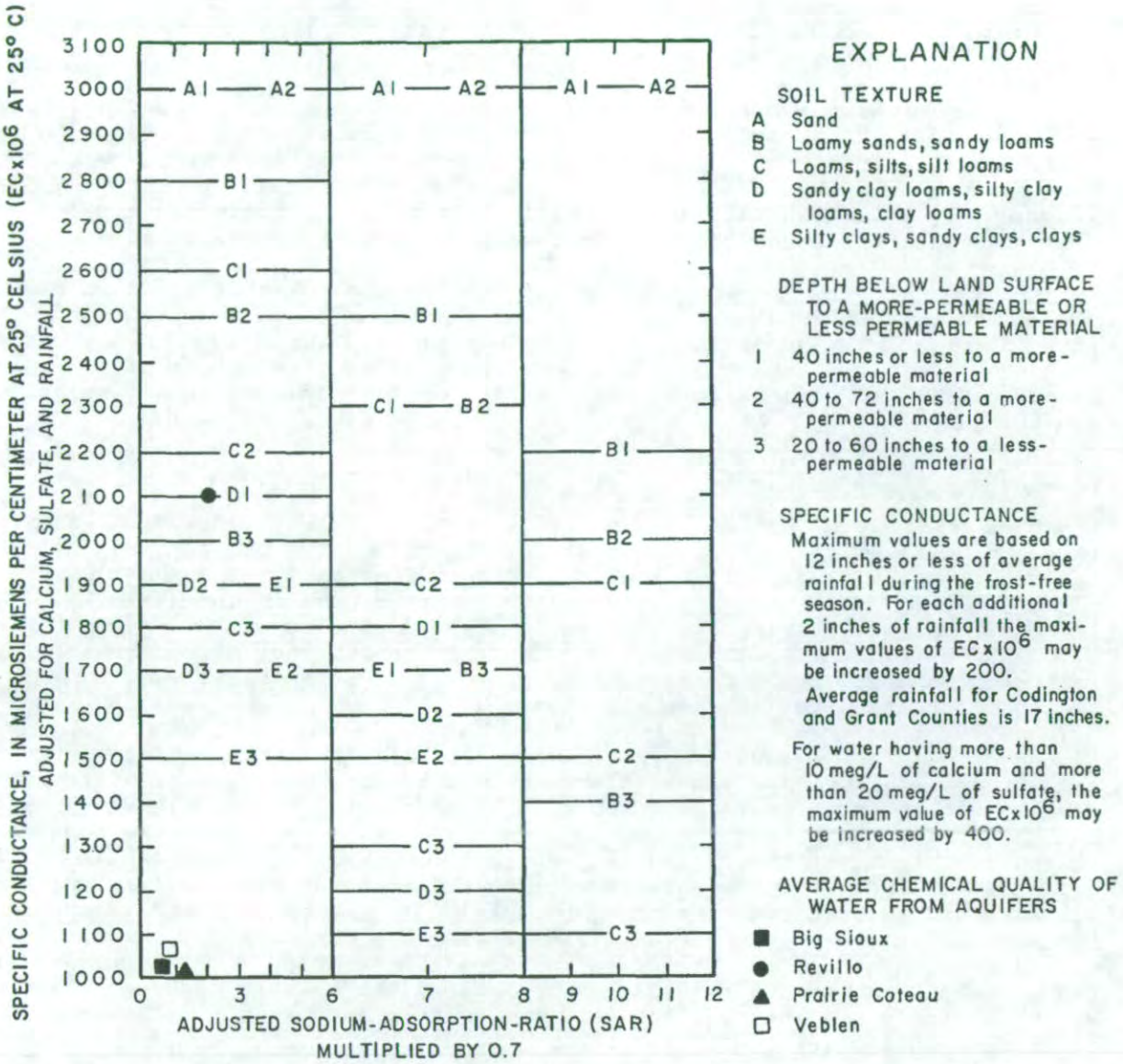
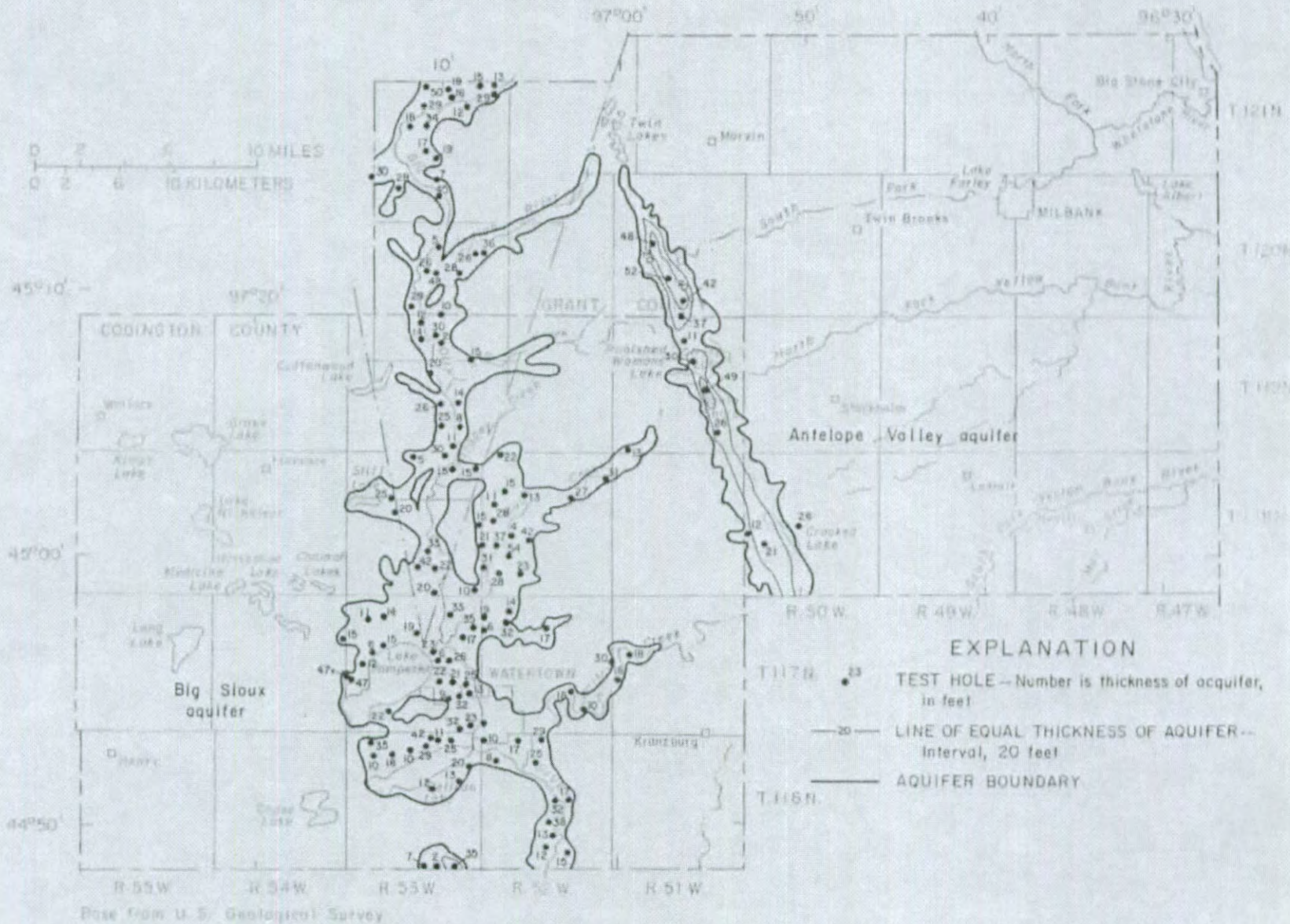
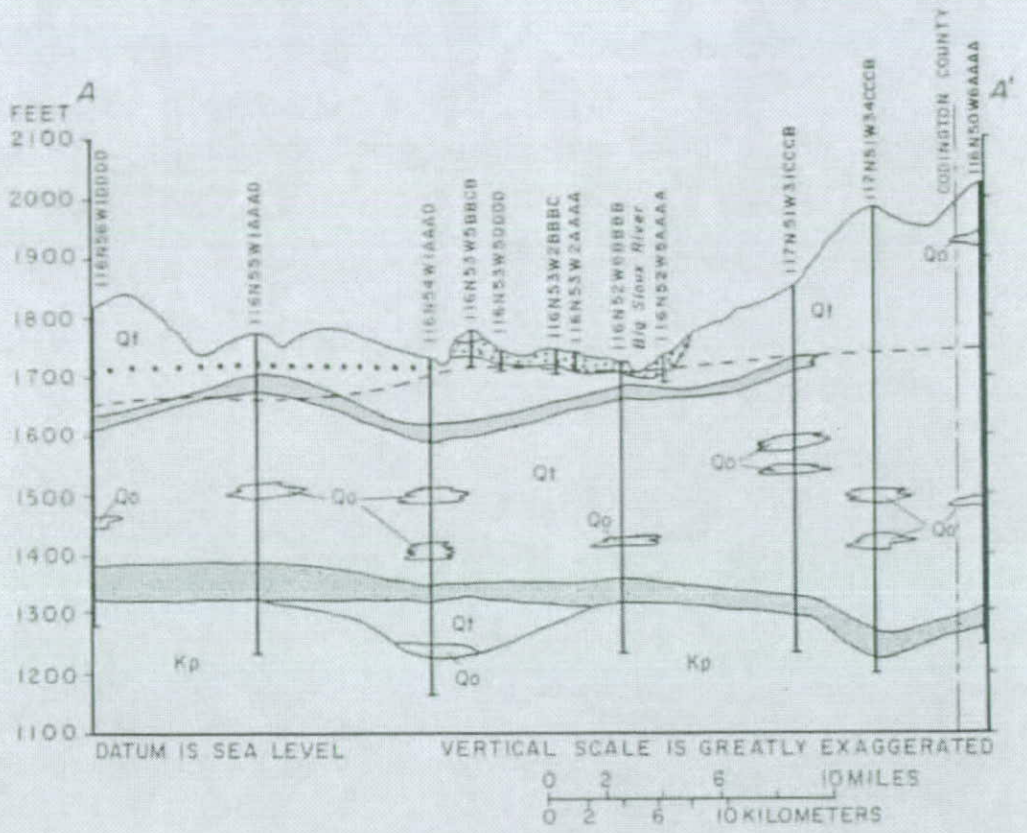


Figure 6.--South Dakota irrigation-water classification diagram based on South Dakota standards (revised Jan. 7, 1982) for maximum allowable specific conductance and adjusted sodium-adsorption-ratio values for which an irrigation permit can be issued for applying water under various soil-texture conditions. Water can be applied under all conditions at or above the plotted point but not below it provided other conditions as defined by the State Conservation Commission are met.



Base from U.S. Geological Survey
1:500,000, 1963

Figure 7.--Extent and thickness of the Big Sioux and Antelope Valley aquifers in Codington and Grant Counties.



EXPLANATION

QUATERNARY
Qt Glacial till
Qo Glacial outwash

CRETACEOUS
Kp Pierre Shale

AQUIFERS
Big Sioux
Prairie Coteau
Altamont

CONTACT

POTENTIOMETRIC SURFACE
Prairie Coteau aquifer
Altamont aquifer

TEST HOLE

Figure 8.--Geologic section A-A' showing the Big Sioux, Prairie Coteau, and Altamont aquifers. (Section A-A' is shown in figure 2.)

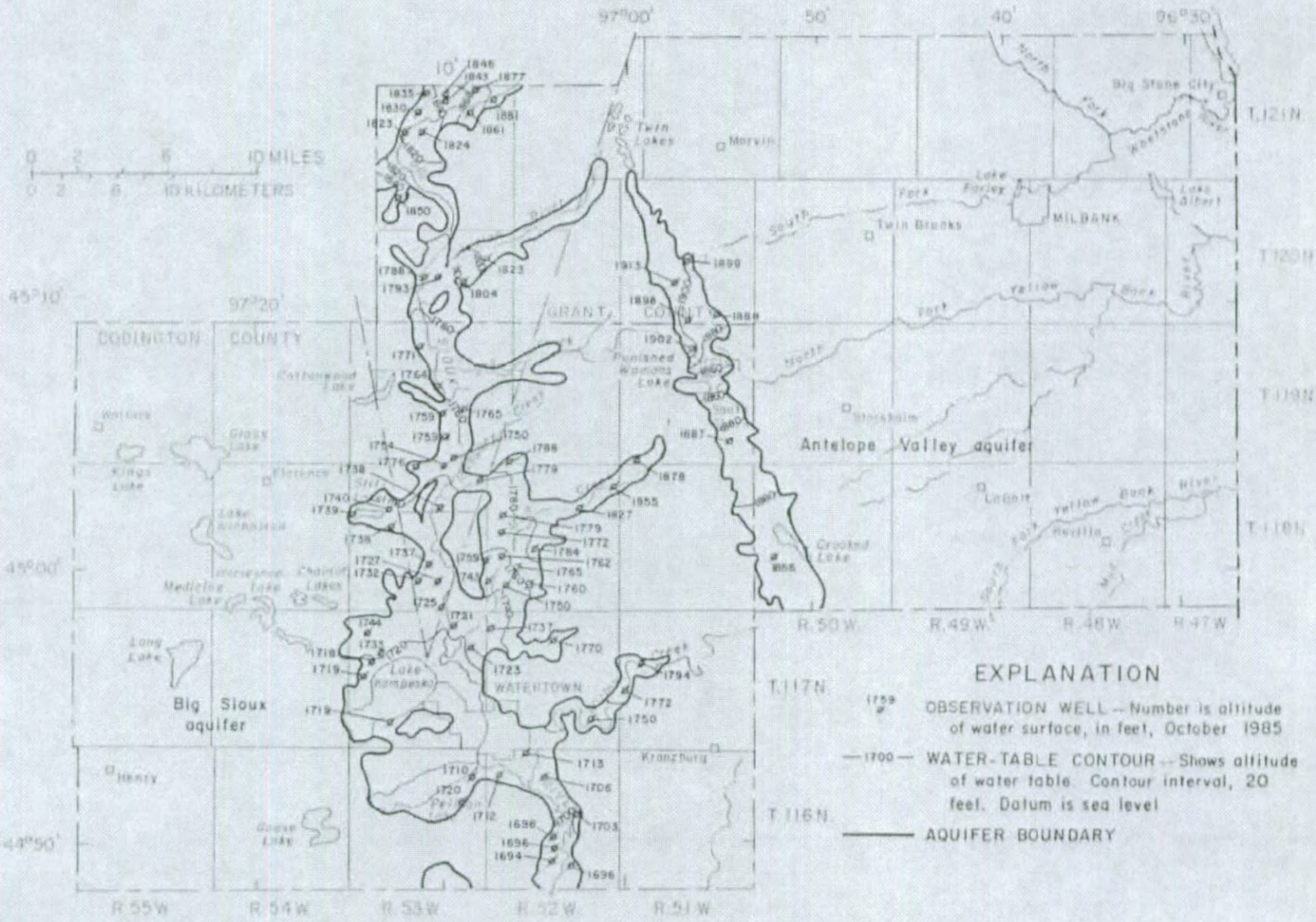


Figure 9.--Water-table surface of the Big Sioux and Antelope Valley aquifers in Codington and Grant Counties, October 1985.

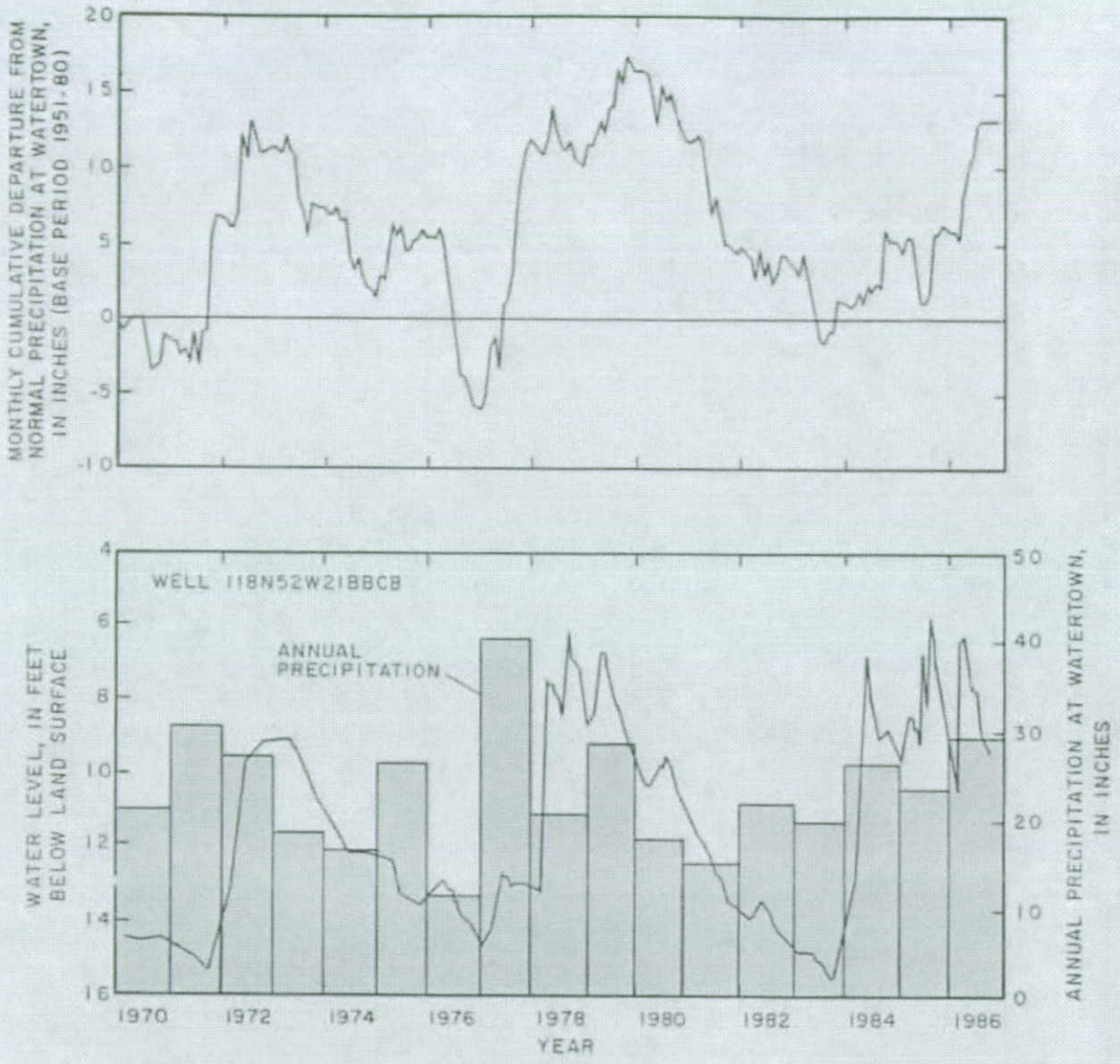


Figure 10.--Water-level fluctuations in the Big Sioux aquifer and annual precipitation and monthly cumulative departure from normal precipitation at Watertown.

Predominant chemical constituents in water from the Big Sioux aquifer are calcium and bicarbonate (table 4). Dissolved-solids concentrations averaged 580 mg/L. Hardness concentrations determined by onsite analysis averaged 400 mg/L. Water from the aquifer is of suitable quality for irrigation (fig. 6). Water from the aquifer also is used for municipal, industrial, domestic, and stock-watering purposes.

Antelope Valley aquifer

The Antelope Valley aquifer is an unconfined glacial-outwash aquifer that lies at or near land surface in northeastern Codington and western Grant Counties (fig. 7). The aquifer is located in the axis of the drainage divide between the Big Sioux and Minnesota Rivers (fig. 4) and is hydraulically connected to numerous small lakes and sloughs. The aquifer is composed of brown, very coarse sand to coarse gravel. The aquifer generally is under water-table conditions; however, at well 119N51W3CCCC the aquifer is covered by 43 ft of till and is under artesian conditions. The aquifer is shown in geologic section B-B' (fig. 11), and hydrologic characteristics are given in table 3.

Recharge to the aquifer is by direct infiltration and subsequent percolation of rainfall and snowmelt through the overlying 1 to 2 ft of topsoil. Test-hole data indicate that Crooked, Punished Womans, and Round Lakes are hydraulically connected to the aquifer. The general direction of water movement in the aquifer is from northwest to southeast. The direction of water movement within 2 mi of Punished Womans, Round, and Crooked Lakes, and numerous sloughs and small lakes located in T. 120 N., R. 51 W. is toward these lakes and sloughs.

Discharge from the aquifer is by: (1) irrigation, domestic, and stock-watering wells; (2) evaporation directly from the water-table surface where the aquifer is at or near land surface; (3) outflow to Punished Womans, Round, and Crooked Lakes; and (4) outflow to small lakes and sloughs in T. 120 N., R. 51 W. near the eastern edge of the aquifer.

Records of long-term water-level fluctuations in wells 119N51W3DDDA and 120N51W34CCCC (fig. 12) show correlation with long-term trends in precipitation. The water-level decline from 1979-83 was caused by below-normal precipitation. The water-level rise from 1983-87 was caused by four years of above-normal precipitation. The sharp annual decline during June and July in well 119N51W3DDDA is caused by pumpage from nearby irrigation wells.

Predominant chemical constituents in water from the Antelope Valley aquifer are calcium and bicarbonate. Specific conductance, determined from onsite analyses, ranged from 320 to 1,850 µS/cm and averaged 1,000 µS/cm. Hardness concentrations, also determined by onsite analyses, ranged from 150 to 890 mg/L and averaged 500 mg/L. A summary of laboratory analyses of water from the aquifer is given in table 4. Water from the aquifer is used for irrigation, domestic, and stock-watering purposes.

Table 4.--Summary of chemical analyses of water from the Big Sioux and Antelope Valley aquifers in Codington and Grant Counties

[Analyses by U.S. Geological Survey. Results in milligrams per liter except as indicated; --, not analyzed]

	Big Sioux aquifer				Antelope Valley aquifer			
	Number of samples	Mean	Minimum value	Maximum value	Number of samples	Mean	Minimum value	Maximum value
Specific conductance, (microsiemens per centimeter at 25 °C)	10	890	650	1,300	17	820	480	1,970
pH, field (units)	8	[1]7.6	7.1	8.4	16	[1]7.4	6.9	8.0
Temperature, water (°C)	4	5.5	5	6.0	5	11.5	7.0	20.5
Dissolved solids	16	580	280	1,140	4	350	344	352
Dissolved calcium	18	100	52	180	17	110	70	220
Dissolved magnesium	18	40	14	65	17	35	7	130
Dissolved sodium	16	26	5.0	82	17	13	2.6	37
Dissolved potassium	16	3	1	7	13	4	2	8
Bicarbonate	9	320	210	380	15	330	220	550
Dissolved sulfate	17	130	19	260	17	150	18	590
Dissolved chloride	18	14	.8	45	17	13	1.0	120
Dissolved fluoride	12	.3	.2	.9	2	.3	.2	.3
Dissolved nitrate	12	4.2	0	14	3	.13	0	.32
Dissolved boron (micrograms per liter)	9	220	20	450	4	120	0	370
Dissolved iron (micrograms per liter)	4	320	40	600	2	1,600	480	2,700
Dissolved manganese (micrograms per liter)	4	160	70	240	--	--	--	--

[1]Median value.

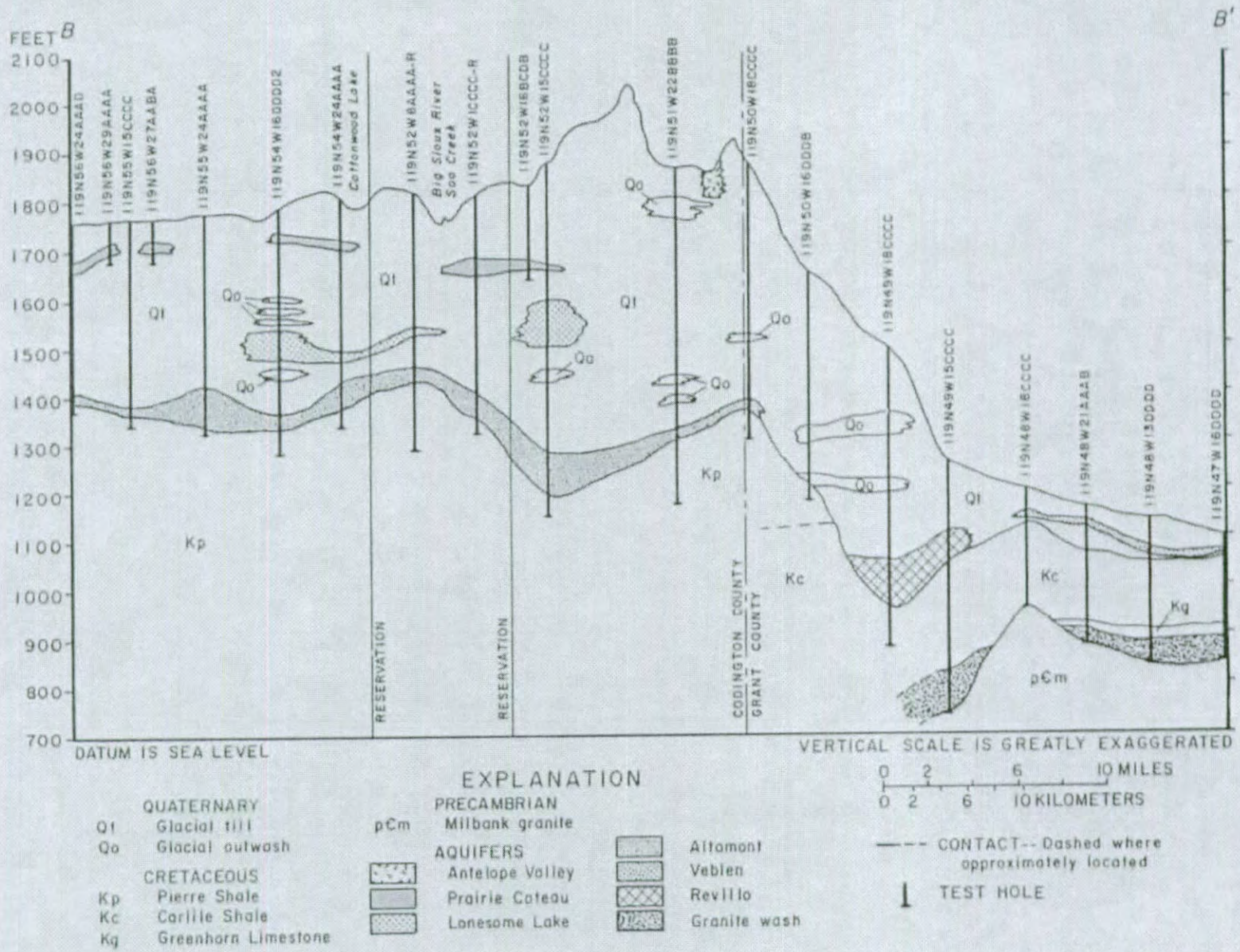


Figure 11.--Geologic section B-B' showing the Antelope Valley, Prairie Coteau, Lonesome Lake, Altamont, Veblen, Revillo, and granite wash aquifers. (Section B-B' is shown in figure 2.)

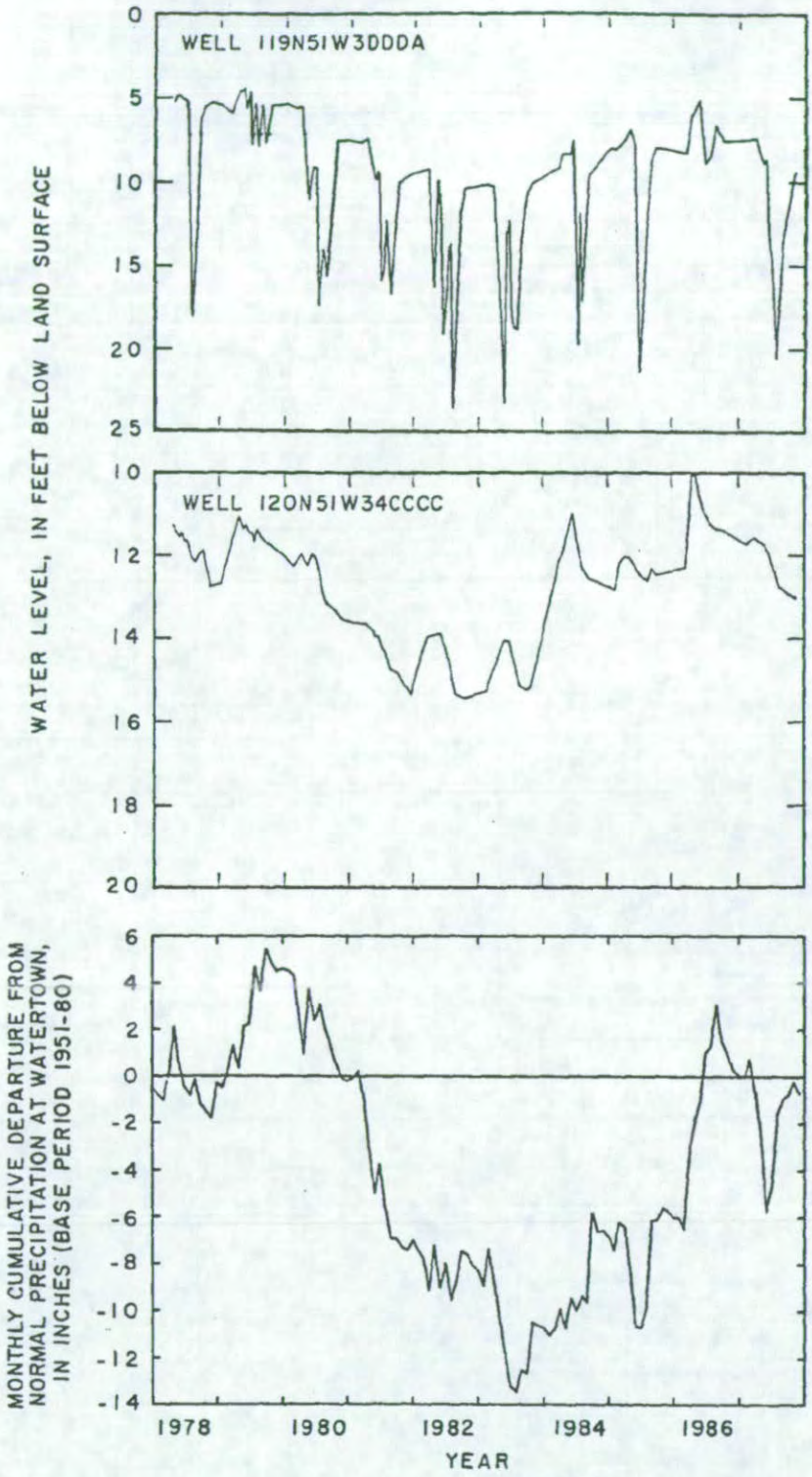


Figure 12.--Water-level fluctuations in the Antelope Valley aquifer and cumulative departure from normal precipitation at Watertown.

Prairie Coteau aquifer

The Prairie Coteau aquifer is composed of brown to gray, coarse to very coarse, well-rounded sand and fine gravel. The aquifer covers most of western Codington County and the western two townships of Grant County (fig. 13). The top of the aquifer may be as much as 380 ft below land surface in eastern Codington County to as little as 21 ft below land surface in northwestern Codington County. Geologic sections of the aquifer are shown in figures 8 and 11. Hydrologic characteristics are given in table 3.

Test-hole data in T. 122 N., R. 52 W. (Roberts County, fig. 1) indicate surficial outwash in that area as much as 65 ft thick. The outwash, known as the Coteau Lakes aquifer (J. A. Goodman, South Dakota Department of Water and Natural Resources, written commun., 1987) may be in hydraulic connection with the Prairie Coteau aquifer and may be the principle source of recharge to the Prairie Coteau aquifer. Recharge to the Prairie Coteau aquifer in western Codington County may be by direct infiltration and subsequent percolation of rainfall and snowmelt in areas where the aquifer is near land surface (fig. 11). These areas include T. 119 N., R. 54 and 55 W.; T. 118 N., R. 54 and 55 W.; and T. 117 N., R. 52 and 53 W. Recharge to the aquifer also may be by leakage from the Big Sioux aquifer. The Big Sioux aquifer and the Prairie Coteau aquifer are separated by 15 to 25 ft of silty, sandy till in T. 120 N., R. 52 W. and T. 116 N., R. 52 W. Recharge to the Prairie Coteau aquifer also may be by leakage from the till. The direction of water movement in the aquifer is from northeast to southwest toward Clark and Hamlin Counties. The gradient of the potentiometric surface is about 6 ft/mi (fig. 14). In T. 119 N., R. 52 W., the gradient is 20 ft/mi, which may be caused by finer aquifer material in this area.

Discharge from the Prairie Coteau aquifer is by: (1) Irrigation wells in western Grant and northern Codington Counties, (2) stock-watering and domestic wells, and (3) possibly, to Long Lake in western Codington County. Specific conductance of water from Long Lake is an order of magnitude less than of water from Nicholson and Medicine Lakes (table 2), which may indicate discharge from the Prairie Coteau aquifer to Long Lake. The average annual reported pumpage from 1980-85 from irrigation wells in western Grant and northern Codington Counties was about 1,700 acre-ft (South Dakota Department of Water and Natural Resources, written commun., 1980-85).

Records of long-term water-level fluctuations in well 121N52W22CCCC-R (fig. 15) show correlation with long-term trends in precipitation. The water-level decline from 1979-83 was caused by below-normal precipitation. The water-level rise from 1983-87 was caused by four years of above-normal precipitation.

Water from the Prairie Coteau aquifer is of the calcium bicarbonate type, based on predominant ions, in western Grant County and eastern Codington County and is of the calcium sulfate type in western Codington County (table 5). Dissolved-solids concentrations ranged from 650 to 2,250 mg/L and averaged 1,490 mg/L in western Codington County. Dissolved-solids concentrations ranged from 430 to 660 mg/L and averaged 510 mg/L in western Grant County and eastern Codington County. The smaller dissolved-solids concentrations in eastern Codington and western Grant Counties probably result from the inflow of less-concentrated water from the nearby recharge area in Roberts County (T. 122 N., R. 52 W.). Water from the aquifer is of suitable quality for irrigation based on South Dakota irrigation-water standards, revised January 1982 (fig. 6).

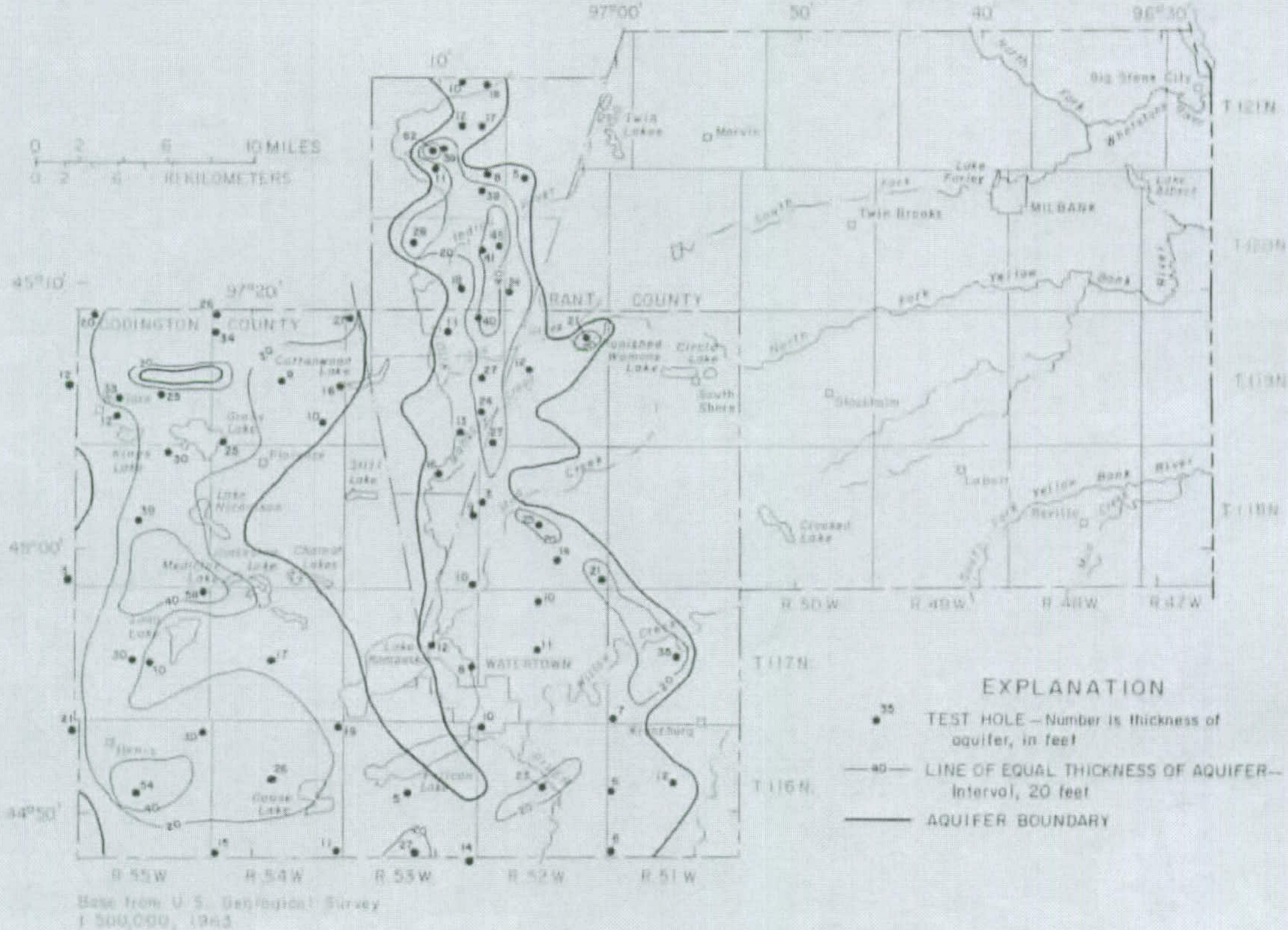


Figure 13.--Extent and thickness of the Prairie Coteau aquifer in Codington and Grant Counties.

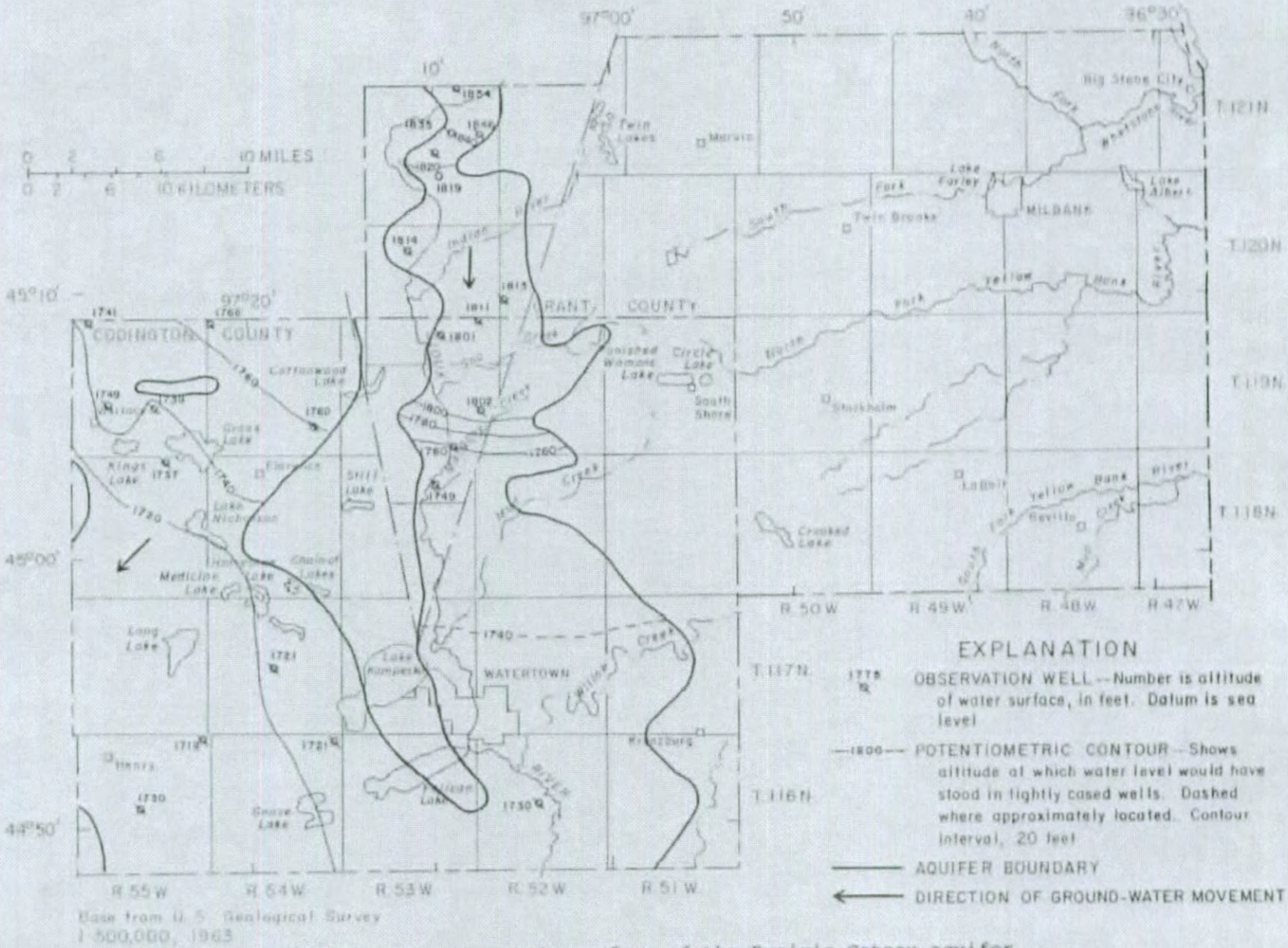


Figure 14.--Potentiometric surface of the Prairie Coteau aquifer in Codington and Grant Counties, October 1985.

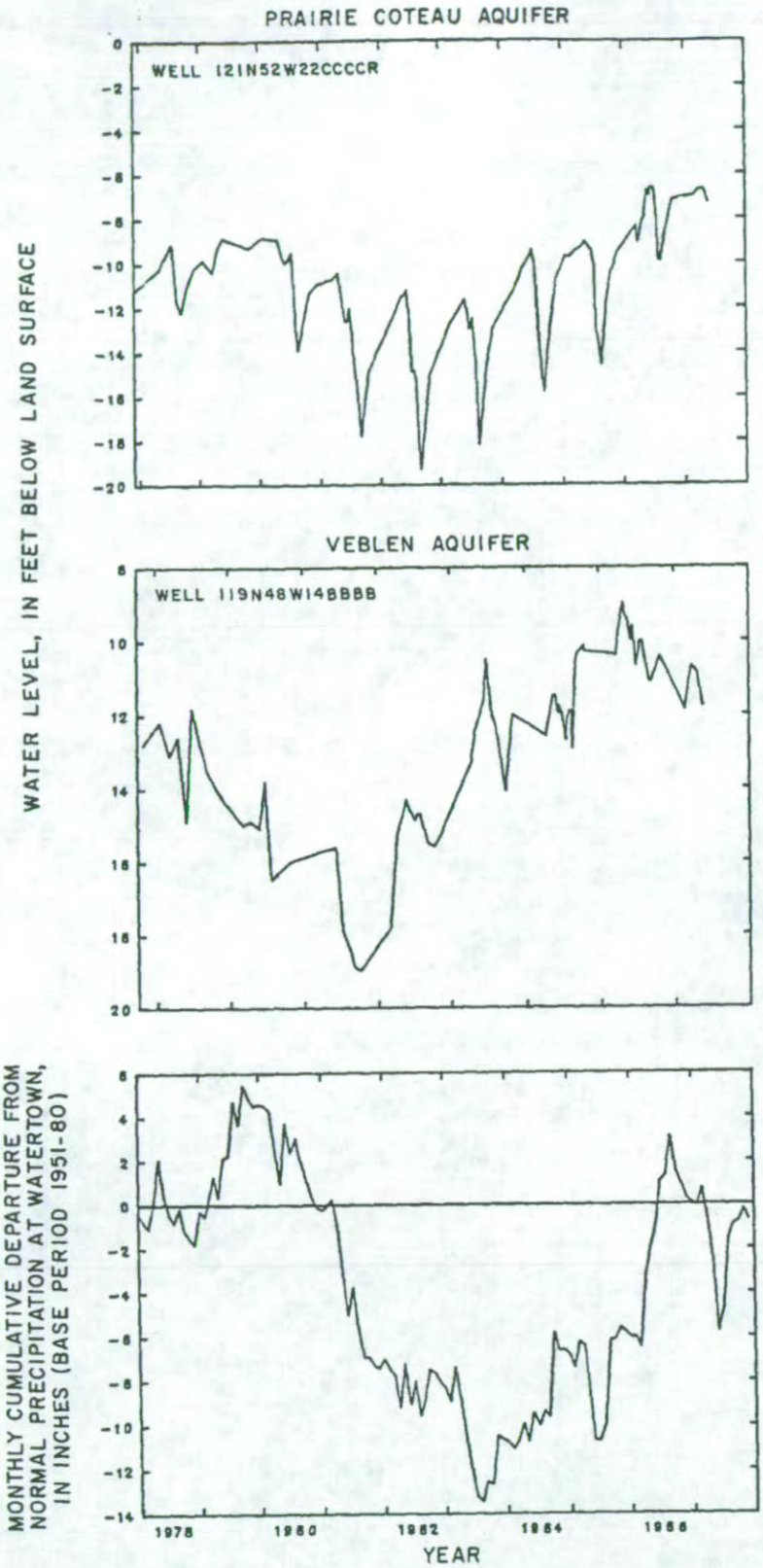


Figure 15.--Water-level fluctuations in the Prairie Coteau and Veblen aquifers and monthly cumulative departure from normal precipitation at Watertown.

Table 5.--Summary of chemical analyses of water from the Prairie Coteau aquifer in Codington and Grant Counties

[Analyses by U.S. Geological Survey and South Dakota Geological Survey. Results in milligrams per liter except as indicated; --, not analyzed]

	Western Grant County and eastern Codington County				Western Codington County			
	Number of samples	Mean	Minimum value	Maximum value	Number of samples	Mean	Minimum value	Maximum value
Specific conductance, field (microsiemens per centimeter at 25 °C)	8	920	630	1,200	32	2,000	1,010	6,510
Dissolved solids	8	510	430	660	16	1,490	650	2,250
Hardness	8	440	320	520	41	1,090	490	3,500
Alkalinity	8	410	250	500	26	360	250	500
Dissolved calcium	8	95	61	140	41	250	110	500
Dissolved magnesium	8	42	29	56	41	75	25	310
Dissolved sodium	8	26	14	48	41	110	14	540
Dissolved potassium	8	2	1	3	16	11	4	43
Bicarbonate	8	500	300	610	25	450	200	860
Dissolved sulfate	8	77	26	130	40	900	250	3,200
Dissolved chloride	8	8.2	1	42	28	18	1	42
Dissolved nitrate	3	4	3	5.8	17	2.1	0	17
Dissolved iron (micrograms per liter)	--	--	--	--	5	2,500	20	6,800
Dissolved manganese (micrograms per liter)	--	--	--	--	5	1,050	50	4,200

Veblen aquifer

The Veblen aquifer is located in eastern Grant County (fig. 16) and is composed of brown, medium to coarse sand and fine gravel. Coarse sand to coarse gravel was found in T. 121 N., R. 47 W., near the North and South Forks of the Whetstone River. As much as 154 ft of sand and gravel is present 2 to 3 mi northeast of Milbank. The extent of this thick section of sand and gravel was limited to about 1 mi^2. The aquifer slopes to the east at about 13 ft/mi and is under artesian conditions in most areas. In T. 120 N., R. 47 W. and the southern part of T. 121 N., R. 46 and 47 W., the aquifer is at or near land surface and is under water-table conditions. A geologic section of the aquifer is shown in figure 11 and hydrologic characteristics are given in table 3.

Recharge to the Veblen aquifer in Grant County is by direct infiltration and subsequent percolation of rainfall and snowmelt in T. 121 N., R. 46 W. where the aquifer is at land surface. The aquifer may be at land surface near the western aquifer boundary in Range 49 West, however, test drilling could not confirm this because of inaccessibility. Recharge to the Veblen aquifer also occurs in Marshall and Roberts Counties (Koch, 1975) where the aquifer is at land surface. Recharge to the aquifer also may occur by leakage from the till.

The direction of water movement (fig. 17) in the aquifer generally is from west to east. The direction of water movement in T. 121 N., R. 47 W. is toward the Whetstone River.

Discharge from the aquifer is: (1) From municipal, domestic, and stock-watering wells; (2) to the Whetstone River in northern Grant County; (3) to the Yellow Bank River in T. 120 N., R. 47 W.; (4) to Big Stone Lake; (5) to granite quarries located 6 mi east of Milbank; and (6) to the Minnesota River located 3 mi east of the Minnesota-South Dakota State line.

Water-level fluctuations (fig. 15) are caused by seasonal changes in recharge and discharge. Water levels in observation wells generally rose from September 1985 to April 1986 because of recharge from snowmelt and spring rainfall. Above-normal precipitation from September 1983 to April 1986 (about 11 inches) caused water levels in well 119N48W14BBBB to rise about 9 ft (fig. 15). The water-level decline from 1980-83 was caused by below-normal precipitation.

Water from the Veblen aquifer is a mixed chemical type in which calcium and sulfate are predominant but which also contains significant concentrations of magnesium and bicarbonate (table 6). Ninety percent of the reacting cations in water from the aquifer are calcium and magnesium, 65 percent of the anions are sulfate, and 35 percent are bicarbonate (fig. 18). Dissolved-solids concentrations ranged from 880 to 3,000 mg/L and averaged 1,300 mg/L. Hardness concentrations ranged from 390 to 2,170 mg/L and averaged 860 mg/L. The average concentration of chemical constituents in water from the aquifer was used to plot the datum point on the South Dakota irrigation-water classification diagram (fig. 6), which indicates that water from the aquifer generally is of suitable quality for irrigation.

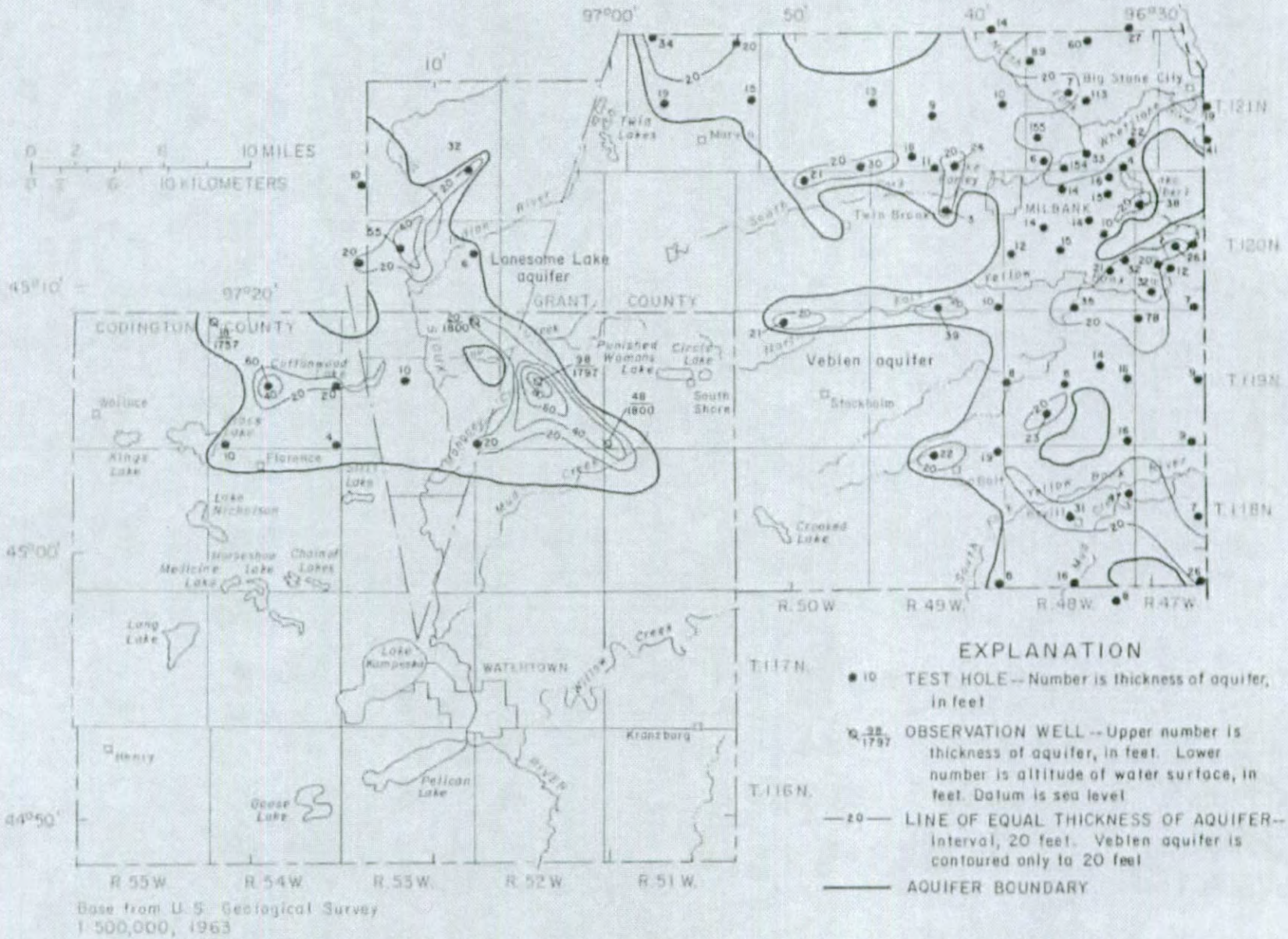


Figure 16.--Extent, thickness, and water-surface altitude of the Lonesome Lake and Veblen aquifers in Codington and Grant Counties, October 1985.

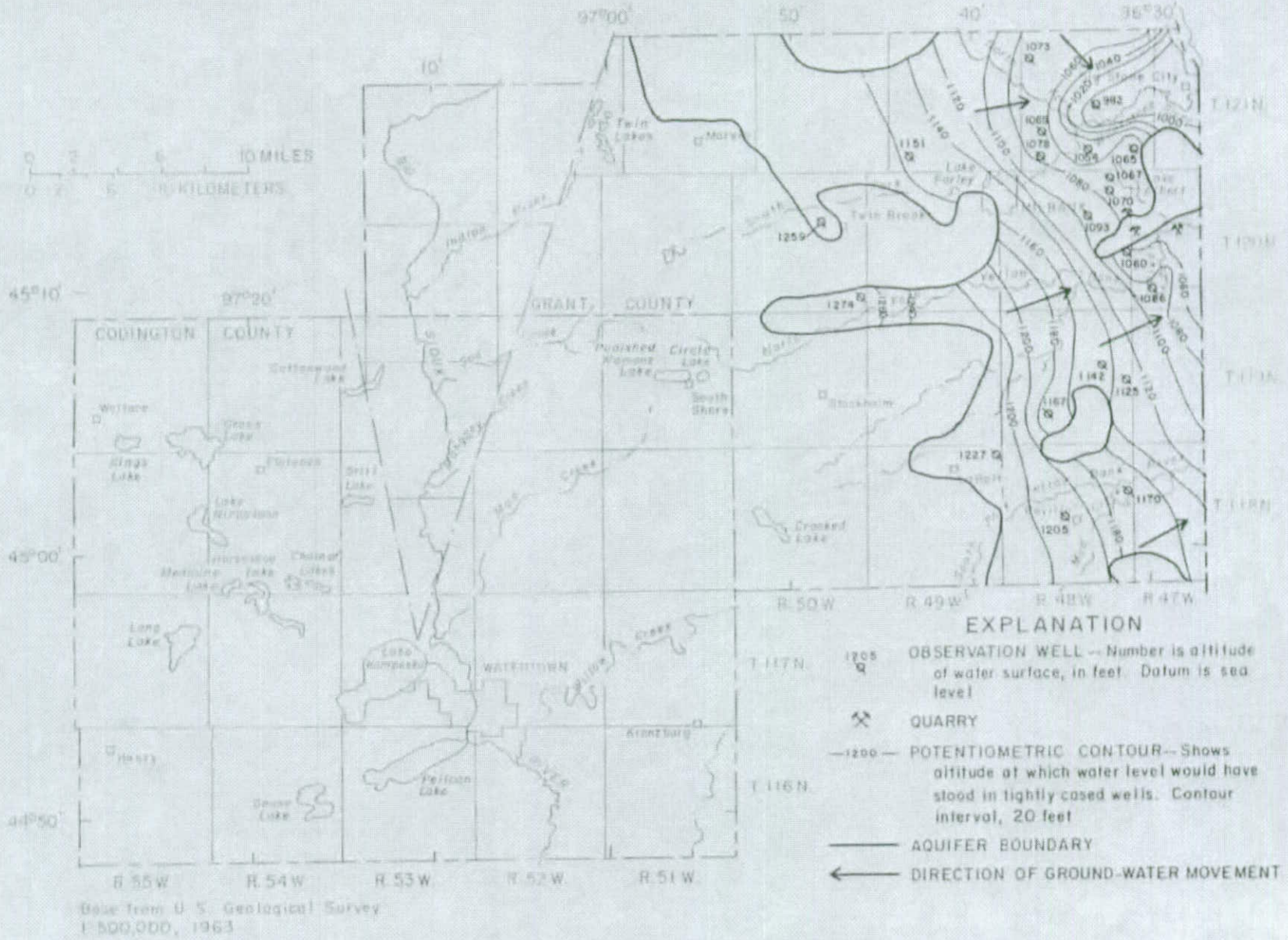


Figure 17.--Potentiometric surface of the Veblen aquifer in Grant County, October 1985.

Table 6.--Summary of chemical analyses of water from the Veblen and Revillo aquifers in Grant County

[Analyses by U.S. Geological Survey and South Dakota Geological Survey. Results in milligrams per liter except as indicated; --, not analyzed]

	Veblen aquifer				Revillo aquifer			
	Number of samples	Mean	Minimum value	Maximum value	Number of samples	Mean	Minimum value	Maximum value
Specific conductance, field (microsiemens per centimeter at 25 °C)	9	1,600	1,100	2,900	8	1,480	1,070	1,900
Hardness	9	860	390	2,170	8	625	490	1,000
Dissolved solids	8	1,300	880	3,000	8	1,200	870	1,500
Dissolved calcium	9	220	86	600	8	160	120	210
Dissolved magnesium	9	78	36	160	8	54	45	80
Dissolved sodium	9	65	26	250	8	120	55	260
Sodium absorption ratio	9	1	.3	6	0	--	--	--
Dissolved potassium	9	10	4	12	8	8	6	9
Bicarbonate	9	420	140	530	8	420	400	460
Dissolved sulfate	9	590	310	1,500	8	520	350	800
Dissolved chloride	9	22	2.0	96	8	22	4.0	43
Dissolved nitrate	8	<.04			8	<.04		
Dissolved iron (micrograms per liter)	9	2,600	0	18,000	8	2,600	50	7,200
Dissolved manganese (micrograms per liter)	9	420	40	1,200	8	220	96	480

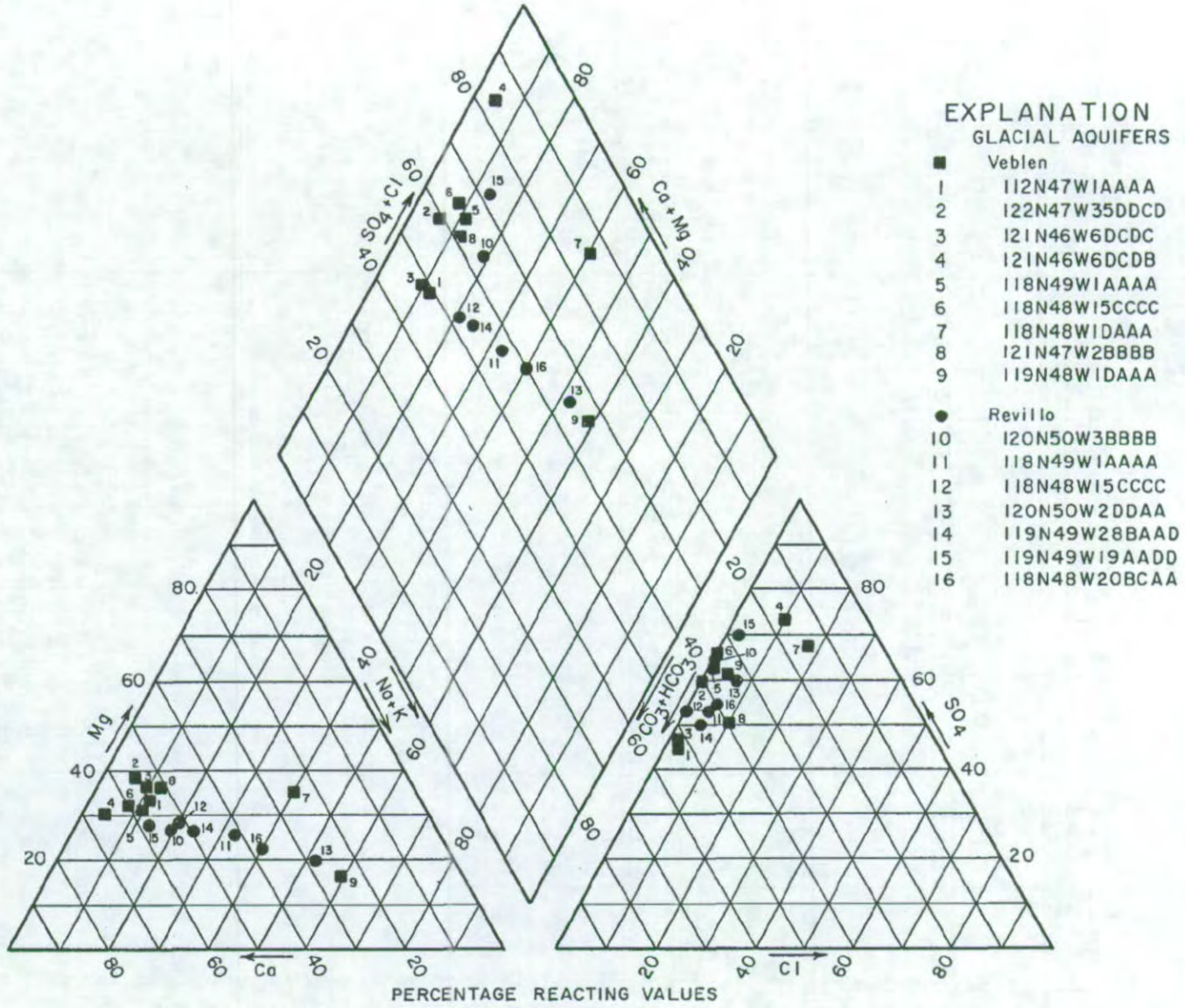


Figure 18.--Trilinear diagram of predominant chemical constituents in water from the Veblen aquifer are calcium and sulfate, and from the Revillo aquifer are calcium, bicarbonate, and sulfate.

Lonesome Lake aquifer

The Lonesome Lake aquifer, located in northern Codington and western Grant Counties (fig. 16), consists of light brown to gray, coarse sand to fine gravel. The sand grains and pebbles are subangular to well rounded and may contain as much as 20 percent clay near the bottom of the aquifer. The aquifer generally occurs between 1,500 and 1,600 ft above sea level, is overlaid by as much as 380 ft of till in eastern Codington County, and is under artesian conditions. A geologic section of the aquifer is shown in figure 11, and hydrologic characteristics of the aquifer are given in table 3.

Water-level fluctuations in four observation wells screened in the aquifer (fig. 16) indicate seasonal changes in recharge and discharge. Water levels in observation well 120N52W26AAAA-R (fig. 19) rose about 4 ft from October 1985 through May 1986 and declined about 1 ft from June 1986 to September 1986. Above-normal precipitation from October 1986 to June 1987 caused water levels to rise about 2 ft. Recharge to the Lonesome Lake aquifer is by leakage from till and by direct infiltration and subsequent percolation of rainfall and snowmelt where the aquifer is at or near land surface in Day County. Test drilling showed that the Lonesome Lake aquifer ranged from 200 to 380 ft below land surface in Codington County.

Predominant chemical constituents in water from the Lonesome Lake aquifer are calcium and sulfate (table 7). Field specific conductance in water samples from three observation wells were 1,380, 1,220, and 2,730 μS/cm.

Revillo aquifer

The Revillo aquifer, located in central Grant County (fig. 20), lies in a buried, preglacial bedrock valley that trends northwest-southeast. In northern Grant County, the aquifer is separated from the Veblen aquifer to the east by a buried shale bedrock ridge (figs. 11 and 21). Test-hole data in Roberts County, 20 mi north of Twin Brooks, indicate that the Revillo and Veblen aquifers may be in hydraulic connection. Koch (1972) described the Veblen aquifer in northeast Marshall County (fig. 1) as glacial outwash that lies in a buried bedrock valley and extends to land surface. The Veblen aquifer in Marshall County (Koch, 1972) may be the same hydrologic unit as the Revillo aquifer described in this report.

The Revillo aquifer consists of glacial outwash composed of gray, fine to very coarse gravel. The aquifer is as much as 150 ft thick in southern Grant County. The base of the aquifer in T. 121 N., R. 49 W. occurs at about 1,050 ft above sea level, declines to 1,000 ft above sea level at Twin Brooks (fig. 22), and declines to 950 ft above sea level at the Grant-Deuel County line. Hydrologic characteristics of the aquifer are given in table 3.

Recharge to the aquifer is by direct infiltration and subsequent percolation of rainfall and snowmelt in Roberts and Marshall Counties where the aquifer is at or near land surface (Koch, 1972) and by leakage from till. The direction of water movement in the aquifer is from north to south. The gradient of the potentiometric surface, based on five observation wells screened in the aquifer, increases from 0.15 ft/mi between Twin Brooks and LaBolt, to about 5.5 ft/mi from LaBolt to the Grant-Deuel County boundary. Discharge from the aquifer primarily is by municipal wells located at Twin Brooks for the city of Milbank, a municipal well located at Revillo for the town of Revillo, and by stock-watering and domestic wells.

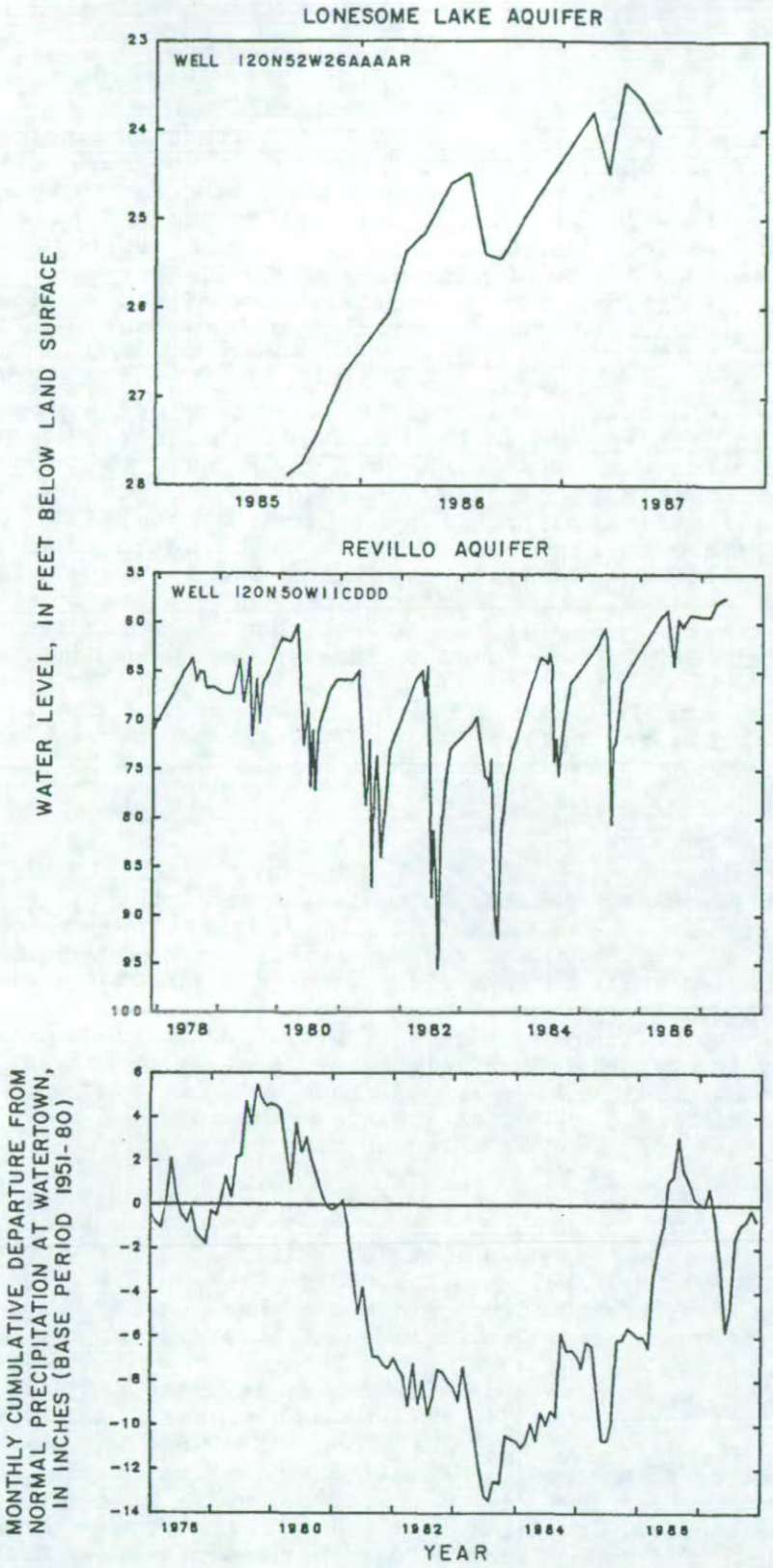


Figure 19.--Water-level fluctuations in the Lonesome Lake and Revillo aquifers and monthly cumulative departure from normal precipitation at Watertown.

Table 7.--Chemical analyses of water from the Altamont, granite wash, Lonesome Lake, and Dakota aquifers in Codington and Grant Counties

[Analyses by U.S. Geological Survey. Results in milligrams per liter except as indicated; --, not analyzed; <, less than]

Location	Dissolved calcium	Dissolved sodium	Dissolved magnesium	Dissolved potassium	Alkalinity	Dissolved sulfate	Dissolved nitrate
			Lonesome Lake aquifer				
119N51W31CCCC	72	130	100	15	220	1,400	0.10
119N52W15CCCC2	140	56	55	7	340	330	.10
119N54W 6BBBB	190	46	56	10	330	470	.10
			Altamont aquifer				
116N51W 4AAB	260	240	120	7	430	1,200	0.1
116N55W34BABB	87	600	61	10	320	1,500	.1
117N55W21BBCB	71	390	58	8	300	970	.1
118N55W11ABBD	140	430	56	15	280	1,200	.1
			Dakota aquifer				
116N52W 2CBBC	6.5	449	27	9	200	760	--
			Granite wash aquifer				
119N48W24AAAA	30	440	8.6	10	310	930	--
119N47W 7DAAD	40	510	11	12	300	1,000	--
119N48W 4DDCC	70	630	19	14	200	1,100	--
120N48W30DAAA	24	580	10	15	420	1,100	--
120N49W 8AAAB	17	590	5.5	14	360	1,200	--
121N49W35DDDC	15	540	5.6	9	370	1,600	--

Table 7.--Chemical analyses of water from the Altamont, granite wash, Lonesome Lake, and Dakota aquifers in Codington and Grant Counties--Continued

Location	Dissolved chloride	Dissolved iron (micrograms per liter)	Dissolved manganese (micrograms per liter)	Dissolved fluoride	Dissolved solids	Specific conductance (field) (microsiemens per centimeter)	pH (field) (units)
			Lonesome Lake aquifer				
119N52W31CCCC	3.6	20	20	0.3	--	2,730	7.6
119N52W15CCCC2	2.6	<10	150	.4	--	1,220	7.3
119N54W 6BBB	7.0	<10	1,700	.5	--	1,380	7.2
			Altamont aquifer				
116N51W 4AAB	17	920	1,500	0.5	2,100	2,600	7.0
116N55W34BABB	96	1,700	210	.2	2,600	3,440	7.6
117N55W21BBCB	9.5	730	240	.2	1,700	2,660	7.8
118N55W11ABBD	92	3,700	230	.4	2,100	2,870	7.5
			Dakota aquifer				
116N52W 2CBBC	110	90	50	--	1,480	2,310	9.5
			Granite wash aquifer				
119N48W24AAAA	--	10	<2	--	--	4,190	7.5
119N47W 7DAAD	--	<10	22	--	--	3,990	8.0
119N48W 4DDCC	--	<10	19	--	--	6,050	7.8
120N48W30DAAA	--	<10	<2	--	--	4,430	8.0
120N49W 8AAAB	--	<10	<2	--	--	4,440	7.7
121N49W35DDDC	--	<10	10	--	--	4,350	8.3

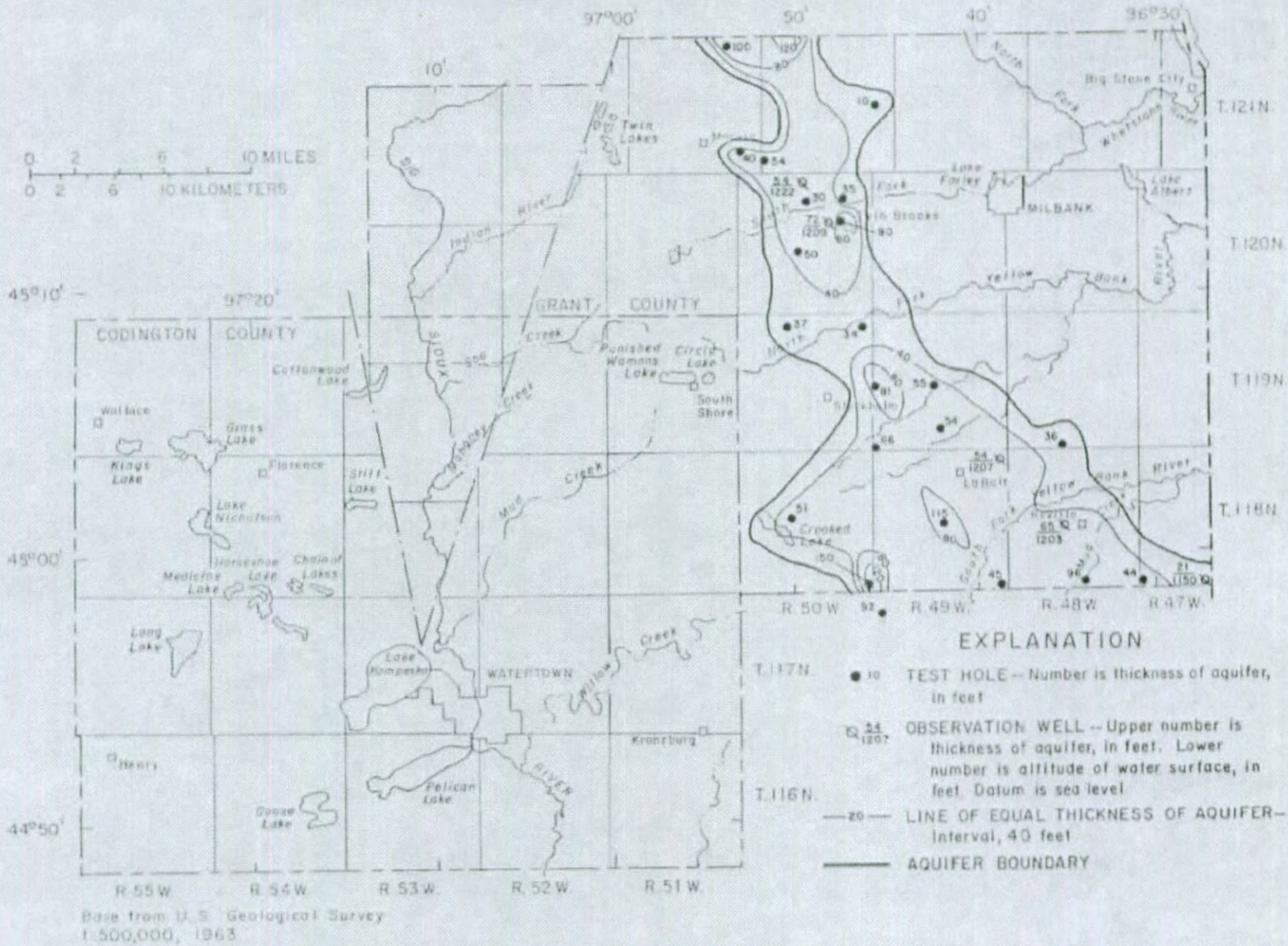


Figure 20.--Extent and thickness of the Revillo aquifer in Grant County.

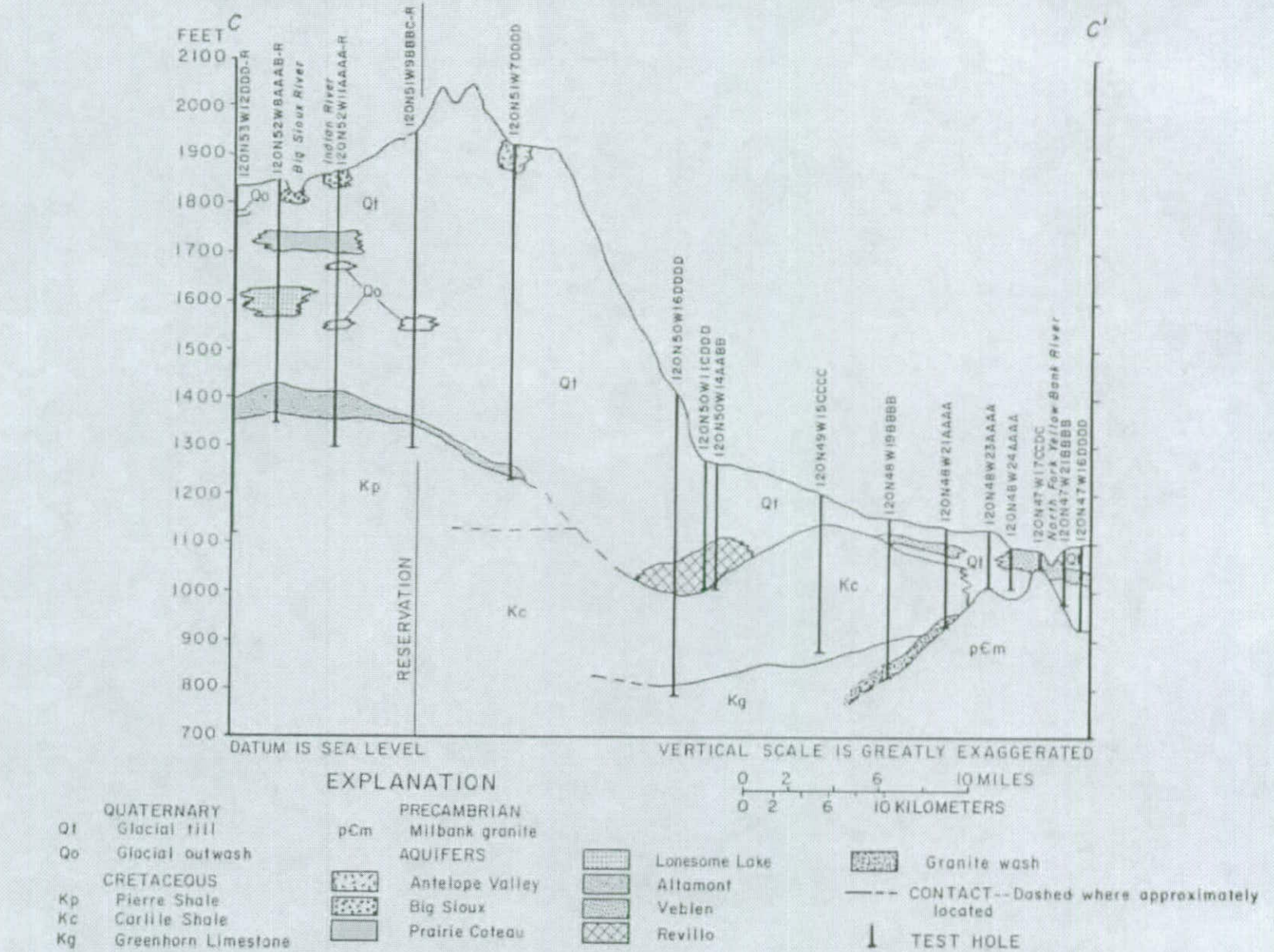


Figure 21.--Geologic section C-C' showing the Antelope Valley, Big Sioux, Prairie Coteau, Lonesome Lake, Altamont, Veblen, Revillo, and granite wash aquifers. (Section C-C' is shown in figure 2.)

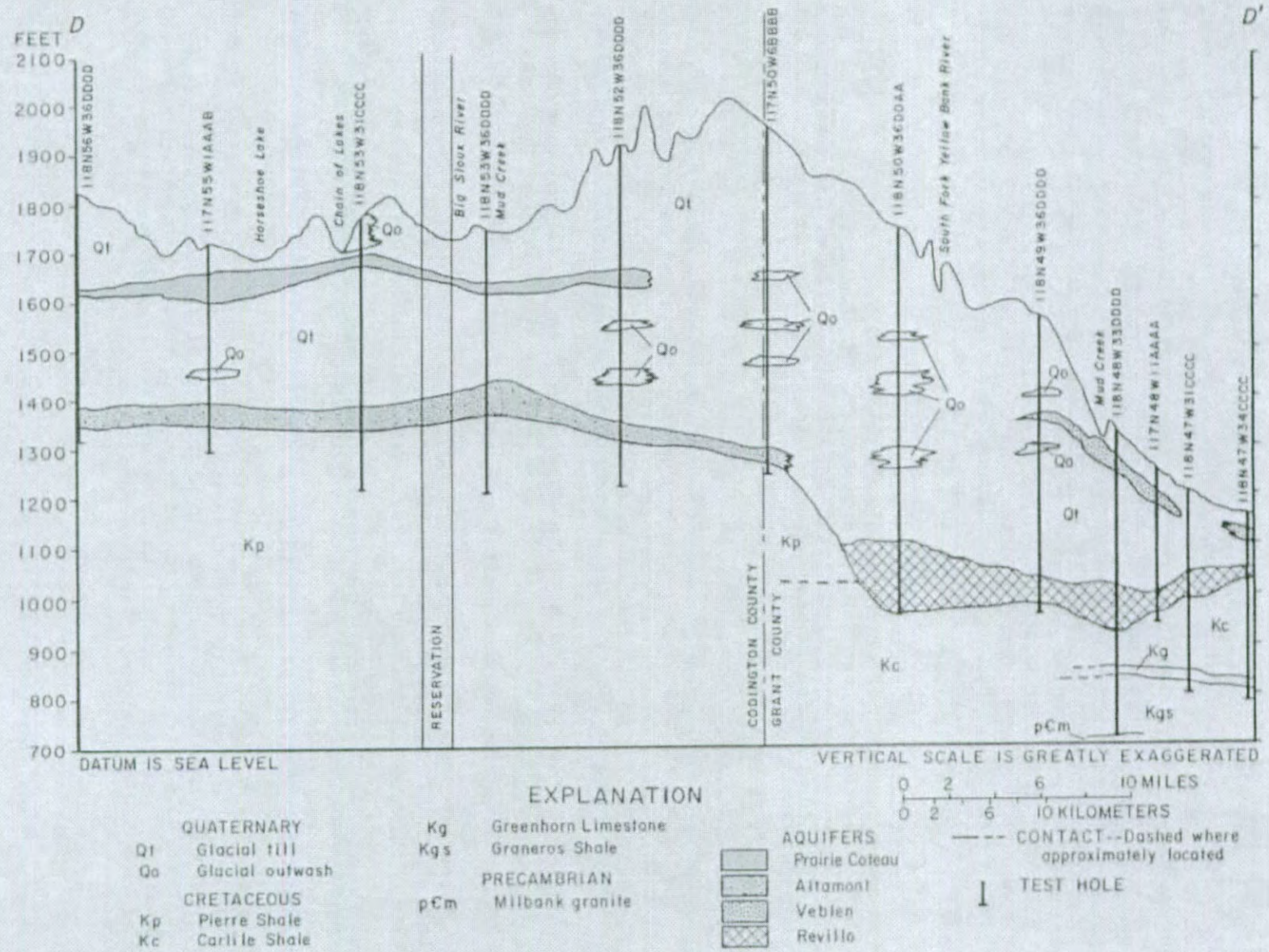


Figure 22.--Geologic section D-D' showing the Prairie Coteau, Veblen, Revillo, and Altamont aquifers. (Section D-D' is shown in figure 2.)

Water-level fluctuations in 5 observation wells screened in the aquifer reflect seasonal changes in recharge and discharge, as well as pumpage from municipal wells (fig. 19). Water levels generally declined from May to August because discharge from municipal wells was greater than recharge. Water levels rose from September to April because recharge from snowmelt and rainfall was greater than discharge. Records of long-term water-level fluctuations in well 120N50W11CDDD show correlation with long-term trends in precipitation. The water-level decline from 1979-83 was caused by below-normal precipitation. The water-level rise from 1983-87 was caused by four consecutive years of above-normal precipitation.

Predominant chemical constituents in water from the Revillo aquifer are calcium and sulfate with significant concentrations also of bicarbonate (table 6). Dissolved calcium ranged from 120 to 210 mg/L and averaged 160 mg/L. Dissolved-sulfate concentrations ranged from 350 to 800 mg/L and averaged 520 mg/L. Specific conductance of water from the aquifer, determined by onsite analysis, ranged from 1,070 to 1,900 µS/cm and averaged 1,480 µS/cm. A comparison of the chemical analysis of water from the Veblen and Revillo aquifers shows that dissolved calcium, bicarbonate, sulfate, and dissolved-solids concentrations are similar. Percent-reacting values of the major constituents in water from the Revillo aquifer are shown in figure 18. Sodium concentrations range from 16 to 52 percent. The variation may be the result of cation exchange with calcium in the clay layers within the aquifer. Water from the aquifer is used primarily for municipal and domestic use and may be suitable for irrigation based on South Dakota irrigation-water standards, revised January 1982 (fig. 6).

Altamont aquifer

The Altamont aquifer is present in most of Codington County and western Grant County (fig. 23). It is composed of well-rounded, medium to coarse sand. The aquifer is interbedded with silt and clay layers in the northwest quarter of Codington County. The average depth to the top of the aquifer is 460 ft below land surface; it occurs between 1,250 and 1,500 ft above sea level. The average thickness of the aquifer is about 40 ft; however, in T. 121 N., R. 52 W. and T. 118 N., R. 52 W., average aquifer thickness is about 65 ft. Hydrologic characteristics of the aquifer are given in table 3 and geologic sections of the aquifer are shown in figures 8, 11, and 21.

Recharge to the Altamont aquifer probably is by leakage from the overlying till. The direction of water movement is to the southwest at a gradient of about 5 ft/mi (fig. 24). Water-level fluctuations in an observation well screened in the aquifer are shown in figure 25. Discharge from the aquifer is primarily by pumping from stock-watering and domestic wells; however, with the introduction of rural water systems (public supply of water to the rural community), stock-watering and domestic wells are being abandoned and water use is declining.

Predominant chemical constituents in water from the Altamont aquifer are sodium and sulfate (table 7). Dissolved-solids concentrations ranged from 1,700 to 2,600 mg/L and averaged 2,120 mg/L. Specific conductance, determined from 40 onsite analyses, ranged from 1,950 to 4,020 µS/cm and averaged 3,160 µS/cm. Hardness concentrations, determined from 40 onsite analyses, ranged from 530 to 1,800 mg/L and averaged 840 mg/L.

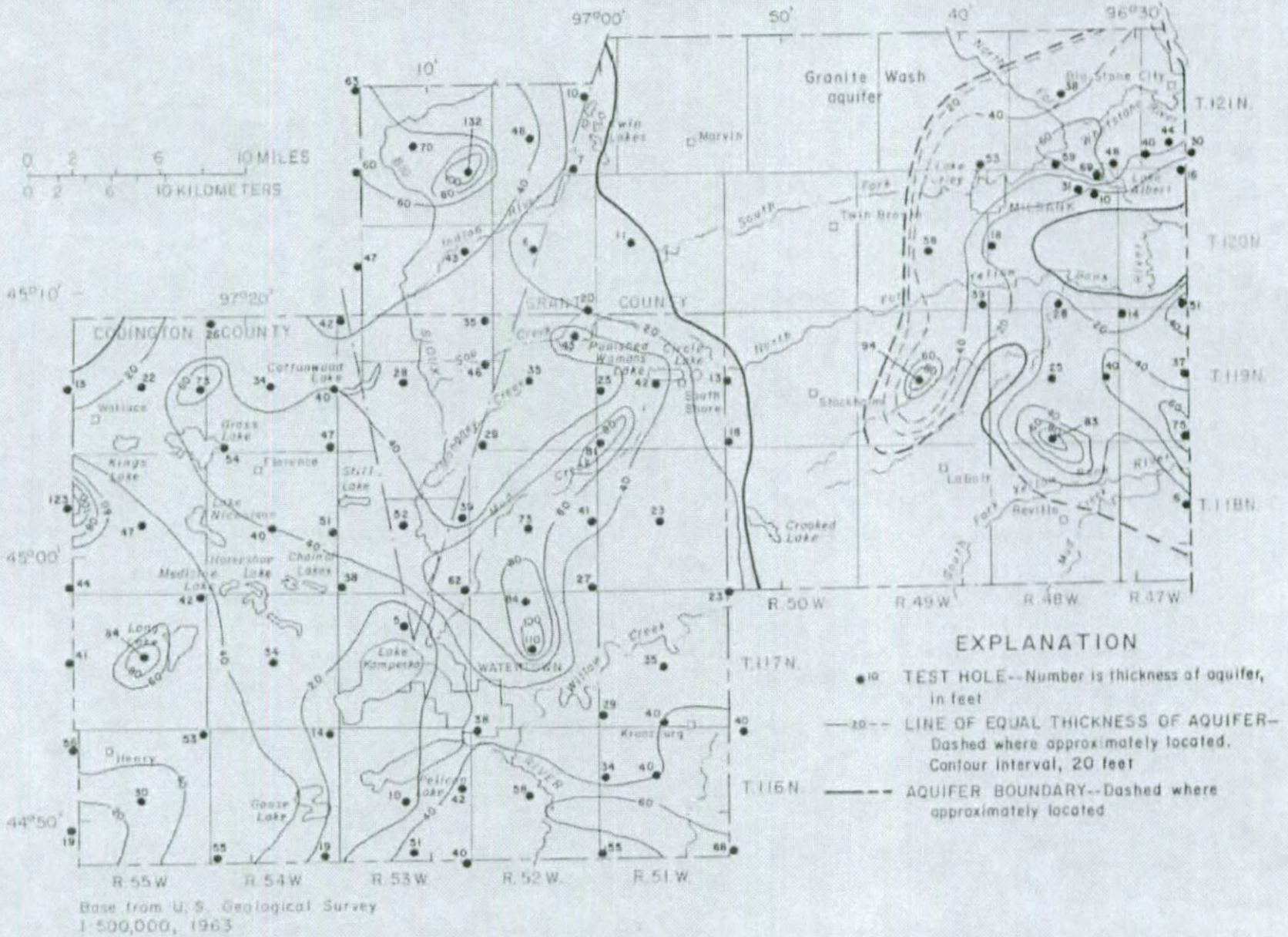


Figure 23.--Extent and thickness of the Altamont and granite wash aquifers in Codington and Grant Counties.

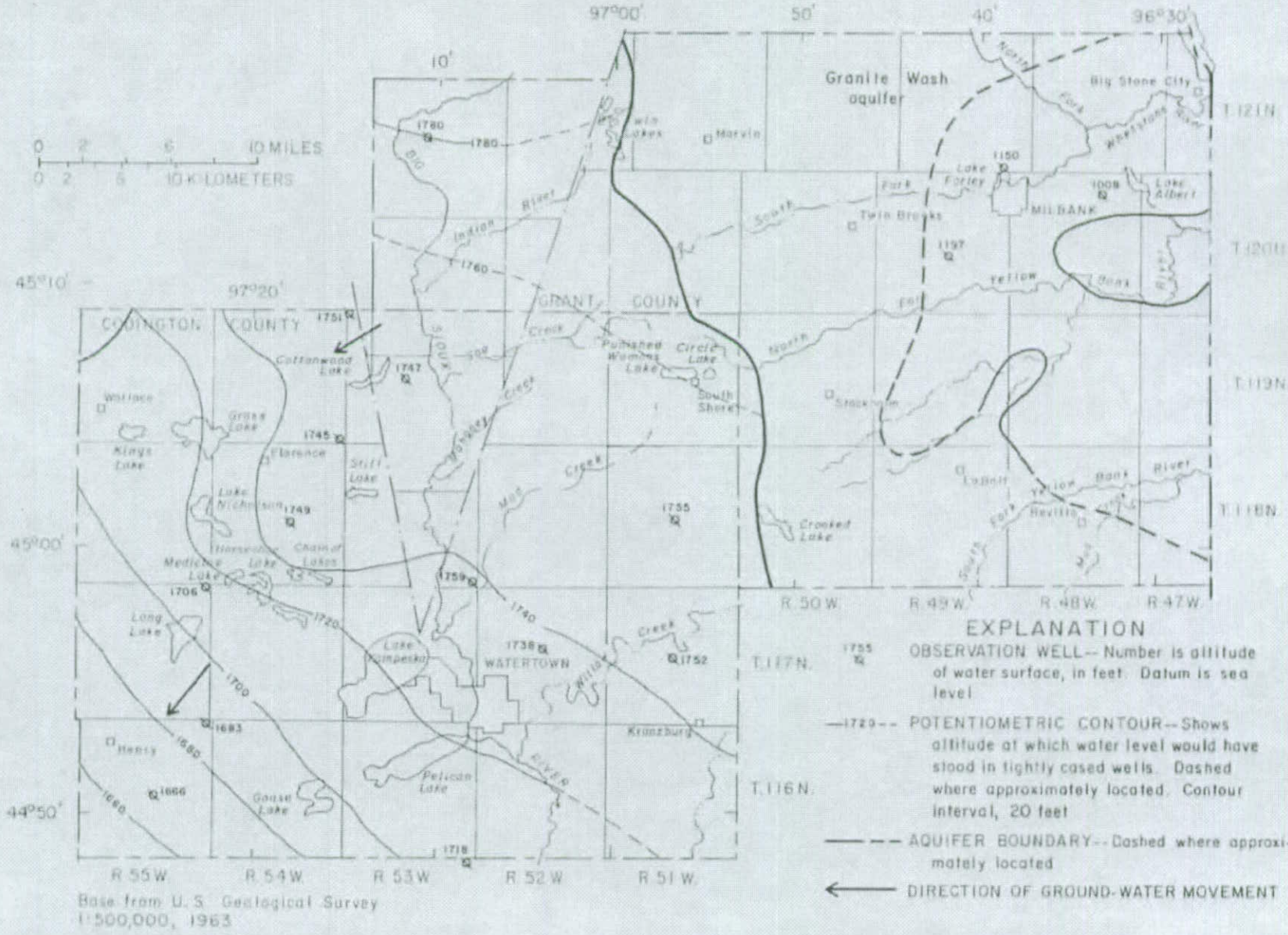


Figure 24.--Potentiometric surface of the Altamont aquifer in Codington and Grant Counties, October 1985.

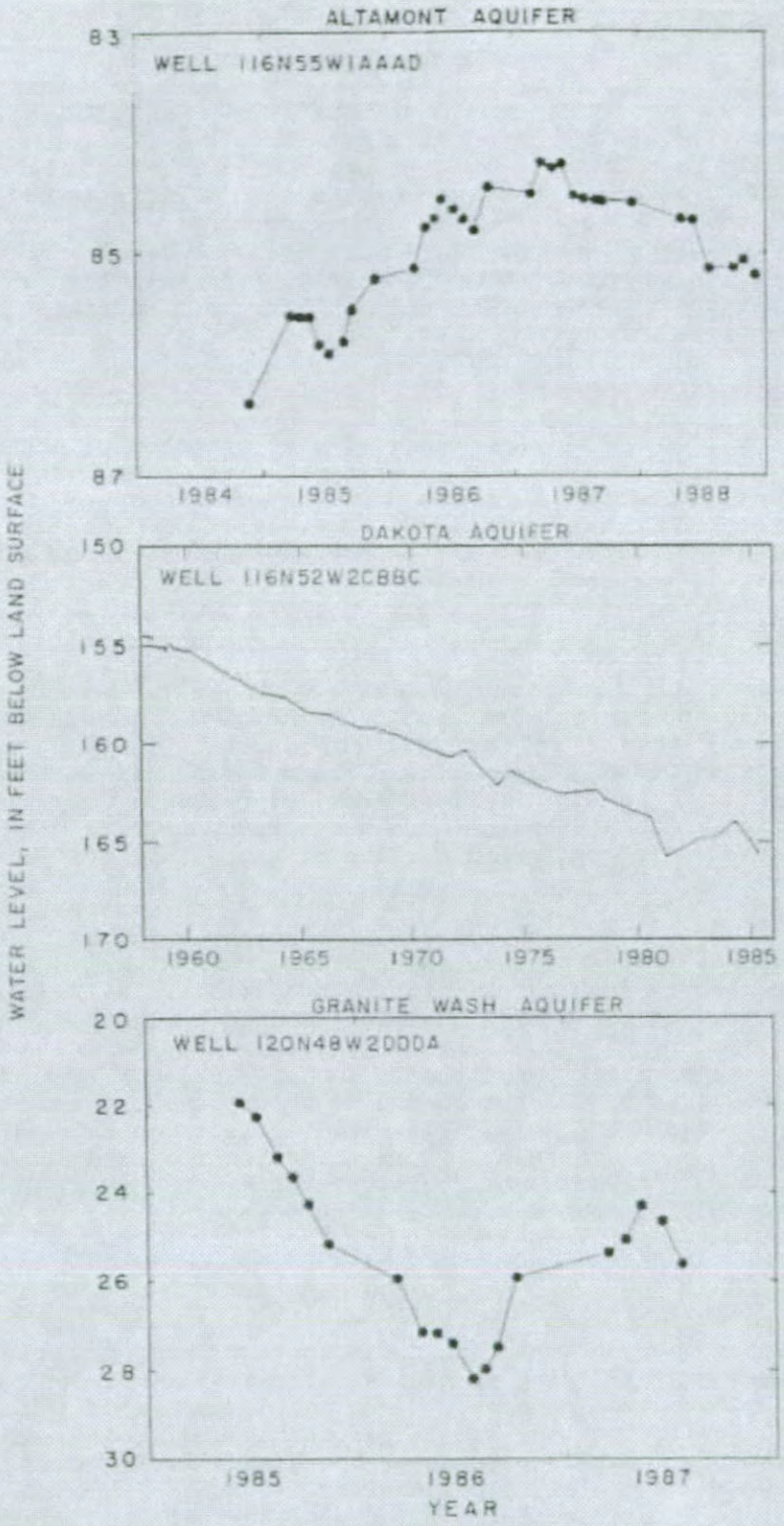


Figure 25.--Water-level fluctuations in the Altamont, Dakota, and granite wash aquifers.

Bedrock Aquifers

Dakota aquifer

The Dakota aquifer, in the Dakota Formation of Cretaceous age, is composed of a fine-grained, gray to brown sandstone that contains interbedded layers of shale. Data for the aquifer are available only from well 116N52W2CBBC. The top of the aquifer is at 1,230 ft below land surface. Water-level fluctuations in the well screened in the aquifer are shown in figure 25. The water level in the Dakota aquifer has declined about 10 ft from 1958-85. A chemical analysis of water from well 116N52W2CBBC, shown in table 7, indicates that water from the aquifer is a sodium sulfate type with a dissolved-solids concentration of 1,480 mg/L.

Granite wash aquifer

The granite wash aquifer (fig. 23) is composed of uncemented, coarse, sub-angular to well-rounded, pink to blue to gray, quartzose and feldspathic sand, containing about 50 percent feldspar. The aquifer overlies the informally named Milbank granite in eastern Grant County. The western boundary of the aquifer in Grant County was approximated because test holes did not penetrate the entire thickness of the Cretaceous sedimentary rocks. A geologic section of the aquifer is shown in figure 11 and hydrologic characteristics are given in table 3.

Water-level fluctuations in observation well 120N48W2DDDA (fig. 25) generally indicate seasonal changes in recharge to and discharge from the aquifer. Water levels in the well rose about 4 ft from September 1985 to June 1986 because recharge from snowmelt and spring rainfall was greater than discharge. Water levels declined from July 1986 to July 1987 because discharge was greater than recharge. Below-normal snowmelt and precipitation probably caused the continued decline of the water level during the spring months of 1987.

Based on three observation wells, the author believes that the direction of water movement in the aquifer may be from west to east. Discharge from the aquifer also is from stock-watering and domestic wells, fractures in the Milbank granite, and to granite quarries located 6 and 15 mi east of Milbank.

Predominant chemical constituents in water from the granite wash aquifer are sodium and sulfate. Dissolved-sodium concentrations ranged from 440 to 630 mg/L and averaged 550 mg/L. Dissolved-sulfate concentrations ranged from 930 to 1,600 mg/L and averaged 1,200 mg/L. Specific conductance ranged from 3,990 to 6,050 μS/cm and averaged 4,575 μS/cm. Chemical analyses of water samples collected from the aquifer are given in table 7.

WATER USE

The primary users of water in Codington and Grant Counties during 1985 (table 8) were gravel-mining companies. The 1985 water use by the companies was 7 Mgal/d. Seventeen percent of the total amount of water used in the counties was for irrigation, and 98 percent of the water used for irrigation was ground water. About 33 percent of the ground water used for irrigation was withdrawn from the Big Sioux aquifer and about 66 percent was withdrawn from the Prairie Coteau aquifer. All the withdrawals in Codington and Grant Counties for public-water supply were from ground water. The city of Watertown and the Sioux Rural Water System obtain water from the Big Sioux aquifer. The cities of Milbank and Revillo obtain their supply from the Revillo aquifer. About sixty percent of the water used for stock watering

was derived from surface-water sources and 40 percent from ground-water sources. Well-inventory data indicate that the primary source of ground water for stock watering is the Prairie Coteau and Altamont aquifers. Total water use in Codington and Grant Counties in 1985 was about 18 Mgal/d.

Table 8.--Water use, in million gallons per day, for Codington and Grant Counties during 1985

	Live-stock	Public water supply	Power genera-tion	Self-supplied domestic	Self-supplied commercial/ industrial/ gravel mining	Irriga-tion	Total
Codington County							
Ground water	0.22	2.41	0	0.08	3.92	1.55	8.18
Surface water	.36	0	0	0	4.19	.05	4.60
Grant County							
Ground water	.24	.67	.03	.05	.10	1.50	2.08
Surface water	.36	0	2.59	0	0	.02	3.48
Total	1.18	3.08	2.62	.13	8.21	3.12	18.34

SUMMARY

The primary sources of surface water in Codington County include Lakes Kampeska and Pelican and numerous small lakes, potholes, and sloughs in the western part of the county. Seasonal variations in streamflow and lake levels are directly related to seasonal variations in precipitation. Long-term lake-level fluctuations indicate correlation with departure from normal precipitation. Specific conductance of water from streams and lakes is inversely related to stream discharge and lake levels, respectively. Dissolved-solids concentration in water from streams and lakes increases as stream discharge decreases and lake levels decline.

Seven glacial aquifers and two bedrock aquifers were delineated in Codington and Grant Counties. The Big Sioux and Antelope Valley aquifers, composed of glacial outwash, generally are less than 10 feet below land surface. The Prairie Coteau, Lonesome Lake, and Veblen aquifers are overlaid by as much as 380 feet of till and are underlaid by till. The Altamont and Revillo aquifers are overlaid by as much as 668 feet of till and, in most locations, lie on top of shale bedrock.

The average thickness of the Big Sioux aquifer is 24 feet and the average thickness of the Antelope Valley aquifer is 34 feet. Recharge to these aquifers is by direct infiltration and subsequent percolation of snowmelt and spring rainfall. Discharge is by domestic, stock-watering, irrigation, and municipal wells, evapotranspiration, outflow to the Big Sioux River from the Big Sioux aquifer, and by outflow to Punished Womans Lake from the Antelope Valley aquifer. Predominant chemical constituents in water from

the aquifers are calcium and bicarbonate. Dissolved solids in the Big Sioux aquifer averaged 580 milligrams per liter and dissolved solids in the Antelope Valley aquifer averaged 350 milligrams per liter.

The average thickness of the Prairie Coteau, Lonesome Lake, and Veblen aquifers ranged from 21 to 32 feet. The Veblen aquifer is as much as 155 feet thick. Recharge to the Prairie Coteau and Veblen aquifers is by direct infiltration and subsequent percolation of snowmelt and spring rainfall. Recharge to the Lonesome Lake aquifer is by leakage from till. Test-hole and observation-well data indicate that the recharge area of the Prairie Coteau aquifer may be in T. 122 N., R. 52 W. in Roberts County. Discharge from these aquifers is by evapotranspiration and by domestic, stock-watering, irrigation, and municipal wells. Discharge from the Prairie Coteau aquifer also may occur as outflow to Long Lake. Discharge from the Veblen aquifer also is to granite quarries 6 miles east of Milbank and to Big Stone Lake. Predominant chemical constituents in water from the Prairie Coteau aquifer in northern Codington and western Grant Counties are calcium and bicarbonate and in western Codington are calcium and sulfate. Predominant chemical constituents in water from the Veblen aquifer are calcium and sulfate with significant concentrations of bicarbonate. Dissolved-solids concentrations in water from the Prairie Coteau aquifer averaged 510 milligrams per liter in northeastern Codington and western Grant Counties and 1,490 milligrams per liter in western Codington County. Dissolved-solids concentrations in water from the Veblen aquifer averaged 1,300 milligrams per liter.

The average thickness of the Revillo aquifer is 63 feet and the average thickness of the Altamont aquifer is 40 feet. Recharge to the Revillo aquifer is by direct infiltration and subsequent percolation of snowmelt and rainfall north of the study area in Roberts and Marshall Counties. Water-level fluctuations in the Revillo aquifer are caused by seasonal changes in recharge and by pumpage from municipal wells. Records of long-term water-level fluctuations show correlation with long-term trends in precipitation. Recharge to the Altamont aquifer is by leakage from till. Discharge from the aquifers is by stock-watering and domestic wells. Discharge from the Revillo aquifer also is by municipal wells.

Predominant chemical constituents in water from the Big Sioux, Antelope Valley, Prairie Coteau, Veblen, Revillo, and Lonesome Lake aquifers are calcium and bicarbonate. Significant concentrations of sulfate also are present in water from the Veblen and Revillo aquifers. Sodium and sulfate are predominant in water from the Altamont aquifer. Average dissolved-solids concentrations in water from the aquifers range from 350 to 2,120 milligrams per liter.

The Dakota aquifer is 1,230 ft below land surface in Codington County. The water level in one observation well screened in the aquifer has declined 10 ft in the last 30 years. Water from the aquifer is a sodium sulfate type with a dissolved-solids concentration of 1,480 milligrams per liter.

The average thickness of the granite wash aquifer is 37 feet. Water-level fluctuations in an observation well indicate seasonal changes in recharge and discharge. Discharge from the aquifer is primarily from stock-watering and domestic wells and to granite quarries located 6 and 15 miles east of Milbank. Predominant chemical constituents in water from the granite wash aquifer are sodium and sulfate.

Total water use in Codington and Grant Counties during 1985 was about 18 million gallons per day. The primary users of water in Codington and Grant Counties are gravel-mining companies. Seventeen percent of total water use was for irrigation, of which 98 percent was ground water.

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South Dakota
Department of Game, Fish and Parks

Division of Wildlife

3305 West South Street
Rapid City, SD 57702
(605) 394-2391

July 23, 1990

Mr. Eric Holm
Natural Resources Engineer
Department of Water and Natural Resource
Joe Foss Building
523 East Capitol
Pierre, SD 57701-3181

RE: Field Granite Permit Application covering E1/2SW1/4 Section 7 T120N R47W

Dear Mr. Holm,

We are in receipt of your letter of July 16, 1990 requesting our appraisal of Field Granite Company's Permit 27 area in relation to special and unique lands designation.

Based on a field inspection of the area in April 1990 we do not believe that the area covered by this permit qualifies for designation as special, exceptional, critical or unique as described in SDCL 45-6B-33.

Sincerely,

Ron Sieg
Energy & Minerals Coordinator

cc Mr. John Kirk

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

May 15, 1990
PACE Project Number: 900419512

Attn: Mr. Donald Sieger

Milbank

PACE Sample Number:			145950	145960	145970
Date Collected:			04/17/90	04/17/90	04/17/90
Date Received:			04/19/90	04/19/90	04/19/90
Parameter	Units	MDL	Carnelian No.1	Carnelian No.2	Carnelian No.3
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Biochemical Oxygen Demand, 05 Day	mg/L	6	6	6	ND
Iron, Dissolved	mg/L	0.05	ND	ND	ND
Nitrogen, Nitrate	mg/L	0.1	0.9	1.3	0.4
Solids, Total Dissolved	mg/L	1	990	810	300
Solids, Total Suspended	mg/L	1	2	1	1
Specific Conductivity	umhos/cm	1	1700	1400	570
Sulfate	mg/L	1	180	250	79
pH		0.1	8.1	7.9	8.4
ORGANIC ANALYSIS					
HEXANE EXTRACTION FOR PETROLEUM PRODUCTS					
Date Analyzed			04/23/90	04/23/90	04/23/90
Date Extracted			04/23/90	04/23/90	04/23/90
Gasoline	mg/L	0.10	ND	ND	ND
Fuel Oil #1	mg/L	0.10	ND	ND	ND
Fuel Oil #2	mg/L	0.10	ND	ND	ND

MDL Method Detection Limit
ND Not detected at or above the MDL.

Mr. Donald Sieger
Page 2

May 15, 1990
PACE Project Number: 900419572

Milbank

PACE Sample Number:			145980
Date Collected:			04/17/90
Date Received:			04/19/90
			Carnelian
Parameter	Units	MDL	H
INORGANIC ANALYSIS			
INDIVIDUAL PARAMETERS			
Biochemical Oxygen Demand, 05 Day	mg/L	6	ND
Iron, Dissolved	mg/L	0.05	ND
Nitrogen, Nitrate	mg/L	0.1	ND
Solids, Total Dissolved	mg/L	1	230
Solids, Total Suspended	mg/L	1	ND
Specific Conductivity	umhos/cm	1	450
Sulfate	mg/L	1	62
pH		0.1	8.3
ORGANIC ANALYSIS			
HEXANE EXTRACTION FOR PETROLEUM PRODUCTS			
Date Analyzed			04/23/90
Date Extracted			04/23/90
Gasoline	mg/L	0.10	ND
Fuel Oil #1	mg/L	0.10	ND
Fuel Oil #2	mg/L	0.10	ND

MDL Method Detection Limit
ND Not detected at or above the MDL.

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

May 15, 1990
PACE Project
Number: 900419549

Attn: Mr. Donald Sieger

Milbank

PACE Sample Number:			186060	186070	186080
Date Collected:			04/17/90	04/17/90	04/17/90
Date Received:			04/19/90	04/19/90	04/19/90
			Carnelian	Carnelian	Carnelian
Parameter	Units	MDL	f1	f2	f3
SUBCONTRACT ANALYSIS					
INDIVIDUAL PARAMETERS					
Gross Alpha	pCi/L	2	2+/-1	5+/-3	4+/-2
Gross Beta	pCi/L	3	5+/-4	6+/-4	8+/-4
Radium 226	pCi/L	-	3.8+/-1.8	3.8+/-1.8	3.1+/-1.7

MDL Method Detection Limit

May 15, 1990
PACE Project
Number: 900419549

Milbank

PACE Sample Number:			186090
Date Collected:			04/17/90
Date Received:			04/19/90
			Carnelian
Parameter	Units	MDL	H
SUBCONTRACT ANALYSIS			
INDIVIDUAL PARAMETERS			
Gross Alpha	pCi/L	2	4+/-2
Gross Beta	pCi/L	3	10+/-4
Radium 226	pCi/L	-	2.7+/-1.4

MDL Method Detection Limit

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

June 22, 1990

South Dakota Department of Water & Natural Resources
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Attn: Eric Holm
National Resources Engineer
Exploration and Mining Program

Dear Eric:

Attached are the results of our water sampling test conducted in mid-May. Also attached is the result of the Radon-222 test.

Call me with questions and comments.

Sincerely,

COLD SPRING GRANITE COMPANY

Don Sieger

Don Sieger
Quarry Engineer

Attachments

cc: Leon Eisenschenk

DS/rl
Holm.let

Controls for Environmental Pollution, Inc.
P.O. BOX 5351 • Santa Fe, New Mexico 87502 OUT OF STATE 800/545-2188 • FAX - 505-982-9289

Pace Laboratories
1710 Douglas Drive North
Minneapolis, MN 55422

Date Received: 05/23/90
Date Reported: 06/06/90
Work Order: 90-05-477
Category:

Attn: Lisa Leither

Work ID. Environmental
P O # :

Test	Units	Quarry No. 1	Quarry No. 2	Quarry No. 3	Quarry No. 4
		05/22/90 09:00	05/22/90 08:30	05/22/90 08:00	05/22/90 08:45
Radon-222	pCi/liter	80+/-1	54+/-1	49+/-1	58+/-1

Test	Units	Quarry "H"
		05/22/90 08:15
Radon-222	pCi/liter	85+/-1

Certified By: ____________

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THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

June 14, 1990
PACE Project Number: 900523517

Attn: Mr. Donald Sieger

Milbank

Parameter	Units	MDL	196720 Quarry No. 1	196730 Quarry No. 2	196740 Quarry No. 3
PACE Sample Number:			196720	196730	196740
Date Collected:			05/22/90	05/22/90	05/22/90
Date Received:			05/23/90	05/23/90	05/23/90
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Bacteria, Fecal Coliform	col/100ml	10	50	10	ND
Biochemical Oxygen Demand, 05 Day	mg/L	6	ND	ND	ND
Iron	mg/L	0.05	0.18	0.25	0.06
Nitrogen, Ammonia	mg/L	0.1	0.1	0.1	0.1
Nitrogen, Nitrate	mg/L	0.1	0.5	1.1	0.3
Solids, Total Dissolved	mg/L	1	1000	800	360
Solids, Total Suspended	mg/L	1	8	6	ND
Specific Conductivity	umhos/cm	1	1800	1300	570
Sulfate	mg/L	1	170	230	79
pH		0.1	8.2	8.1	8.4

MDL Method Detection Limit
ND Not detected at or above the MDL.

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

Offices: Minneapolis, Minnesota; Tampa, Florida; Iowa City, Iowa; San Francisco, California; Kansas City, Missouri; Los Angeles, California; Charlotte, North Carolina; Asheville, North Carolina; New York, New York; Pittsburgh, Pennsylvania

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REPORT OF LABORATORY ANALYSIS

Mr. Donald Sieger
Page 2

June 14, 1990
PACE Project Number: 900523517

Milbank

PACE Sample Number:			196750
Date Collected:			05/22/90
Date Received:			05/23/90
			Quarry
Parameter	Units	MDL	No. 4
INORGANIC ANALYSIS			
INDIVIDUAL PARAMETERS			
Bacteria, Fecal Coliform	col/100ml	10	10
Biochemical Oxygen Demand, 05 Day	mg/L	6	ND
Iron	mg/L	0.05	0.11
Nitrogen, Ammonia	mg/L	0.1	0.1
Nitrogen, Nitrate	mg/L	0.1	0.6
Solids, Total Dissolved	mg/L	1	930
Solids, Total Suspended	mg/L	1	16
Specific Conductivity	umhos/cm	1	1300
Sulfate	mg/L	1	430
pH		0.1	8.4

MDL Method Detection Limit
ND Not detected at or above the MDL.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

September 24, 1990

SOUTH DAKOTA DEPARTMENT OF WATER
AND NATURAL RESOURCES
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Attn: Eric Holm
National Resources Engineer
Exploration and Mining Program

Dear Eric:

Attached are the results of our water sampling test conducted in late August.

Call me with questions and comments.

Sincerely,

COLD SPRING GRANITE COMPANY

Don Sieger

Don Sieger
Quarry Engineer

Attachments

cc: Leon Eisenschenk

DS/rl
Holm.let

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THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

September 14, 1990

Mr. Donald Sieger
Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

RE: PACE Project No. 900831.502

Dear Mr. Sieger:

Enclosed is the report of laboratory analyses for samples received August 31, 1990.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

R. Lorraine Vokaty

R. Lorraine Vokaty
Project Manager

Enclosures

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

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REPORT OF LABORATORY ANALYSIS

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

September 14, 1990
PACE Project
Number: 900831502

Attn: Mr. Donald Sieger

PACE Sample Number:			10 0346063	10 0346071	10 0346080
Date Collected:			08/29/90	08/29/90	08/29/90
Date Received:			08/31/90	08/31/90	08/31/90
Parameter	Units	MDL	CARN # 1	CARN # 2	CARN # 3
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Bacteria, Fecal Coliform	col/100ml	1	1 H	5 H	1
Bacteria, Fecal Coliform	col/100ml	2	--	--	ND H
Biochemical Oxygen Demand, 05 Day	mg/L	6	ND	ND	ND
Iron	mg/L	0.05	0.05	0.05	0.08
Nitrogen, Ammonia	mg/L	0.1	ND	0.2	ND
Nitrogen, Nitrate	mg/L	0.1	0.2	1.0	0.2
Solids, Total Dissolved	mg/L	1	800	450	260
Solids, Total Suspended	mg/L	1	ND	2	ND
Specific Conductivity	umhos/cm	1	1600	830	520
Sulfate	mg/L	2	130	160	75
pH		0.1	8.2	8.1	8.3

MDL Method Detection Limit
ND Not detected at or above the MDL.
H EPA recommended holding time exceeded.

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Minneapolis, MN 55422
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FAX: 612-525-3377

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REPORT OF LABORATORY ANALYSIS

September 14, 1990
PACE Project
Number: 900831502

PACE Sample Number:			10 0346098
Date Collected:			08/29/90
Date Received:			08/31/90
Parameter	Units	MDL	CARN # 4
INORGANIC ANALYSIS			
INDIVIDUAL PARAMETERS			
Bacteria, Fecal Coliform	col/100ml	1	24 H
Biochemical Oxygen Demand, 05 Day	mg/L	6	6
Iron	mg/L	0.05	0.06
Nitrogen, Ammonia	mg/L	0.1	ND
Nitrogen, Nitrate	mg/L	0.1	0.5
Solids, Total Dissolved	mg/L	1	820
Solids, Total Suspended	mg/L	1	3
Specific Conductivity	umhos/cm	1	1200
Sulfate	mg/L	2	390
pH		0.1	8.3

MDL Method Detection Limit
ND Not detected at or above the MDL.
H EPA recommended holding time exceeded.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

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CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Cold Spring Granite Co.
Address: 202 South 3rd Ave. Cold Spring, MN 56320
Phone: 612-685-3621

Report To: Don Siegen
Bill To: Cold Spring Granite Co.
P.O. # / Billing Reference:
Project Name / No.:

Pace Client No. 075801
Pace Project Manager RLV
Pace Project No. 90083,502
*Requested Due Date:

Sampled By (PRINT): Donald J. Sieger
Sampler Signature: Don Sieger
Date Sampled: 8/29/90

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H2SO4	HNO3	VOA	whirlpak	ANALYSES REQUEST: NO3	SO4	TDS	Sp Cond	pH	Fe	TSS	BOD-5	N-NH3	Fecal Col.	REMARKS
1	CARN #1			34606.3	5	2	1	1		1	X	X	X	X	X	X	X	X	X	X	
2	CARN #2			34607.1	5	2	1	1		1	X	X	X	X	X	X	X	X	X	X	
3	CARN #3			34608.0	5	2	1	1		1	X	X	X	X	X	X	X	X	X	X	
4	CARN #4			34609.8	5	2	1	1		1	X	X	X	X	X	X	X	X	X	X	
5																					
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE	ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
				1-4	Don Sieger - CSG HR	Rod	9/21/90	1045

Additional Comments:
1/2

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SEE REVERSE SIDE FOR INSTRUCTIONS

December 10, 1990

SOUTH DAKOTA DEPARTMENT OF WATER
AND NATURAL RESOURCES
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Attn: Eric Holm
National Resources Engineer
Exploration and Mining Program

Dear Eric:

Attached are the results of our water sampling test conducted in early November.

Call me with questions and comments.

Sincerely,

COLD SPRING GRANITE COMPANY

Don Sieger

Don Sieger
Quarry Engineer

Attachments

cc: Leon Eisenschenk

DS/rl
Holm.let

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THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

December 05, 1990
PACE Project
Number: 901107508

Attn: Mr. Donald Sieger

Milbank

PACE Sample Number:			10 0436054	10 0436062	10 0436070
Date Collected:			11/06/90	11/06/90	11/06/90
Date Received:			11/07/90	11/07/90	11/07/90
Parameter	Units	MDL	CARN-1	CARN-2	CARN-3
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Biochemical Oxygen Demand, 05 Day	mg/L	12	ND	ND	ND
Iron	mg/L	0.05	3.5	0.28	0.10
Nitrogen, Ammonia	mg/L	0.1	ND	ND	ND
Nitrogen, Nitrate	mg/L	0.1	ND	0.8	0.2
Solids, Total Dissolved	mg/L	1	920	740	300
Solids, Total Suspended	mg/L	1	ND	5	2
Specific Conductivity	umhos/cm	1	1600	1200	520
Sulfate	mg/L	1	90	240	76
pH		0.1	7.8	8.0	8.1
			No Fecal	No Fecal	No Fecal

MDL Method Detection Limit
ND Not detected at or above the MDL.

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

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REPORT OF LABORATORY ANALYSIS

December 05, 1990
PACE Project
Number: 901107508

Milbank

PACE Sample Number:			10 0436089
Date Collected:			11/06/90
Date Received:			11/07/90
Parameter	Units	MDL	CARN-4
INORGANIC ANALYSIS			
INDIVIDUAL PARAMETERS			
Biochemical Oxygen Demand, 05 Day	mg/L	12	ND
Iron	mg/L	0.05	0.48
Nitrogen, Ammonia	mg/L	0.1	ND
Nitrogen, Nitrate	mg/L	0.1	0.4
Solids, Total Dissolved	mg/L	1	1100
Solids, Total Suspended	mg/L	1	16
Specific Conductivity	umhos/cm	1	1400
Sulfate	mg/L	1	530
pH		0.1	7.8

No Fecal

MDL Method Detection Limit
ND Not detected at or above the MDL.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

January 22, 1991

SOUTH DAKOTA DEPARTMENT OF WATER
AND NATURAL RESOURCES
Joe Foss Building
523 East Capitol
Pierre, SD 57501-3181

Attn: Eric Holm
National Resources Engineer
Exploration and Mining Program

Dear Eric:

Attached is a summarized list of all the water analysis obtained on samples of water from the Milbank quarries during 1990. The lab made a mistake in reporting the dissolved iron at Quarry No. 1 location. A corrected copy of the lab report is attached.

Please review and call me with questions.

Sincerely yours,

COLD SPRING GRANITE COMPANY

Don Sieger

Don Sieger
Quarry Engineer

DS/rl

COLD SPRING GRANITE COMPANY
202 SOUTH 3RD. AVENUE
COLD SPRING, MINNESOTA 56320
(612) 685-3621

Water quality analysis of samples taken from old quarry holes located on Cold Spring Granite Company property near Milbank, South Dakota. These samples were collected and analyzed to fulfill the requirements for Large Scale Mining Permits issued by the State of South Dakota to Cold Spring Granite Company to operate 4 quarries in the area.

WATER QUALITY COMPARISON

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Biochemical Oxygen Demand, 05 Day							
04/17/90	mg/l	6	6	6	ND	-	ND
05/22/90	mg/l	6	ND	ND	ND	ND	-
08/29/90	mg/l	6	ND	ND	ND	6	-
11/06/90	mg/l	12	ND	ND	ND	(ND)	-

Comments: Minimal values.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Iron, Dissolved							
04/17/90	mg/l	0.05	ND	ND	ND	-	ND
05/22/90	mg/l	0.05	0.18	0.25	0.06	0.11	-
08/29/90	mg/l	0.05	0.05	0.05	0.08	0.06	-
11/06/90	mg/l	0.05	ND	0.28	0.10	(0.48)	-

Comments: Value range from 0.05 to .48 mg/l. The 3.5 value reported by the lab for 11/06/90 at Quarry 1 was in error. A corrected lab report is attached.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Nitrogen, Nitrate							
04/17/90	mg/l	0.1	0.9	1.3	0.4	-	ND
05/22/90	mg/l	0.1	0.5	1.1	0.3	0.6	-
08/29/90	mg/l	0.1	0.2	1.0	0.2	0.5	-
11/06/90	mg/l	0.1	ND	0.8	0.2	(0.4)	-

Comments: Value range from 0.2 to 1.3 mg/l.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Solids, Total dissolved							
04/17/90	mg/l	1	990	810	300	-	230
05/22/90	mg/l	1	1000	800	360	930	-
08/29/90	mg/l	1	800	450	260	820	-
11/06/90	mg/l	1	920	740	300	1100	-

Comments: Value range 230 to 1100 mg/l.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Solids, Total Suspended							
04/17/90	mg/l	1	2	1	1	-	ND
05/22/90	mg/l	1	8	6	ND	16	-
08/29/90	mg/l	1	ND	2	ND	3	-
11/06/90	mg/l	1	ND	5	2	16	-

Comments: Value range 1 to 16 mg/l.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Specific Conductivity							
04/17/90	umhos/cm	1	1700	1400	570	-	450
05/22/90	umhos/cm	1	1800	1300	570	1300	-
08/29/90	umhos/cm	1	1600	830	520	1200	-
11/06/90	umhos/cm	1	1600	1200	520	1400	-

Comments: Value range 450 to 1800 umhos/cm.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Sulfate							
04/17/90	mg/l	1	180	250	79	-	62
05/22/90	mg/l	1	170	230	79	430	-
08/29/90	mg/l	2	130	160	75	390	-
11/06/90	mg/l	1	90	240	76	530	-

Comments: Value range 62 to 530 mg/l.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: pH							
04/17/90		0.1	8.1	7.9	8.4	-	8.3
05/22/90		0.1	8.2	8.1	8.4	8.4	-
08/29/90		0.1	8.2	8.1	8.3	8.3	-
11/06/90		0.1	7.8	8.0	8.1	7.8	-

Comments: Value range 7.8 to 8.4.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Nitrogen, Ammonia							
04/17/90	(Not analyzed for during this test period)						
05/22/90	mg/l	0.1	0.1	0.1	0.1	0.1	-
08/29/90	mg/l	0.1	ND	0.2	ND	ND	-
11/06/90	mg/l	0.1	ND	ND	ND	ND	-

Comments: Minimal variation.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Bacteria, Fecal Coliform							
04/17/90	(not analyzed for during this test period)						
05/22/90	col/100ml	10	50	10	ND	10	-
08/29/90	col/100ml	1	1 H	5 H	-	24 H	-
08/29/90	col/100ml	2	-	-	ND H	-	-
11/06/90	(not analyzed for during this test period)						

Comments: Value range 1 to 50 col/100 ml.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: Sulfate							
04/17/90	mg/l	1	180	250	79	-	62
05/22/90	mg/l	1	170	230	79	430	-
08/29/90	mg/l	2	130	160	75	390	-
11/06/90	mg/l	1	90	240	76	530	-

Comments: Value range 62 to 530 mg/l.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: HEXANE EXTRACTION FOR PETROLEUM PRODUCTS * Date Analyzed: 04/23/90 Date Extracted: 04/23/90							
Gasoline	mg/l	0.10	ND	ND	ND	-	ND
Fuel Oil #1	mg/l	0.10	ND	ND	ND	-	ND
Fuel Oil #2	mg/l	0.10	ND	ND	ND	-	ND

* These items were only analyzed for during this one testing period.

Sample Date	Units	MDL	- - QUARRY HOLE - - 1	2	3	4	H
Parameter: RADIONUCLIDES * (Sample date: 04/17/90)							
Gross Alpha	pCi/l	2	2+/-1	5+/-3	4+/-2	-	4+/-2
Gross Beta	pCi/l	3	5+/-4	6+/-4	8+/-4	-	10+/-4
Radium 226	pCi/l	-	Quarry No. 1	3.8+/-1.8			
			Quarry No. 2	3.8+/-1.8			
			Quarry No. 3	3.1+/-1.7			
			Quarry No. 4	-			
			Quarry No. H	2.7+/-1.4			
Radon-222	pCi/l	-	Quarry No. 1	80+/-1			
			Quarry No. 2	54+/-1			
			Quarry No. 3	49+/-1			
			Quarry No. 4	58+/-1			
			Quarry No. H	85+/-1			

* These items were only analyzed for during this one testing period.

MDL Method Detection Limit
ND Not detected at or above the MDL
H EPA recommended holding time exceeded.

Quarry hole locations:

No. 1 is the hole that Cold Spring was operating in through the end of 1989. At that time operations in the deep hole stopped and drive-in operations continued adjacent to the hole.

No. 2 and No. 3 are old holes that exist within the active quarry areas at No. 2 and No. 3.

No. 4 is an old hole on the Steiner-Rausch property adjacent to an active quarry.

No. H is a quarry South of the Dakota Granite Company plant which was operated by Cold Spring Granite Company in the past. This quarry has not been active for a long period of time and was sampled as a comparison of a quarry hole that has stabilized vs. holes that are adjacent to active quarries. The quarry is full of water that runs out over the top of ledge, vegetation has established itself on all areas covered with any type of soil and the pond is used by all sorts of wildlife in the area. This is the type of pond the company expects to develop in the active quarries when mining stops.

NOTE: Stripping activities were taking place near Quarry Hole No. 4 at the time the November 6, 1990 sample was taken. A large amount of soil and rock was dropped into the hole prior to the sample collection and may influence the results.

Compiled by: Donald J. Sieger

Donald J. Sieger

Quarry Engineer

December 10, 1990

file: DS-mb1207

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THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

January 18, 1991

Mr. Donald Sieger
Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

RE: PACE Project No. 901107.508
Milbank

Dear Mr. Sieger:

Enclosed is the revised report of laboratory analyses for samples received November 07, 1990.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

R. Lorraine Vokaty

R. Lorraine Vokaty
Project Manager

Enclosures

LAB7056/gma

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

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INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

Cold Spring Granite Company
202 South 3rd Avenue
Cold Spring, MN 56320

January 18, 1991
PACE Project
Number: 901107508

Attn: Mr. Donald Sieger

Milbank

PACE Sample Number:			10 0436054	10 0436062	10 0436070
Date Collected:			11/06/90	11/06/90	11/06/90
Date Received:			11/07/90	11/07/90	11/07/90
Parameter	Units	MDL	CARN-1	CARN-2	CARN-3
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
Biochemical Oxygen Demand, 05 Day	mg/L	12	ND	ND	ND
Iron	mg/L	0.05	ND	0.28	0.10
Nitrogen, Ammonia	mg/L	0.1	ND	ND	ND
Nitrogen, Nitrate	mg/L	0.1	ND	0.8	0.2
Solids, Total Dissolved	mg/L	1	920	740	300
Solids, Total Suspended	mg/L	1	ND	5	2
Specific Conductivity	umhos/cm	1	1600	1200	520
Sulfate	mg/L	1	90	240	76
pH		0.1	7.8	8.0	8.1

MDL Method Detection Limit
ND Not detected at or above the MDL.

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

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THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

Mr. Donald Sieger
Page 2

January 18, 1991
PACE Project
Number: 901107508

Milbank

PACE Sample Number:			10 0436089
Date Collected:			11/06/90
Date Received:			11/07/90
Parameter	Units	MDL	CARN-4
INORGANIC ANALYSIS			
INDIVIDUAL PARAMETERS			
Biochemical Oxygen Demand, 05 Day	mg/L	12	ND
Iron	mg/L	0.05	0.48
Nitrogen, Ammonia	mg/L	0.1	ND
Nitrogen, Nitrate	mg/L	0.1	0.4
Solids, Total Dissolved	mg/L	1	1100
Solids, Total Suspended	mg/L	1	16
Specific Conductivity	umhos/cm	1	1400
Sulfate	mg/L	1	530
pH		0.1	7.8

MDL Method Detection Limit
ND Not detected at or above the MDL.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my supervision.

Starla Enger
Inorganic Chemistry Manager

1710 Douglas Drive North
Minneapolis, MN 55422
TEL: 612-544-5543
FAX: 612-525-3377

February 20, 1991

Mr. Donald Sieger
Cold Spring Granite Company
202 S. 3rd Avenue
Cold Spring, MN 56320

Dear Mr. Sieger:

This letter is in reference to your current NPDES permit No. SD-0026646.

The water quality data received by the Department during the past year indicates that all quarries, except Carnelian no. 4, are in full compliance with the NPDES and South Dakota Surface Water Quality Standards, ARSD CHAPTER 74:03:02. However, one more quarterly sample for Carnelian no. 4 must be submitted to the Department before the operational monitoring plan can be determined.

Our most recent records indicate that each quarry was sampled last on November 6, 1990. The lab results for this period of sampling show that the values for Carnelian no. 4 showed relatively high TDS and Sulfate values. If possible, please inform the Department on the reason(s) for the high values.

Thank you for your cooperation. If you have any questions or comments, please feel free to give me a call.

Sincerely,

Thomas G. Hack
Hydrologist
Exploration & Mining Program
Telephone: (605) 773-4201

Parameter	SW	GW	DW
Fe, dissolved			
NO_3	50 mg/l	10 mg/l	10 mg/l
NH_4			
SO_4		500 mg/l	
Fecal Coliform	1,000/100 ml	>2.2/100 ml	1/100 ml
Conductivity	2500 mhos/cm		
TDS	2500 mg/l	1000 mg/l	
TSS	90 mg/l		
PH	6.0 – 9.0	6.5 - 8.5	
BOD	* 7-10		
Radon 222	> handbook 69		300 pCi/l
tot Alpha		15 pCi/l (gross)	15 pCi/L (gross)
tot Beta	100 pCi/l (gross)		
Radium 226	5 pCi/l	5 pCi/l	3 pCi/l
Gasoline	10 mg/l (petroleum)		Sec 74:04:06
Fuel Oil 1	10 mg/l " "		" "
Fuel Oil 2	10 mg/l " "		" "

* Not a standard

Course ground bentonite
≥ 400' deep

COLD SPRING GRANITE
WATER QUALITY DATA

Carnelian No. 1

PARAMETER		SW STANDARD	GW STANDARD	DW STANDARD	4/17/90	5/22/90	8/29/90	11/6/90	MAX	MIN	AVERAGE
Fe, Dissolved	mg/l	--	--	0.3	< .05	0.18	0.05	< .05	0.18	0	0.058
NO3	mg/l	50	10	10	0.9	0.5	0.2	<.1	0.9	0	0.400
NH4	mg/l	--	--	--	--	0.1	<.1	<.1	0.1	0	0.025
SO4	mg/l	--	500	--	180	170	130	90	180	90	142.500
Fecal Coliform	col/100ml	1000	< 2.2	1	--	50	--	--	50	0	12.500
Conductivity	uMHO/cm	2500/4000	--	--	1700	1800	1600	1600	1800	1600	1675.000
TDS	mg/l	2500	1000	1000	990	1000	800	920	1000	800	927.500
TSS	mg/l	90	--	--	2	8	<1	<1	8	0	2.500
pH	--	6.5/9.0	6.5/8.5	6.5/8.5	8.1	8.2	8.2	7.8	8.2	7.8	8.075
BOD	mg/l	--	--	--	6	<6	<6	<12	6	0	1.500
Radon 222	pCi/l	--	--	300	--	80+/-1	--	--	0	0	0.000
Total Alpha	pCi/l	--	15	15	2+/-1	--	--	--	0	0	0.000
Total Beta	pCi/l	100	--	--	5+/-4	--	--	--	0	0	0.000
Radium 226	pCi/l	5	5	3	3.8+/-1.8	--	--	--	0	0	0.000
Gasoline	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 1	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 2	mg/l	10	--	--	<.1	--	--	--	0	0	0.000

COLD SPRING GRANITE
WATER QUALITY DATA

Carnelian No. 2

PARAMETER		SW STANDARD	GW STANDARD	DW STANDARD	4/17/90	5/22/90	8/29/90	11/6/90	MAX	MIN	AVERAGE
Fe, Dissolved	mg/l	--	--	0.3	< .05	0.25	0.05	0.28	0.28	0	0.145
NO3	mg/l	50	10	10	1.3	1.1	1	0.8	1.3	0.8	1.050
NH4	mg/l	--	--	--	--	0.1	0.2	<.1	0.2	0	0.075
SO4	mg/l	--	500	--	250	230	160	240	250	160	220.000
Fecal Coliform	col/100ml	1000	< 2.2	1	--	10	--	--	10	0	2.500
Conductivity	uMHO/cm	2500/4000	--	--	1400	1300	830	1200	1400	830	1182.500
TDS	mg/l	2500	1000	1000	810	800	450	740	810	450	700.000
TSS	mg/l	90	--	--	1	6	2	5	6	1	3.500
pH	--	6.5/9.0	6.5/8.5	6.5/8.5	7.9	8.1	8.1	8	8.1	7.9	8.025
BOD	mg/l	--	--	--	6	<6	<6	<12	6	0	1.500
Radon 222	pCi/l	--	--	300	--	54+/-1	--	--	0	0	0.000
Total Alpha	pCi/l	--	15	15	5+/-3	--	--	--	0	0	0.000
Total Beta	pCi/l	100	--	--	6+/-4	--	--	--	0	0	0.000
Radium 226	pCi/l	5	5	3	3.8+/-1.8	--	--	--	0	0	0.000
Gasoline	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 1	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 2	mg/l	10	--	--	<.1	--	--	--	0	0	0.000

COLD SPRING GRANITE
WATER QUALITY DATA

Carnelian No. 3

PARAMETER		SW STANDARD	GW STANDARD	DW STANDARD	4/17/90	5/22/90	8/29/90	11/6/90	MAX	MIN	AVERAGE
Fe, Dissolved	mg/l	--	--	0.3	< .05	0.06	0.08	0.1	0.1	0	0.060
NO3	mg/l	50	10	10	0.4	0.3	0.2	0.2	0.4	0.2	0.275
NH4	mg/l	--	--	--	--	0.1	<.1	<.1	0.1	0	0.025
SO4	mg/l	--	500	--	79	79	75	76	79	75	77.250
Fecal Coliform	col/100ml	1000	< 2.2	1	--	< 10	--	--	0	0	0.000
Conductivity	uMHO/cm	2500/4000	--	--	570	570	520	520	570	520	545.000
TDS	mg/l	2500	1000	1000	300	360	260	300	360	260	305.000
TSS	mg/l	90	--	--	1	< 1	< 1	2	2	0	0.750
pH	--	6.5/9.0	6.5/8.5	6.5/8.5	8.4	8.4	8.3	8.1	8.4	8.1	8.300
BOD	mg/l	--	--	--	< 6	< 6	< 6	<12	0	0	0.000
Radon 222	pCi/l	--	--	300	--	49+/-1	--	--	0	0	0.000
Total Alpha	pCi/l	--	15	15	4+/-2	--	--	--	0	0	0.000
Total Beta	pCi/l	100	--	--	8+/-4	--	--	--	0	0	0.000
Radium 226	pCi/l	5	5	3	3.1+/-1.7	--	--	--	0	0	0.000
Gasoline	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 1	mg/l	10	--	--	<.1	--	--	--	0	0	0.000
Fuel Oil 2	mg/l	10	--	--	<.1	--	--	--	0	0	0.000

COLD SPRING GRANITE
WATER QUALITY DATA

Carnelian No. 4

PARAMETER		SW STANDARD	GW STANDARD	DW STANDARD	5/22/90	8/29/90	11/6/90	MAX	MIN	AVERAGE
Fe, Dissolved	mg/l	--	--	0.3	0.11	0.06	0.48	0.48	0.06	0.217
NO3	mg/l	50	10	10	0.6	0.5	0.4	0.6	0.4	0.500
NH4	mg/l	--	--	--	0.1	<.1	<.1	0.1	0	0.033
SO4	mg/l	--	500	--	430	390	530	530	390	450.000
Fecal Coliform	col/100ml	1000	< 2.2	1	10	--	--	10	0	3.333
Conductivity	uMHO/cm	2500/4000	--	--	1300	1200	1400	1400	1200	1300.000
TDS	mg/l	2500	1000	1000	930	820	1100	1100	820	950.000
TSS	mg/l	90	--	--	16	3	16	16	3	11.667
pH	--	6.5/9.0	6.5/8.5	6.5/8.5	8.4	8.3	7.8	8.4	7.8	8.167
BOD	mg/l	--	--	--	< 6	6	<12	6	0	2.000
Radon 222	pCi/l	--	--	300	58+/-1	--	--	0	0	0.000
Total Alpha	pCi/l	--	15	15	--	--	--	0	0	0.000
Total Beta	pCi/l	100	--	--	--	--	--	0	0	0.000
Radium 226	pCi/l	5	5	3	--	--	--	0	0	0.000
Gasoline	mg/l	10	--	--	--	--	--	0	0	0.000
Fuel Oil 1	mg/l	10	--	--	--	--	--	0	0	0.000
Fuel Oil 2	mg/l	10	--	--	--	--	--	0	0	0.000

COLD SPRING GRANITE
WATER QUALITY DATA

Carnelian H

PARAMETER		SW STANDARD	GW STANDARD	DW STANDARD	4/17/90	5/22/90
Fe, Dissolved	mg/l	--	--	0.3	< .05	--
NO3	mg/l	50	10	10	< .1	--
NH4	mg/l	--	--	--	--	--
SO4	mg/l	--	500	--	62	--
Fecal Coliform	col/100ml	1000	< 2.2	1	--	--
Conductivity	uMHO/cm	2500/4000	--	--	450	--
TDS	mg/l	2500	1000	1000	230	--
TSS	mg/l	90	--	--	< 1	--
pH	--	6.5/9.0	6.5/8.5	6.5/8.5	8.3	--
BOD	mg/l	--	--	--	< 6	--
Radon 222	pCi/l	--	--	300	--	85+/-1
Total Alpha	pCi/l	--	15	15	4+/-2	--
Total Beta	pCi/l	100	--	--	10+/-4	--
Radium 226	pCi/l	5	5	3	2.7+/-1.4	--
Gasoline	mg/l	10	--	--	<.1	--
Fuel Oil 1	mg/l	10	--	--	<.1	--
Fuel Oil 2	mg/l	10	--	--	<.1	--

[redacted]gidered: _____ WATER PERMIT NO. 5564-3

Phone: 612-685-3621

RECEIVED
JUN 27 2016
MINERALS & MINING PROGRAM

Name of Applicant: Cold Spring Granite Company

Post Office Address: 202 South 3rd Ave, Cold Spring MN 56320

Amount of Water Claimed: 0.67 (0.27-well 0.10-each hole) Total Acres: NA

Source of Water Supply: groundwater

Water to be used for: de-watering project County: Grant

About _____ miles _____ of Milbank

PROOF OF PUBLICATION: Received _____ Not Received _____

APPLICATION: Approved _____ Subject to _____

F.F.& C/.L. Adopted _____ Not Approved _____ Deferred _____

PRIORITY Date Received: 7-15-91 Fee: $225.00 Remarks _____

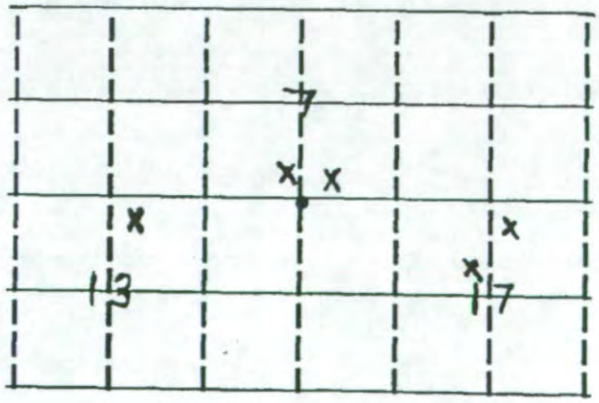
Corrected Application Received _____ Period of Annual Use Jan 1- Dec 31

WATER QUALITY APPROVAL RECEIVED NA APPROVED/CONDITIONAL (Circle one)

WI-1 Description same as Application YES ___ NO ___ REMARKS _____

Diversion Point: Hole No. 1-SE 1/4 NW 1/4 Sec 17-T120N-R47W; No. 2-SE 1/4 SW 1/4 and well-SW 1/4 SE 1/4 Sec 7-T120N-R47W; No. 3-NW 1/4 NE 1/4 Sec 13-T120N-R48W; No. 4-NW 1/4 NE 1/4 Sec 17-T120N-R47W

~~Land to be Irrigated~~



Well Log: Driller: _____ Licensed YES ___ NO ___

Depth of Well: about 60' REMARKS not necessary

Type of Map: plat PREPARED BY: Donald R Larson, PE Reviewed and the Number Assigned on 7-17-91 By Karen Schlaak

Cold Spring Granite Company
Permit Conditions
Permits (New large and small expansion areas)

74:29:03:16. Technical revisions

(1) Monitoring plans or parameters;
(2) Plans and specifications for permitted facilities;
(3) Seeding mixtures or rates;
(4) Relocation of proposed roads within permitted affected land;
(5) Relocation of chemical or petroleum product storage areas;
(6) Modification or relocation of erosion, sedimentation, or drainage control;
(7) Compliance limits for chemical parameters;
(8) Quality control and quality assurance plans;
(9) Topsoil stripping or storage; and
(10) Relocation or Modification of ancillary facilities, including equipment storage areas, parking lots, perimeter fencing, and stock piles:
(11) Implementing new and improved reclamation techniques as they are developed:
(12) Implementing new surface mining techniques and/or equipment as they are developed

Permit Boundary #1 Large Permit near Carnelian 2 Permitted acreage 7.8

Permit Boundary #2 Small Permit near Carnelian 3 Permitted acreage .2

Technical revisions must comply with § 74:29:03:03, as applicable, and must be submitted to the department in writing. The department shall approve, disapprove, conditionally approve, or request additional information within 30 days after receipt.

U.S. ENVIRONMENTAL PROTECTION AGENCY – REGION VIII
1595 Wynkoop St., Denver, CO 80202-1129 800-227-891

Oil Spill Prevention Control and Countermeasure Plan

This constitutes the required SPCC Plan, pursuant to Title 40, Code of Federal Regulations, Part 112, Oil Pollution Prevention. This completed plan needs to be signed by the owner or operator of a facility and a professional engineer. A complete copy of the Plan shall be maintained at the facility and made available for review upon request by a representative from U.S. EPA or Minnesota Pollution Control Agency.

Facility Description

Facility Name: Coldspring – Milbank Operations
Facility Address: 14982 485th Avenue
City: Milbank State: SD Zip: 57252
County: Grant Telephone Number: 605-432-9389

Owner or Operator Name: Cold Spring Granite Company
Owner or Operator Address: 17482 Granite West Road
City: Cold Spring State: MN Zip: 56320
County: Stearns Telephone Number: 320-685-3621

I. A. Certification Statement {§112.3(d)}

I hereby certify that each of the following is true in order to comply with SPCC requirements:
(i) That I am familiar with the requirements of this part ;
(ii) That I or my agent has visited and examined the facility;
(iii) That the Plan has been prepared in accordance with good engineering practice, including consideration of applicable industry standards, and with the requirements of this part;
(iv) That procedures for required inspections and testing have been established; and
(v) That the Plan is adequate for the facility.

STATE OF TEXAS
DONALD J. SCHEELE
105628
LICENSED
PROFESSIONAL ENGINEER

Signature: Donald J. Scheele Date: 12/10/13
Name: Donald J. Scheele. P.E. Title: Chief Environmental Engineer

B. Management Approval {§112.7}

I hereby certify that the necessary resources to implement this Plan have been committed.

Signature: Steven Karels Date: 12/12/2013
Name: Steve Karels Title: Manager, Milbank Operations

II. Record of Plan Review and Amendments

Five year Review {§112.5(b)}:
Complete a review and evaluation of this SPCC Plan at least once every five years. As a result of the review, amend this Plan within six months to include more effective prevention and control measures for the facility, if applicable. Implement any amendment as soon as possible, but no later than six months following the Plan amendment. Document completion of the review and evaluation, and complete the Five Year Review Log in Attachment 1.1.

Table G-1 Technical Amendments {§§112.5(a), (c) and 112.6(a)(2)}	
This SPCC Plan will be amended when there is a change in the facility design, construction, operation, or maintenance that materially affects the potential for a discharge to navigable waters or adjoining shorelines. Examples include adding or removing containers, reconstruction, replacement, or installation of piping systems, changes to secondary containment systems, changes in product stored at the facility, or revisions to standard operating procedures.	☒
Any technical amendments to this Plan will be re-certified in accordance with Section I of this Plan. {§112.6(a)(2)} [See Technical Amendment Log in Attachment 1.2]	☒

III. Plan Requirements

1. Oil Storage Containers {§112.7(a)(3)(i)}:

Oil Storage Container {Indicate whether aboveground (A) or completely buried (B)}	Type of Oil	Shell Capacity (gallons)
Milbank Shop		
Steel Tank in Shop #1	Mobil DTE	265
Steel Tank in Shop #2	Mobil 424	500
Steel Tank in Shop #3	Motor Oil 15W-40	500
Steel Tank in Lined Containment Unit #4	Diesel	265
Steel Tank in Lined Containment Unit	Diesel	28,000
Steel Tank in Lined Containment Unit	Gasolines	2500
Plastic Tank in Shop	Antifreeze	200
Partially Below Grade Steel Tank in Shop	Used Oil	500
Steel Drum Yard (6)	Used Oil Filters	55 each
Steel Drum Indoors (8)	Motor Oil	55 each
Subtotal		**33,500**
Milbank No. 1		
Steel Drum on Containment Pallet in Oil Shed	Mobil ATF	55
Plastic Drum on Containment Pallet in Oil Shed	Ultra Coolant	55
Steel Drum on Containment Pallet in Oil Shed	Almo 527	55
Subtotal		**165**
Milbank No. 2		
Steel Drum on Containment Pallet	Compressor Oil	55
Steel Drum on Containment Pallet (2)	Motor Oil	55 each
Subtotal		**165**
Milbank No. 3		
Steel Drum on Containment Pallet Indoors (3)	Motor Oil	55 each
Steel Drum on Containment Pallet Indoors (3)	Motor Oil	55 each
Steel Drum in Rail Dike Covered (2)	Mobilfluid 424	55 each
Steel Drum in Rail Dike Covered (2)	15W-40	55 each
Steel Drum in Rail Dike Covered (2)	Mobiltrans AST	55 each
Steel Drum in Rail Dike Covered	Almo 529	55
Steel Drum in Rail Dike Covered	HD-30	55
Steel Drum in Rail Dike Covered (2)	Methanol	55 each
Steel Drum in Rail Dike Covered (4)	HD-50	55 each
Steel Drum in Rail Dike Covered (2)	Mobil DTE	55 each
Steel Drum in Rail Dike Covered (2)	Mobil ATF	55 each
Steel Drum in Rail Dike Covered	10W	55
Steel Drum in Rail Dike Covered (2)	Rarus 427	55 each

Steel Drum in Rail Dike Covered	Rotella C	55
Steel Drum in Rail Dike Covered (2)	Delvac	55 each
Steel Drum in Rail Dike Covered	Almo 527	55
Steel Drum in Rail Dike Covered (2)	Antifreeze	55 each
Subtotal		**1815**

Total Aboveground Storage Capacity* 35,645 **gallons**

Total Completely Buried Storage Capacity 0 **gallons**

Facility Total Oil Storage Capacity 35,645 **gallons**

* Counts toward qualified facility applicability threshold

[a] Aboveground storage containers that must be included when calculating total facility oil storage include: tanks and mobile or portable containers; oil-filled operational equipment (e.g. transformers); other oil-filled equipment, such as flow-through process equipment. Exempt containers that are not included in the capacity calculation include: any container with a storage capacity less than 55 gallons of oil; containers used exclusively for wastewater treatment; permanently closed containers; motive power containers; hot-mix asphalt containers; heating oil containers used solely at a single family residence; and pesticide application equipment or related mix containers.

[a] Although the criteria to determine eligibility for qualified facilities focuses on the aboveground oil storage containers at the facility, the completely buried tanks at a qualified facility are still subject to the rule requirements and must be addressed in the plan; however, they are not counted toward the qualified facility threshold.

2. Secondary Containment and Oil Spill Control {§112.6(a)(3)(i) & (ii), §112.7(c) and §112.9(c)(2)}:

Table G-3 Secondary Containment and Oil Spill Control	
Appropriate secondary containment and/or diversionary structures or equipment[a] is provided for all oil handling containers, equipment, and transfer areas to prevent a discharge to navigable waters or adjoining shorelines. The entire secondary containment system, including walls and floor, is capable of containing oil and is constructed so that any discharge from a primary containment system, such as a tank or pipe, will not escape the containment system before cleanup occurs.	☒

Table G-4 below identifies the tanks and containers at the facility with the potential for an oil discharge; the mode of failure; the flow direction and potential quantity of the discharge; and the secondary containment method and containment capacity that is provided.

Table G-4 Containers with Potential for an Oil Discharge					
Area	**Type of Failure** (discharge scenario)	**Potential Discharge Volume** (gallons)	**Direction of Flow for Uncontained Discharge**	**Secondary Containment Method[b]**	**Secondary Containment Capacity** (gallons)
Bulk Storage Containers and Mobile/Portable Containers[c]					
Milbank Shop					
Steel Tank in Shop #1	Slow Leak to Sudden Release	265	NA	Spill Kit	NA
Steel Tank in Shop #2	Slow Leak to Sudden Release	500	NA	Spill Kit	NA
Steel Tank in Shop #3	Slow Leak to Sudden Release	500	NA	Spill Kit	NA
Steel Tank in Lined Containment Unit #4	Slow Leak to Sudden Release	265	NA	Lined Containment Dike	>21,000
Steel Tank in Lined Containment Unit	Slow Leak to Sudden Release	21,000	NA	Lined Containment Dike	>21,000
Steel Tank in Lined Containment Unit	Slow Leak to Sudden Release	2500	NA	Lined Containment Dike	>21,000
Plastic Tank in Shop	Slow Leak to Sudden Release	200	NA	Spill Kit	NA
Partially Below Grade Steel Tank in Shop	Slow Leak to Sudden Release	500	NA	Spill Kit	NA
Steel Drum Yard (6)	Slow Leak to Sudden Release	55	NA	Spill Kit	NA
Steel Drum Indoors (8)	Slow Leak to Sudden Release	55	NA	Spill Kit	NA

[a] Use one of the following methods of secondary containment or its equivalent: (1) Dikes, berms, or retaining walls sufficiently impervious to contain oil; (2) Curbing; (3) Culverting, gutters, or other drainage systems; (4) Weirs, booms, or other barriers; (5) Spill diversion ponds; (6) Retention ponds; (7) Sorbent materials.

[b] Use one of the following methods of secondary containment or its equivalent: (1) Dikes, berms, or retaining walls sufficiently impervious to contain oil; (2) Curbing; (3) Culverting, gutters, or other drainage systems; (4) Weirs, booms, or other barriers; (5) Spill diversion ponds; (6) Retention ponds; (7) Sorbent materials.

[c] For storage tanks and bulk storage containers, the secondary containment capacity must be at least the capacity of the largest container plus additional capacity to contain rainfall or other precipitation.

Milbank No. 1					
Steel Drum on Containment Pallet in Oil Shed	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Plastic Drum on Containment Pallet in Oil Shed	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum on Containment Pallet in Oil Shed	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Milbank No. 2					
Steel Drum on Containment Pallet	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum on Containment Pallet (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Milbank No. 3					
Steel Drum on Containment Pallet Indoors (3)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum on Containment Pallet Indoors (3)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (4)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55
Steel Drum in Rail Dike Covered (2)	Slow Leak to Sudden Release	55	NA	Containment Pallet	>55

Table G-4 Containers with Potential for an Oil Discharge (Continued)					
Area	**Type of Failure** (discharge scenario)	**Potential Discharge Volume** (gallons)	**Direction of Flow for Uncontained Discharge**	**Secondary Containment Method**[d]	**Secondary Containment Capacity** (gallons)
Oil-Filled Operational Equipment (e.g., hydraulic equipment, transformers)[e]					
Electric Transformers (Active)	Slow Leak to Sudden Release	Varies	NA	Spill Cleanup Kits	NA
Piping, Valves, etc.					
NA					
Product Transfer Areas (location where oil is loaded to or from a container, pipe or other piece of equipment)					
Truck Fueling	Small Spillage	0 to 200 gallons	NA	Spill Cleanup Kits	NA
Other Oil-Handling Areas of Oil-Filled Equipment (e.g., flow-through process vessels at an oil production facility)					
NA	NA	NA	NA	NA	NA

3. Inspections, testing, recordkeeping and Personnel training {§§112.7(e) & (f), 112.8(c)(6), 112.12(c)(6)}:

Table G-5 Inspections, Testing, Record keeping and Personnel Training	
An inspection and testing program is implemented for all aboveground storage containers and piping at this facility. {§§112.8(c)(6) & 112.12(c)(6)}	☒
The following is a description of the inspection and testing program (e.g., reference to industry standard utilized, scope, frequency, method of inspection or test, and person conducting the inspection) for all aboveground storage containers and piping at the facility: **Tank inspections are done monthly using Attachment 3.1 – Inspection Log and Schedule or COLDSPRING Form EN-017 (attached)**	
Inspections, tests, and records are conducted in accordance with written procedures developed for the facility. Records of inspections and tests kept under usual and customary business practices will suffice for purpose of the paragraph. {§112.7(e)}	☒
A record of the inspections and tests are kept at the facility with the SPCC Plan for a period of three years. {§112.7(e)} [See Inspection Log and Schedule in Attachment 3.1]	☒
Inspections and tests are signed by the appropriate supervisor or inspector. {§112.7(e)}	☒
Personnel training and Discharge Prevention Procedures {§112.7(f)}	
Oil-handling personnel are trained in the operation and maintenance of equipment to prevent	☒

[d] Use one of the following methods of secondary containment or its equivalent: (1) Dikes, berms, or retaining walls sufficiently impervious to contain oil; (2) Curbing; (3) Culverting, gutters, or other drainage systems; (4) Weirs, booms, or other barriers; (5) Spill diversion ponds; (6) Retention ponds; (7) Sorbent materials.
[e] For oil-filled operational equipment: Document in the table above if alternative measures to secondary containment {as described in §112.7(k)} are implemented at the facility.

discharges; discharge procedure protocols; applicable pollution control laws, rules and regulations; general facility operations; and the contents of the facility SPCC Plan. {§112.7(f)}	
A person who reports to facility management is designated and accountable for discharge prevention. {§112.7(f)}: Name: Chuck Roehrl Title: Quality and Safety Manager	☒
Discharge prevention briefings are conducted for oil-handling personnel annually to assure adequate understanding of the SPCC Plan for that facility. Such briefings highlight and describe past reportable discharges or failures, malfunctioning components, and any recently developed precautionary measures. {§112.7(f)} [See Oil-Handling Personnel Training and Briefing Log in Attachment 3.4]	☒

4. Security (excluding oil production facilities) {§112.7(g)}:

Table G-6 Implementation and Description of Security Measures	
Security measures are implemented at this facility to prevent unauthorized access to oil handling, processing, and storage areas. The following is a description of how you secure and control access to the oil handling, processing and storage areas; secure master flow and drain valves; prevent unauthorized access to starter controls on oil pumps; secure out-of-service and loading/unloading connections of oil pipelines; address the appropriateness of security lighting to both prevent acts of vandalism and assist in the discovery of discharges: **The site is protected by the presence of facility personnel during business hours and by a security fence during off-hours.**	☒

5. Emergency Procedures and Notifications {§§112.7(a)(3)(iv) and 112.7(a)(5)}:

Table G-7 Description of Emergency Procedures and Notifications	
The following is a description of the immediate actions taken by facility personnel in the event of a discharge to navigable waters or adjoining shorelines. {§112.7(a)(3)(iv) and §112.7(a)(5)}: **Oil spill response procedures are outlined in Coldspring work instruction WI-EN-061, Oil Spill Response Procedure (attached)**	☒

6. **Contact List {§112.7(a)(3)(vi)}:**

Table G-8 Contact List	
Contact Organization/Person:	**Telephone Number**
National Response Center (NRC)	800-424-8802
South Dakota DENR	605-773-3206
South Dakota DENR Radio Dispatch (After Hours)	605-773-3231
US EPA Region VIII	303-312-6312
	http://www2.epa.gov/region8/emergency-response-and-oil-pollution-act
Cleanup Contractor(s):	
Dakota Environmental, Inc.	800-888-0423
Huron, SD	http://dakotaenv.com/
GeoTek Engineering & Testing Services, Inc.	800 354-5512
Sioux Falls, SD	http://www.geotekeng.com/
West Central Environmental Consultants, Inc., Morris, MN	800-422-8356
Morris, MN	http://www.wcec.com/
Key facility Personnel:	
Steve Karels, Manger, Milbank Operations	Office: 605-432-9389
	Emergency: 605-261-4208
Gary Theisen, Director of Risk Management	Office: 320-685-4745
	Emergency: 320-249-5588
Donald Scheele, Chief Environmental Engineer	Office:320-685-5082
	Ermergency:320-761-2886
Jeff Rausch, Environmental & Quarry Safety Engineer	Office: 320-685-4808
	Emergency: 320-200-8890
Local Police/Fire Department	911
Hospital	Milbank Area Hospital Avera 901 E. Virgil Avenue Milbank, SD 57252 605-432-4538

7. **NRC Notification Procedures {§§112.7(a)(4) and (a)(5)}:**

Table G-9 NRC Notification Procedure	
In the event of a discharge of oil to navigable waters or adjoining shorelines, the following information identified in Attachment 4 will be provided to the National Response Center immediately following identification of a discharge to navigable waters or adjoining shorelines [See Discharge Notification Form in Attachment 4]: {§112.7(a)(4)}	☒
• The exact address or location and phone number of the facility; • Date and time of the discharge; • Type of material discharged; • Estimate of the total quantity discharged; • Estimate of the total quantity discharged to navigable waters; • Source of discharge; • Description of all affected media; • Cause of the discharge; • Any damages or injuries caused by the discharge • Actions being used to stop, remove, and mitigate the effects of the discharge; • Whether an evacuation may be needed; and • Names of individuals and/or organizations who have also been contacted.	

8. SPCC Spill Reporting Requirements (Report within 60 days) {§112.4}:

Submit information to the EPA Regional Administrator (RA) and the appropriate agency or agencies in charge of oil pollution control activities in the State in which the facility is located within 60 days from one of the following discharge events:

1. a single discharge of more than 1,000 U.S. gallons of oil to navigable waters or adjoining shorelines **or**
2. Two discharges to navigable waters or adjoining shorelines each more than 42 U.S. gallons of oil occurring within any twelve month period.

You must submit the following information to the RA:

(1) Name of the facility;
(2) Your name;
(3) Location of the facility;
(4) Maximum storage or handling capacity of the facility and normal daily throughput;
(5) Corrective action and countermeasures you have taken, including a description of equipment repairs and replacements;
(6) An adequate description of the facility, including maps, flow diagrams, and topographical maps as necessary;
(7) The cause of the reportable discharge, including a failure analysis of the system or subsystem in which the failure occurred; and
(8) Additional preventive measures you have taken or conpland to minimize the possibility of recurrence.

A. Onshore Facilities (excluding production) {§§112.8(b) and (d), 112.12(b) and (d)}:
The owner or operator must meet the general rule requirements as well as requirements under this section. Note that not all provisions may be applicable to all owners/operators. For example, a facility may not maintain completely buried metallic storage tanks installed after January 10, 1974, and thus would not have to abide by requirements in §§112.8(c)(4) and 112.12(c)(4), listed below. In cases where a provision is not applicable, write "N/A".

Table G-10 General Rule Requirements for Onshore Facilities	
Drainage from diked storage areas is restrained by valves to prevent a discharge into the drainage system or facility effluent treatment system, except where facility systems are designed to control such discharge. {§§112.8(b)(1) and 112.12(b)(1)}	NA+
Valves of manual, open-and-closed design are used for the drainage of diked areas. {§§112.8(b)(2) and 112.12(b)(2)}	NA+
The containers at the facility are compatible with materials stored and conditions of storage such as pressure and temperature. {§§112.8(c)(1) and 112.12(c)(1)}	☒
Secondary containment for the bulk storage containers (including mobile/portable oil storage containers) holds the capacity of the largest container plus additional capacity to contain precipitation. Mobile or portable oil storage containers are positioned to prevent a discharge as described in §112.1(b). {§112.6(a)(3)(ii)}	☒
If uncontaminated rainwater from diked areas drains into a storm drain or open watercourse the following procedures will be implemented at the facility: {§§112.8(c)(3) and 112.12(c)(3)} • Bypass valve is normally sealed closed. • Retained rainwater is inspected to ensure that its presence will not cause a discharge to navigable waters or adjoining shorelines. • Bypass valve is opened and resealed under responsible supervision. • Adequate records of drainage are kept [See Dike Drainage Log in Attachment 3.3].	NA+ ☒ NA+ ☒
For completely buried metallic tanks installed on or after January 10, 1974 at this facility: {§§112.8(c)(4) and 112.12(c)(4)} • Tanks have corrosion protection with coatings or cathodic protection compatible with local soil conditions. • Regular leak testing is conducted.	NA# NA#
For partially buried or bunkered metallic tanks: {§§112.8(c)(5) and 112.12(c)(5)} • Tanks have corrosion protection with coatings or cathodic protection compatible with local soil conditions.	NA#
Each aboveground container is tested or inspected for integrity on a regular schedule and whenever material repairs are made. Scope and frequency of the inspections and inspector qualifications are in accordance with industry standards. Container supports and foundations are regularly inspected. [See Inspection Log and Schedule and Bulk Storage Container Inspection Schedule in Attachments 3.1 and 3.2] {§§112.8(c)(6) and 112.12(c)(6)(i)}	☒
Outsides of containers are frequently inspected for signs of deterioration, discharges, or accumulation of oil inside diked areas. [See Inspection Log and Schedule in Attachment 3.1] {§§112.8(c)(6) and 112.12(c)(6)}	☒
For bulk storage containers that are subject to 21 CFR part 110 which are shop-fabricated, constructed of austenitic stainless steel, with manhole and have no external insulation, formal visual inspection is conducted on a regular schedule. Appropriate qualification for personnel performing tests and inspections are documented. [See Inspection Log and Schedule and Bulk Storage Container Inspection Schedule in Attachments 3.1 and 3.2] {§112.8(c)(6)(ii)}	NA#
Each container is provided with a system or documented procedure to prevent overfills for the container, Describe: **Liquid level gauges are provided for each tank and the liquid level is determined by manual monitoring during liquid transfer**	☒
Liquid level sensing devices are regularly tested to ensure proper operation. [See Inspection Log and Schedule in Attachment 3.1] {§112.6(a)(3)(iii)}	☒
Visible discharges which result in a loss of oil from the container, including but not limited to seams, gaskets, piping, pumps, valves, rivets, and bolts are promptly corrected and oil in diked areas are promptly removed. {§§112.8(c)(10) and 112.12(c)(10)}	☒
Aboveground valves, piping, and appurtenances, such as flange joints, expansion joints, valve glands and bodies, catch pans, pipeline supports, locking of valves, and metal surfaces are inspected regularly. [See Inspection Log and Schedule in Attachment 3.1] {§§112.8(d)(4) and 112.12(d)(4)}	☒
Integrity and leak testing are conducted on buried piping at the time of installation, modification, construction, relocation, or replacement. [See Inspection Log and Schedule in Attachment 3.1] {§§112.8(d)(4) and 112.12(d)(4)}	NA#

NA+ No manual drainage valves are provided. Precipitation is managed by evaporation or manual pumping.
NA# There are no completely or partially buried tanks, piping or containers on site, and there are also no field erected tanks on site.

Attachment 1 – Five Year Review and Technical Amendment Logs

Attachment 1.1 – Five Year Review Log

I have completed a review and evaluation of the SPCC Plan for the facility, and will/ will not amend this Plan as a result.

Table G-13 Review and Evaluation of SPCC Plan for Facility			
Review Date	Plan Amendment		Name and signature of person authorized to review this Plan
	Will Amend	Will Not Amend	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
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	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	
	☐	☐	

Attachment 1.2 – Technical Amendment Log

Any technical amendments to this Plan will be re-certified in accordance with Section I of this Plan.

Table G-14 Description and Certification of Technical Amendments		
Review Date	Description of Technical Amendment	Name and signature of person certifying this technical amendment

Attachment 2 – Oil Spill Contingency Plan and Checklist

An oil spill contingency plan and written commitment of resources is required for:

- Flowlines and intra-facility gathering lines at oil production facilities and
- Qualified oil-filled operational equipment which has no secondary containment.

An oil spill contingency plan meeting the provisions of 40 CFR part 109, as described below, and a written commitment of manpower, equipment and materials required to expeditiously control and remove any quantity of oil discharged that may be harmful is attached to this Plan.	☒

Complete the checklist below to verify that the necessary operations outlined in 40 CFR part 109 – Criteria for State, Local and Regional Oil Removal Contingency Plans – have been included.

Table G-15 Development and Implementation Criteria for State, Local and Regional Oil Removal Contingency Plans[a] Checklist (§109.5)	
(a) Definition if the authorities, responsibilities and duties of all persons, organizations or agencies which are to be involved in planning or directing oil removal operations.	☒
(b) Establishment of notification procedures for the purpose of early detection and timely notification of an oil discharge including:	☒
(1) The identification of critical water use areas to facilitate the reporting of and response to oil discharges.	☒
(2) A current list of names, telephone numbers and addresses of the responsible persons (with alternates) and organizations to be notified when an oil discharge is discovered.	☒
(3) Provisions for access to a reliable communications system for timely notification of an oil discharge, and the capability of interconnection with the communication systems established under related oil removal contingency plans, particularly State and National Plans (e.g. NCP).	☒
(4) An established prearranged procedure for requesting assistance during a major disaster or when the situation exceed the response capability of the State, local or regional authority.	☒
(c) Provisions to assure that full resource capability is known and can be committed during an oil discharge situation including:	☒
(1) The identification and inventory of applicable equipment, materials and supplies which available locally and regionally.	☒
(2) An estimate of the equipment, materials and supplies which would be required to remove the maximum discharge to be anticipated.	☒
(3) Development of agreements and arrangements in advance of an oil discharge for the acquisition of equipment, materials and supplies to be used in responding to such a discharge.	☒
(d) Provisions for well defined and specific actions to be taken after discovery and notification of an oil discharge including:	☒
(1) Specification of an oil discharge response operating team consisting of trained, prepared and available operating personnel.	☒
(2) Predesignation of a properly qualified oil discharge response coordinator who is charged with the responsibility and delegated commensurate authority for directing and coordinating response operations and who knows how to request assistance from Federal authorities operating under existing national and regional contingency plans.	☒
(3) A preplanned location for an oil discharge response operation center and a reliable communication system for directing the coordinated overall response operations.	☒
(4) Provisions for varying degrees of response effort depending on the severity of the oil discharge.	☒
(5) Specification of the order of priority in which the various water uses are to be protected where more than one water use may be adversely affected as a result of an oil discharge and where response operations may not be adequate to protect all uses.	☒
(6) Specific and well defined procedures to facilitate recovery of damages and enforcement measures as provided for by State and local statutes and ordinances.	☒

[a] The contingency plan must be consistent with all applicable State and local plans, Area Contingency Plans, and the National Contingency Plan (NCP).

Attachment 3 – Inspections, Dike Drainage and Personnel Training Logs [Alternatively use Coldspring Form EN-021G(TankInspectionForm-Milbank)]

Attachment 3.1 – Inspection Log and Schedule

Table G-16 Inspection Log This log is intended to document compliance with §§112.6(a)(3)(iii), 112.8(c)(6), 112.8(d)(4), 112.9(b)(2), 112.9(c)(3), 112.9(d)(1), 112.9(d)(4), 112.12(c)(6), and 112.12(d)(4), as applicable.					
Date of Inspection	Container/ Piping/ Equipment	Describe Scope (or cite Industry Standard)	Observations	Name/ Signature of Inspector	Records Maintained Separately[a]
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐
					☐

[a]Indicate in the table above if records of facility inspections are maintained separately at this facility.

Attachment 3.2 – Bulk Storage Container Inspection Schedule – Onshore Facilities (excluding production):

To comply with integrity inspection requirements for bulk storage containers, inspect/test each shop-built aboveground bulk storage container on a regular schedule in accordance with a recognized container inspection standard based on the minimum requirements in the following table:

Table G-17 Bulk Storage Container Inspection Schedule	
Container Size and Design Specification	**Inspection Requirement**
Portable containers {including drums, totes, and intermodal bulk containers (IBC)}	Visually inspect for signs of deterioration, discharges or accumulation of oil inside diked areas
55 to 1,100 U.S. gallons with sized secondary containment	Visually inspect for signs of deterioration, discharges or accumulation of oil inside diked areas, plus any annual inspection elements per industry inspection standards
1,101 to 5,000 U.S. gallons with sized secondary containment and a means of leak detection[a]	
5,001 to 25,000 U.S. gallons with sized secondary containment and no method of leak detection[a]	Visually inspect for signs of deterioration, discharges or accumulation of oil inside diked areas, plus any annual inspection elements and other specific integrity tests that may be required per industry inspection standards

[a]Examples of leak detection include, but are not limited to, double-walled tanks and elevated containers where a leak can be visually identified.

Milbank SD Site

Dooley's Petroleum Inc.
Above ground storage tank/ Containment area
Weekly Visual Check

Name of person doing monitoring:_____

Date of monitoring:_____

Containment area

☐ Walk the site to identify cracks in the containment and substance transfer areas.

Above ground storage tanks

Visually examine all tanks, piping, valves, pumps and other equipment surfaces for, cracks, corrosion, releases and maintenance deficiencies.

Identify poor maintenance and operating practices or malfunctioning equipment

Please check off the tanks listed below as you complete their inspection:

☐ 1001 Diesel 28,000 capacity
☐ 1002 Gasoline 2,000 capacity

Maintenance or action needed:_____

Turn into Gary Zimmer as soon as completed
Keep on file for 3 years

AST Bulk Plant Inspection

Form # EN-021G (05Aug13)

Attachment 3.4 – Oil-handling Personnel Training and Briefing Log [Alternatively use Coldspring Form QU-020 (Quarry TCA)]

Table G-19 Oil-Handling Personnel Training and Briefing Log		
Date	**Description/Scope**	**Attendees**

Attachment 4 – Discharge Notification Form

In the event of a discharge of oil to navigable waters or adjoining shorelines, the following information will be provided to the National Response Center [also see the notification information provided in Section 7 of the Plan]:

[Alternatively use Coldspring Form EN-026(NotificationReportableSpillEvents)]

Table G-20 Information Provided to the National Response Center in the Event of a Discharge				
Discharge/Discovery		Time		
Facility Name				
Facility Location (Address/Lat-Long/ Section, Township, Range)				
Name of Reporting		Telephone #		
Type of Material Discharged		Estimated Quantity Discharged gallons barrels		
Source of the Discharge:		Media affected: ☐ Soil _____ ☐ Water (specify) _____ ☐ Other (specify) _____		
Actions Taken:				
Damage or Injuries? ☐ No ☐ Yes (specify)		Evacuation Needed? ☐ No ☐ Yes (specify)		
Organizations and Individuals Contacted	☐ National Response	**800-424-8802**	Date:	Time:
	☐ Cleanup Contractor		Date:	Time:
	☐ Facility Personnel		Date:	Time:
	☐ Facility Personnel		Date:	Time:
	☐ Federal Agency		Date:	Time:
	☐ State Agency (EMA Warning		Date:	Time:
	☐ State Agency		Date:	Time:
	☐ State Agency		Date:	Time:
	☐ State Agency		Date:	Time:
	☐ Local Agency		Date:	Time:
	☐ Local Agency		Date:	Time:
	☐ Other		Date:	Time:
	☐ Other		Date:	Time:
	☐ Other		Date:	Time:
	☐ Other		Date:	Time:

CERTIFICATION OF SUBSTANTIAL HARM DETERMINATION FORM

CERTIFICATION OF SUBSTANTIAL HARM DETERMINATION FORM

FACILITY NAME: Coldspring – Milbank Operations
FACILITY ADDRESS: 14982 485th Avenue, Milbank, SD 57252

1. Does the facility transfer oil over water to or from vessels and does the facility have a total oil storage capacity greater than or equal to 42,000 gallons?
   Yes ___ No X

2. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and does the facility lack secondary containment that is sufficiently large to contain the capacity of the largest aboveground oil storage tank plus sufficient freeboard to allow for precipitation within any aboveground oil storage tank area?
   Yes ___ No X

3. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the formula in Attachment C-III, Appendix C, 40 CFR 112 or a comparable formula[f]) such that a discharge from the facility could cause injury to fish and wildlife and sensitive environments? For further description of fish and wildlife and sensitive environments, see Appendices I, II, and III to DOC/NOAA's "Guidance for Facility and Vessel Response Environments" (Section 10, Appendix E, 40 CFR 112 for availability) and the applicable Area Contingency Plan.
   Yes ___ No X

4. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and is the facility located at a distance (as calculated using the appropriate formula (Attachment C-III, Appendix C, 40 CFR 112 or a comparable formula[f]) such that a discharge from the facility would shut down a public drinking water intake[g]?
   Yes ___ No X

5. Does the facility have a total oil storage capacity greater than or equal to 1 million gallons and has the facility experienced a reportable oil spill in an amount greater than or equal to 10,000 gallons within the last 5 years?
   Yes ___ No X

CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document, and that based on my inquiry of those individuals responsible for obtaining this information, I believe that the submitted information is true, accurate, and complete.

Donald Scheele
Name (please type or print)

Signature

Chief Environmental Engineer
Title

12/10/13
Date

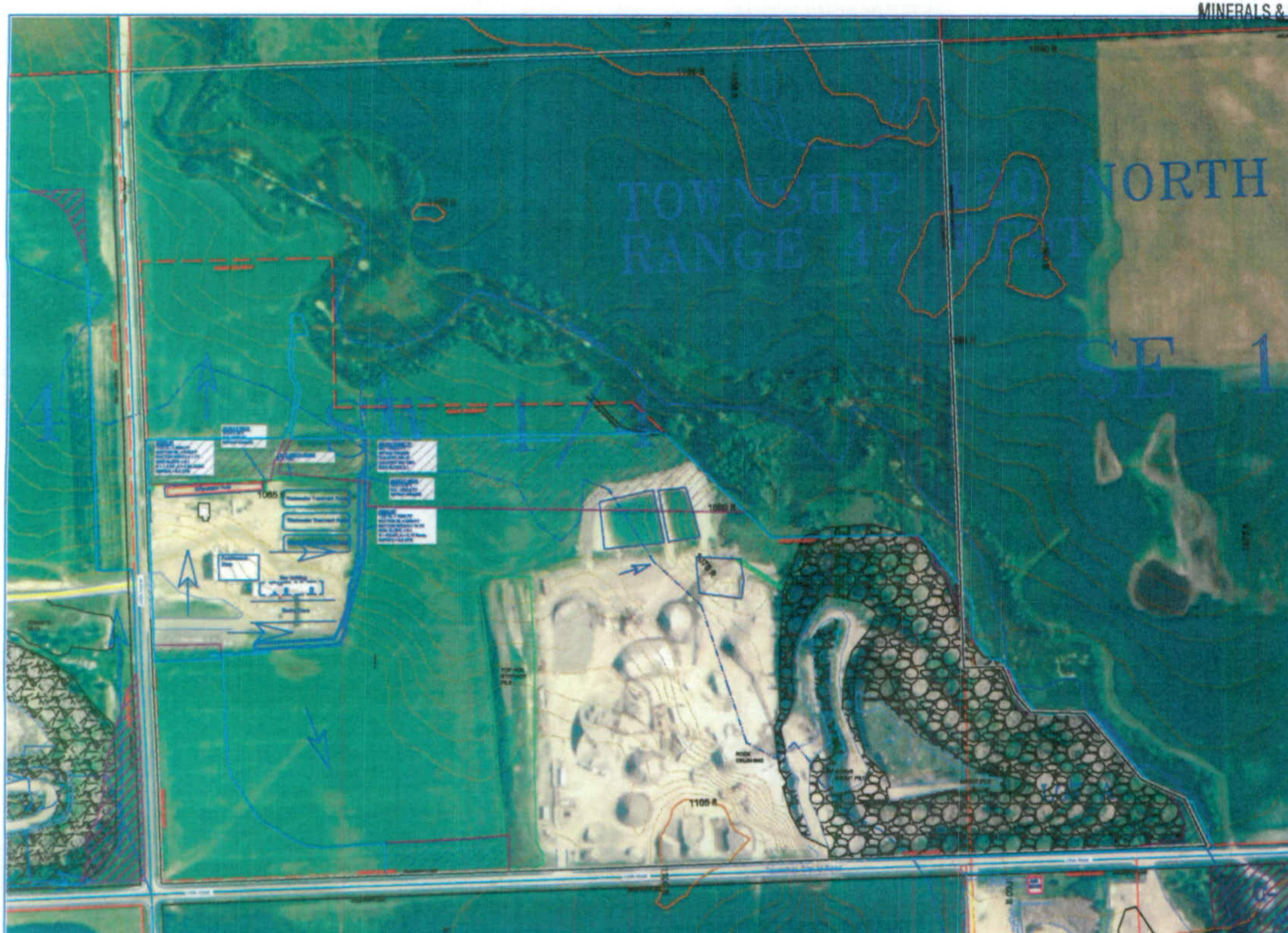
[f] If a comparable formula is used, documentation of the reliability and analytical soundness of the comparable formula must be attached to this form.

[g] For the purposes of 40 CFR part 112, public drinking water intakes are analogous to public water systems as described at 40 CFR 143.2(c).(from 40 CFR 112 Appendix C, Attachment C-II)

RECEIVED

JUL 13 2016

MINERALS & MINING PROGRAM



PERMANENT REFERENCE POINTS

CNTL 808
CNTL 805
CNTL 305-V

Milbank Shop
14882 485th Avenue
Milbank, SD 57252, Grant County

45.2118 N, 96.4855 W
T120N, R47W, S 8-9

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-08 for State Plane Coordinate System.

BOUNDRY 1
PERMIT No. 28 (Steiner-Rausch) OL 3 & 4
PERMIT No. 8 (Site 1)
PERMIT No. 11 (Site 2)

PREVIOUS DRAWING: P-0115

MAP KEY

KEY	DESCRIPTION
	RECLAIMED AREAS / PLANTED TREES
	GROUT PILE
	PERMIT AFFECTED AREA TECHNICAL REVISION........ 9.8 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	PERMITTED AFFECTED BOUNDRY..........78.3 Acres
	PERMIT BOUNDRY..........85.3 Acres
	TOTAL AFFECTED AREA..........51.5 Acres
	AFFECTED AREA (PRE 1971)..........0.0 Acres
	SURFACE MINE LAND DISTURBED..........19.5 Acres
	PROPERTY LINE..........161.0 Acres
	RECLAIMED AREAS..........0.0 Acres
	QUARRY BENCHES
	HAUL ROADS
	BUILDINGS / STRUCTURES
	STORMWATER
	STORMWATER MONITORING POINT
	WETLAND (DELINEATED / MITIGATED / ESTIMATED)
	ELECTRICAL
	COMMUNICATION / TELEPHONE
	NATURAL GAS
	PROPANE
	FRESH WATER
	RECYCLED INDUSTRIAL WATER
	INDUSTRIAL WASTE WATER
	DOMESTIC WASTE WATER
	ABANDONDED UTILITIES
	FENCING

SCALE

Contour Interval = 5 feet

COLD SPRING GRANITE COMPANY
17482 Granite West Road
Cold Spring, MN 56320

COLD SPRING GRANITE COMPANY, COLD SPRING, MN

QUARRY #1 GROUT PILE & SHOP
QUARRY & GROUT PILE PLAN

Rev.	CHANGE	DATE	BY
	[illegible]		

RECEIVED

JUL 13 2016

PERMANENT REFERENCE POINTS

162-W		NW of Hoisthouse on Slab
PT109-W		S Quarry Wall at Bottom of Ramp
CTL 108-V		S Quarry Wall at Bottom of Ramp
506	521287.18, 2876299.95	Nail

Milbank #1 Quarry
48551 150th Street
Milbank, SD 57252, Grant County

Grant County,
TWP 120N, R 47W, S 8-8, 17-N
45.2055 N, 96.4869 W

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.

BOUNDRY 1
PERMIT No. 28 (Steiner-Rausch) OL 3 & 4 TR485 (Block Yard Expansion)
PERMIT No. 8 (Site 1)
PERMIT No. 11 (Site 2)

PREVIOUS DRAWING: P-0137

MAP KEY

KEY	DESCRIPTION
	RECLAIMED AREAS / PLANTED TREES
	GROUT PILE
///	PERMIT AFFECTED AREA TECHNICAL REVISION....... 9.8 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	PERMITTED AFFECTED BOUNDRY.............89.0 Acres
- - -	PERMIT BOUNDRY..............................89.0 Acres
	TOTAL AFFECTED AREA.......................74.4 Acres
	AFFECTED AREA (PRE 1971)..................7.0 Acres
	SURFACE MINE LAND DISTURBED.............35.5 Acres
	PROPERTY LINE................................102.8 Acres
	RECLAIMED AREAS.............................3.5 Acres
	QUARRY BENCHES
	HAUL ROADS
	BUILDINGS / STRUCTURES
	STORMWATER
	STORMWATER MONITORING POINT
	WETLAND (DELINEATED / MITIGATED / ESTIMATED)
	ELECTRICAL
	COMMUNICATION / TELEPHONE
	NATURAL GAS
	PROPANE
	FRESH WATER
	RECYCLED INDUSTRIAL WATER
	INDUSTRIAL WASTE WATER
	DOMESTIC WASTE WATER
	ABANDONDED UTILITIES
	FENCING

SCALE

Contour Interval = 5 feet

COLD SPRING GRANITE COMPANY
17482 Granite West Road
Cold Spring, MN 56320

COLD SPRING GRANITE COMPANY, COLD SPRING, MN

MILBANK #1 QUARRY

QUARRY & GROUT PILE PLAN

EN-013-08

Rev	CHANGE	DATE	BY
a			
b			
c			
d			

BY	
CKD	
DATE	
SCALE	
DRAWING NO.	
APPROVED BY	

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JUL 13 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 113 — Western wall at bottom of Ramp
CTL 188-V — Aluminum Can Bottom on Ledge
505 — 521087.57, 2871087.44 — ½" Rebar
504 — 520881.82, 2865914.83 — Nail Above Stone

Milbank #2 Quarry
48450 150th Street
Milbank, SD 57252, Grant County

45.2083 N, 96.5074 W
T120N, R47W, S 7-8

Mining Permit No. 8, 11, & 26

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.

BOUNDRY 1
PERMIT No. 26 (Steiner-Rausch) OL 3 & 4 TR 486 (for Wetland Diversion Project)
PERMIT No. 8 (Site 1)
PERMIT No. 11 (Site 2)

PREVIOUS DRAWING: P-0104

MAP KEY

KEY	DESCRIPTION
	RECLAIMED AREAS / PLANTED TREES
	GROUT PILE
	PERMIT AFFECTED AREA TECHNIACAL REVISION........ 3.9 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	PERMITTED AFFECTED BOUNDRY..........121.1 Acres
	PERMIT BOUNDRY..........174.2 Acres
	TOTAL AFFECTED AREA..........80.5 Acres
	AFFECTED AREA (PRE 1971)..........0.0 Acres
	SURFACE MINE LAND DISTURBED..........57.6 Acres
	PROPERTY LINE..........174.7 Acres
	RECLAIMED AREAS..........4.1 Acres
	QUARRY BENCHES
	HAUL ROADS
	BUILDINGS / STRUCTURES
	STORMWATER
	STORMWATER MONITORING POINT
	WETLAND (DELINEATED / MITIGATED / ESTIMATED)
	ELECTRICAL
	COMMUNICATION / TELEPHONE
	NATURAL GAS
	PROPANE
	FRESH WATER
	RECYCLED INDUSTRIAL WATER
	INDUSTRIAL WASTE WATER
	DOMESTIC WASTE WATER
	ABANDONDED UTILITIES
	FENCING

SCALE

Contour Interval = 5 feet

COLD SPRING GRANITE COMPANY
17482 Granite West Road
Cold Spring, MN 56320

COLD SPRING GRANITE COMPANY . COLD SPRING . MN

Rev	CHANGE	DATE	BY
a	Survey Quarry Benches (2009)	[illegible]	[illegible]
b	Revised Permit Affected Area for Technical Revision	[illegible]	[illegible]
c	Designated Proposed Use for each of the Additional Contiguous Land	[illegible]	[illegible]
d	Added Permit Lines drawn by SDDENR for Technical Revision	[illegible]	[illegible]

MILBANK #2 QUARRY
QUARRY & GROUT PILE PLAN

BY: Jeff Rausch
CKD:
DATE: 8-13-09
SCALE: 1:[illegible]
DRAWING NO. P-0103
APPROVED BY:

EN-012-08

JUL 13 2016

MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 305-V
503 520706.89, 2863289.5 Nail Above Stone
504 520661.82, 2865914.83 Nail Above Stone

Milbank #3 Quarry
48369 150 St.
Milbank, SD 57252, Grant County

45.2086 N, 96.5250 W
T120N, R48W, NE 1/4 Sect. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP, PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOGCS "Geographic Coordinate System", DATUM: "NAD83"
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines) : Completed on 8-24-1994 by Don Larson and updated 10-22-09 for State Plane Coordinate System.

BOUNDRY 1
PERMIT No. 373 (Site 3)

PREVIOUS DRAWING: P-0111

MAP KEY

KEY	DESCRIPTION
	RECLAIMED AREAS / PLANTED TREES
	GROUT PILE
	PERMIT AFFECTED AREA REVISED
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	PERMITTED AFFECTED BOUNDRY.........73.0 Acres
	PERMIT BOUNDRY.........73.0 Acres
	TOTAL AFFECTED AREA.........58.2 Acres
	AFFECTED AREA (PRE 1971).........0.0 Acres
	SURFACE MINE LAND DISTURBED.........42.8 Acres
	PROPERTY LINE.........73.0 Acres
	RECLAIMED AREAS.........0.0 Acres
	QUARRY BENCHES
	HAUL ROADS
	BUILDINGS / STRUCTURES
	STORMWATER
	STORMWATER MONITORING POINT
	WETLAND (DELINEATED / MITIGATED / ESTIMATED)
	ELECTRICAL
	COMMUNICATION / TELEPHONE
	NATURAL GAS
	PROPANE
	FRESH WATER
	RECYCLED INDUSTRIAL WATER
	INDUSTRIAL WASTE WATER
	DOMESTIC WASTE WATER
	ABANDONDED UTILITIES
	FENCING

SCALE

0 75' 150'

Contour Interval = 5 feet

COLD SPRING GRANITE COMPANY
17482 Granite West Road
Cold Spring, MN 56320

COLD SPRING GRANITE COMPANY . COLD SPRING . MN

Rev	CHANGE	DATE	BY
a	Revised Permit Affected Area for Technical Revision		JJR
b	Quarry Ledges Surveyed		JJR

MILBANK #3 QUARRY
QUARRY & GROUT PILE PLAN

BY: Jeff Rausch
CKD
DATE: 8-13-09
SCALE: 1:150
DRAWING NO. P-0134
APPROVED BY

EN-013-96

RECEIVED

JUL 13 2016

MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

CTL 3054

503	520706.69, 2663289.5	Nail Above Stone
504	521661.62, 2663514.80	Nail Above Stone

Millbank #3 Quarry
46350 156 St.
Millbank, SD 57252, Grant County

45.2046 N, 96.5230 W
T122N, R49W, NE 1/4 Sect. 13

MAP DATA SOURCES

AERIAL: 2008 NAIP; PROJECTION: "NAD83 / South Dakota North (ft)"
VERTICAL DATUM: GEOCOS "Geographic Coordinate System"; DATUM:
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don Larson and updated 10-22-03 for State Plane Coordinate System.
BOUNDARY T
PERMIT NO. 173 (Blk 1)
PREVIOUS DRAWING: P-011

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA
	Quarry face-edge
	Elevation
	Min elevation changes: Slight drop in elevation to north of property.

SCALE

N

0 100 200 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-5621, FAX (320) 685-8490

Drawing---Premining Site topography Drawn By: SC

SCALE see above Date Drawn:5-19-16

Checked BY:

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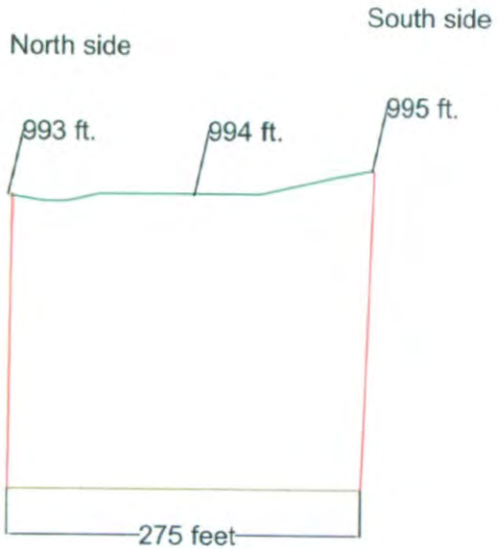

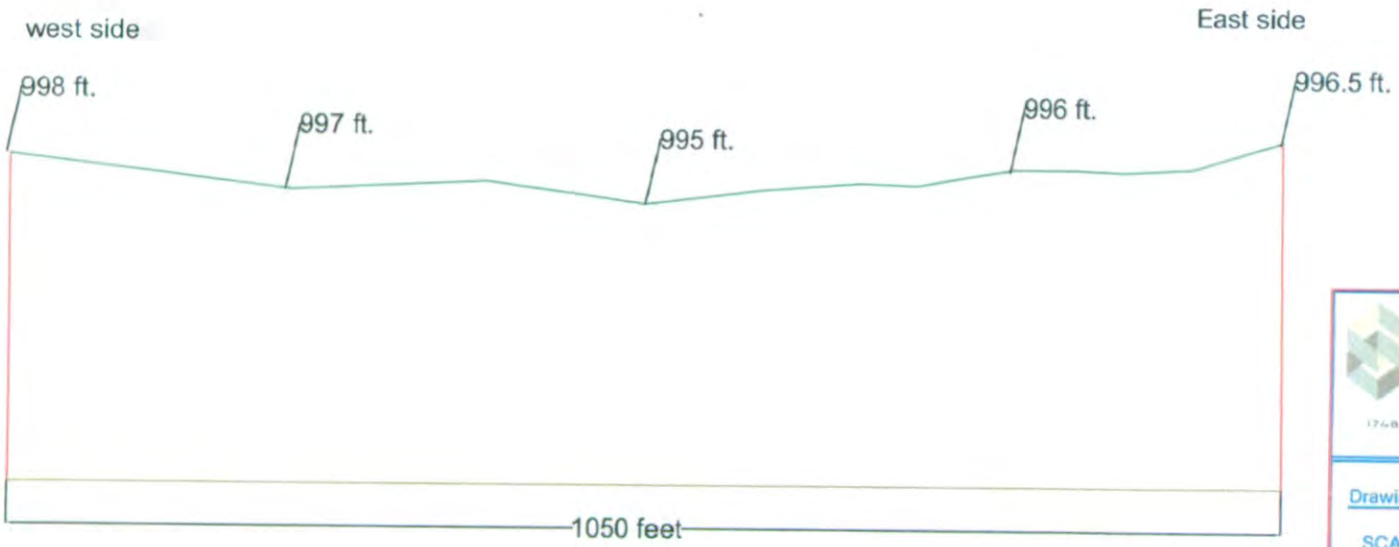

PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA EDGE
	TOPSOIL
	GROUND

SCALE

NTS

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Premining Cross Section Map Drawn By: SC

SCALE see above Date Drawn:5-19-16

Checked BY:

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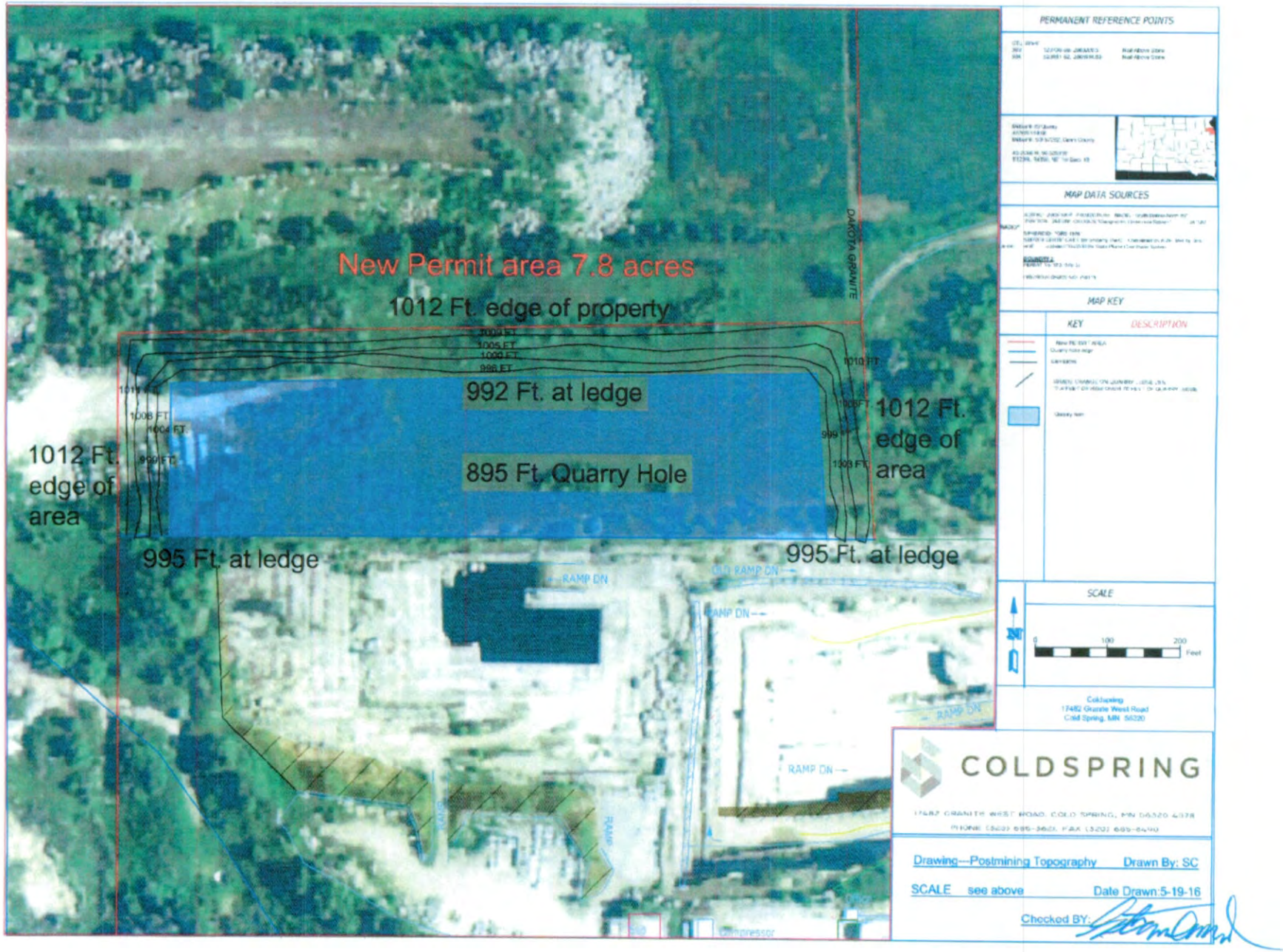

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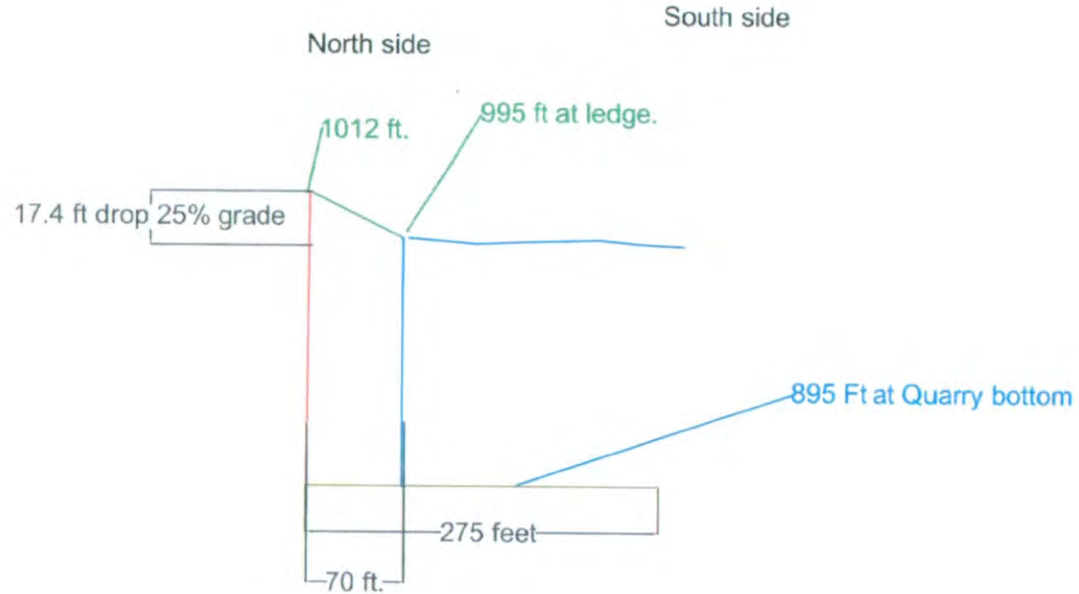

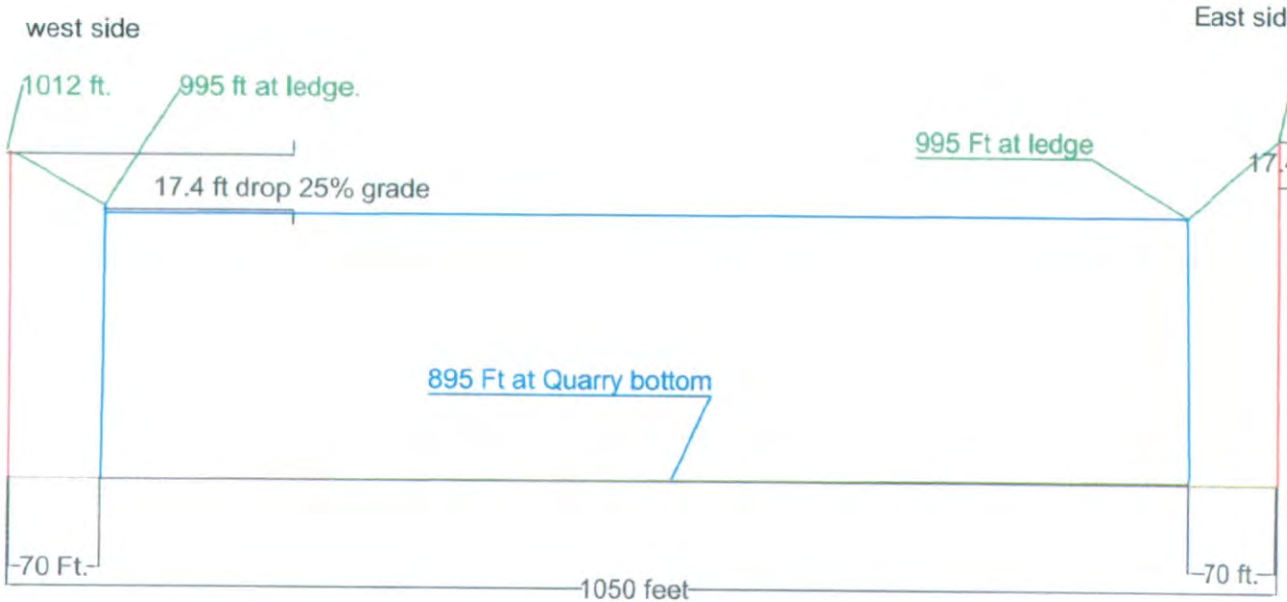

PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY	DESCRIPTION
	NEW PERMIT AREA EDGE
	TOPSOIL
	GROUND
	WATER LEVEL AND QUARRY LEDGE
	EXPANSION AREA DISTANCES

SCALE

NTS

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing---Postmining Cross Section Map Drawn By: SC

SCALE see above Date Drawn:5-19-16

Checked BY:

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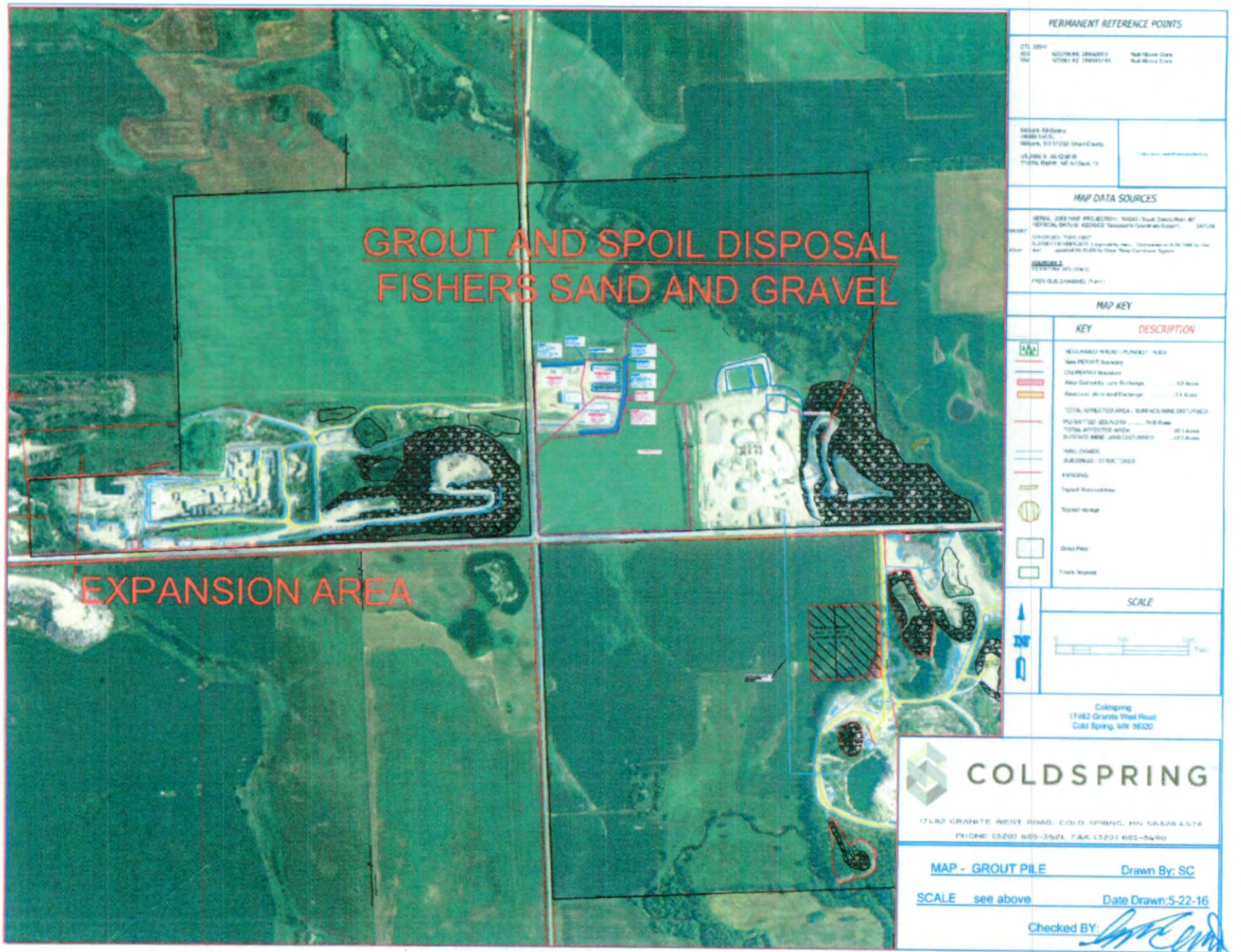
JUL 13 2016
MINERALS & MINING PROGRAM



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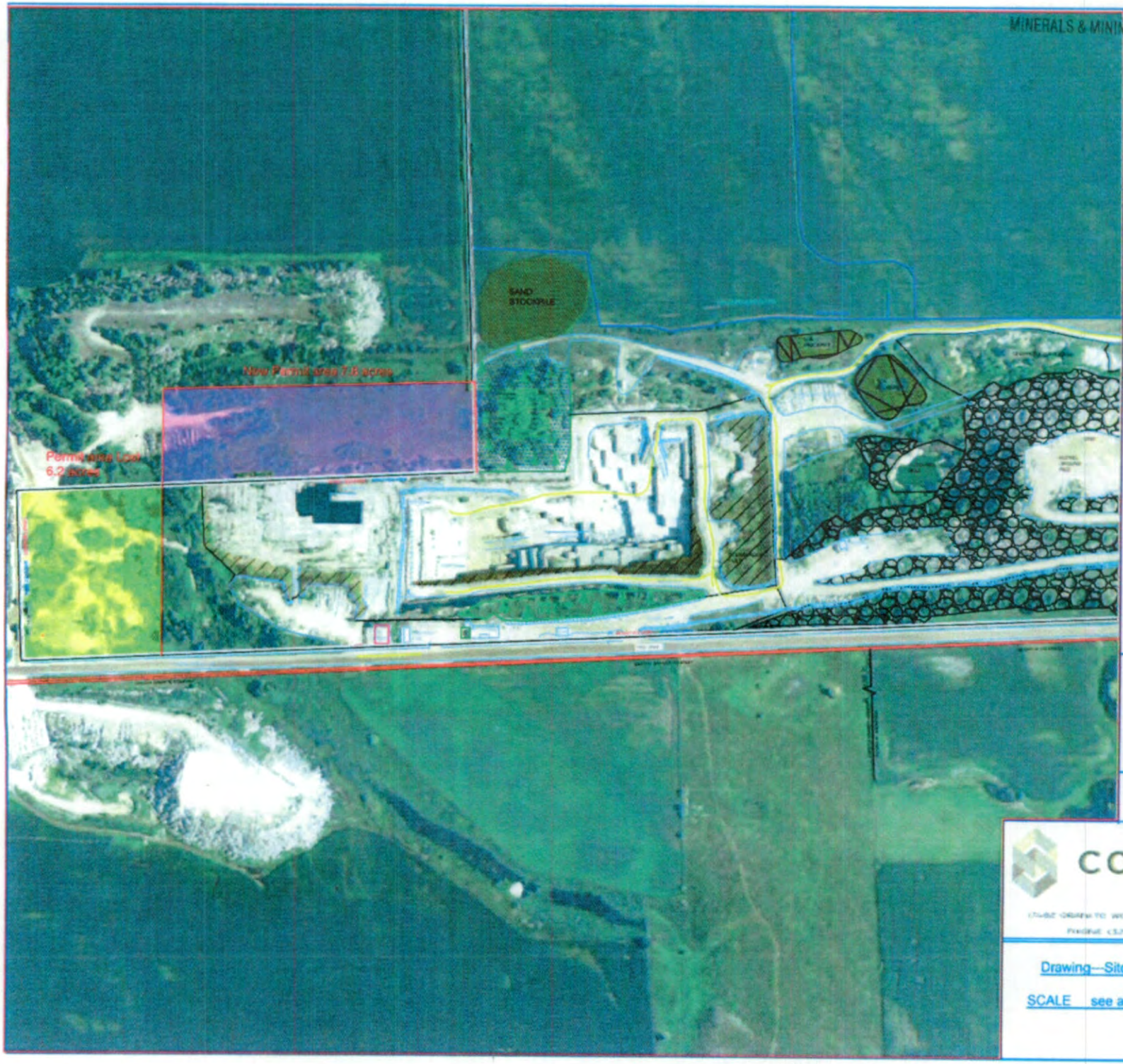
MINERALS & MINING PROGRAM



PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY	DESCRIPTION

SCALE

Containing
17482 Gazelle West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD COLD SPRING, MN 56320-4578

PHONE (320) 685-3621 FAX (320) 685-8948

Drawing---Site Map 2 Drawn By: SC

SCALE see above Date Drawn:5-4-16

Checked BY:

PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY	DESCRIPTION

SCALE

N

Coldspring
17492 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17492 GRANITE WEST ROAD, COLD SPRING, MN 56320-4534
PHONE (320) 685-3601 FAX (320) 685-8690

Drawing–Reclamation Map 3 Drawn By: SC

SCALE see above Date Drawn: 5-4-16

Checked BY:

PERMANENT REFERENCE POINTS

CTL 39-V
SC3 520706.69 2963260.5 Nail Above Stone
SC4 520661.62 2963884.83 Nail Above Stone

Milbank #3 Quarry
46369 150 St
Milbank, SD 57252 Grant County

45.2088 N, 96.5250 W
T120N, R48W, NE 1/4 Sect. 12

MAP DATA SOURCES

AERIAL: 2008 NAIP PROJECTION: "NAD83 / South Dakota North (ft)" DATUM:
VERTICAL DATUM: GEOID12 "Geographic Coordinate System". DATUM:
SPHEROID: "GRS 1980"
SURVEY CERTIFICATE (for property lines): Completed on 8-24-1994 by Don and updated 10-22-09 for Sioux Plane CoordPlate System.
BOUNDARY 2
PERMIT NO. 171 (Rev 5)
PREVIOUS DRAWING: P-8-11

MAP KEY

KEY	DESCRIPTION
	New PERMIT AREA
	Area Gained by Land Exchange ..... 7.8 Acres
	Area Lost do to land Exchange ..... 6.2 Acres
	TOTAL AFFECTED AREA / SURFACE MINE DISTURBED
	TOTAL AFFECTED AREA ..... 80.5 Acres
	SURFACE MINE LAND DISTURBED ..... 57.6 Acres
	PERMITTED AFFECTED BOUNDRY ..... 70.9 Acres
	PERMIT BOUNDRY ..... 675.8 Acres
	PROPERTY LINE ..... 676.3 Acres
	HAUL ROADS
	BUILDINGS / STRUCTURES
	FENCING
	Topsoil removal area
	Trash Disposal
	Topsoil Stockpile Area

SCALE

N

0 250 500 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING
17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-3621, FAX (320) 685-8490

Drawing—Revised Permit Boundary #4 Drawn By: SC

SCALE see above Date Drawn:5-4-16

Checked BY:

RECEIVED
JUL 13 2016
MINERALS & MINING PROGRAM

PERMANENT REFERENCE POINTS

MAP DATA SOURCES

MAP KEY

KEY DESCRIPTION

200 feet buffer area items

SCALE

0 250 500 Feet

Coldspring
17482 Granite West Road
Cold Spring, MN 56320

COLDSPRING

17482 GRANITE WEST ROAD, COLD SPRING, MN 56320-4578
PHONE (320) 685-5621, FAX (320) 685-8490

Drawing---Site Map 5 Drawn By: SC

SCALE see above Date Drawn:5-4-16

Checked BY: