Water Right Number 1768-3

1. Considered September 9, 19 70

2. Name of Applicant Northwestern Public Service Co.,Huron, S.D.; Montana-Dakota

3. Post Office Address Utilities Co.,Bismarck, N.D. and Otter Tail Power Co.,Fergus Falls, Minnesota.

4. Amount of Water claimed 7000 acre feet annually, at Max.Div.rate of 100 cfs

5. Source of Water supply Big Stone Lake

6. Water to be used for Industrial

Acres to be irrigated -

7. Water to be diverted and used in Grant County

about 1 miles NW of Big Stone City

8. Proof of Publication Received 9-3-70

Not Received

9. Application

ORVILLE B. JOHNSON P.E.
MECHANICAL ENGINEER

10. Remarks:

OTTER TAIL POWER COMPANY
215 S. CASCADE STREET
FERGUS FALLS, MINN.
739-5411

Form 2 - Application for Permit to Appropriate Water-Original (Includes Approval and Permit)

No. 1768-3

Map No. 1288-3 Water Division No. 3 WHETSTONE CREEK Dist.
(Blanks to be Filled by the Engineer for the W. R. C.)

RECEIVED
JUL 24 1970
STATE WATER RESOURCES COMM
PIERRE, SOUTH DAKOTA

APPLICATION FOR PERMIT

To Appropriate Water within the State of South Dakota

(NOTE--Draw a line through items not applicable)

Northwestern Public Service Company, Huron, South Dakota
Montana-Dakota Utilities Co., Bismarck, North Dakota

1. Name of Applicant Otter Tail Power Company, Fergus Falls, Minnesota

Postoffice address _____, State _____

If a corporation show date and place of incorporation NWPS - 11/27/23 - Delaware; MDU - 3/14/24 - Delaware; OTP - 12/23/07 - Minnesota

2. Method of accomplishing work (contract, employment of others, or by direct labor) Engineering and construction by Bechtel Corporation

3. Name of diversion work Big Stone Plant

4. Amount of water claimed (cubic feet per second) 7,000 acre feet annually (10 cfs continuously). Approval of withdrawal rates to 100 cfs is requested.

5. Source of water supply Big Stone Lake

6. Location of point of diversion 1,320 feet South of the North section line of Section 8, Township 121N., Range 46W. and 1,440 feet East of the West section line of said Section 8. Map attached.

_____ County Grant

7. Annual period or periods during which water is to be used Every day. Use will be continuous throughout the year.

8. Use to be made of water. (irrigation, industrial, municipal, commercial, recreation, etc.) Industrial

9. For irrigation use. N/A Total number of acres to be irrigated _____

List below each forty acre subdivision, or lot, or fraction thereof and show number of acres to be irrigated in each.

Land Description	No. Acres Irr.	Land Description	No. Acres Irr.

Attach sheet if more space is needed

10. Time required to complete construction of water supply system 4 to 5 years. Additional time required to complete application of water to the proposed beneficial use approximately 4 years.

11. Choice of newspaper for Notice of Intent to Appropriate Water publication Milbank Herald Advance and Grant County Review

12. Principal Features of the Proposed Water Supply System.

A. Works proposed to divert water from its natural source.

Pumping station located on the westerly shore of Big Stone Lake approximately one mile north of Big Stone City will be constructed to pump water from the water of Big Stone Lake to the site of the Big Stone Plant, a proposed 400 megawatt lignite-fired generating plant to be constructed and owned jointly by the three applicant companies.

B. Works proposed to transport water to place of use.

A pipeline approximately two miles long is proposed from the shore of Big Stone Lake to be placed underground to carry the water from Big Stone Lake to the site of the generating plant.

C. Works proposed to apply water to beneficial use. The proposed generating plant will require water for the cooling water system. Some water will also be required to be treated in the water treatment plant for use in the steam generator of the plant. Some of the water used in the cooling pond is lost through evaporation (and the resulting cooling effect) and cooling pond drift. Water will also be drawn off the cooling pond and reused for refractory cooling and for the ash-hopper water seal and the discharged water from these two sources will be further used together with the balance of the cooling pond blow down for sluicing ash from the plant to the ash settling pond. After the ash has settled out, the remaining water will be available for return to the surface water system. Approximately one fifth of the water taken Estimated Total Cost $ 1,250,000 from Big Stone Lake will remain after it has traveled through the plant and been used for these purposes and discharged to the ash settling pond.

Attachments: Attach Form 2A if diversion from a well or dugout, or if storage of water, is proposed. Attach map. (See instructions concerning preparation.)

STATE OF MINNESOTA)
) ss.
County of Otter Tail)

I, H. R. Cowles* the applicant, certify that I have read the foregoing application and have examined the attached map and that the matters therein stated are true and that I intend, and am able to complete the necessary construction.

Signed H. R. Cowles

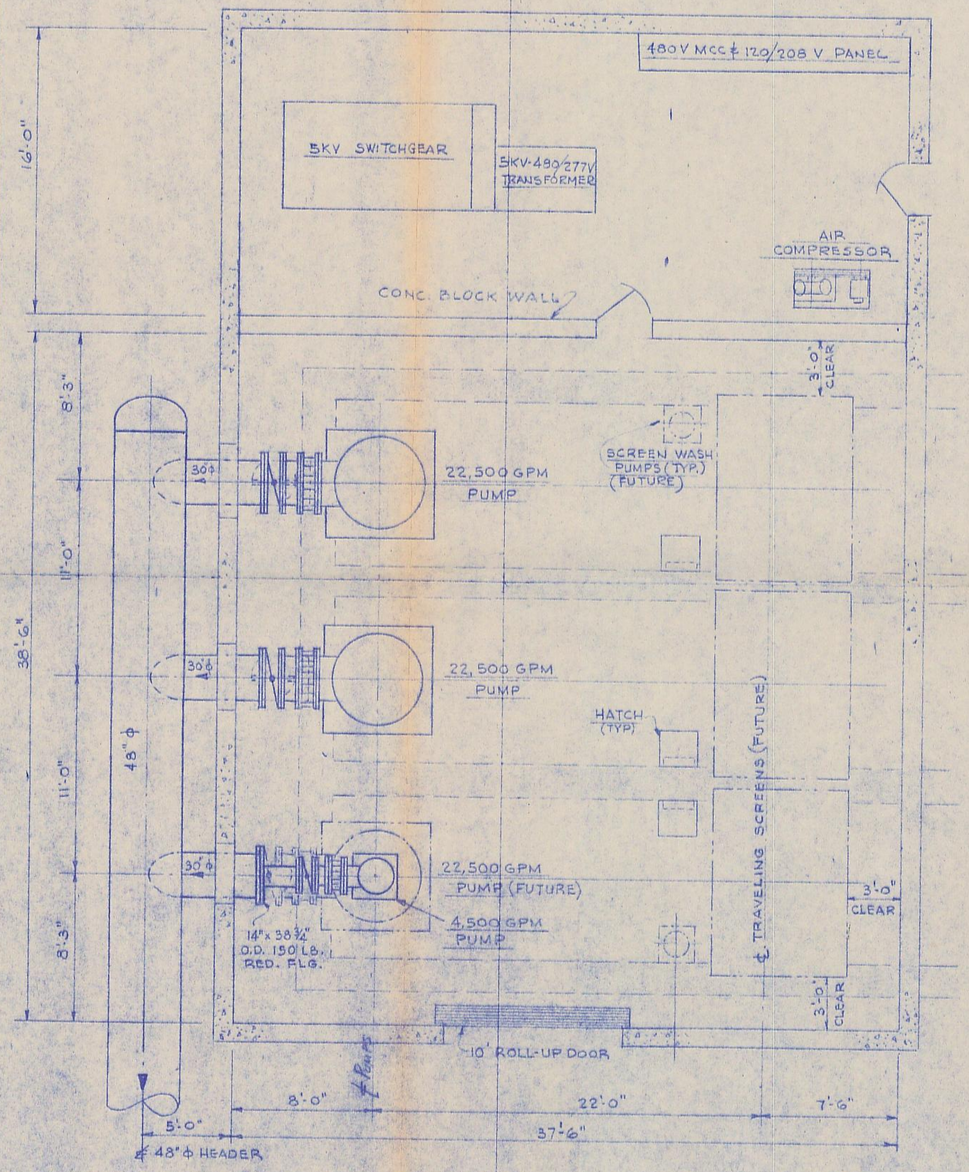
Subscribed and sworn to before me this 23rd day of July 19 70

H. A. Just
Notary Public (or other qualified officer)

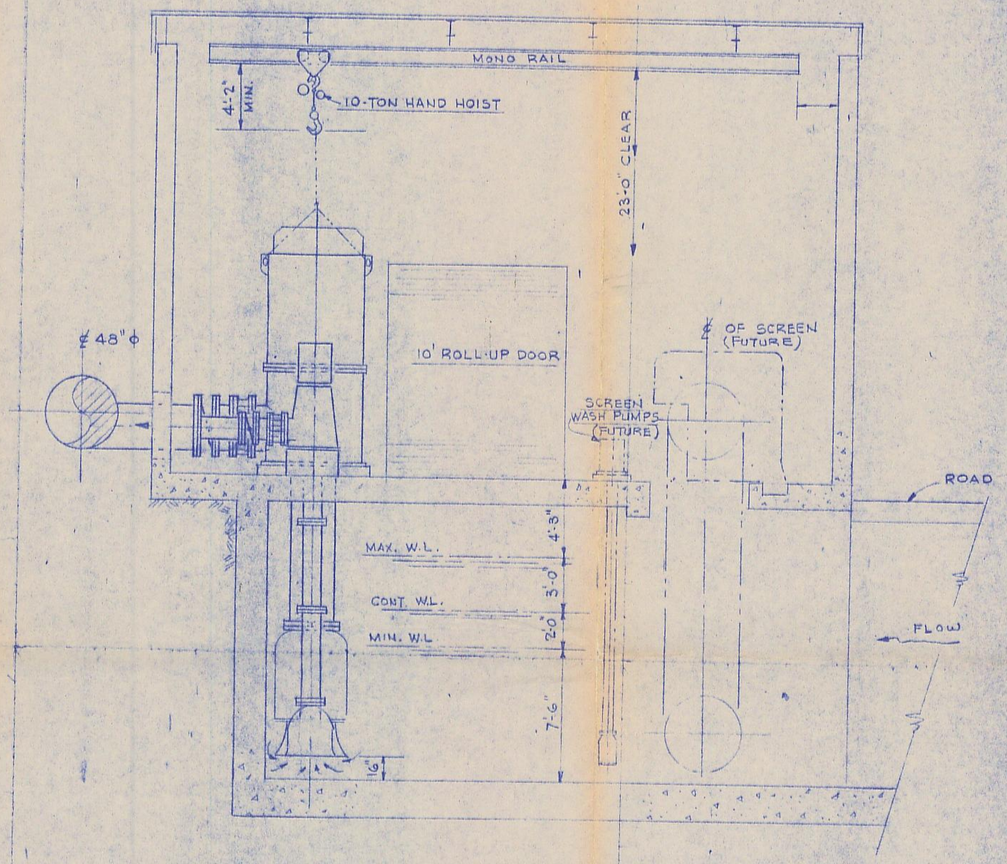
*Vice President of Otter Tail Power Company and duly authorized to sign on behalf of

H. A. JUST
Notary Public, OTTER TAIL CO., MINN.
My Commission Expires May 19, 1974

This drawing and the design it covers are the property of BECHTEL. They are merely loaned and on the borrower's express agreement that they will not be reproduced, copied, loaned, exhibited, or used except in the limited way and private use permitted by any written consent given by the lender to the borrower.



PLAN



ELEVATION

PRELIMINARY

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV.	ENGR	PROJ ENGR	APPR.
1	12/10/70	ISSUED FOR INFORMATION						

SCALE 1/4"=1'-0" DESIGNED GFB DRAWN CHIEF ENGR

BECHTEL
SAN FRANCISCO

NORTHWESTERN PUBLIC SERVICE COMPANY | OTTER TAIL POWER COMPANY | MONTANA-DAKOTA UTILITIES CO.

BIG STONE PLANT — UNIT 1

MAKE-UP INTAKE STRUCTURE STUDY ALT "B"

JOB No.	DRAWING No.	REV.
7581	SK-M-99	A

Drawing #3 Appl # 17-8-3

22 x 34 "D" SIZE

This drawing and the design it covers are the property of BECHTEL. They are merely loaned and on the borrower's express agreement that they will not be reproduced, copied, loaned, exhibited, or used except in the limited way and private use permitted by any written consent given by the lender to the borrower.

SCALING RULES

SIZE E

GASCOYNE 'KNIFE RIVER' COAL MINING CO.

GRID NORTH

KEY PLAN

SCALE IN MILES

PREVAILING WINTER WINDS

PREVALING SUMMER WINDS

NEW ROAD

PROPERTY LINE

EXISTING ROAD

B.M. ELEV. 1120.35
NE1/4 OF NE SEC. 11 - T 121 - R47
BRASS CAP IN CONCRETE LOCATED IN FIRST FARM YARD NO OF 1/8 LINE ROAD WEST OF ROAD & NE 100' FROM FARM HOUSE.
SOUTH DAKOTA GRID
COORD. N 557,410.99
E 2,896,445.56

NORTH PLANT GATE ENTRANCE (LOCKED)

WEATHER STATION

ROAD VACATED (TOWNSHIP ROAD)

COOLING POND
SEE DWG. C-1095

BLOWDOWN PUMP

ROAD VACATED (COUNTY ROAD)

WAREHOUSE

COAL STORAGE SHED

INDEXER

STACK

SERVICE BLDG.

DISCH. STRUCTURE

SEWAGE DISPOSAL PLANT

COAL STORAGE

ROTARY CAR DUMPER

UNIT NO 1

POND INTAKE STRUCTURE

FORMER WERNER PROPERTY LINE

SPILLWAY

POND CONTROL LEVEL 1121'

SWITCHYARD

GATE HOUSE

POND BOUNDARY

FUT. COAL AREA ACCESS ROADS

PLANT ACCESS RD. SEE DWG. C-1021 THRU C-1023.

FENCE SEE DWG C-1017

MAKE-UP PUMP

BOILER MAKE-UP POND H.W. EL. 1123.50

SECTION 12 T 121 N, R 41 W

SECTION 11

SECTION 13

SECTION 14

SECTION 7

SECTION 18

FUT. EVAPORATION POND No 1

See Unit one Map

DREDGING SPOIL DISPOSAL AREA

FUT. EVAPOR. POND No 2

MAKE-UP WATER LINE SEE DWG. C-1060

FUTURE EVAP. POND No 3

FUTURE EVAP. POND No 4

APPR. 30 YEAR CAPACITY ASH DISPOSAL AREA (TOP OF POND EL. 1100)

CEMETERY

Greenwood Cem

Big Stone Lake

BIG STONE PLANT

BIG STONE DAM

LAKE INTAKE STRUCTURE SEE DWG. C-1068

B.M. ELEV. 1091.82 - SE 1/4 - SEC 7 - T 121 - R 48
BRASS CAP IN CONCRETE LOCATED ON NORTH SIDE OF CEMETERY APPROX. 4' NO. OF 1/4 LINE FENCE & 30' WEST OF WEST HWY-ISY R/W LINE.
SOUTH DAKOTA GRID
COORD. N 555,925.56
E 2,907,049.48

S.D. STATE HIGHWAY ISY 200' RIGHT OF WAY

EXISTING TRAIL

TRAIL VACATED

R.R. UNDERPASS SEE DWG. C-1042.

NEW RAILROAD SEE DWGS. C-1040 THRU C-1055

B.M. ELEV. 1090.139
NW 1/4 OF NW 1/4 - SEC 13 - T. 121 - R 47
BRASS CAP IN CONCRETE LOCATED BETWEEN TWO ROWS OF B'TREES, APPROX. 150' EAST OF THE WEST SEC. LINE & 80' SOUTH OF THE NO. SEC. LINE.
SOUTH DAKOTA GRID
COORD. N 553,135.12
E 2,898,923.72

Whetstone River

LEVEL CROSSING

ROAD VACATED (COUNTY ROAD)

IMPROVED INTERSECTION

Big Stone City

CHICAGO MILWAUKEE ST. PAUL AND PACIFIC RAILROAD

B.M. ELEV. 1034.01 PAINTED X - TOP OF N.E. CONC. CORNER OF RR BRIDGE - WHETSTONE RIVER.
B.M. ELEV. 1034.24 - TOP OF NO. RAIL - EAST END OF RR BRIDGE.

LEGEND

- EXISTING STRUCTURES
- FENCE LINE
- PROPERTY LINE
- FUTURE EVAP. POND DIKES
- ASH DISPOSAL AREA DIKE
- ROAD
- RAILROAD

No.	DATE	REVISIONS	BY	CHKD	PROJ ENGR	ENGR	PROJ MGR	APVD
4	1/24/71	REV. SWITCHYARD, INDEXER, ROAD, ASH DISP. ADD. WERNER PROP. LINE	A. HANAN	BSS	TJS	RDO		
3	1/20/71	REV. PACKING & ENLARGE DISPOSAL PLANT	A. HANAN	BSS		RDO		
2	9/25/70	ESTABLISHED FENCE & PROPERTY LINES	RDO	TJS	RDO			
1	5/5/70	ISSUED FOR INFORMATION REVISED COAL AREA	A. HANAN	RC	RDO			
0	3/12/70	ISSUED FOR EARTHWORK BIDS & CLIENT APPROVAL	A. HANAN	DJ	RDO			
A	2/2/70	ISSUED FOR PLANT ROAD REVIEW ADDED KEY PLAN.	A. HANAN	BSS	RDO			
A	1/8/70	ISSUED FOR CLIENT MEETING.	A. HANAN	BSS				

SCALE 1" = 400' | DESIGNED R. OBENAUS | DRAWN A. HANAN | SPEC'N DWN

BECHTEL
SAN FRANCISCO

NORTHWESTERN PUBLIC SERVICE COMPANY | OTTER TAIL POWER COMPANY | MONTANA-DAKOTA UTILITIES CO.

BIG STONE PLANT — UNIT 1

SITE LAYOUT

JOB No.	DRAWING No.	REV.
7581	C - 1001	4

REGISTERED PROFESSIONAL ENGINEER REG. NO. 1896 BRONISLAW S. SHICKER SOUTH DAKOTA

B. S. Shicker

Dec # 1258-3 Apr # 1361-3

N

BIG STONE LAKE

USC.& G. SURVEY
AZIMUTH MARK ELEV. 990.058
AND

CHICAGO MILWAUKEE ST. PAUL PACIFIC RAILWAY

ELEVATION - 971.468 (TOP CONC. ABUT.)

SILT PILING

8	9	SECTION 9	TWP. 121 N.	RGE. 46 W.
17	16	SECTION 16	TWP. 121 N.	RGE 46 W.

GRANT COUNTY - SOUTH DAKOTA
LAC QUI PARLE COUNTY - MINNESOTA

RIVER LEVEL - 965.61

ELEVATION - 972.581 (CONC. WALK - TOP OF DAM)

MINNESOTA RIVER

RIVER LEVEL - 960.061

WHETSTONE RIVER

SURVEY : R. SCHAUFF — APRIL 27-28, 1970

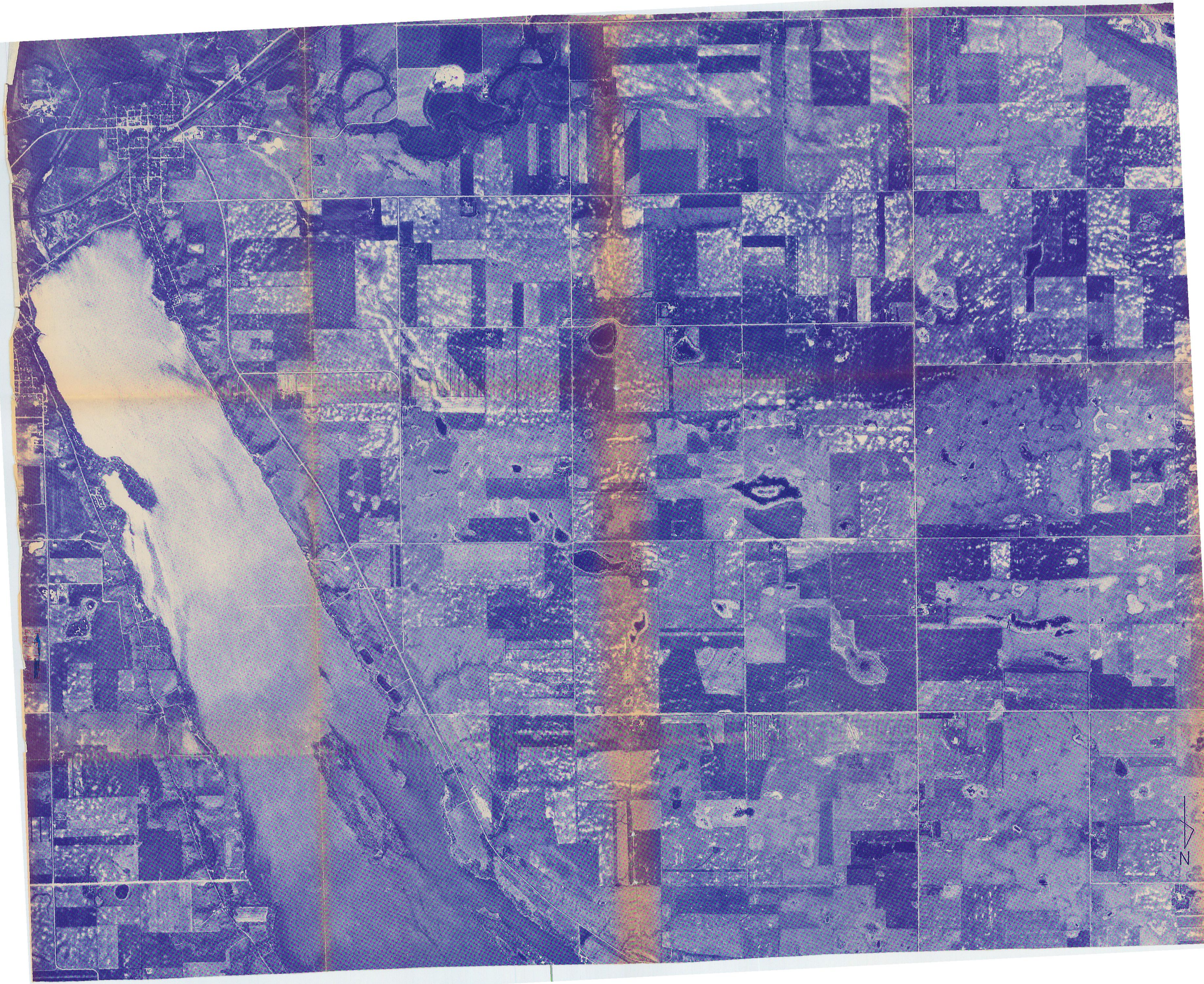
DATE	REVISION	BY

MINNESOTA FLOOD CONTROL DAM SURVEY
AT ORTONVILLE, MINNESOTA

OTTER TAIL POWER COMPANY
FERGUS FALLS, MINNESOTA

SCALE 1" = 100'	DATE: MAY 8, 1970	L-R/W-H-524-12
DR. V. EBBIGHAUSEN	APR. H Howlin.	

~~Appl # 1288-3~~ Appl # 1768-3


N

This drawing and the design it covers are the property of BECHTEL. They are merely loaned and on the borrower's express agreement that they will not be reproduced, copied, loaned, exhibited, or used except in the limited way and private use permitted by any written consent given by the lender to the borrower.

SIZE E

NOTES

1. TOPOGRAPHY BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS TAKEN IN NOVEMBER, 1969 BY MARK HURD AERIAL SURVEYS INC., MINNEAPOLIS, MINN.
2. ALL COORDINATES AND GRID LINES REFER TO THE SOUTH DAKOTA STATE GRID, NORTH ZONE.
3. ELEVATIONS ARE BASED ON MEAN SEA LEVEL.
4. FOR CONSTRUCTION DETAILS SEE DRAWINGS C-1096 THROUGH C-1098.
5. TYPE OF DIKE — STATION
   - POND AND BOILER MAKE-UP DIKE — STA. 100+00 TO STA. 259+86.50 and 300+00 TO STA. 325+33.15
   - BAFFLE DIKE — STA. 400+00 TO STA. 415+54.68
   - PARTITION DIKE — STA 500+00.14 TO STA. 512+88.51
   - BOILER MAKE-UP DIKE — STA. 116+34.69 TO STA. 134+68.59
   - PLUG — STA. 415+54.68 TO STA. 418+20.00

POINT OF INTERSECTION OF TANGENTS AND CURVE DATA ARE AS FOLLOWS:

P.I. OR PT.		COORDINATES NORTH	COORDINATES EAST	CURVE DATA AHEAD STATION P.C. STA.	P.T. STA.	R	Δ	T	L
A		555,210.13	2,898,692.33	252+96.38	253+06.45	40'	14°25'40"	5.06'	10.07'
B		553,590.00	2,901,795.00	SEE PLAN	SEE PLAN	550'	119°39'23"	946.07'	1148.61'
C		556,475.00	2,901,690.01	150+00.82	150+10.14	40'	13°21'20"	4.68'	9.32'
D		557,525.00	2,901,400.01	160+85.55	161+03.68	40'	25°58'31"	9.22'	18.13'
E		558,493.17	2,900,546.00	174+88.81	175+24.28	40'	51°46'39"	18.00'	35.47'
F		558,340.52	2,896,618.64	213+18.75	213+81.31	40'	84°36'23"	39.73'	62.56'
G		557,855.00	2,896,650.00	220+95.39	221+18.64	40'	33°17'54"	11.90'	23.25'
H		555,912.72	2,897,912.03	242+57.63	242+66.26	40'	12°04'56"	4.23'	8.43'
I		556,385.00	2,899,305.00	312+71.07	312+93.12	40'	63°10'24"	24.60'	22.05'
J		557,230.00	2,898,000.00						
K		555,905.00	2,900,475.00						
L		554,145.67	2,900,730.84						
M		554,939.11	2,901,745.90						
N		555,541.36	2,898,324.47						
P		557,060.00	2,897,740.00						
Q		557,702.08	2,898,657.58	—	—	600'	48°03'08"	267.48'	503.29'
R		555,700.00	2,900,625.00						

6. ALL EARTHWORK SHALL BE IN ACCORDANCE WITH SPEC. 7581-C-6.

REFERENCE DRAWINGS

DWG. NO.	TITLE
C-1096	COOLING POND - DIKE PROFILE
C-1097	COOLING POND - DIKE SECTIONS
C-1098	COOLING POND - REQUIRED EXCAVATION

0 200 400 600 800 FT.
SCALE

APPROVED FOR CONSTRUCTION

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV.	ENGR	PROJ ENGR	APPR
6	9/29/72	REVISED COFFERDAM AT INTAKE & DISCHARGE STRUCTURES	C.S.	DHC				
5	4/14/72	ADDED PLANT MAKE-UP PUMP STATION	DH	JS	DHC			
4	8/6/71	ADDED SECTION C-1082 P.I. Q & R	TPW	A	A			
3	7/16/71	REVISED COORD. FOR P.I.'S 'E', & 'F' REVISED STAS (BK) FOR P.I.'S E, F & G	TPW	A	DHC			
2	5/24/71	REVISED ALIGNMENT ISSUED FOR CONSTRUCTION	TPW	DHC	DHC			
1	3/12/71	ISSUED FOR BID	D.H.	SHS	DHC			

SCALE As Shown | DESIGNED S.H. | DRAWN D.H. | CHIEF ENGR DWH

BECHTEL
SAN FRANCISCO

NORTHWESTERN PUBLIC SERVICE COMPANY | OTTER TAIL POWER COMPANY | MONTANA-DAKOTA UTILITIES CO.

BIG STONE PLANT — UNIT 1

COOLING POND PLAN

JOB No.	DRAWING No.	REV.
7581	C-1095	5

REGISTERED PROFESSIONAL ENGINEER — REG. NO. 1896 — BRONISLAW S. SHICKER — SOUTH DAKOTA

Map # 1038-3 | Book # 1768-3

34 x 44 "E" SIZE

T. 121 R. 47

T. 121 R. 46

SEC. COR.

SEC. COR.

SEC. COR NE 1/4 SEC. 7 T. 121 N. R. 46 GRANT CO.

SECTION 11 T. 121 N. R. 47

BIG STONE LAKE

N

DISCHARGE

INTAKE

COOLING POND
APPROXIMATE 340 ACRES

TO ADDITIONAL WATER STORAGE

EVAPORATION PONDS
370 ACRE TOTAL

TOP OF DIKE ELEV. 1112'

(PIPELINE 7245' APPROXIMATE)

1320'

1320'

1440'

1/16

1165'

310'

PUMP STATION

POINT OF DIVERSION

54" PIPELINE (WATER)

5490'

54" PIPELINE (WATER)

FROM ASH SLUICE

POND 1

DIKE OR SHEET PILING

DEAD COAL

(SEE DIKE DETAL BELOW)

SECTION 12

SECTION 7

SECTION 8

POND 2

TOP OF DIKE ELEV. 1106'

PARK

DEAD COAL

POND 3

PLANT

1120 CONTOUR

TOP OF DIKE ELEV. 1122'

TOP OF DIKE ELEV. 1100'

SUBSTATION

POND 4

TOP OF DIKE ELEV. 1094'

ALL DETAILS SHOWN ARE ON PROPERTY OWNED BY PROJECT OWNERS.

ASH SLUICE POND NO.1

ASH SLUICE POND NO.2

DISCHARGE TO EVAPORATION POND

SEC. COR.

SEC. COR.

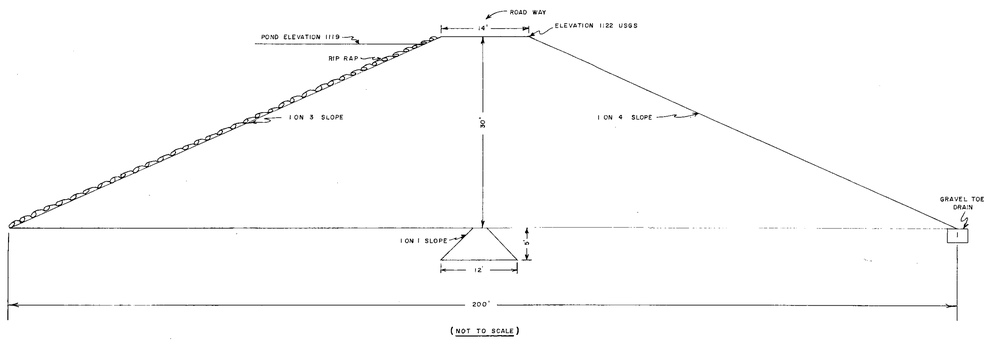
2640'

SEC. COR.

APPROXIMATE 3300' TO BIG STONE VILLAGE HALL

APPROXIMATE 4795' TO THE CENTER OF MILWAUKEE R.R.

CROSSECTION AT MAXIMUN WATER DEPTH



(NOT TO SCALE)

BIG STONE LAKE HAS THE FOLLOWING CHARACTERISTICS:

AREA - 12,356 ACRES (19.4 SQUARE MILES) AT A WATER SURFACE ELEVATION OF 956 PROJECT DATUM, OR 963.7 SEA LEVEL DATUM OF 1929.

MAXIMUM DEPTH - 16 feet

AVERAGE DEPTH - 11 feet

LENGTH - 24.6 miles

SHORELINE - 59.9 MILES (NOT INCLUDING 6.9 MILES OF SHORELINE OF ISLANDS).

NOTE: (ABOVE DATA OBTAINED FROM BIG STONE LAKE STUDY A JOINT MINNESOTA, SOUTH DAKOTA REPORT. NOV. 1, 1967)

State of Minnesota, } ss.
County of Otter Tail }

On this 22 day of JULY 1970. A. D., before me a Notary Public in and for said county personally appeared HENRY R. COWLES to me well known to be the person who executed the forgoing certificate and that he acknowledged that he executed the same as His free act and deed.

Subscribed and sworn before me:— H.R. Just
Notary Public

PREPARED FOR:

OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE COMPANY
MONTANA DAKOTA UTILITIES CO.

I hereby certify that this plan, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Henry R. Cowles

Date 7-22-70 Reg. No 1177

BIG STONE
T. 121 N. R. 46-47 W

LEGEND — DIKE
RAILROAD TRACKS

DATE	REVISION	BY

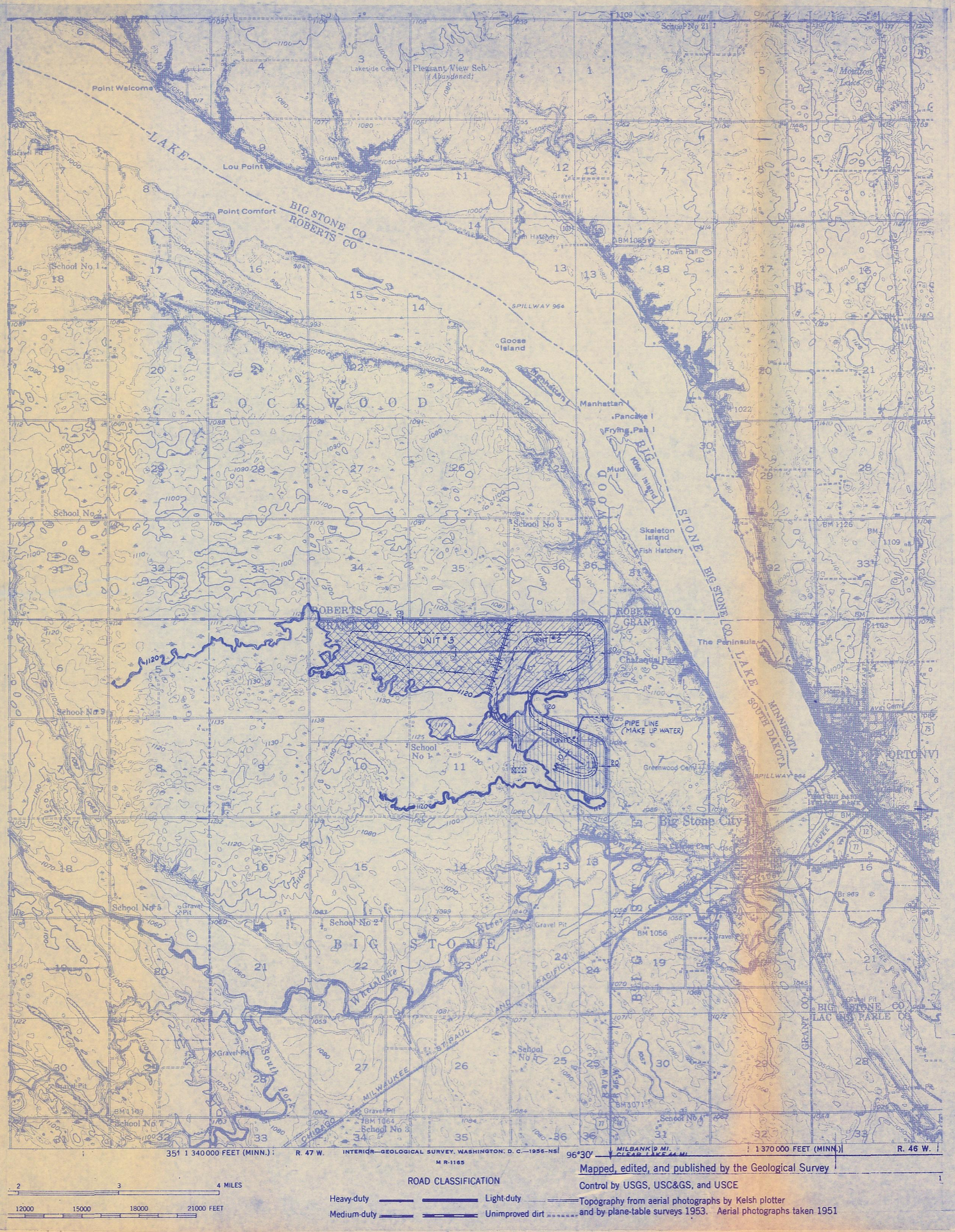
BIG STONE PLANT
SOUTH DAKOTA
OTTER TAIL POWER COMPANY
FERGUS FALLS, MINNESOTA

SCALE 1"= 400'	DATE 7-21-70	UNIT - 1
DR. R.L.S.	APP.	

Appl # 1768-3

SCALING RULES

SIZE E



Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and USCE

Topography from aerial photographs by Kelsh plotter and by plane-table surveys 1953. Aerial photographs taken 1951

1

LEGEND:

INDICATES WATER AREA AT EL. 1119.0 UNIT #1
UNIT #2
UNIT #3

POND DEVELOPMENT PROCEDURE:

FOR UNIT #1 BUILD EMBANKMENT SHOWN THUS

FOR UNIT #2 BUILD EMBANKMENT SHOWN THUS AND REMOVE PARTS OF EMBANKMENT FOR UNIT #1 SHOWN THUS ~~X X X~~

FOR UNIT #3 BUILD EMBANKMENT SHOWN THUS AND CUT THRU PARTS OF EMBANKMENT FOR UNIT #2 SHOWN THUS ~~X X X~~

No.	DATE	REVISIONS	BY	CHKD	DESIGN SUPV	ENGR	PROJ ENGR	APPR
1	7/6/70	ISSUED FOR INFORMATION (PRELIMINARY)	E.Mc					

SCALE AS NOTED | DESIGNED S. RUPIPER | DRAWN E.Mc | CHKD | SUPV CHKD

BECHTEL
SAN FRANCISCO

NORTHWESTERN PUBLIC SERVICE COMPANY | OTTER TAIL POWER COMPANY | MONTANA-DAKOTA UTILITIES CO.

BIG STONE PLANT — UNIT 1

TENTATIVE COOLING POND DEVELOPMENT

JOB No.	DRAWING No.	REV.
7581	SK-C-200	A

34 x 44 "E" SIZE

This drawing and the design it covers are the property of BECHTEL. They are merely loaned and on the borrower's express agreement that they will not be reproduced, copied, loaned, exhibited, or used except in the limited way and private use permitted by any written consent given by the lender to the borrower.

WATER RIGHT APPLICATION APPROVAL

The Water Resources Commission hereby approves Water Right Application No. 1768-3

NORTHWESTERN PUBLIC SERVICE CO., MONTANA-DAKOTA UTILITIES CO. & OTTER TAIL POWER CO. (Applicant) 215 S. CASCADE ST., FERGUS FALLS, (Post Office Address)

MINNESOTA (State) With the following modifications:

Unappropriated water exists in Big Stone Lake under two conditions; (1) when water is flowing through the lake (water is spilling over the outlet structures) and (2) when water levels in the lake are between project datum elevations 967 (ordinary high water mark) and 965 (ordinary low water mark) subject to statutory provisions (SDCL 46-29-12). The quantities of unappropriated water under these conditions are sufficient to satisfy Application for Permit to Appropriate Water No. 1768-3.

1. Diversion of water from the lake, not to exceed 100 cubic feet per second, may be made when the water surface elevation is at or above project datum elevation. 967.

See attachment for additional stipulations

Date of first receipt of application JULY 24 19 70

Date of return to applicant for correction, amendments or changes required ____ 19 ____

Date of receipt of corrected application ____ 19 ____

Approved SEPTEMBER 10 19 70, Recorded in Book 11 P. 134

WATER RIGHT PERMIT NO. FOR 1768-3

The Water Resources Commission hereby grants and issues this Water Right Permit No. 1768-3 authorizing the construction of the water use system and the putting of water to beneficial use as stated in the Application and as modified in the Water Right Application approval, subject, however, to the following limitations and conditions:

1. The date from which applicant may claim right is JULY 24 19 70

2. The equivalent of at least one-fifth of the work above specified is to be completed on or before MARCH 10 19 73

3. The whole of said work is to be completed on or before SEPTEMBER 10 19 75

4. The limit of time from proof of beneficial use of water appropriated in accordance herewith is SEPTEMBER 10 19 79

5. The water appropriated shall be used for the purpose of INDUSTRIAL USE (ELECTRIC POWER GENERATING PLANT)

6. The prior right of all persons who, by compliance with the laws of the State of South Dakota, have acquired a right to the use of water must not be injuriously affected by this appropriation.

7. The amount of the appropriation herein granted shall not exceed 7010 ACRE FEET ANNUALLY AT DIVERSION RATES AND STORAGE AS SPECIFIED ABOVE ~~cubic feet per second~~; neither shall it exceed the capacity of the above described water supply system, nor shall it exceed the amount of water needed for ~~beneficial use and for the aforesaid appropriation and diversion per acre per year and is limited to not more than ____ acre feet~~ USED IN THE POWER PLANT OPERATION actually and beneficially ~~applied for irrigation~~ on or before SEPTEMBER 10 19 79 said water to be used during the following described annual period AS SPECIFIED ABOVE

Witness my hand this 14TH day of SEPTEMBER 19 70

WATER RESOURCES COMMISSION

By _____

Chief Engineer, Executive Officer

Certificate of Construction Issued NOVEMBER 28 19 72

Water License Issued ____ 19 ____

Attachment

2. Diversion of water from the lake at a continuous rate of 10 cubic feet per second, or its daily acre feet equivalent, when lake surface levels are between project datum elevations 967 and 965 during the annual period October to April, inclusive.

3. Pursuant to statute, SDCL 46-29-12, water may not be diverted from the lake when lake levels are at or below project datum elevation 967 during the annual period May to September, inclusive, without permission of the South Dakota-Minnesota Boundary Waters Commission.

4. This permit includes 7000 acre feet of off-stream storage of water for cooling pond and reserve water supply purposes.

Form 2A - Wells, Dugouts or Water Storage Dams (Supplement to form 2)

12. Principal Features of the Proposed Water Supply System (continued.)

D. Well Information or Estimates

(1) Drill Hole, Diameter _____ Depth _____

(2) Casing, Type _____ (wood, concrete, steel, etc) Diameter _____ Thickness _____

(3) Perforated Screen.

Type _____, Diameter _____, Length _____

(4) Gravel Pack. Thickness _____, Length of gravel pack _____

E. Dugout Information or Estimates.

(1) Surface dimensions _____, Depth _____

F. Fill out for Either a Well or a Dugout.

(1) Water Bearing Materials. (Please attach a copy to test well log if available.)

Character of Water bearing materials _____

Depth to top of water bearing material _____

Depth to bottom of water bearing material _____

Thickness of water bearing material _____

Depth to water (ground surface to water level) _____

(2) Distance to nearest existing household or livestock watering wells.

On same owner's property _____ rds. On property owned by others _____ rds.

G. Water Storage Dams.

If the proposed water use system contains one or more water storage dams, please show in the space below, the height, maximum water depth, surface area and storage capacity of each storage dam. The location of each water storage dam should be shown on the water right map.

	HEIGHT*	WATER DEPTH	APPROXIMATE SURFACE AREA ACRES	APPROXIMATE STORAGE ACRE FT.
Cooling Pond	1122 USGS	29' Max. 10' Avg.	340	3,000
Evaporation Pond				
No. 1	1112	10' Max.	180	1,800
No. 2	1106	10' Max.	70	700
No. 3	1100	10' Max.	90	900
No. 4	1094	10' Max.	30	300
Ash Storage Ponds				
No. 1	1100	5' Approx.	8	40
No. 2	1100	5' Approx.	9	45
Water Storage Pond (Under Consideration)				
	1122	10' Avg.	500	5,000

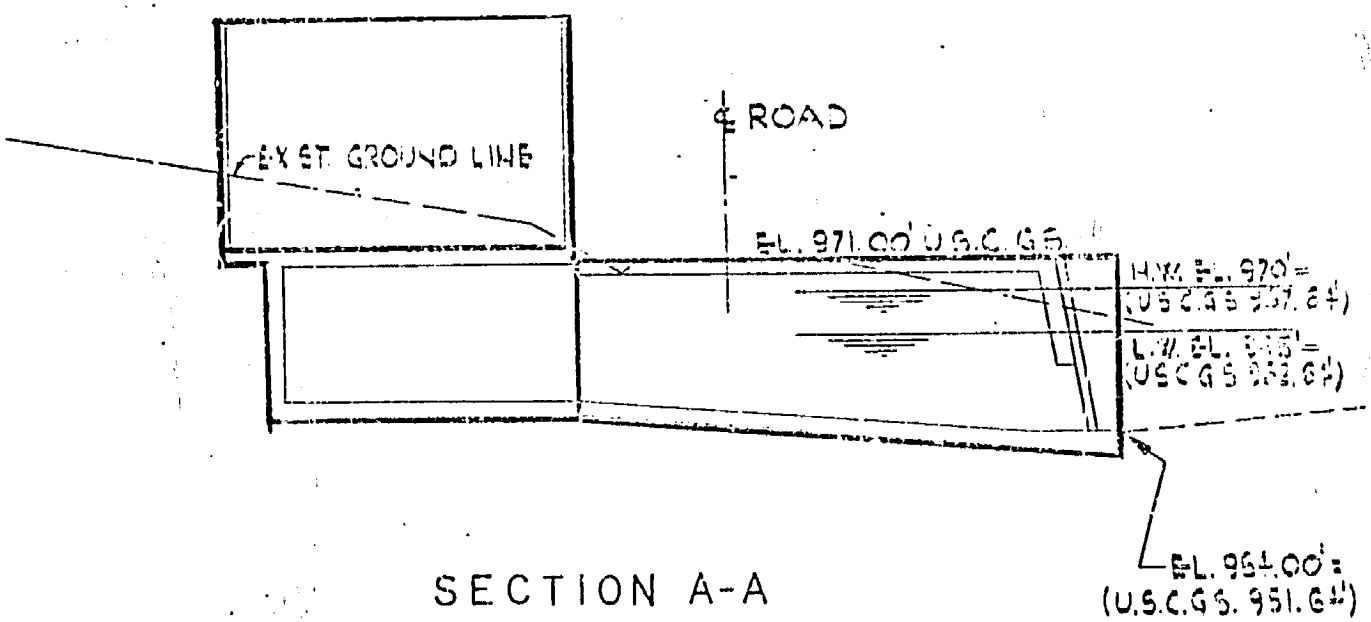
*Dike level planned 3 ft. above pond level.

Pond locations (except storage) shown on water rights map.

Signature of Applicant

Vice President of Otter Tail Power Company and duly authorized to sign of behalf of Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company

NOTE: APPROX. 7,500 CU. YDS OF DREDGING WILL BE REQUIRED. DREDGED MATERIAL WILL BE DISPOSED INLAND ON O.T.P. CO. PROPERTY.



SECTION A-A

PROPOSED PUMP STATION AND DREDGING

IN: BIG STONE LAKE
AT: BIG STONE CITY
COUNTY OF: GRANT, SOUTH DAKOTA

APPLICATION BY: OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE CO.
MONTANA-DAKOTA UTILITIES CO.

Form 15.

Permit No. 1768-3

Water Diversion No. 3 WHETSTONE CREEK Water District

CERTIFICATE OF CONSTRUCTION

This is to Certify, That Northwestern Public Service Co., Montana-Dakota Utilities Co., and Otter Tail Power Co.

the holder ___ of Permit No. 1768-3, issued upon Application No. 1768-3, bearing date of priority of July 24, 1970 authorizing the diversion of 100* cu. ft. per second of the waters of Big Stone Lake County of Grant, State of South Dakota at a point 1220 feet South and 1640 ft. East of the NW Corner, Section 8, T121N, R46W

, for storage of 5,000 acre feet annually for use in Power Generation

purposes, ha. ve complied with the provisions of the laws of the State of South Dakota relating to proof of completion of the works of diversion set out and described in said Permit; that said works are found in satisfactory condition for diverting and conveying to the place of intended use 100 cu. ft. per second of water.

Date November 28, 1972

WATER RESOURCES COMMISSION

By:

J.V. GRIFFS, Executive Officer

* Under conditions specified in Water Permit No. 1768-3, diversions between 10 and 100 c.f.s. are authorized.

Form 12.

Permit No. 1768-3

Water Division 3 WHETSTONE CREEK Water District

REPORT OF EXAMINATION OF WORKS
AND/OR APPLICATION OF WATER TO BENEFICIAL USE

TO: Water Resources Commission, State Office Building No. 2, Pierre, South Dakota 57501

I have this day made a thorough examination of the water use system constructed by Montana-Dakota Utilities Co. of Bismarck,N.D.,Otter Tail Power Co.,of Fergus Falls,Minn. & Northwestern Public Service Co, of Huron,S.D. of _____ holder

of Permit No. 1768-3, bearing date of priority of July 24, 19 70

authorizing the diversion of 10 to 100 cu. ft. per second of the waters of Big Stone Lake

for Industrial purposes purposes, in Grant County.

I have to report on the condition of the same as follows:

The Water Use System consists of,

A. Works used to divert the water:

Pumping house containing six water inlet cells, 8' wide x 12+' deep.Two "Peerless" centrifugal pumps (50 c.f.s. rated capacity) each powered by a "Westinghouse" 1500 HP electric motor and one "Peerless" centrifugal pump. (10 c.f.s. rated capacity) and powered by "Westinghouse" 450 HP electric motor.

B. Works used to transport water to place of use,

48 inch diameter concrete pipe with steel liner. Approximately 7650 feet from pump house to discharge structure in boiler make up pond and 200 feet discharge structure to outlet in cooling pond.

C. Works used to store water.--Boiler make up pond (approximately 9 acres surface area) Total pond area approximately 360 acres. Maximum storage capacity of pond is 5000 acre feet. There is about 16000 lineal feet of border dikes and 4100 lineal feet of baffle dikes. Dry side slopes are 2½ to 1. Wet side slopes are 3 to 1. The width of the top of the dikes is 18 ft. The dikes contain 1,087,085 cu.yds.of fill and 70,782 cu.yds of granite rip-rap. Rip-rap consists of about 1 ft. thick crushed granite rock.

The system is in the following condition: Excellent

The point of diversion is located 1320 ft. South and 1440 ft. East of the NW Corner of Section 8, T121N, R46W

The works are capable of diverting and conveying to the place of use 100 cu. ft. per second of water which is to be used for Industrial purposes

Water has been put to beneficial use to the maximum extent as follows: There has been no beneficial use of water. This inspection was made so that a "Certificate of Construction" can be issued for the completed water diversion and storage system.

comprising a total of _____ acres of land.

See drawing No. C-1001 for locations covered in this report.

Date November 7, 1972

Donald Driscoll
(Signature)

DONALD DRISCOLL, Deputy Chief Engineer, W.R.C.

Form 6 - Notice of Intent to Appropriate Water

1768-3

Publish first publication, on or before August 13, 1970

NOTICE
INTENT TO APPROPRIATE WATER

Pierre, South Dakota 57501

July 28, 1970

Notice is hereby given that Otter Tail Power Company Northwestern Public Service Co., Montana-Dakota Utilities C

whose post office address is Fergus Falls, Minnesota, South Dakota, has made an application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use 7000 acre feet annually, at a maximum diversion rate of 100 cubic feet of water per second of time from the Big Stone Lake through the Big Stone Plant, the point of diversion of which is to be located in the

NE¼ NW¼

of Section 8, Twp. 121N, Range 46W. Said water to be used for the purpose of providing irrigation on the following described land:

for industrial use as cooling water in operation of electric generating plant.

This application No. 1768-3 will be considered by the Water Resources Commission at their office at Pierre upon the 9th day of September, 1970, at XXX 2:00 P.M. All interested persons may appear and be heard.

WATER RESOURCES COMMISSION

By:

BURTON F. JONES, Water Rights Specialist

cc: Mr. H.R. Cowles, Vice President
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minn, 56537

Form 8 - Proof of Publication - Notice of Intent to Appropriate Water

No. 1768-3

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA)
) ss.
County Grant)

I, Clarence Justice hereby certify that the annexed printed copy of Notice of Intent to Appropriate Water was taken from the Grant County Review

A newspaper which during the whole time of publication of said notice herein after stated, has been and is printed and published in the Grant County Review at Milbank

County of Grant and State of South Dakota; that the said notice was published in said newspaper on the following four dates:

August 12, 1970

August 19, 1970

August 26, 1970

September 2, 1970

Clarence Justice
(Signature)

Foreman
(Title)

September 2, 1970
(Date Signed)

NOTICE INTENT TO APPROPRIATE WATER

Pierre, South Dakota 57501
July 28, 1970

Notice is hereby given that Northwestern Public Service Co., Montana-Dakota Utilities Co., Otter Tail Power Company whose post office address is Fergus Falls, Minnesota has made an application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use 7000 acre feet annually, at a maximum diversion rate of 100 cubic feet of water per second of time from Big Stone Lake through the Big Stone Plant, the point of diversion of which is to be located in the NE 1/4 NW 1/4 of Section 8, Twp. 121N, Range 46W. Said water to be used for the purpose of providing irrigation on the following described land: for industrial use as cooling water in operation of electric generating plant.

This application No. 1768-3 will be considered by the Water Resources Commission at their office at Pierre upon the 9th day of September, 1970, at 2:00 p. m. All interested persons may appear and be heard.

Water Resources Commission
By: Burton F. Jones,
Water Rights Specialist

Aug. 12 Sept. 2

RECEIVED
SEP 3 1970
STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

Form 8 - Proof of Publication - Notice of Intent to Appropriate Water

No. _____

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA)
) ss.
County of Grant)

I, Lawrence P. Anderson hereby certify that the annexed printed copy of Notice of Intent to Appropriate Water was taken from the Milbank Herald Advance

A newspaper which during the whole time of publication of said notice herein after stated, has been and is printed and published in the City of Milbank County of Grant and State of South Dakota, that the said notice was published in said newspaper on the following four dates:

August 6, 1970

August 13, 1970

August 20, 1970

August 27, 1970

Lawrence P. Anderson
(Signature)

Business Manager
(Title)

August 28, 1970
(Date Signed)

JOANNE ANDERSEN
Notary Public, Grant County, S. Dak.
My Commission Expires October 5, 1972

NOTICE INTENT TO APPROPRIATE WATER

Pierre, South Dakota 57501
July 28, 1970

Notice is hereby given that Otter Tail Power Company, Northwestern Public Service Co., Montana-Dakota Utilities Co., whose post office address is Fergus Falls, Minnesota, has made an application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use 7000 acre feet annually at a maximum diversion rate of 100 cubic feet of water per second of time from Big Stone Lake through the Big Stone Plant Cooling Diversion of which is to be located in the NE¼ NW¼ Section 8, Twp. 121N, Range 48W. Said water to be used for the purpose of providing irrigation or the following described canal for industrial use as cooling water in operation of electric generating plant.

This application No. 2768-2 will be considered by the Water Resources Commission at their office at Pierre, upon the 9th day of September, 1970, at 2:00 P.M. All interested persons may appear and be heard.

WATER RESOURCES COMMISSION
By: Burton F. Jones,
Water Rights Specialist.
Aug. 6, 13, 20 & 27, 1970

RECEIVED
AUG 28 1970
STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

G. W. Grimes

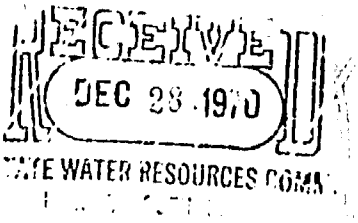
215 South Cascade Street

Otter Tail
POWER COMPANY

Fergus Falls, Minnesota 56537

COPY

December 18, 1970



Col. Charles I. McGinnis
District Engineer, St. Paul District
Corps of Engineers, Department of the Army
1210 U.S. Post Office and Custom House
St. Paul, Minnesota 55101

In re: Application for Permit for Work in Navigable Waters
Big Stone Plant--Big Stone Lake

Dear Col. McGinnis:

I request a permit for the construction of an intake structure to be built as shown on the attached plans along the South Dakota shore of Big Stone Lake in Big Stone City, Big Stone Township, Grant County, South Dakota. This request is made by me as Project Manager for three companies, Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company, who have jointly proposed to build a 400 megawatt lignite-fired generating plant in Big Stone Township, Grant County, South Dakota, to be known as the Big Stone Plant. The three companies own the land along the lake where the intake structure is proposed. A portion of the proposed intake structure will be constructed across right of way granted to Big Stone City, South Dakota, for a roadway or street 40 feet in width along the East or water front of Government Lot One (1), Section Eight (8), Township One Hundred Twenty-one (121) North, Range Forty-six (46) West. Enclosed is a copy of a resolution adopted by the governing body of Big Stone City authorizing the issuance to Minnesota-Dakota Generating Company, or its assigns, of a permit or easement for the construction and maintenance of the intake structure crossing under such street or roadway. Minnesota-Dakota Generating Company is a wholly owned subsidiary of Otter Tail Power Company. The adjacent property owners along the lakeshore are as follows:

Big Stone Camp of the South Dakota Conference of United Methodist Church, Inc.
Milbank, South Dakota
(formerly Dakota Conference of Evangelical United Brethren)

John M. and Clara Oyan
Colman, South Dakota

C. John and Elizabeth Forge
Big Stone City, South Dakota

William T. and Grace Voeltz
Big Stone City, South Dakota

Paul and Mabel Stoltz
Big Stone City, South Dakota

David W. and Charles Austin and Marie Haugen
Sioux Falls, South Dakota

Elizabeth H. Forge and Martha P. Witt
Big Stone City, South Dakota

Otter Tail
POWER COMPANY

The adjacent properties and their respective owners are shown on the enclosed map.

Construction of the intake structure will require some dredging or removal of material from the lake bed. I estimate that removal of about 7,500 cubic yards of material will be required. It will be disposed of on the companies' inland property, as stated on the enclosed plan.

This letter is furnished in duplicate with all attached papers furnished in quadruplicate.

Sincerely yours,

H. R. COWLES, Vice President of Otter Tail Power Company and duly authorized to sign on behalf of Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company.

HRC:ndg

Enclosures

Application for Permit to Appropriate Water
Within the State of South Dakota

Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company, Applicants

---

APPENDIX

The applicant companies seek a water rights permit to appropriate 7,000 acre feet annually from Big Stone Lake for beneficial use in the 400 megawatt lignite fired electric generating plant which they jointly propose. General information on the proposed Big Stone Plant is summarized in the attached Exhibit A.

The available data for Big Stone Lake and the surrounding area support and form the basis for the request for water rights. The availability of the unappropriated water for which this application is made is shown by the following:

Exhibit B to this Appendix contains a summary of the available records and data for the Minnesota River at Ortonville, Minnesota, and shows, for the period February 1938 to September 1968:

"Average discharge.--30 years, 111 cfs (80,360 acre feet per year)."

Exhibit C to this Appendix shows average monthly and annual flows of the Minnesota River at Ortonville, Minnesota in cfs. It was compiled by the Bechtel Corporation from daily records of the United States Geological Survey at the gage on the Minnesota River 1300 feet downstream from the outlet of Big Stone Lake. It

also includes a duration curve at the same location. This compilation shows an average discharge for the 28 year period, February 1938 to September 1966, of 116 cfs.

As shown by Exhibits B and C, the average discharges from Big Stone Lake down the Minnesota River are in the 111 to 116 cfs range.

Big Stone Lake has the following characteristics:[1]

AREA - 12,356 acres (19.4 square miles) at a water surface elevation of 966 project datum, or 963.7 sea level datum of 1929.

MAXIMUM DEPTH - 16 feet

AVERAGE DEPTH - 11 feet

LENGTH - 24.6 miles

SHORELINE - 59.9 miles (not including 6.9 miles of shoreline of islands)

Estimates of the area which drains into Big Stone Lake vary from 1130[2] to 1160[3] square miles. The drainage area includes about 586,880 acres (917 square miles) in Roberts, Grant and Marshall Counties of South Dakota, and about 136,300 acres (213 square miles) in Big Stone and Traverse Counties, Minnesota.

The South Dakota drainage area has its highest elevation in the Sisseton Hills at about 2,000 feet above sea level. Within a short distance, the elevation decreases to about 1,200 feet in the region near Veblen, Claire City, and Wilmot. About 64 percent of the drainage area in South Dakota is agricultural cropland, 30 percent is agricultural grasslands or woodland, and 6 percent consists of roads, urban developments, and other non-agricultural land and water.

---

(1) All footnotes are on page 11.

The Minnesota drainage area is bounded by a glacial ridge (moraine) which varies in elevation from about 1,150 - 1,190 feet above sea level. Most of the area has an elevation of from 1,100 - 1,125 feet above sea level. A few miles from Big Stone Lake the elevation drops about 100 - 150 feet to the level of the lake. About 90 percent of the area is in farmlands and 10 percent consists of roads, urban developments, and non-agricultural lands.

The two principal tributaries of the lake are the Little Minnesota River (which enters the northerly end of the lake) and the Whetstone River (which formerly was a tributary of the Minnesota River below Big Stone Lake but in 1937 was diverted into the southerly end of the lake). Data for the flows in these tributaries is available from the gage on the Little Minnesota River near Peever, South Dakota, for the period October 1939 to September 1968, and from a gage on the Whetstone River near Big Stone City, South Dakota, for the period March 1931 to September 1968. The average discharges for the periods are

Little Minnesota River, near Peever, South Dakota

29 years - 45.8 cfs (33,160 acre feet per year).(4)

Whetstone River, near Big Stone City, South Dakota

37 years (1931-68) - 44.3 cfs (32,070 acre feet per year).(5)

The drainage areas of these two tributaries and the ungaged remainder of Big Stone Lake are reported to be approximately as follows:

	Corps of Engineers Report (Pages 16 and 20)	Big Stone Lake Study (Page 13)
Little Minnesota River	452	447 square miles
Whetstone River	395	389 " "
Ungaged remainder	313	313 " "
Total drainage area	1160	1149 " "

Annual precipitation averages 20 - 24 inches in the area. It has ranged from a low of about 11.5 to a high of about 39 inches. Rainfall during the growing season, April through September, averages 16 - 18 inches.

The available data for points in the surrounding areas indicates that average annual evaporation from the surface of the lake is approximately 33 inches.

A dam, with stop log controls, was completed and put into operation at the outlet of Big Stone Lake in 1937. As a part of the dam project the Whetstone River was diverted into the lake. Control of the stop logs has varied from time to time. In 1958 a silt barrier at approximately 966 project datum (963.7 sea level datum of 1929) was placed in the outlet channel above the dam and between the Whetstone River and the lake. The historical level of the lake has varied during that time, as follows:

Date	Rank	Historical Lake Level Project Datum
June 1942	Maximum	971.2
March 1943	2nd highest	971.1
November 1940	Minimum	962.2*
February 1948	2nd lowest	964.6
October 1959	2nd lowest	964.6

*Believed incorrect reading resulting from ice jam upstream.

The lake level has fluctuated at least 6.6 feet from 964.2 feet to 971.2 feet.

In 1962, Congress authorized a project proposed by the Corps of Engineers, U. S. Army, for Big Stone Lake and the Whetstone River. The project involves raising the silt barrier at the outlet of Big Stone Lake approximately one foot to 967 project datum (964.7 sea level datum of 1929) and includes modifications in the Ortonville dam on the Minnesota River.

The proposal of Bechtel Corporation, consulting engineer for the applicant companies, is to further modify the Corps of Engineers proposal to incorporate motor operated slide gates in lieu of the manually operated stop logs proposed by the Corps of Engineers. The applicant companies also propose to offer to furnish supervision and operation of the control gates in accordance with operating procedures to be established by the responsible governmental regulatory bodies.

The operating plan proposed by the companies' consulting engineer would keep the control gates in the dam (at 967 feet project datum) until there was at least one foot of water flowing over the top of the gates; when this point is reached, the gates would be removed until the water level was reduced to 967.4 feet project datum and at that point the gates again would be lowered in place in the dam.

Representatives of the Corps of Engineers have indicated that there is no incompatibility between this proposal and their Corps of Engineers project and implementation of this proposal will not compromise the Corps of Engineers project purposes.

A historic reservoir operation study was made by Bechtel Corporation for this proposed mode of operation which included the diversion of 10 cfs continuously for plant use. The study showed that of the 145 month-end lake levels for the months of May through September, in the 29 year period, 1940 - 1968, only six month-end lake levels would have been more than one foot higher or lower than 967.0 feet project datum. Of these 139 months, 57 were within 0.2 feet of this level. The highest of the six month-ends exceeding one foot from this level was 969.1 and the lowest 965.9. No two of these months occurred in the same year.

From this study, Bechtel Corporation concluded that, based on the historical data, the diversion of 10 cfs continuously for plant requirements could have been and can be obtained from Big Stone Lake without additional storage in the lake.

The Corps of Engineers furnished daily (or smaller incremental) hydrographs for the ten floods used in their studies and also rating curves for the dam and silt barrier, a capacity curve for Big Stone Lake, and sample copies of their computations. These data were used by Bechtel Corporation to route four of these floods through Big Stone Lake using the currently proposed plan, with the gates at 967.0 feet project datum. The Corps indicated that, for their purposes, it would not be necessary to study all ten floods, but that only the floods of 1947, 1950, 1951 and 1952 need be routed. These floods are the highest (1952), the third highest (1947), and the two lowest (1950 and 1951). The 1950 flood was chosen because it had an unusually large volume of runoff, despite a relatively low peak discharge.

The results of routing these floods are shown below. The maximum stages in Big Stone Lake are the same as for the Corps project in 1947 and 1950 and are 0.2 and 0.4 feet higher for 1951 and 1952 respectively. The peak discharges down the Minnesota River range from 10 cfs to 290 cfs higher than those of the Corps.

Date of Flood	Maximum Elevation of Big Stone Lake (project datum)			Maximum Discharge, Minnesota River at Ortonville (cfs)		
	Present Conditions*	Corps of Engineers Project*	Companies' Proposal	Present Conditions*	Corps of Engineers Project*	Companies' Proposal
April 1947	970.6	970.1	970.1	1,840	2,950	2,960
March-May 1950	968.0	968.2	968.2	750	1,690	1,810
April 1951	968.0	968.4	968.6	770	1,790	2,080
April 1952	972.8	972.0	972.4	3,060	4,110	4,350

*Corps of Engineers Report, Table A-5

Under the companies' proposal, maximum flood levels in Big Stone Lake would be a few tenths of a foot higher than levels expected with the Corps of Engineers flood control plan. Peak discharges down the Minnesota River would be increased slightly, but not significantly.

The three companies have purchased approximately 2,800 acres. This property is shown on Exhibit D to this Appendix. The so-called working segments of the 400 MW plant require about 600 acres. The remaining 2,200 acres will be used for waste water disposal, control of environmental aspects, and potential water resource arrangements.

Preliminary soil borings have been made in Section 12 and the general site area. Bechtel Corporation concluded in its April, 1970, Report entitled "Engineering Report Prepared for Governmental Regulatory Agencies of South Dakota" that the in situ soil appears to have characteristics amenable to construction of cooling or ash ponds. The ponds should not require linings, and they can probably be constructed of this soil. Further detailed investigation may reveal that local conditions require special treatment, such as seepage control.

Samples of the site core borings and their characteristics were discussed with South Dakota State Geological representatives and they have indicated that there is mutual agreement on the site geological information available at this time.

Final engineering plans for the plant are still under study. Certain features of plant design will be influenced by the precise nature of the water rights which are acquired for the project. Some of the alternate water processes under consideration are shown on the attached Exhibit E.

Plan "A," shown on Exhibit E, assumes the use of a cooling pond with a storage capacity of 3,000 acre feet and a reserve water storage pond having an additional capacity of 3,000 acre feet.

The plant will require approximately 7,000 acre feet annually (10 cfs continuously) at maximum load utilizing a pond for cooling. Evaporation from a cooling pond having a surface area of approximately 340 acres will meet plant requirements.

Plan "A" also assumes that no waste water will be discharged back to the Whetstone River or Big Stone Lake.

Waste water will amount to approximately 1,400 acre feet annually (2 cfs continuously) at maximum plant loading. It will be treated and stabilized, and is expected to contain essentially the same dissolved solids that were in the 10 cfs (7,000 acre feet annually) originally withdrawn from the lake. This water can be evaporated from a waste water pond or may be available for irrigation, or if desired by appropriate governmental regulatory bodies, could be discharged to the lake or river.

Plan "B" is the same as Plan "A" except it recognizes the potential of returning acceptable quality water to either Big Stone Lake or the Whetstone River and shows discharge lines to both.

Plan "C" shows an alternative cooling method, using cooling towers in lieu of a cooling pond. While not shown in Plan "C," use of cooling towers may also be made in conjunction with a reserve water storage pond such as is shown in Plan "A."

Plan "C," as shown on Exhibit E, shows an alternative pipeline diameter of 24 inches (in lieu of the 54" diameter of Plans "A" and "B") and a pumping rate of

10 cfs. This pumping rate of 10 cfs is the minimum pumping rate, on a continuous basis, that will meet plant requirements. If withdrawal of water from the lake is to be other than continuous at 10 cfs, higher pumping rates (up to 100 cfs), increased pipeline diameter (up to 54 inches) and water storage ponds will be necessary to supply water requirements for the plant.

Plan "C" further shows another alternative, raising the level of Big Stone Lake one foot to elevation 968 project datum. The companies believe this alternative would have beneficial effects for all concerned. It would require action by the legislatures of both South Dakota and Minnesota, the modification of the outlet control structures (silt barrier and/or dam), and might require acquisition of flowage easements around the lake. This alternacive is also compatible with the Corps of Engineers Big Stone Lake - Whetstone River Project and affords potential additional flood control of 12,000 acre feet.

Waste water disposal under Plan "C" of 1,400 acre feet annually (2 cfs continuously) can be made through the same three alternatives as shown for Plan "A" and "B," viz:

(1) evaporated through waste water evaporation ponds

(2) available for irrigation

(3) discharged to the Whetstone River, or to Big Stone Lake or both

The cooling pond shown in Plan "A" would be formed by utilizing the existing land contours and diking to an elevation of 1122 USGS datum. The lowest point in the cooling pond area is 1090 and the head on the dike for a distance of 400 feet will be 29 feet. This dike would be 200 feet wide at the base, 14 feet wide at the top and 30 feet high. A core wall 12 feet wide and 5 feet deep will be built

below the center of the dike. The water side of the dike will have a 1 on 3 riprapped slope and the dry side will have a 1 on 4 slope. Toe drains are also part of the dike design. The applicants own all of the land between the pond and the Whetstone River. Runoff from the surrounding area has been reviewed. The layout and construction of the dikes will eliminate pond flooding by runoff and therefore no spillways are required.

Two ash settling basins each having a surface area of 9 and 8 acres respectively are now planned. The location of these basins are shown on the water rights map. Water storage will be minimum because the waste water will be pumped to the waste water evaporation pond location in Section 7.

The four waste water evaporation ponds will have a total surface area of 370 acres and be located in Section 7 as outlined on the water rights map. After the plant is in operation, tests may show that after proper settling and treatment, most of the plant waste water will be of satisfactory quality for returning to the lake or the Whetstone River. The maximum water depth in the waste water evaporation ponds will not exceed 10 feet and will average approximately 3 feet.

FOOTNOTES

(1) "Big Stone Lake Study," A Joint Report by Minnesota and South Dakota, dated November 1, 1967, at page 2. See also Report, Corps of Engineers, U. S. Army, dated May 18, 1962 - 87th Congress, 2nd Session, House Document No. 579, at pages 16, 18 and 20.

(2) "Big Stone Lake Study," at page 2.

(3) Corps of Engineers Report, at page 20.

(4) Water Resources Data for Minnesota 1968, U. S. Dept. of Interior - Geological Survey - Water Resources, page 122.

(5) Water Resources Data for Minnesota 1968, page 123.

REFERENCES

(1) "Big Stone Lake Study," a Joint Report by Minnesota and South Dakota, dated November 1, 1967.

(2) Report, Corps of Engineers, U. S. Army, dated May 18, 1962 - 87th Congress, 2nd Session, House Document No. 579.

(3) Water Resources Data for Minnesota 1968, U. S. Dept. of Interior - Geological Survey - Water Resources.

(4) "Power Station Site Investigation," Bechtel Corporation, November, 1968.

(5) "Power Plant Study - South Dakota Site," Bechtel Corporation, August, 1969.

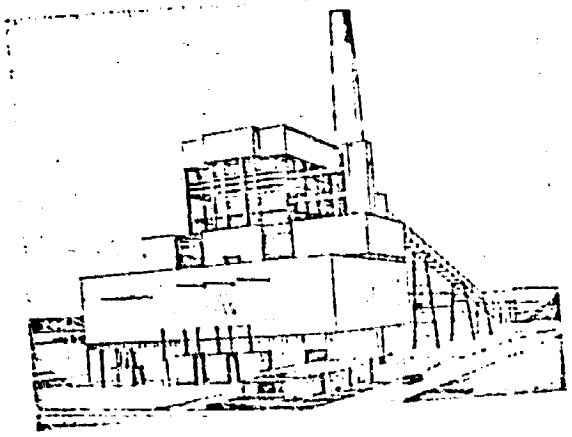
(6) "Big Stone Lake Plant - South Dakota - Engineering Report Prepared for Governmental Regulatory Agencies of South Dakota," Bechtel Corporation, April, 1970.

(7) "Big Stone Lake Plant - South Dakota - Proposed Water Supply," Bechtel Corporation, June, 1970; "Supplement No. 1," July, 1970.

(8) U. S. Geological Survey, Water Resources Division
Gage records for
Little Minnesota River near Peever, South Dakota
Whetstone River near Big Stone City, South Dakota
Minnesota River near Ortonville, Minnesota
Big Stone Lake near Ortonville, Minnesota

(9) U. S. Department of Commerce, Environmental Science Services Administration, Climatological Data
Precipitation Records for Beardsley, Minnesota

(10) Evaporation data for Aberdeen, Redfield, Watertown and Brookings, South Dakota



Artist's conception of new $100 million South Dakota power plant.

BIG STONE PLANT

GRANT COUNTY SOUTH DAKOTA

JOINTLY OWNED BY——

MONTANA DAKOTA UTILITIES
NORTHWESTERN PUBLIC SERVICE
OTTER TAIL POWER COMPANY

Pamphlet #1 - May 12, 1970

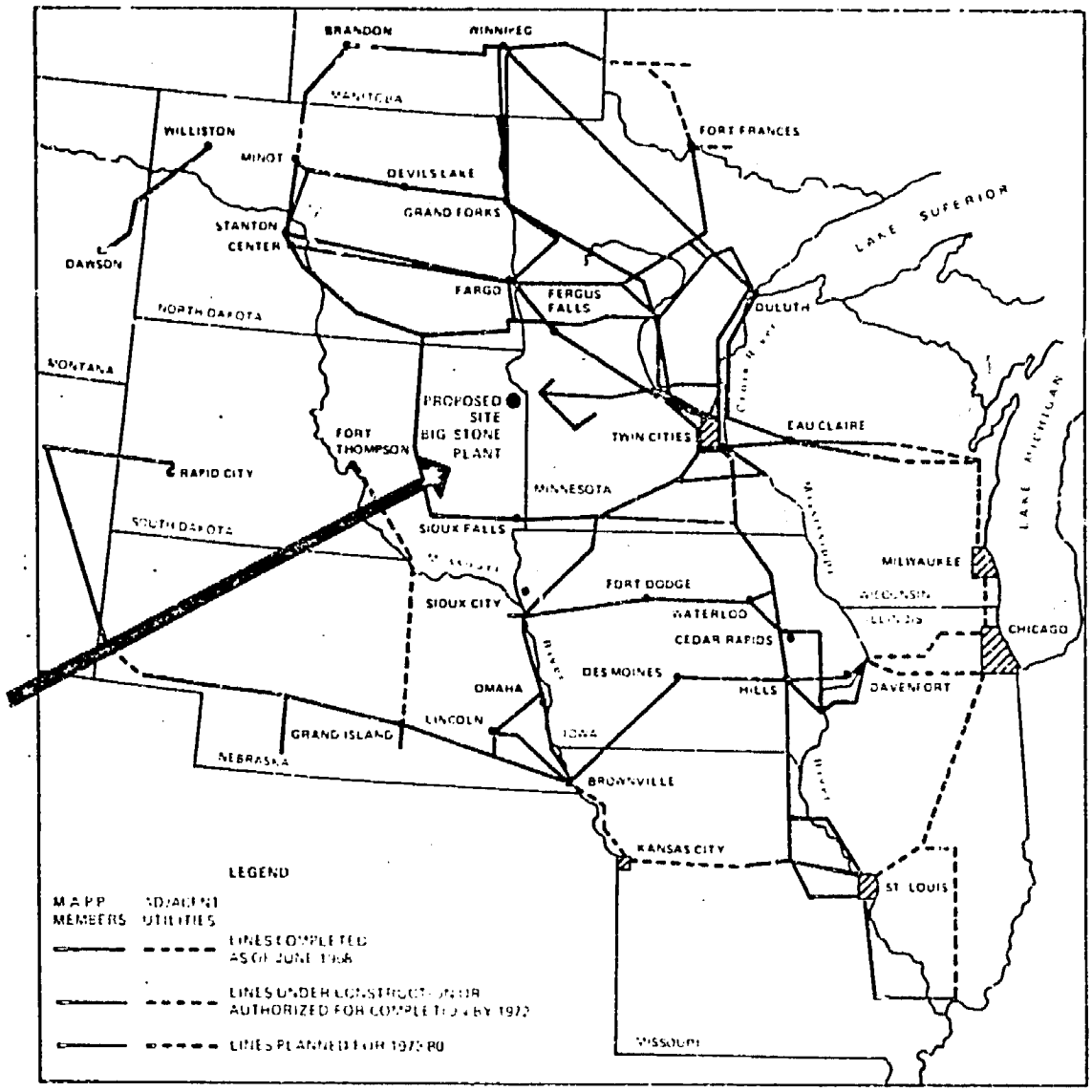
Northwestern Public Service Company, Montana-Dakota Utilities Co. and Otter Tail Power Company, after two years of study, made the decision in late 1969 to jointly own and operate a 400-megawatt North Dakota lignite-fueled electric power generating plant. (400-megawatt is equal to 400,000 kilowatts)

The plant size, timing and location was coordinated with the long-range planning of the Upper Mississippi Valley Power Pool (UMVPP) and the Mid-Continent Area Power Planners (MAPP). The scheduled operational date of May, 1975, is actually dictated by the UMVPP members' requirements.

The owners' load schedule would not require plant operation until November, 1975. The sale of surplus capacity to the UMVPP, starting May 1, 1975, was one part of the project feasibility study. The MAPP transmission network layout (right) illustrates the plant's strategic location for system reliability.

The site was selected on March 13, 1970, and the land has now been acquired. The exact location of the plant in Section 12, rail sidings and such will be determined through further engineering studies and regulatory requirements. Work has already started on soils exploration; an aerial survey; mapping; investigation of local meteorology, hydrology and geology; a fuel survey; analysis of transportation requirements; and the all-important social and economic aspects of modern public demands.

Plant design and equipment procurement have been going forward since



October, 1969. Construction will start early in 1972, with commercial operation scheduled for May 1, 1975.

A peak work force of approximately 500 will be needed to meet the construction schedule. The permanent operational staff of 50 will consist mainly of technical and professional personnel.

The Bechtel Corporation of San Francisco has been retained to engineer, construct and be the purchasing agent for the project.

The Otter Tail Power Company was selected by the presidents of the three companies to be the project manager. The project is under the control of three committees functioning under the respective titles of Coordinating, Engineering and Operating, and Auditing.

The energy conversion system will convert over 2-1/4 million tons of lignite to electricity each year. We expect that one 100-car unit trainload of lignite will be required five times per week.

The plant will be an extension of the present "good neighbor policy" of the three owning companies. It will be designed so that all regulatory requirements relating to the environment are met or exceeded. In addition, environmental enhancement features will be built in to the limits of technology available, even though legal restrictions may not yet be fully developed at that time.

In other words, the owning companies intend to "go beyond the law" in being a good neighbor.

The purchase of sufficient land to provide a large "buffer zone" is an example. No neighbor is closer than 1/2 mile to the plant itself. Another example will be the ultimate use of that buffer land for public benefits.

A cooling pond will be used so that the lake will not receive any warm water. We will burn lignite, a very low-sulphur (1/2 to 3/4 percent) fuel. Sulphur oxides are considered to be one of the more serious air pollutants. Bituminous coals commonly have 3 to 5 percent sulphur.

But lignite does have a drawback that is not "bad," per se, but it is misunderstood. It is a high moisture fuel, as high as 40 percent by weight. Within the emission control system it is handled as an invisible gas (steam). But when the moisture strikes the outside atmosphere, it condenses, forming a cloud instantly. In the winter, the reaction of warm, moist air mixing with cold, dry air will result in a long white plume.

Northwestern Public Service Company, Montana-Dakota Utilities Co. and Otter Tail Power Company are not unfamiliar with all of the characteristics of the Dakota lignites. The best knowledge and experience of the three companies is being pooled together with that of the Bechtel Corporation to assure a completed project compatible with modern dictates.

START OF CONSTRUCTION	Spring, 1972
APPROXIMATE COST	$100 Million
COMPLETION	May, 1975
EMPLOYEES	50
SITE ACREAGE	2,800 Acres
ENGINEERS - CONSTRUCTORS	Bechtel Corp. San Francisco

EXHIBIT B

5-2920. Minnesota River at Ortonville, Minn.

Location.--Lat 45°17'44", long 96°26'38", in NW¼NW¼ sec.16, T.121 N., R.49 W., on left bank 400 ft downstream from bridge on U.S. Highway 12 and 1,300 ft downstream from dam at outlet of Big Stone Lake, at Ortonville.

Drainage area.--1,160 sq mi, approximately.

Records available.--February 1938 to September 1968

Gage.- Water-stage recorder. Datum of gage is 956.18 ft above mean sea level, datum of 1929. Prior to Mar. 31, 1939, staff gage on downstream side of dam 1,300 ft upstream at datum 1.31 ft higher.

Average discharge.--30 years, 111 cfs (80,360 acre-ft per year).

Extremes.--Maximum discharge during year, 248 cfs Apr. 23 (gage height, 4.64 ft); minimum, 1.2 cfs Sept. 27 (gage height, 1.14 ft).
1938-68: Maximum discharge, 3,060 cfs Apr. 11, 1952 (gage height, 12.97 ft); no flow Dec. 13, 1940.

Remarks.--Records fair. Flow affected by natural storage in Big Stone Lake (see preceding page). Records of chemical analyses for the water year 1968 are published in Part 2 of this report.

DISCHARGE, IN CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1967 TO SEPTEMBER 1968

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	13	4.6	5.5	3.3	3.0	3.4	11	.2	35	42	27	14
2	15	4.6	5.5	3.2	3.0	3.6	8.8	13	28	26	26	13
3	13	4.5	5.6	3.2	3.0	3.8	15	20	27	25	27	14
4	13	4.2	5.6	3.1	3.0	4.0	28	15	25	25	26	14
5	12	4.4	5.5	3.1	3.0	4.2	9.4	12	23	25	26	13
6	10	4.5	5.5	3.0	3.0	4.6	11	11	23	25	25	13
7	12	4.3	5.5	3.0	3.0	4.7	18	14	23	25	25	13
8	11	5.2	5.3	3.0	3.0	4.9	25	25	25	27	24	20
9	10	4.9	5.5	3.0	3.0	5.1	14	20	23	25	23	19
10	9.1	5.1	5.5	3.0	3.0	5.2	12	17	23	24	23	12
11	8.5	6.1	5.5	3.0	3.0	5.2	12	19	31	23	22	9.9
12	8.4	5.7	5.5	3.0	3.0	5.1	17	19	28	22	23	7.7
13	8.4	5.4	5.5	3.0	3.0	5.1	14	21	26	22	24	8.4
14	7.4	5.4	5.4	3.0	3.0	5.6	15	33	27	22	21	6.4
15	7.6	5.4	5.3	3.0	3.0	5.7	13	39	21	22	21	5.5
16	7.6	5.8	5.0	3.0	3.0	6.1	15	47	23	23	24	5.4
17	6.2	5.5	5.0	3.0	3.0	6.5	15	31	23	25	26	5.4
18	6.6	4.7	5.1	3.0	3.0	7.0	13	47	23	24	22	7.0
19	6.4	4.3	5.1	3.0	3.0	7.6	11	49	22	25	23	5.1
20	7.5	4.4	5.0	3.0	3.0	8.5	16	31	22	23	18	4.9
21	5.6	5.4	4.7	3.0	3.0	9.1	16	30	27	22	18	3.5
22	5.4	5.1	4.5	3.0	3.0	9.8	31	29	21	23	19	4.3
23	6.3	5.1	4.2	3.0	3.0	10	92	30	22	25	18	4.4
24	7.8	5.2	4.2	3.0	3.0	11	22	30	21	25	25	5.6
25	6.0	5.2	4.2	3.0	3.1	10	13	31	22	25	14	5.4
26	5.0	5.4	4.0	3.0	3.2	10	13	32	22	28	12	2.2
27	5.2	5.5	3.8	3.0	3.2	11	14	34	22	27	12	3.1
28	3.8	5.5	3.6	3.0	3.2	11	14	35	21	25	12	5.9
29	4.5	5.5	3.6	3.0	3.3	11	14	32	25	24	12	5.8
30	4.4	5.5	3.6	3.0	------	13	13	31	22	25	13	5.3
31	4.4	------	3.4	3.0	------	19	------	30	------	27	14	------
TOTAL	255.0	153.4	151.5	93.9	89.0	230.8	539.2	855	732	786	648	253.1
MEAN	8.23	5.11	4.89	3.03	3.07	7.45	18.0	27.7	24.4	25.4	20.9	8.44
MAX	15	6.5	5.6	3.3	3.3	19	92	69	35	42	27	20
MIN	3.8	4.2	3.4	3.0	3.0	3.4	8.8	11	21	22	12	2.2
AC-FT	506	304	301	186	177	458	1,070	1,700	1,450	1,560	1,290	502

CAL YR 1967 TOTAL 26,352.9 MEAN 73.7 MAX 639 MIN 3.4 AC-FT 53,240
WTR YR 1968 TOTAL 4,783.9 MEAN 13.1 MAX 92 MIN 2.2 AC-FT 9,500

Source:

Water Resources Data for Minnesota, 1968,
U. S. Dept. of Interior - Geological Survey - Water Resources, page 123

EXHIBIT B

Table 1

AVERAGE MONTHLY AND ANNUAL FLOW OF MINNESOTA RIVER AT ORTONVILLE (CFS)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1938	-	0.71	129	55.6	83.5	67.9	25.5	39.6	9.44	0.2	0.2	0.2	-
1939	0.2	0.2	78.6	159	90.4	44.5	33.5	9.12	2.22	1.55	1.52	0.46	35.9
1965	0.17	0.16	6.98	119	172	32.4	23.3	4.67	4.95	5.04	2.64	0.94	39.1
1941	11.9	1.92	1.14	1.27	0.91	5.33	33.7	22.2	14.7	6.73	10.9	6.1	11.4
1942	46.7	26.9	33.1	5.75	376	720	363	192	253	183	166	156	212
1943	164	153	209	1058	435	655	445	160	82.3	23.6	9.38	19.0	328
1944	29.0	134	183	238	462	419	188	68.3	25.3	7.48	23.9	57.7	156
1945	58.9	43.5	273	229	338	439	295	43.0	23.6	8.24	3.93	3.48	173
1946	0.47	0.58	135	605	127	64.2	136	109	61.6	12.9	7.04	5.87	140
1947	8.92	13.2	144	1033	737	402	147	35.2	2.66	2.52	83.9	92.5	223
1948	72.8	65.0	239	650	324	62.3	45.9	29.5	10.6	9.24	15.6	23.7	132
1949	71.2	107	154	168	44.1	22.4	8.56	7.02	5.87	4.38	2.87	3.31	49.3
1950	0.36	0.76	55.7	535	387	96.7	8.54	3.72	0.81	1.43	5.47	0.76	76.4
1951	0.69	2.30	22.7	612	269	131	82.0	31.4	34.8	10.4	4.92	23.9	109
1952	34.6	46.2	148	2215	561	212	77.3	33.7	5.67	5.46	2.82	1.44	298
1953	2.38	2.52	96.4	240	258	192	179	143	25.4	3.46	2.92	1.01	68.2
1954	8.48	27.8	122	145	133	454	125	31.1	24.5	23.3	47.0	4.36	97.0
1955	6.65	6.14	53.2	152	33.6	15.1	5.25	2.79	2.93	2.23	1.44	0.44	26.3
1956	0.45	0.45	12.5	96.3	31.1	51.0	31.7	37.5	24.6	14.2	6.54	3.12	31.9
1957	4.50	4.61	20.8	178	312	549	178	132	179	149	160	109	158
1958	56.5	35.0	139	479	208	99.0	24.4	6.43	4.01	5.05	10.6	2.44	65.5
1959	2.63	1.51	35.3	23.8	14.0	5.83	2.08	0.25	0.67	2.14	3.26	5.17	7.97
1960	4.77	3.26	34.5	251	173	91.4	62.4	24.4	32.2	9.52	33.1	13.3	62.4
1961	10.3	8.33	17.0	32.5	19.6	43.5	14.3	12.0	8.42	3.75	1.75	1.15	12.4
1962	8.82	1.69	48.3	374	693	1334	915	409	150	95.8	46.5	29.5	349
1963	17.1	14.2	75.5	113	62.7	49.2	62.2	112	91.0	50.4	32.9	24.1	69.7
1964	18.2	19.0	36.5	131	126	53.2	31.5	10.2	11.1	1.77	1.16	0.83	36.5
1965	0.70	0.51	1.77	472	438	638	160	32.7	40.6	35.3	26.7	33.8	158
1966	45.4	38.0	413	533	239	61.3	33.6	20.3	16.2				

Average discharge, 28 years, 116 cfs

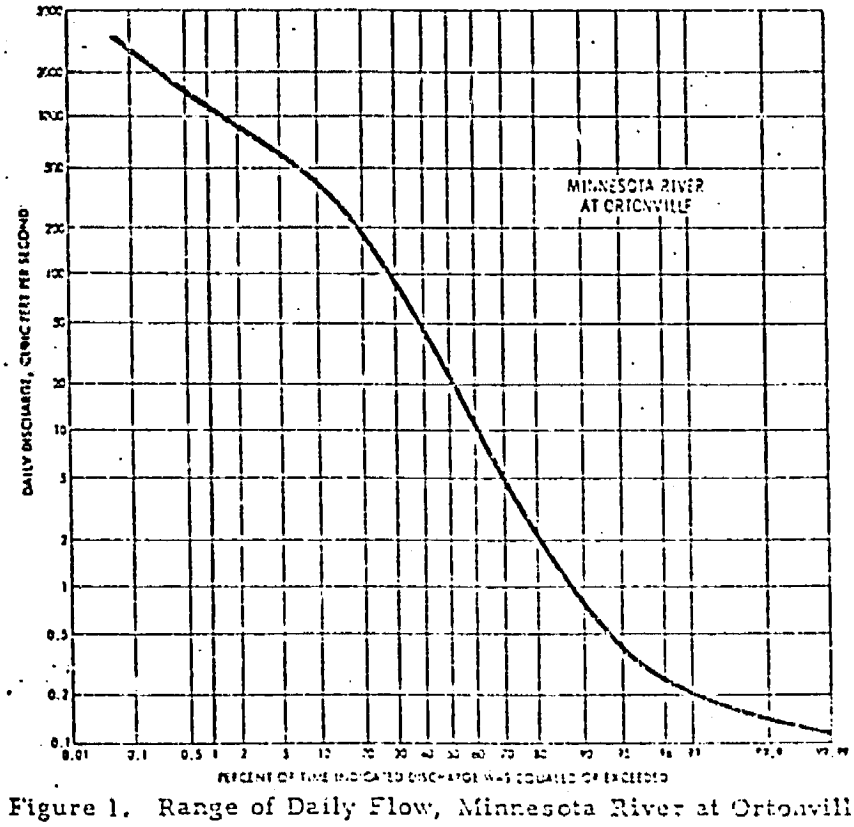


Figure 1. Range of Daily Flow, Minnesota River at Ortonville (1938 - 1966)

SOURCE:

Bechtel November 1968 Report—
"Power Station Site Investigation"

BIG STONE

TOWNSHIP 121 N. RANGE 46 & 47 W.

EXHIBIT D

ROBERTS

CODE LETTER - A

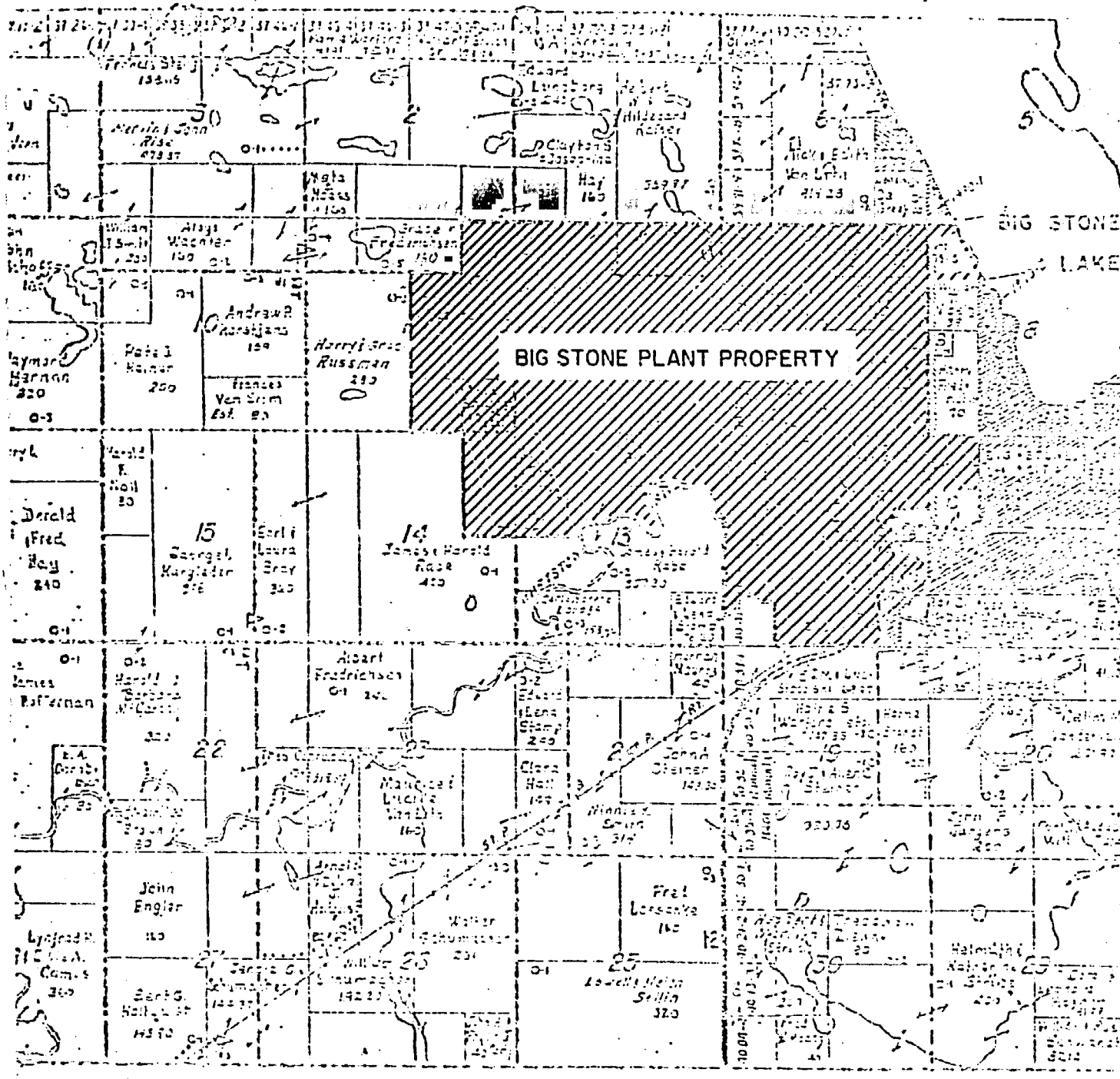
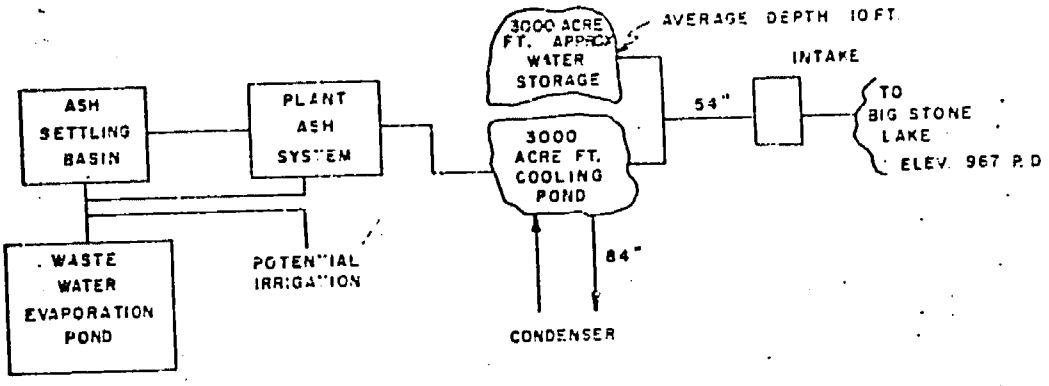


EXHIBIT D

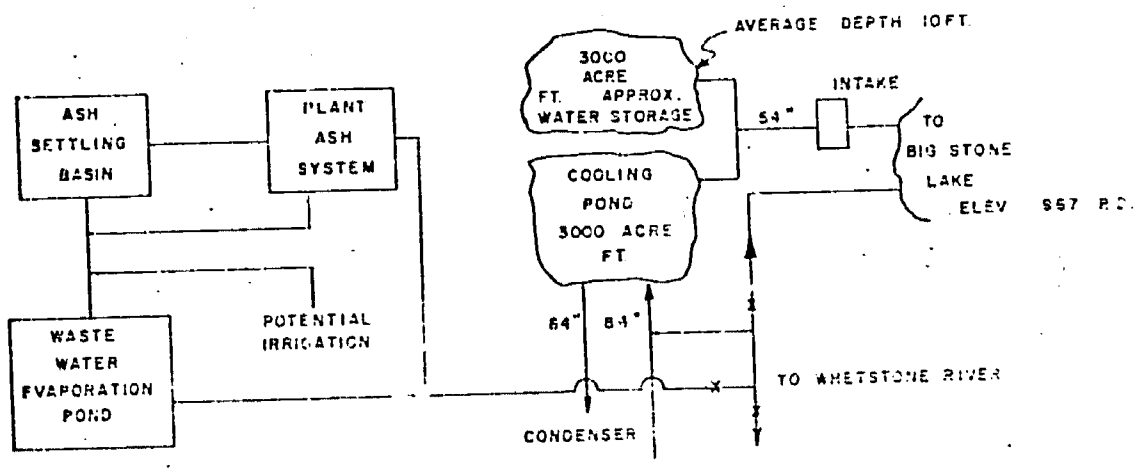
EXHIBIT E

BIG STONE PLANT
BLOCK DIAGRAM OF WATER PROCESSES UNDER CONSIDERATION

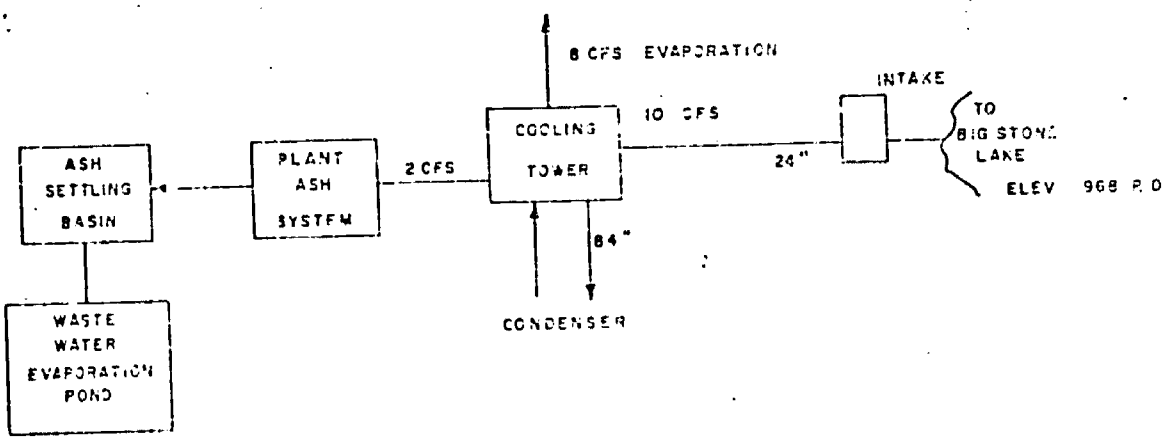
PLAN "A"



PLAN "B"



PLAN "C"



BIG STONE CITY, SOUTH DAKOTA

RESOLUTION

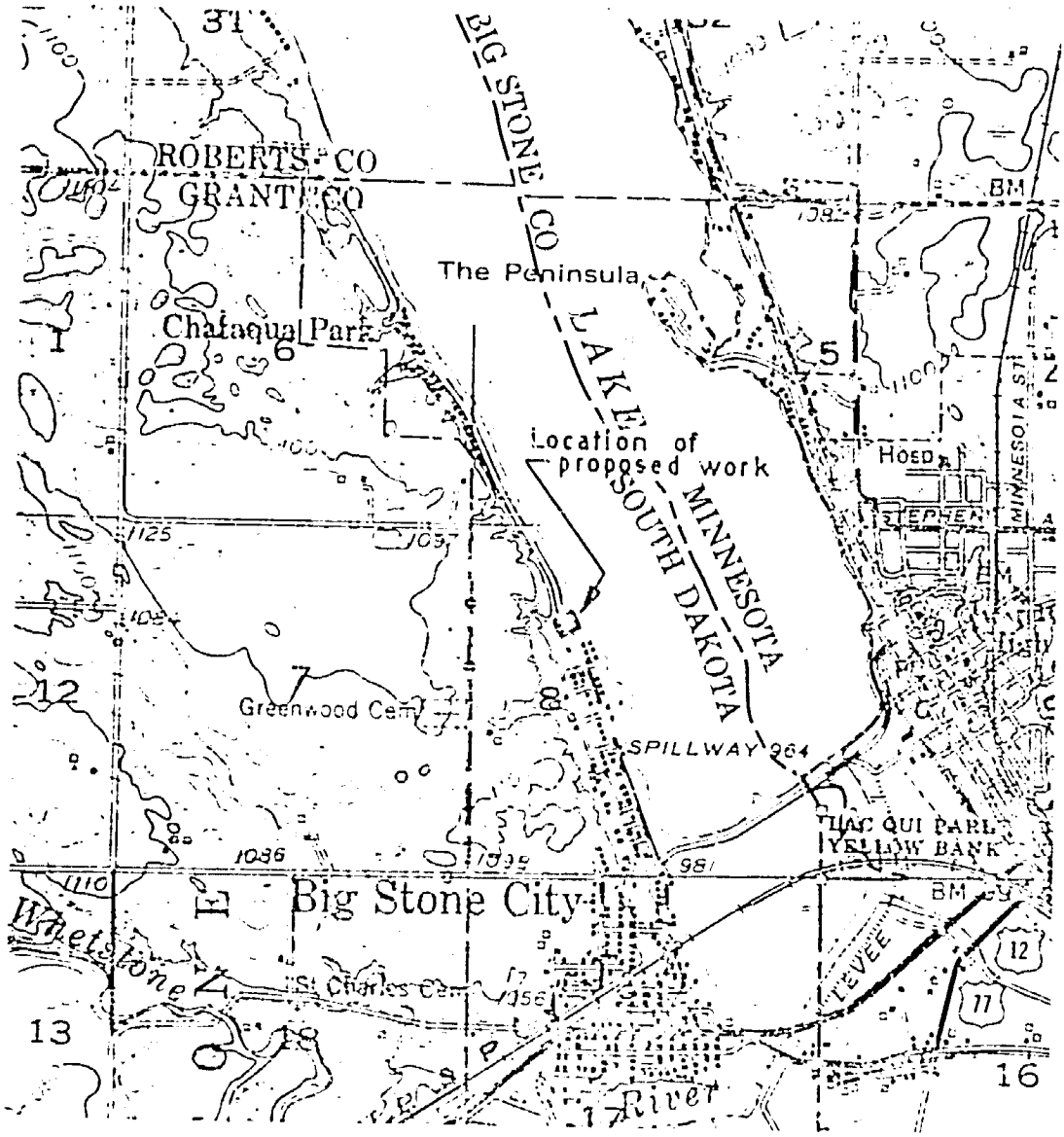
WHEREAS, Big Stone City, a municipal corporation, is the owner of the street and highway along the west side of Big Stone Lake within the municipal limits of Big Stone City by virtue of a grant of record in the office of the Register of Deeds in and for Grant County, South Dakota, in Book 3 of Deed Records at page 555. The road therein deeded and platted is a part of:

Lot 1, Section 8, Township 121 and Range 46; and

WHEREAS, Minnesota Dakota Generating Company has applied to this Board for a permit to construct and maintain a water intake crossing under such street and road for the purpose of supplying water to an electric generating station to be located west of Big Stone City;

NOW, THEREFORE, BE IT RESOLVED, By the City Council of Big Stone City that the Mayor and City Auditor be, and they hereby are, authorized to issue a permit and easement to the Minnesota-Dakota Generating Company, which permit and easement provides that the Minnesota-Dakota Generating Company may construct a water intake under said road and maintain the same in the future to provide water to its electric generating station. Such permit and easement shall also provide that in the construction of said water intake the traffic along said street and highway shall be permitted to move over detours, temporary roads, bridges or trestles, but shall not be barred from movement, and that in the future, free travel over the intake structure as the same is located under the road shall be maintained, such easement and permit to be approved by the City Attorney. The Minnesota-Dakota Generating Company, or its assigns, shall repair the road where the same crosses over the water intake.

The foregoing resolution was adopted by the governing body of Big Stone City, South Dakota, on July 6, 1970.



LOCATION MAP

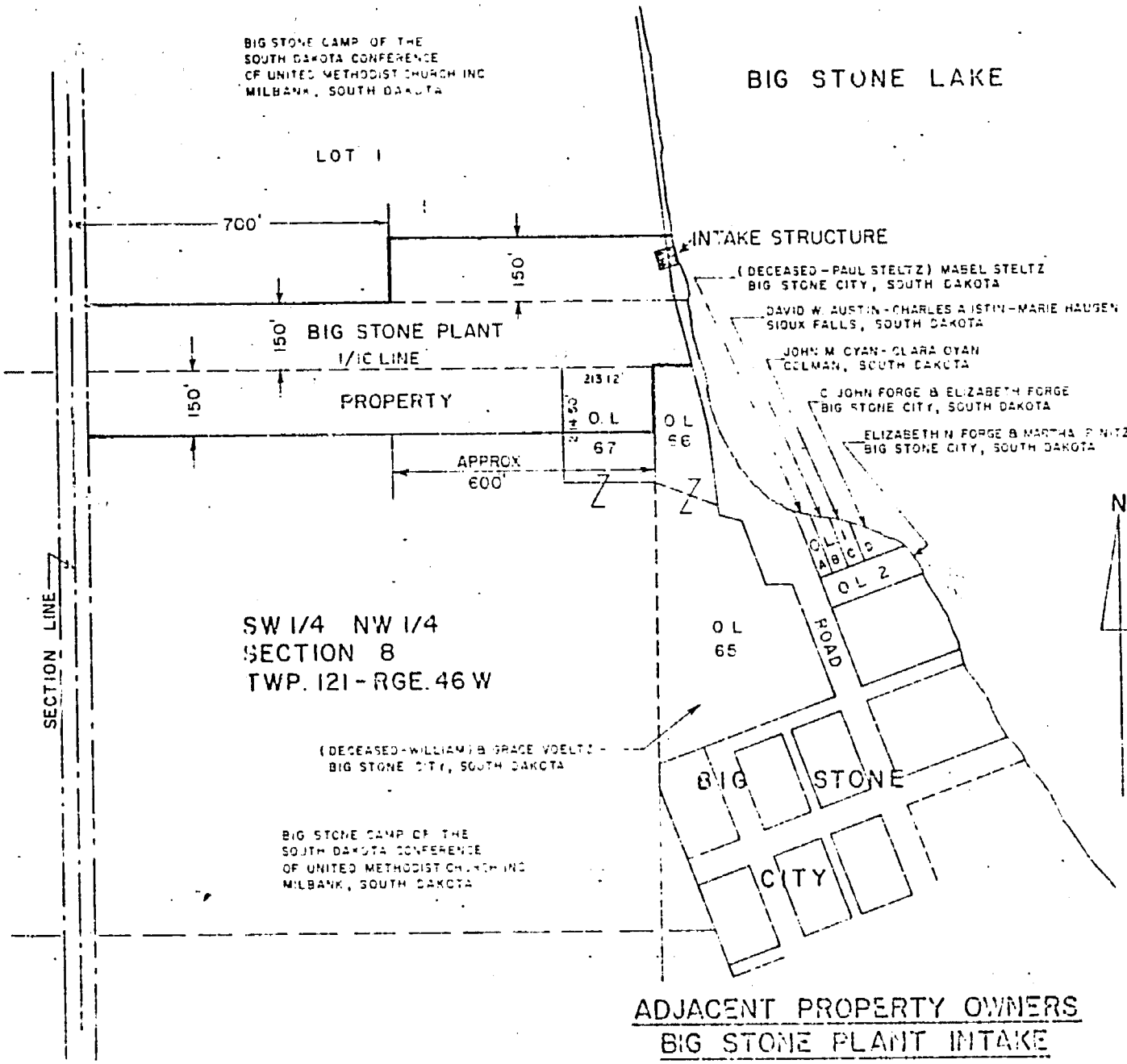
0 1 2 3 4000'

Enlarged from U.S.C.& G.S map of
ORTONVILLE QUADRANGLE
Minnesota – South Dakota
N4515 – W9615

PROPOSED PUMP STATION AND DREDGING

IN: BIG STONE LAKE
AT: BIG STONE CITY
COUNTY OF: GRANT, SOUTH DAKOTA

APPLICATION BY: OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE CO.
MONTANA-DAKOTA UTILITIES CO.

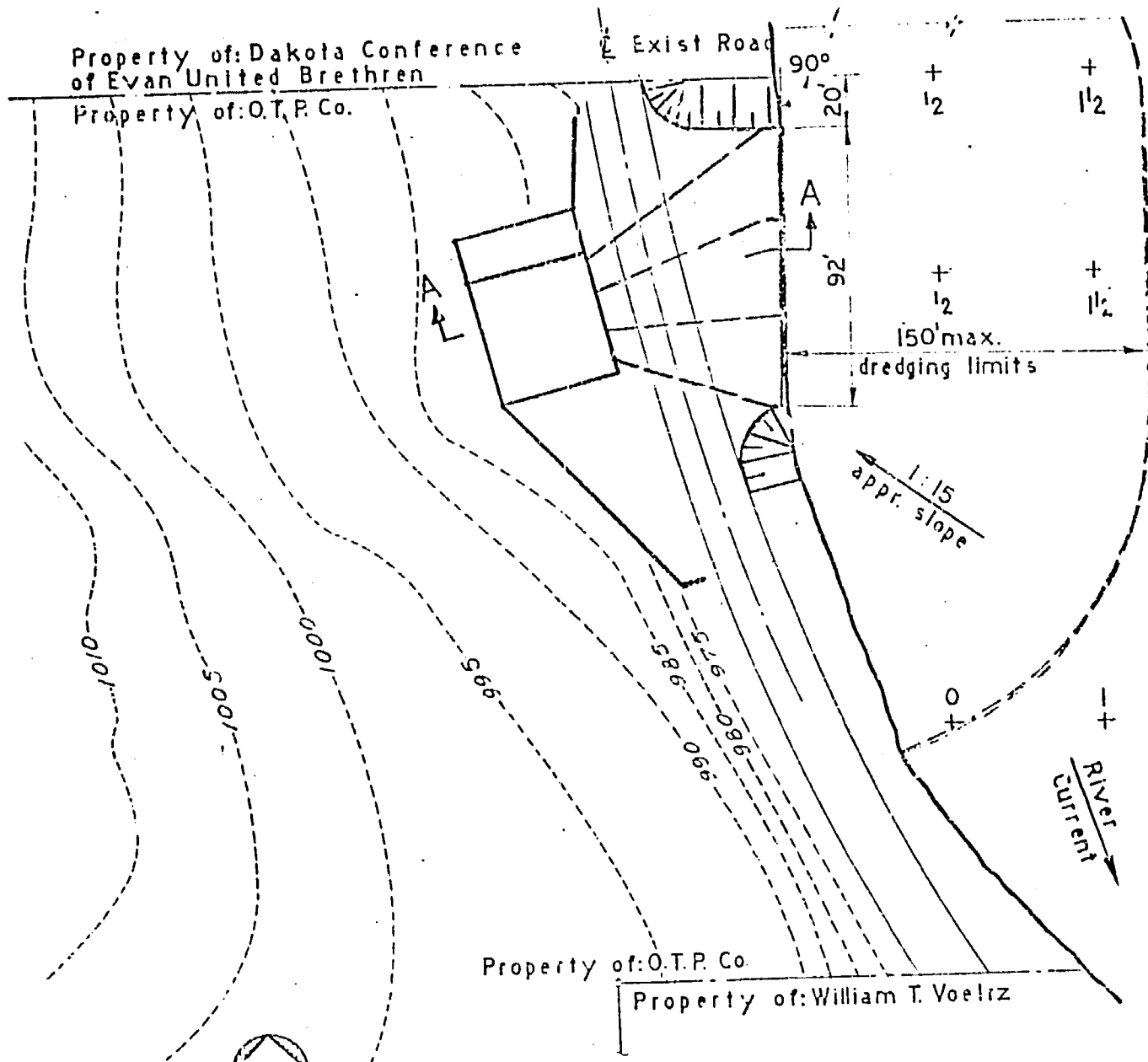


ADJACENT PROPERTY OWNERS
BIG STONE PLANT INTAKE

IN --- BIG STONE CITY, SOUTH DAKOTA
AT --- SECTION 8 TWP. 121 RGE. 46 W
COUNTY --- GRANT COUNTY, SOUTH DAKOTA
APPLICATION BY --- NORTHWESTERN PUBLIC SERVIC
MONTANA DAKOTA UTILITIES
OTTER TAIL POWER COMPANY

SCALE --- 1" = 300' (APPROX)

DATE --- DEC 5, 1970



PLAN

0' 50' 100'

+ Lake soundings shown in feet below low water level

PROPOSED PUMP STATION AND DREDGING

IN: BIG STONE LAKE
AT: BIG STONE CITY
COUNTY OF: GRANT, SOUTH DAKOTA

APPLICATION BY: OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE CO.
MONTANA-DAKOTA UTILITIES CO.

NEWS REPORT

PASTE NEWSPAPER CLIPPINGS BELOW

PAPER Ortonville Independent TOWN Ortonville, Minnesota DATE Feb. 25 19 71

Engineers to Advertise for Bids This May

More good news this week regarding the Big Stone Lake-Whetstone River Project here.

Lem Kaercher, general chairman of the project, vacationing in Hawaii, writes today that actual construction will definitely get underway this year, as President Nixon has released the funds of $185,000 to get the work started.

"Congressman John Zwach's office informed me of this release last week," writes Lem, "and we owe much to Zwach's efforts, who has been a steady workhorse for us in Washington."

Lem further reported that he had been contacted by the St. Paul office of the U. S. Army Engineers saying that they plan to advertise for construction bids this May, with construction bids to be awarded in June.

"This is for the first stage of construction," said Lem, "for the excavation of the service spillway of the highway 75 dam and construction of the outlet channel."

FORM : 241

NEWS REPORT

PASTE NEWSPAPER CLIPPINGS BELOW

PAPER ORTONVILLE INDEPENDENT TOWN ORTONVILLE, MINNESOTA DATE Feb. 25 19

Otter Tail Applies for Lake Dredging Project

Notice comes today from the State of Minnesota Pollution Control Agency that Otter Tail Power Company has applied to the Agency for certification of a dredging project on Big Stone Lake.

The project is located in government lot 1 of section 7, township 121 north, range 46 west, Big Stone City, S.D. It is assumed this is in regard to the $100,000,000 power plant to be constructed near the lake.

The application is on file in the MPCA office and available for review by any interested person, the notice states.

The plans indicate the project will consist of constructing an intake structure and removal of about 7,500 cubic yards of material from Big Stone Lake.

The dredged material will be placed in an area from which it will not enter state waters. Any waste water resulting from this operation will be contained within the cofferdam for clarification before being pumped back into the dredging area. No effluent is to be discharged therefrom to surface waters.

The applicant seeks certification that there is reasonable assurance that the project will not violate applicable water quality standards. Interested parties are invited to submit to the State MPCA office written statements of facts, arguments, or objections concerning the project.

The statements should primarily refer to the adequacy of the project with regard to avoidance of water pollution and possible conflicts between the conduct of the project and the discharge of the effluent, if any, and other actual or potential uses of the waters involved or other environmental impact, and suggest any appropriate changes in the project which may be deemed desirable from this viewpoint.

All statements should be addressed to the Minnesota Pollution Control Agency, Division of Water Quality, 717 Delaware Street S. E., Old Street Station, Minneapolis, Minn. 55440, and mailed so as to be received by not later than March 19, 1971.

Enclosure #2

FORM : 241

Supplement No. 1 July 1970

BIG STONE PLANT
SOUTH DAKOTA

Proposed Water Supply

OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE COMPANY
MONTANA-DAKOTA UTILITIES CO.

BECHTEL

June 1970

SUPPLEMENT NO. 1 (JULY 1970)

to report

BIG STONE PLANT, SOUTH DAKOTA
PROPOSED WATER SUPPLY, JUNE 1970

I. BACKGROUND

At a meeting on June 16, 1970, at Ortonville, Minnesota, the report "Proposed Water Supply, June 1970," was presented to the Boundary Waters Commission. Representatives of the Corps of Engineers were asked to comment. They noted that the proposed method of operating the dam at the Big Stone Lake outlet differed in some respects from the operation plan in the Corps' Minnesota River flood-control project. Because of these differences, they suggested that the ten floods used in their studies be routed through the lake on a daily basis, using the proposed power company plan, to determine the comparative effect on those floods. The Boundary Waters Commission requested that this work be done and reported to them on July 16, 1970.

This report contains the results of these flood routing studies. It also includes a change in the proposed basic plan as outlined in the June 1970 report.

II. CHANGE IN BASIC PLAN

The plan presented in the June 1970 report visualized the raising of the silt barrier to 967.0 ft, project datum; the lowering of the crest of the dam to 963.0 ft, project datum; and installation of 5-foot high slide gates on the crest of the dam (top elevation, 968.0 ft). The gates would be kept in the closed position until the lake level rose to 969.0 ft, or one foot above the top of the gates. The gates would then be fully opened, to remain so until the lake level declined to 968.4, when they would again be closed.

This plan would require a change in the legal level of the lake from 967.0 to 968.0 feet, necessitating legislative action by both South Dakota and Minnesota. Also, flowage rights-of-way for the additional foot of water would have to be negotiated with the numerous property owners abutting on the lake. It became increasingly evident that these legal procedures, if they could eventually be accomplished, could be very time-consuming and might result in delay of construction of the plant. Accordingly, further studies were conducted to attempt to formulate a plan which would not require changing the legal lake level.

The studies revealed that the required 10 cfs could be obtained while still maintaining the lake level very close to 967.0 feet during the legally-designated control months of May through September by using the scheme outlined below.

The silt barrier would be raised to 967.0 ft as in the original plan. The crest of the dam would be lowered to 963.0 ft, the same elevation originally proposed. Instead of the 5-foot gates at the dam, however, 4-foot gates would be used, with their crests at 967.0 ft. They would be kept closed until the lake rose to 968.0, when they would be completely opened, to be reclosed when the lake declined to 967.4 ft.

With this mode of operation, the target lake level for May through September would be the existing legally-designated 967.0 ft, obviating the necessity for legislative action by the States and for obtaining additional flowage rights.

A monthly reservoir operation study was made for this proposed mode of operation, using the methods and data outlined in the June 1970 report, including the 10 cfs diversion for plant use. The study is identical to that in the appendix of the report, with the changes explained above. The month-end reservoir levels for each year for the months of May through September are shown on the attached graphs.

It will be noted that of the 145 month-end lake levels shown for May through September, only six are more than one foot higher or lower than the legal level of 967.0 ft. Of these 139 months, 57 were within 0.2 ft of the legal level. The highest of the six month-ends exceeding one foot from the legal level was 969.1 and the lowest 965.9. No two of these months occurred in the same year.

It is evident from this study that the 10 cfs plant requirement can be obtained from Big Stone Lake without additional storage in the lake, as originally planned.

III. FLOOD STUDIES

The Corps of Engineers furnished daily (or smaller incremental) hydrographs for the ten floods used in their studies and also rating curves for the dam and silt barrier, a capacity curve for Big Stone Lake, and sample copies of their computations. These data were used to route the floods through Big Stone Lake using (1) the originally proposed mode of operation, with the top of the gates at 968.0 ft, project datum, and (2) the currently proposed plan, with the gates at 967.0 ft. These two series of routings are discussed separately below.

A. Gates and Legal Level at 968

The results of routing the ten floods through the lake with the originally-proposed method of operation are shown in the attached table. The maximum lake level reached varied from 0.7 to 1.3 ft higher than the results obtained by the Corps' plan, with the smallest increases applicable to the largest floods. The peak flows down the Minnesota River would be increased by amounts varying from 210 to 780 cfs over the peaks predicted by the Corps.

B. Gates and Legal Level at 967

At the time of the Corps' review of the flood results in the preceding section, the new proposal was discussed. The Corps indicated that, for their purposes, it would not be necessary to study all ten floods, but that only the floods of 1947, 1950, 1951, and 1952 need be routed. These floods are the highest (1952), the third highest (1947), and the two lowest (1950 and 1951). The 1950 flood was chosen because it has an unusually large volume of runoff, despite a relatively low peak discharge.

The results of routing these floods are shown in the attached table. The maximum stages in Big Stone Lake are the same as for the Corps project in 1947 and 1950 and are 0.2 and 0.4 ft higher for 1951 and 1952, respectively. The peak discharges down the Minnesota River range from 10 cfs to 290 cfs higher than those of the Corps.

IV. CONCLUSIONS

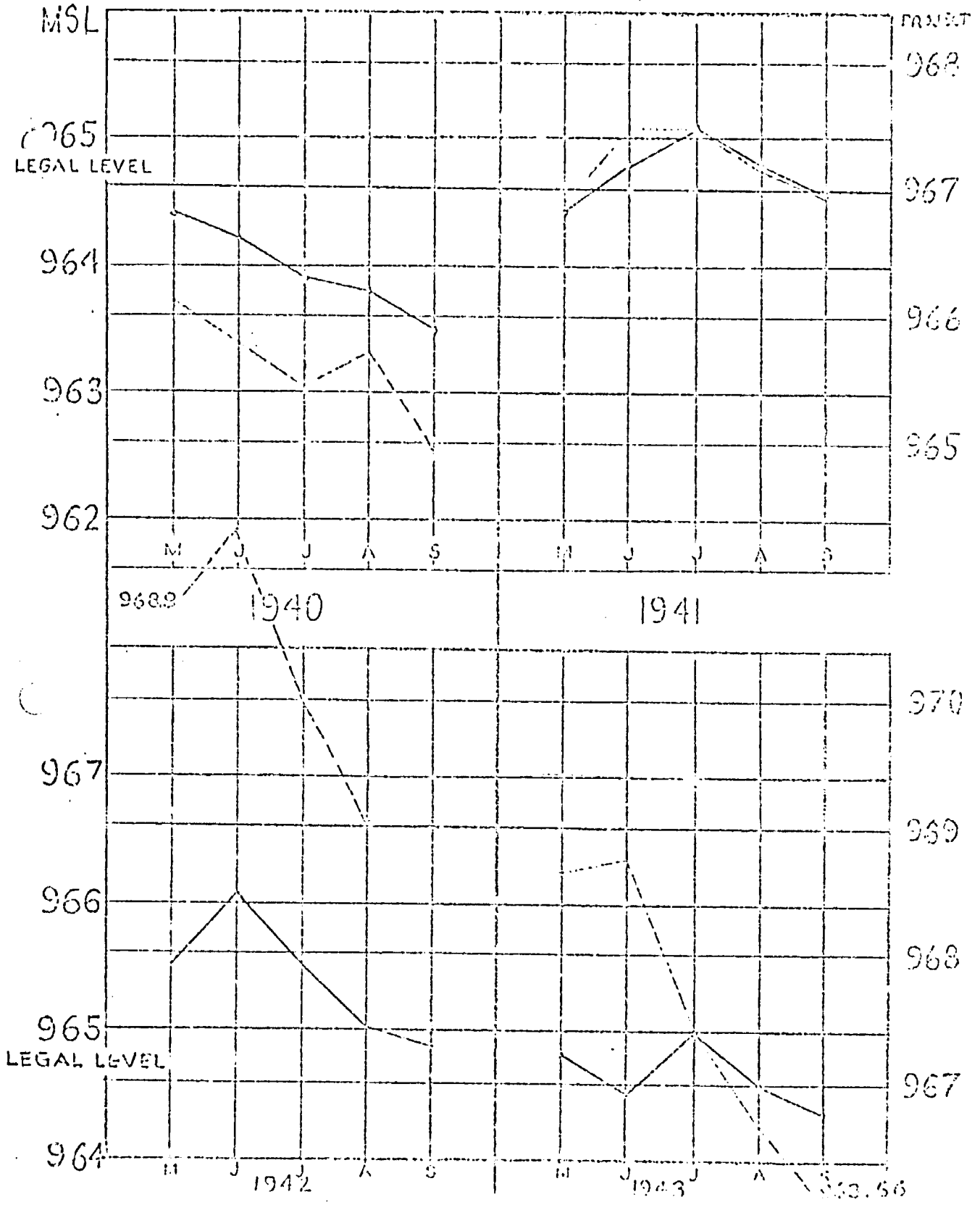
A revised plan for modifying and operating the dam while diverting the required 10 cfs is presented. The legal level of the lake would remain at 967.0 ft, project datum. With the new proposed plan, the lake level could be maintained within one foot of 967.0 during May through September of most years.

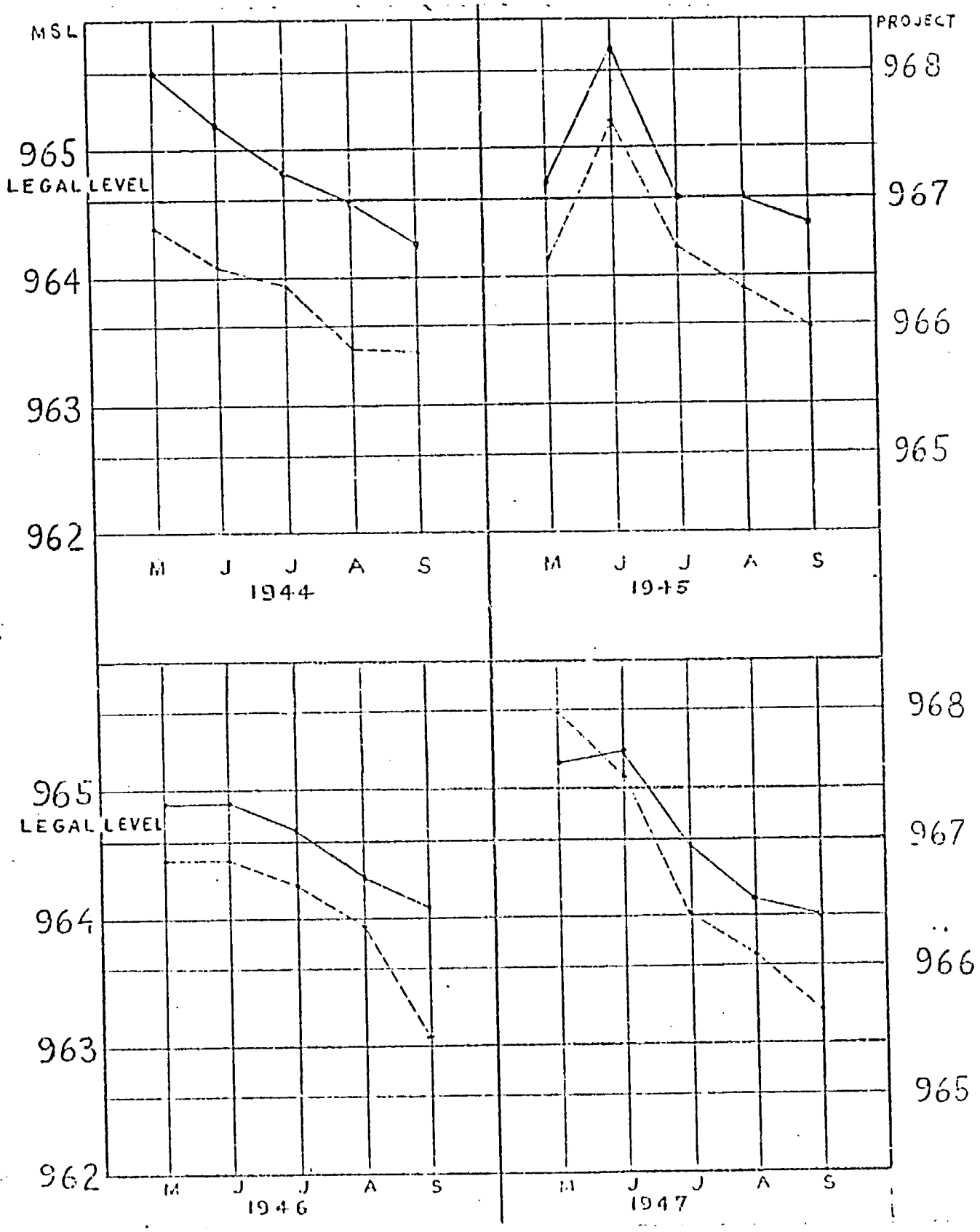
Maximum flood levels in Big Stone Lake would be a few tenths of a foot higher than levels expected with the Corps of Engineers flood control plan. Peak discharges down the Minnesota River would be increased slightly, but not significantly.

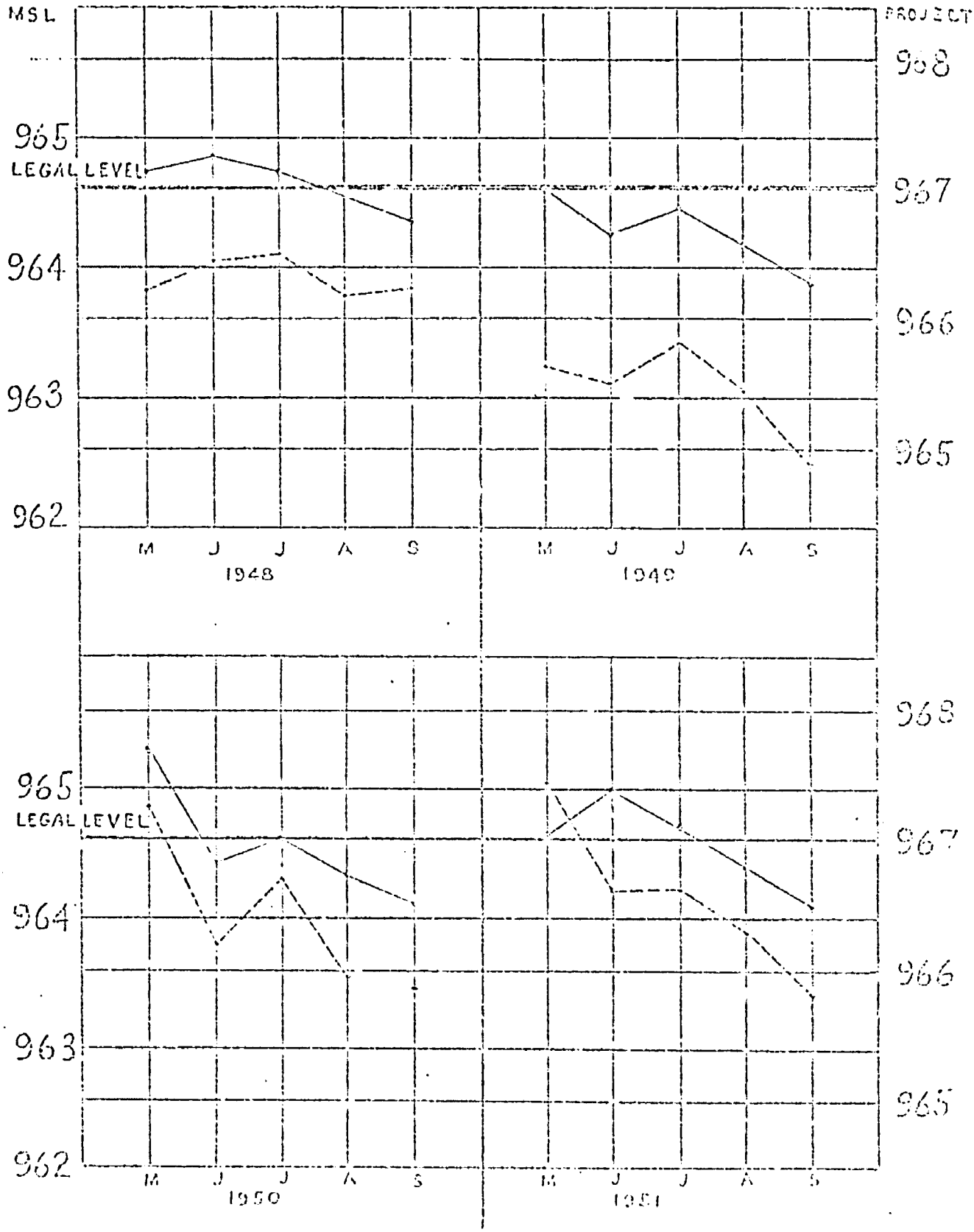
Flood	Maximum elevation of Big Stone Lake (project datum)				Maximum discharge, Minnesota River at Ortonville (cfs)			
	Present Conditions *	Corps of Engineers plan *	Proposed power company plan: Gates and legal level 968	Proposed power company plan: Gates and legal level 967	Presen Conditions *	Corps of Engineers plan *	Proposed power company plan: Gates and legal level 968	Proposed power company plan: Gates and legal level 967
June 1942	969.4	968.5	969.5		1,240	2,300	2,600	
April 1943	971.1	970.6	971.3		2,100	3,250	3,640	
March-April 1946	968.4	968.2	969.0		905	1,800	2,270	
April 1947	970.6	970.1	970.8	970.1	1,840	2,950	3,360	2,960
April 1948	969.1	969.1	970.2		1,130	2,420	3,080	
March-May 1950	968.0	968.2	969.1	968.2	750	1,690	2,300	1,810
April 1951	968.0	968.4	969.4	968.6	770	1,790	2,570	2,080
April 1952	972.8	972.0	972.8	972.4	3,060	4,110	4,710	4,350
June 1954	968.7	967.9	969.0		905	2,140	2,350	
May 1957	969.0	967.9	969.2		939	2,240	2,520	

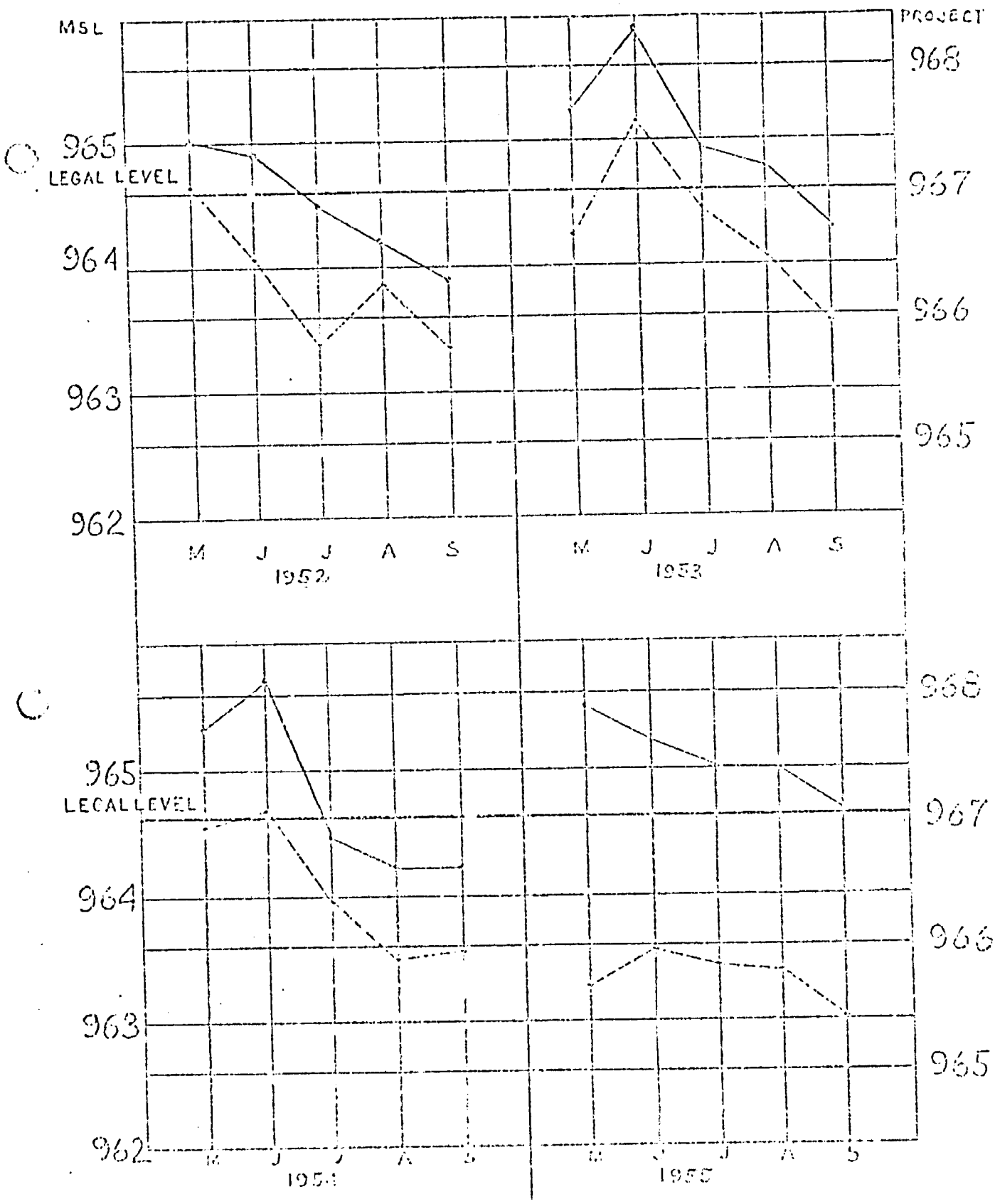
* From Table A-5, Corps of Engineers report

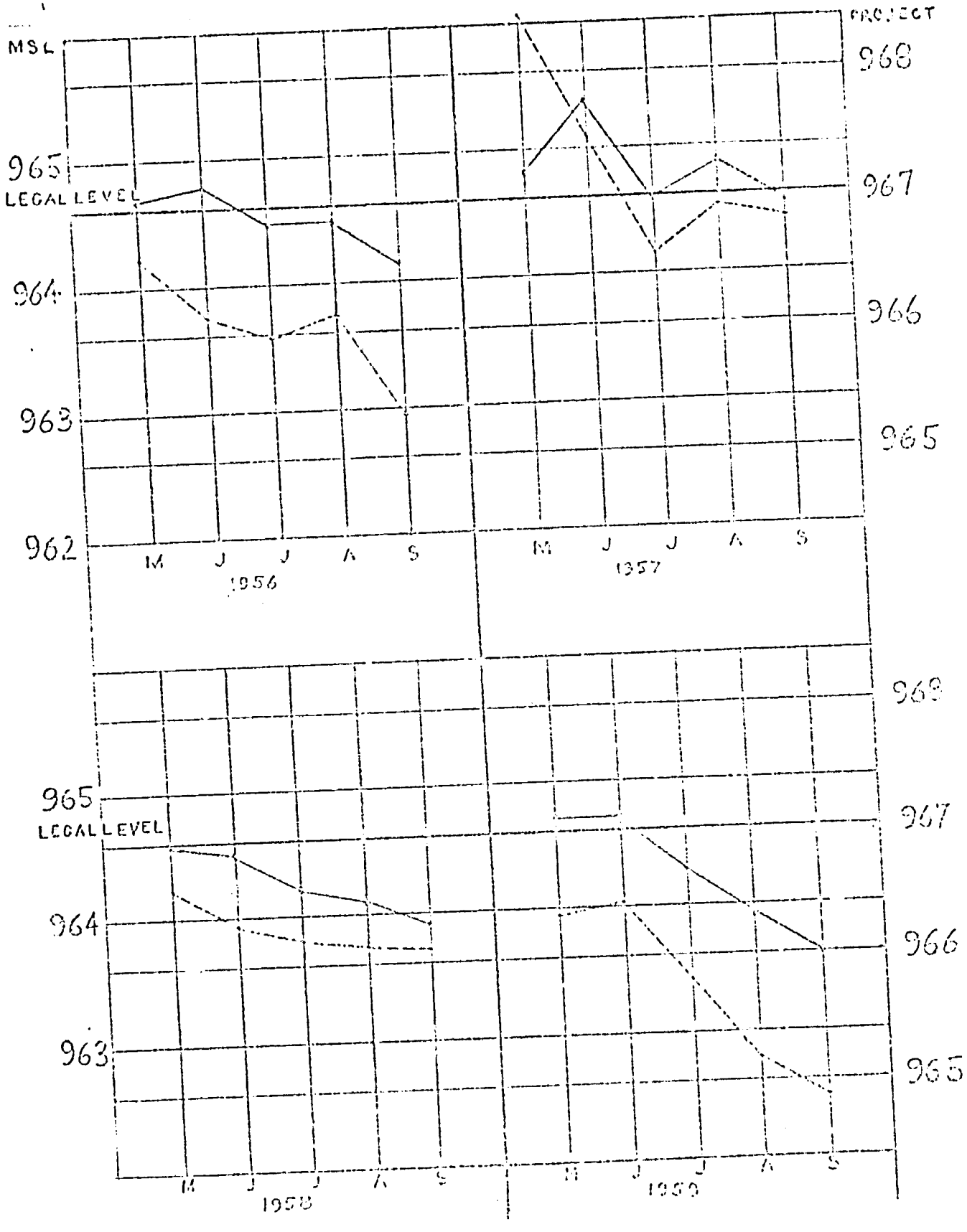
THE FOLLOWING GRAPHS SHOW THE MONTH-END LEVELS WITH 10 CFS DIVERTED FOR PLANT USE, CREST OF GATES IN DAM AT 967.0 FT (PROJECT DATUM). DASHED LINES REPRESENT HISTORICAL LAKE LEVELS.

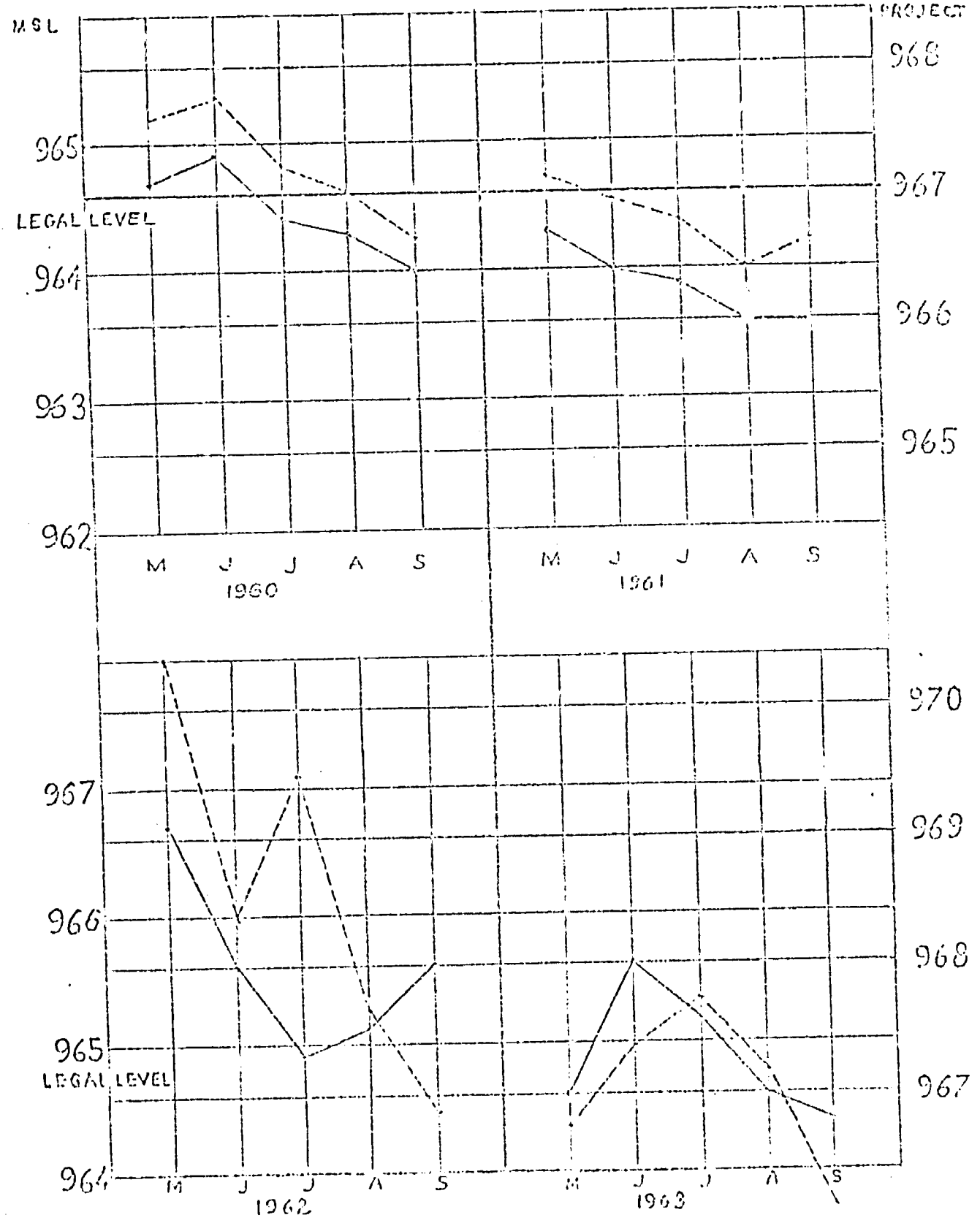

MSL
LEGAL LEVEL
968
967
966
965
964
963
962
M J J A S
968.8
1940
1941
970
969
968
967
966
965
LEGAL LEVEL
964
1942
1943
963.56

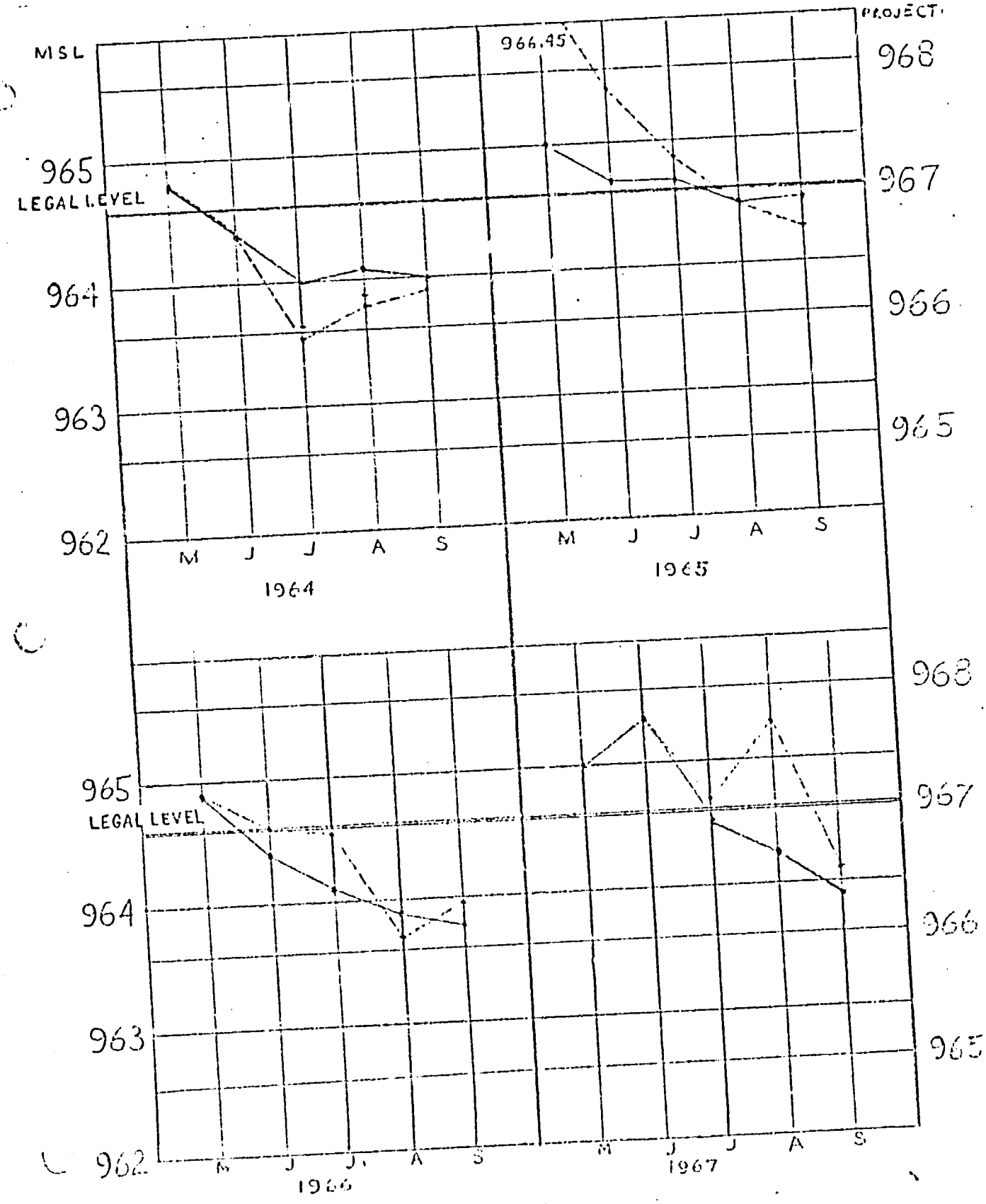

MSL
PROJECT
968
965
LEGAL LEVEL
967
964
966
963
965
962
M J J A S
1944
M J J A S
1945
968
965
LEGAL LEVEL
967
964
966
963
965
962
M J J A S
1946
M J J A S
1947

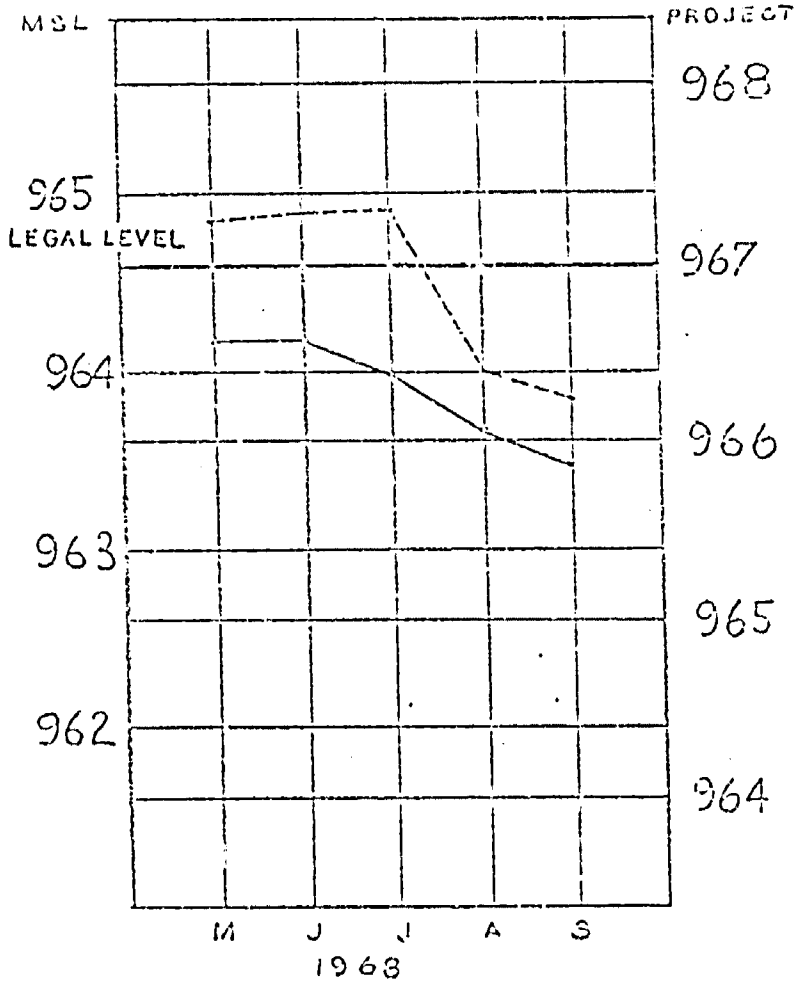

MSL
PROJECT
968
967
966
965
964
963
962
965
LEGAL LEVEL
M J J A S
1948
1949
1950
1951


MSL
PROJECT
968
967
966
965
964
963
962
965
LEGAL LEVEL
M J J A S
1952
M J J A S
1953
968
967
966
965
964
963
962
965
LEGAL LEVEL
M J J A S
1954
M J J A S
1955


MSL
PROJECT
965
LEGAL LEVEL
964
963
962
968
967
966
965
M J J A S
1956
M J J A S
1957
965
LEGAL LEVEL
964
963
968
967
966
965
M J J A S
1958
M J J A S
1959


MSL
PROJECT
968
965
967
LEGAL LEVEL
964
966
963
965
962
M J J A S
1960
M J J A S
1961
970
967
969
966
968
965
967
LEGAL LEVEL
964
M J J A S
1962
M J J A S
1963


MSL
PROJECT
966.45
968
967
966
965
965
LEGAL LEVEL
964
963
962
M J J A S
1964
M J J A S
1965
968
967
966
965
965
LEGAL LEVEL
964
963
962
M J J A S
1966
M J J A S
1967


MSL
PROJECT
968
965
LEGAL LEVEL
967
964
966
963
965
962
964
M
J
J
A
S
1968

STATE OF MINNESOTA
POLLUTION CONTROL AGENCY

Notice of Application for Certification of Dredging Project

The Otter Tail Power Company of 215 South Cascade Street, Fergus Falls, has applied to the Agency in accordance with the Federal Water Quality Improvement Act of 1970, Public Law 91-224, section 21, paragraph (b)(1), for certification of a project located in government lot 1 of section 8, township 121 north, range 46 west, Big Stone City, Grant County, South Dakota. The project will be conducted in or near Big Stone Lake.

A sketch map of the area showing details of the project is attached. The application is on file in this office and available for review by any interested person during normal business hours.

The plans and/or application indicate that the project will consist of constructing an intake structure and removal of approximately 7,500 cubic yards of material from Big Stone Lake. The dredged material will be placed in an area from which it will not enter state waters. Any wastewater resulting from this operation will be contained within the cofferdam for clarification before being pumped back into the dredging area. No effluent is to be discharged therefrom to surface waters.

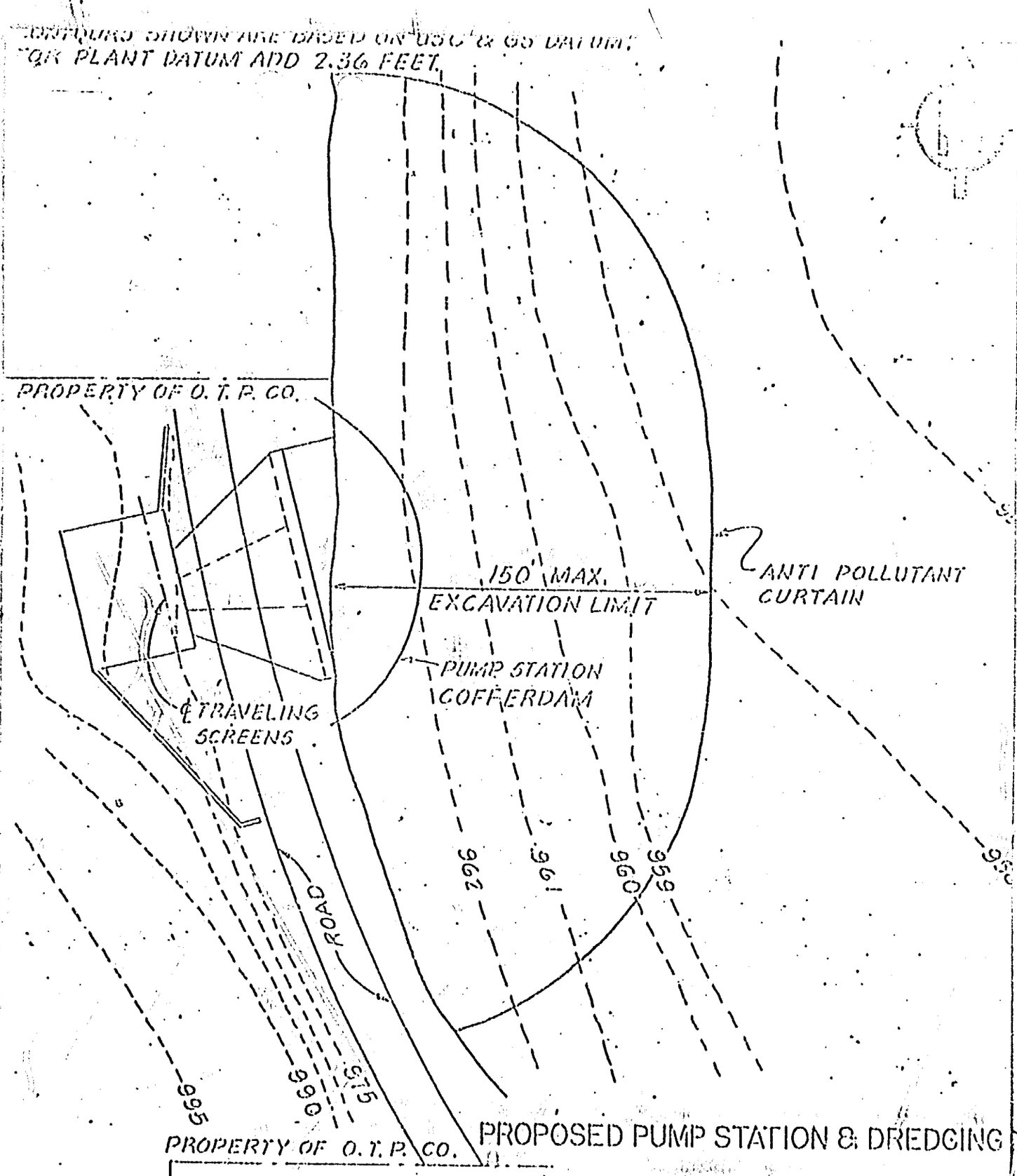
The applicable water and effluent quality or other standards are set forth in regulations WPC 15, 25, and 28, which are available for purchase from the Documents Section, Minnesota Department of Administration, 140 Centennial Building, Capitol Complex, St. Paul, Minnesota 55101.

RECEIVED
FEB 24 1971
STATE WATER RESOURCES BOARD

The applicant seeks certification that there is reasonable assurance that the project will not violate applicable water quality standards. Interested parties are invited to submit to this office written statements of facts, arguments, or objections concerning the project. The statements primarily should refer to the adequacy of the project with regard to avoidance of water pollution and possible conflicts between the conduct of the project and the discharge of the effluent, if any, and other actual or potential uses of the waters involved or other environmental impact, and suggest any appropriate changes in the project which may be deemed desirable from this viewpoint. All statements should be addressed to the Minnesota Pollution Control Agency, Division of Water Quality, 717 Delaware Street S.E., Oak Street Station, Minneapolis, Minnesota 55440, and mailed so as to be received by not later than March 19, 1971.

Dated: February 16, 1971

John P. Badalich, P.E.
Executive Secretary and
Chief Executive Officer



PROPOSED PUMP STATION & DREDGING

IN: BIG STONE LAKE
AT: BIG STONE CITY
COUNTY OF: GRANT, SOUTH DAKOTA

APPLICATION BY: OTTER TAIL POWER COMPANY
NORTHWESTERN PUBLIC SERVICE CO
MONTANA-DAKOTA UTILITIES CO.

7581 SK-C-59. JANUARY 22, 71

STATE OF SOUTH DAKOTA – BUREAU OF ADMINISTRATION – OFFICE OF RECORDS MANAGEMENT – CERTIFICATE OF AUTHENTICITY
THIS IS TO CERTIFY THAT THE MICROPHOTOGRAPHIC IMAGE APPEARING ON THIS SLIDE OF MICROFILM IS AN ACCURATE REPRODUCTION OF THE ORIGINAL RECORD AND WAS MICROFILMED IN THE REGULAR COURSE OF BUSINESS ACCORDING TO THE PROVISIONS OF SOUTH DAKOTA COMPILED LAW 1-27-4. IT IS FURTHER CERTIFIED THAT THE PHOTOGRAPHIC PROCESS USED FOR MICROFILMING OF THE ABOVE RECORDS WAS IN A MANNER AND ON MICROFILM WHICH MEET THE RECOMMENDED REQUIREMENTS OF THE NATIONAL BUREAU OF STANDARDS FOR PERMANENT MICROPHOTOGRAPHIC REPRODUCTIONS. REDUCTION 25:1 ROLL NO 30 4-13-82 Dave Palmer
DATE MICROFILMED CAMERA OPERATOR

Watertown
1768-3

Rapid City Journal
3/11/71

Minnesota grants water use permit for power plant

The Minnesota Department of Natural Resources has granted a water use permit for the Big Stone electric generating plant project in northeastern South Dakota, it was announced Tuesday by David M. Heskett, president of Montana-Dakota Utilities Co. His company, along with Northwestern Public Service Company and Otter Tail Power Company, will construct and share in the ownership of the $100 million, 400,000-kilowatt power station. The South Dakota Water Resources Commission previously had granted a similar water rights permit for the Big Stone Plant.

The permits provide for the maintenance, under close supervision, of Big Stone Lake at statutory levels as provided for by the states of South Dakota and Minnesota.

STATE OF MINNESOTA
DEPARTMENT OF CONSERVATION

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake. (P.A. 70-1182)

NOTICE OF HEARING

NOTICE IS HEREBY GIVEN, that pursuant to Minnesota Statutes, Chapter 105, a public hearing will be held before the Commissioner of Conservation, or his authorized representative, at the National Guard Armory, 309 Madison Avenue, in the Village of Ortonville, Minnesota, on the 3rd day of December, 1970, at 10:00 o'clock a.m., or as soon thereafter as the matter can be heard, upon the application of the Northwestern Public Service Company, Montana-Dakota Utilities Co., and Otter Tail Power Company for a permit for the following:

To appropriate 7,000 acre feet per year of water from Big Stone Lake, the point of taking to be located in South Dakota on the westerly shore of Big Stone Lake 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-one (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said section, Grant County, South Dakota;

To raise the silt barrier at the outlet of Big Stone Lake approximately one foot to 967.0 project datum (964.7, 1929 S.L.D.) and modify the Ortonville dam on the Minnesota River;

To supervise the operation of, and operate the modified control works in such a manner as to stabilize the level of Big Stone Lake in accordance with operating procedures to be established by the responsible governmental regulatory bodies;

That at said time and place all affected persons shall have an opportunity to be heard. Evidence will be received as to whether it is in the public interest to grant the permit applied for.

Dated at Saint Paul, Minnesota, chis 10th day of November, 1970.

JARLE LEIRFALLOM
Commissioner of Conservation

STATE OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.
(P.A. 70-1182)

NOTICE OF ORDER

NOTICE IS HEREBY GIVEN, That, after public hearing held pursuant to due notice, the Commissioner of Natural Resources, Robert Herbst, on February 25, 1971, made Findings of Fact in the above-entitled matter and thereupon made the following CONCLUSIONS AND ORDER:

CONCLUSIONS

I

That a permit be granted to the applicants pursuant to Minnesota Statutes 1969, Chapter 105, for the following purposes in the manner and upon the terms and conditions hereinafter stated:

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 450 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

must be approved by the above agencies.

The applicants must provide emergency alternative plans and means of measuring levels and manipulating the outlet controls in the event of mechanical failure or malfunction of any portion of the automated monitoring and control system.

(b) The applicants must submit a plan of operation of the control structure which is in accordance with a coordinated plan of operation to fulfill the project objectives established by the local sponsoring agencies, the States of Minnesota and South Dakota, the federal government, and the South Dakota-Minnesota Boundary Waters Commission.

(c) The applicants' plans must provide for a minimum discharge of at least two (2) cubic feet per second natural river flow, from the Whetstone River into the Minnesota River channel below the Big Stone Lake outlet control structure at all times when there is available flow in the Whetstone River.

5. This permit shall not release the permittees from any liability or obligation imposed by Minnesota Statutes or local ordinances relating thereto and shall remain in force subject to all conditions and limitations now or hereafter imposed by law.

6. This permit is not assignable except with the written consent of the Commissioner of Natural Resources.

7. The Commissioner of Natural Resources shall be notified at least five (5) days in advance of the commencement of the work authorized hereunder.

8. No change shall be made without written permission previously obtained from the Commissioner of Natural Resources in the hydraulic dimensions, capacity or location of any items of

work authorized hereunder.

9. The permittees shall grant access to the site at all reasonable times during and after construction to authorized representatives of the Commissioner of Natural Resources for inspection of the operation authorized hereunder.

10. This permit may be terminated by the Commissioner of Natural Resources, without notice, at any time he deems it necessary for the conservation of the water resources of the state, or in the interest of public health and welfare, or for violation of any of the provisions of this permit.

11. In all cases where the doing by the permittees of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements thereon or interests therein, the permittees, before proceeding herewith, shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all property, rights and interests necessary therefor.

12. This permit is permissive only. No liability shall be imposed upon or incurred by the State of Minnesota or any of its officers, agents or employees, officially or personally, on account of the granting hereof or on account of any damage to any person or property resulting from any act or omission of the permittees or any of their agents, employees, or contractors relating to any matter hereunder. This permit shall not be construed as estopping or limiting any legal claims or right of action of any person against the permittees, their agents, employees, or contractors, for any damage or injury resulting from any such act or omission, or as estopping or limiting any legal claim or right of action of the state against the permittees, their agents, employees, or contractors for violation of or failure to comply with the provisions of the

permit or applicable provisions of law.

13. This permit shall not be construed as establishing any priority of use.

14. Before construction thereof, the permittees shall obtain written approval of the Commissioner of Natural Resources of detailed plans for dams, dikes, pumps and other hydraulic structures authorized hereunder.

15. The permittees shall install such measuring devices as may be required by the Commissioner of Natural Resources to measure hydrologic conditions in the area including but not limited to the flows of the Little Minnesota River above Big Stone Lake, the flows of the Minnesota River below the outlet dam, and of the Whetstone River at Big Stone City.

16. The permitteesshall keep records of all water pumped from Big Stone Lake under this permit and shall report the same to the Commissioner in such form and frequency as he shall require.

II

That operations of the applicants, subject to the terms and conditions herein set forth, will not interfere with the waters of Big Stone Lake in a manner which will be detrimental to the public use thereof.

III

That the plans of the applicants, subject to the terms and conditions herein set forth, provide for practical use of the waters of the state and will adequately protect public safety and promote the public welfare.

ORDER

IT IS HEREBY ORDERED, That a permit be granted pursuant to Minnesota Statutes 1969, Chapter 105, to Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company, under the terms and conditions set forth in the Conclusions herein.

Dated at Saint Paul, Minnesota, this 25th day of February, 1971.

ROBERT HERBST
Commissioner of Natural Resources

STATE OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.
(P.A. 70-1182)

P E R M I T

Pursuant to the Findings, Conclusions, and Order of the Commissioner of Natural Resources, dated February 25, 1971, a Permit is hereby granted to Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company, subject to the provisions of Minnesota Statutes 1969, Chapter 105, authorizing the permittees to appropriate a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year with maximum rate of withdrawals not to exceed 100 cubic feet per second for use in the operation of a fossil fueled power plant. All upon the following terms and conditions:

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

the volume of water which may be appropriated during certain periods of time.

3. Upon commencement of the construction of the federally-authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) Detailed plans for the applicants' proposals for alteration of the Big Stone Lake outlet control dam shall be submitted to the States of Minnesota and South Dakota and to the U. S. Corps of Engineers for their review and analysis, and no construction shall be commenced without their written approval.

(b) Submission to the Minnesota Pollution Control Agency of substantiating evidence by the applicants that the proposed work will in no way violate applicable state water quality standards in accordance with provisions of the Water Quality Improvement Act of 1970 and any other applicable water quality requirements of the State of Minnesota.

4. After completion of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) The applicants must secure written approval from the South Dakota-Minnesota Boundary Waters Commission; the States of Minnesota and South Dakota; and the federal government of the number and location of instruments, and methods of determining the mean water level of Big Stone Lake for use in the computer monitoring program. Further, all aspects of the computer monitoring and gate control system

must be approved by the above agencies. The applicants must provide emergency alternative plans and means of measuring levels and manipulating the outlet controls in the event of mechanical failure or malfunction of any portion of the automated monitoring and control system.

(b) The applicants must submit a plan of operation of the control structure which is in accordance with a coordinated plan of operation to fulfill the project objectives established by the local sponsoring agencies, the States of Minnesota and South Dakota, the federal government, and the South Dakota-Minnesota Boundary Waters Commission.

(c) The applicants' plans must provide for a minimum discharge of at least two (2) cubic feet per second natural river flow, from the Whetstone River into the Minnesota River channel below the Big Stone Lake outlet control structure at all times when there is available flow in the Whetstone River.

5. This permit shall not release the permittees from any liability or obligation imposed by Minnesota Statutes or local ordinances relating thereto and shall remain in force subject to all conditions and limitations now or hereafter imposed by law.

6. This permit is not assignable except with the written consent of the Commissioner of Natural Resources.

7. The Commissioner of Natural Resources shall be notified at least five (5) days in advance of the commencement of the work authorized hereunder.

8. No change shall be made without written permission previously obtained from the Commissioner of Natural Resources in the hydraulic dimensions, capacity or location of any items of

work authorized hereunder.

9. The permitteesshall grant access to the site at all reasonable times during and after construction to authorized representatives of the Commissioner of Natural Resources for inspection of the operation authorized hereunder.

10. This permit may be terminated by the Commissioner of Natural Resources, without notice, at any time he deems it necessary for the conservation of the water resources of the state, or in the interest of public health and welfare, or for violation of any of the provisions of this permit.

11. In all cases where the doing by the permittees of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements thereon or interests therein, the permittees, before proceeding herewith, shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all property, rights and interests necessary therefor.

12. This permit is permissive only. No liability shall be imposed upon or incurred by the State of Minnesota or any of its officers, agents or employees, officially or personally, on account of the granting hereof or on account of any damage to any person or property resulting from any act or omission of the permittees or any of their agents, employees, or contractors relating to any matter hereunder. This permit shall not be construed as estopping or limiting any legal claims or right of action of any person against the permittees, their agents, employees, or contractors, for any damage or injury resulting from any such act or omission, or as estopping or limiting any legal claim or right of action of the state against the permittees, their agents, employees, or contractors for violation of or failure to comply with the provisions of the

permit or applicable provisions of law.

13. This permit shall not be construed as establishing any priority of use.

14. Before construction thereof, the permittees shall obtain written approval of the Commissioner of Natural Resources of detailed plans for dams, dikes, pumps and other hydraulic structures authorized hereunder.

15. The permittees shall install such measuring devices as may be required by the Commissioner of Natural Resources to measure hydrologic conditions in the area including but not limited to the flows of the Little Minnesota River above Big Stone Lake, the flows of the Minnesota River below the outlet dam, and of the Whetstone River at Big Stone City.

16. The permittees shall keep records of all water pumped from Big Stone Lake under this permit and shall report the same to the Commissioner in such form and frequency as he shall require.

Dated at Saint Paul, Minnesota, this 25th day of February, 1971.

ROBERT L. HERBST
Commissioner of Natural Resources

STATE OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

RECEIVED
MAR 8 - 1971
STATE WATER RESOURCES BOARD
PIERRE, SOUTH DAKOTA

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.
(P.A. 70-1182)

FINDINGS OF FACT

CONCLUSIONS

AND

ORDER

Pursuant to due notice and in accordance with the applicable statutes, a public hearing was held on December 3, 1970, at the National Guard Armory, 309 Madison Avenue, Ortonville, Minnesota, before Eugene R. Gere of the Department of Natural Resources, appointed by the Commissioner of Natural Resources as referee to conduct the hearing, upon the application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.

The applicants were represented through their attorney, Mr. David F. Lundeen. Field, Arvensen, Doncho, Lundeen, and Hoff. Mr. Larry K. Houk, Special Assistant Attorney General, appeared on behalf of the State of Minnesota. No appearances were entered in opposition to granting the permit.

Said matter having been duly heard, and all evidence and testimony presented at said hearing having been duly considered, the Commissioner of Natural Resources now makes the following FINDINGS OF FACT, CONCLUSIONS, AND ORDER:

FINDINGS OF FACT

1. That Big Stone Lake is a boundary water lying between the State of Minnesota and the State of South Dakota, and is a public navigable water of the State of Minnesota.

2. That the applicants, Northwestern Public Service Company, Montana-Dakota Utilities Company and the Otter Tail Power Company, in order to meet the expanding electric requirements of the public in the region, plan to add to their system an electric generating plant to be located on a 2,800-acre tract adjacent to Big Stone Lake about one and one-half miles north of the City of Big Stone, Grant County, South Dakota. The plant will be a 400 megawatt lignite-fired steam generating plant which is scheduled to begin commercial production on May 1, 1975.

3. That the applicants propose to appropriate water by pumping from Big Stone Lake a volume not to exceed 7,000 acre feet per year with maximum rate of withdrawal not to exceed 100 cubic feet per second.

4. That the principal purpose for which water is required by the plant is for condenser cooling water, and that the applicants will construct cooling pond facilities with a storage capacity of 5,000 acre feet to be used for storing water obtained from Big Stone Lake primarily during periods when levels are above elevation 967 project datum.

5. That the applicants propose to construct the storage pond in 1971 and will wish to take water from Big Stone Lake in 1971 or early in 1972 in order to fill the storage pond.

6. That whenever the water level of Big Stone Lake is between elevation 965 feet and 967 feet project datum during October through April, the applicants propose to pump, during any period of 7 consecutive days, a volume of water not to exceed a total of 460 acre feet from Big Stone Lake.

7. That whenever the water level of Big Stone Lake is above elevation 967 feet project datum during May through September, the applicants propose to pump water from Big Stone Lake. The applicants propose that no appropriation would be made during this period without the permission of the South Dakota-Minnesota Boundary Waters Commission.

8. That the applicants propose to appropriate a volume of water from Big Stone Lake not to exceed 198 acre feet in any 24-hour period whenever the water level elevation of Big Stone Lake is sufficient to warrant such withdrawal.

9. That during prolonged drought periods when levels of Big Stone Lake are low, the applicants would provide for means of obtaining water supply other than by pumping from the lake for the plant operation, such as utilizing stored water or other authorized sources.

10. That the plans of the applicants show that no waste water from the plant operation will be discharged to Big Stone Lake. All waste water will be discharged to evaporation ponds from which it can be further discharged if authorized by the regulatory agencies involved.

11. That the applicants propose certain modifications in the construction of an outlet control structure and lake level monitoring system proposed as a part of the presently authorized federal flood control project for Big Stone Lake and the Whetstone River. That the applicants propose to provide sufficient funds to the U. S. Corps of Engineers for the additional costs of purchasing and installing control gates and a motor-operated unit to replace the proposed stop log controls. Further, that the applicants propose to establish a computer programming installation for monitoring the lake levels, river flows, precipitation and other hydrologic factors and for the

operation of the control gates.

12. That the U. S. Corps of Engineers, after review and analysis of the applicants' proposals and supporting data, have concluded that the operation would not adversely affect the authorized federal flood control project on the Big Stone Lake and the Whetstone River, provided that the applicants assure the compatibility of the power companies' proposal with the federal flood control project.

13. That the legislature of the State of Minnesota has concurred with a plan for remodeling, extending and completing of control works, including a silt barrier and Whetstone River-Minnesota River outlet channel modifications designed, among other things, to stabilize the level of Big Stone Lake within reasonable limits at elevation 967 feet project datum. Minnesota Statutes 1969, §§ 110.46 and 114.12. The plan was approved by the South Dakota-Minnesota Boundary Waters Commission May 1, 1956.

14. That the controlling low water runout elevation of Big Stone Lake since 1958 has been the silt barrier with a fixed crest elevation of 966 feet project datum, and therefore, it is undesirable for pumping to take place when the lake is below that level.

15. That there is in most years surplus water available from Big Stone Lake.

Pursuant to the foregoing findings of fact, the Commissioner CONCLUDES AND ORDERS:

CONCLUSIONS

I

That a permit be granted to the applicants pursuant to Minnesota Statutes 1969, Chapter 105, for the following purposes in the manner and upon the terms and conditions hereinafter stated:

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

the volume of water which may be appropriated during certain periods of time.

3. Upon commencement of the construction of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) Detailed plans for the applicants' proposals for alteration of the Big Stone Lake outlet control dam shall be submitted to the States of Minnesota and South Dakota and to the U. S. Corps of Engineers for their review and analysis, and no construction shall be commenced without their written approval.

(b) Submission to the Minnesota Pollution Control Agency of substantiating evidence by the applicants that the proposed work will in no way violate applicable state water quality standards in accordance with provisions of the Water Quality Improvement Act of 1970 and any other applicable water quality requirements of the State of Minnesota.

4. After completion of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) The applicants must secure written approval from the South Dakota-Minnesota Boundary Waters Commission; the States of Minnesota and South Dakota; and the federal government of the number and location of instruments, and methods of determining the mean water level of Big Stone Lake for use in the computer monitoring program. Further, all aspects of the computer monitoring and gate control system

must be approved by the above agencies.

The applicants must provide emergency alternative plans and means of measuring levels and manipulating the outlet controls in the event of mechanical failure or malfunction of any portion of the automated monitoring and control system.

(b) The applicants must submit a plan of operation of the control structure which is in accordance with a coordinated plan of operation to fulfill the project objectives established by the local sponsoring agencies, the States of Minnesota and South Dakota, the federal government, and the South Dakota-Minnesota Boundary Waters Commission.

(c) The applicants' plans must provide for a minimum discharge of at least two (2) cubic feet per second natural river flow, from the Whetstone River into the Minnesota River channel below the Big Stone Lake outlet control structure at all times when there is available flow in the Whetstone River.

5. This permit shall not release the permittees from any liability or obligation imposed by Minnesota Statutes or local ordinances relating thereto and shall remain in force subject to all conditions and limitations now or hereafter imposed by law.

6. This permit is not assignable except with the written consent of the Commissioner of Natural Resources.

7. The Commissioner of Natural Resources shall be notified at least five (5) days in advance of the commencement of the work authorized hereunder.

8. No change shall be made without written permission previously obtained from the Commissioner of Natural Resources in the hydraulic dimensions, capacity or location of any items of

work authorized hereunder.

9. The permittees shall grant access to the site at all reasonable times during and after construction to authorized representatives of the Commissioner of Natural Resources for inspection of the operation authorized hereunder.

10. This permit may be terminated by the Commissioner of Natural Resources, without notice, at any time he deems it necessary for the conservation of the water resources of the state, or in the interest of public health and welfare, or for violation of any of the provisions of this permit.

11. In all cases where the doing by the permittees of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements thereon or interests therein, the permittees, before proceeding herewith, shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all property, rights and interests necessary therefor.

12. This permit is permissive only. No liability shall be imposed upon or incurred by the State of Minnesota or any of its officers, agents or employees, officially or personally, on account of the granting hereof or on account of any damage to any person or property resulting from any act or omission of the permittees or any of their agents, employees, or contractors relating to any matter hereunder. This permit shall not be construed as estopping or limiting any legal claims or right of action of any person against the permittees, their agents, employees, or contractors, for any damage or injury resulting from any such act or omission, or as estopping or limiting any legal claim or right of action of the state against the permittees, their agents, employees, or contractors for violation of or failure to comply with the provisions of the

permit or applicable provisions of law.

13. This permit shall not be construed as establishing any priority of use.

14. Before construction thereof, the permittees shall obtain written approval of the Commissioner of Natural Resources of detailed plans for dams, dikes, pumps and other hydraulic structures authorized hereunder.

15. The permittees shall install such measuring devices as may be required by the Commissioner of Natural Resources to measure hydrologic conditions in the area including but not limited to the flows of the Little Minnesota River above Big Stone Lake, the flows of the Minnesota River below the outlet dam, and of the Whetstone River at Big Stone City.

16. The permittees shall keep records of all water pumped from Big Stone Lake under this permit and shall report the same to the Commissioner in such form and frequency as he shall require.

II

That operations of the applicants, subject to the terms and conditions herein set forth, will not interfere with the waters of Big Stone Lake in a manner which will be detrimental to the public use thereof.

III

That the plans of the applicants, subject to the terms and conditions herein set forth, provide for practical use of the waters of the state and will adequately protect public safety and promote the public welfare.

ORDER

IT IS HEREBY ORDERED, that a permit be granted to the applicants under the terms and conditions set forth in the conclusions herein.

Dated at Saint Paul, Minnesota, this 24th day of February, 1971.

ROBERT L. HERBST
Commissioner of Natural Resources

STATE OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.
(P.A. 70-1182)

P E R M I T

Pursuant to the Findings, Conclusions, and Order of the Commissioner of Natural Resources, dated February [illegible], 1971, a Permit is hereby granted to Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company, subject to the provisions of Minnesota Statutes 1969, Chapter 105, authorizing the permittees to appropriate a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year with maximum rate of withdrawals not to exceed [illegible]00 cubic feet per second for use in the operation of a fossil fueled power plant. All upon the following terms and conditions:

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

the volume of water which may be appropriated during certain periods of time.

3. Upon commencement of the construction of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) Detailed plans for the applicants' proposals for alteration of the Big Stone Lake outlet control dam shall be submitted to the States of Minnesota and South Dakota and to the U. S. Corps of Engineers for their review and analysis, and no construction shall be commenced without their written approval.

(b) Submission to the Minnesota Pollution Control Agency of substantiating evidence by the applicants that the proposed work will in no way violate applicable state water quality standards in accordance with provisions of the Water Quality Improvement Act of 1970 and any other applicable water quality requirements of the State of Minnesota.

4. After completion of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) The applicants must secure written approval from the South Dakota-Minnesota Boundary Waters Commission; the States of Minnesota and South Dakota; and the federal government of the number and location of instruments, and methods of determining the mean water level of Big Stone Lake for use in the computer monitoring program. Further, all aspects of the computer monitoring and gate control system

must be approved by the above agencies.

The applicants must provide emergency alternative plans and means of measuring levels and manipulating the outlet controls in the event of mechanical failure or malfunction of any portion of the automated monitoring and control system.

(b) The applicants must submit a plan of operation of the control structure which is in accordance with a coordinated plan of operation to fulfill the project objectives established by the local sponsoring agencies, the States of Minnesota and South Dakota, the federal government, and the South Dakota-Minnesota Boundary Waters Commission.

(c) The applicants' plans must provide for a minimum discharge of at least two (2) cubic feet per second natural river flow, from the Whetstone River into the Minnesota River channel below the Big Stone Lake outlet control structure at all times when there is available flow in the Whetstone River.

5. This permit shall not release the permittees from any liability or obligation imposed by Minnesota Statutes or local ordinances relating thereto and shall remain in force subject to all conditions and limitations now or hereafter imposed by law.

6. This permit is not assignable except with the written consent of the Commissioner of Natural Resources.

7. The Commissioner of Natural Resources shall be notified at least five (5) days in advance of the commencement of the work authorized hereunder.

8. No change shall be made without written permission previously obtained from the Commissioner of Natural Resources in the hydraulic dimensions, capacity or location of any items of

work authorized hereunder.

9. The permittees shall grant access to the site at all reasonable times during and after construction to authorized representatives of the Commissioner of Natural Resources for inspection of the operation authorized hereunder.

10. This permit may be terminated by the Commissioner of Natural Resources, without notice, at any time he deems it necessary for the conservation of the water resources of the state, or in the interest of public health and welfare, or for violation of any of the provisions of this permit.

11. In all cases where the doing by the permittees of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements thereon or interests therein, the permittees, before proceeding herewith, shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all property, rights and interests necessary therefor.

12. This permit is permissive only. No liability shall be imposed upon or incurred by the State of Minnesota or any of its officers, agents or employees, officially or personally, on account of the granting hereof or on account of any damage to any person or property resulting from any act or omission of the permittees or any of their agents, employees, or contractors relating to any matter hereunder. This permit shall not be construed as estopping or limiting any legal claims or right of action of any person against the permittees, their agents, employees, or contractors, for any damage or injury resulting from any such act or omission, or as estopping or limiting any legal claim or right of action of the state against the permittees, their agents, employees, or contractors for violation of or failure to comply with the provisions of the

permit or applicable provisions of law.

13. This permit shall not be construed as establishing any priority of use.

14. Before construction thereof, the permittees shall obtain written approval of the Commissioner of Natural Resources of detailed plans for dams, dikes, pumps and other hydraulic structures authorized hereunder.

15. The permittees shall install such measuring devices as may be required by the Commissioner of Natural Resources to measure hydrologic conditions in the area including but not limited to the flows of the Little Minnesota River above Big Stone Lake, the flows of the Minnesota River below the outlet dam, and of the Whetstone River at Big Stone City.

16. The permittees shall keep records of all water pumped from Big Stone Lake under this permit and shall report the same to the Commissioner in such form and frequency as he shall require.

Dated at Saint Paul, Minnesota, this 4th day of February, 1971.

ROBERT L. HERBST
Commissioner of Natural Resources

STATE OF MINNESOTA

DEPARTMENT OF NATURAL RESOURCES

In the Matter of the Application of Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company for a permit to appropriate water and to reconstruct and operate a dam and silt barrier necessary to regulate the level of Big Stone Lake, all for the purpose of operating a power plant near Big Stone Lake.
(P.A. 70-1182)

NOTICE OF ORDER

NOTICE IS HEREBY GIVEN, That, after public hearing held pursuant to due notice, the Commissioner of Natural Resources, Robert Herbst, on February [illegible] 1971, made Findings of Fact in the above-entitled matter and thereupon made the following CONCLUSIONS AND ORDER:

CONCLUSIONS

I

That a permit be granted to the applicants pursuant to Minnesota Statutes 1969, Chapter 105, for the following purposes in the manner and upon the terms and conditions hereinafter stated:

1. To pump a volume of water from Big Stone Lake not to exceed 7,000 acre feet per year for cooling purposes in operation of a fossil fueled steam electric generating plant with pumping intakes located 1,320 feet south of the north section line of Section Eight (8), Township One Hundred Twenty-One (121) North, Range Forty-six (46) West, and 1,440 feet east of the west section line of said Section 8, all in Grant County, South Dakota, at volumes based on the time of the year and the level of the lake as follows:

(a) At any time of the year when the water level of Big Stone Lake is above elevation 967 feet project datum, the maximum volume of water appropriated from the lake shall not exceed 198 acre feet during any consecutive 24-hour period.

(b) At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

(c) At any time during May through September when the water level of Big Stone Lake is below elevation 967 feet project datum, no water shall be appropriated from Big Stone Lake.

(d) At any time of the year when the water level of Big Stone Lake is below elevation 966 feet project datum, no water shall be appropriated from Big Stone Lake.

2. Before commencement of any pumping from Big Stone Lake the applicants must secure written approval from the States of Minnesota and South Dakota and the federal government of the number and location of instruments, and methods of calculating the mean water level of Big Stone Lake for use in determining

the volume of water which may be appropriated during certain periods of time.

3. Upon commencement of the construction of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) Detailed plans for the applicants' proposals for alteration of the Big Stone Lake outlet control dam shall be submitted to the States of Minnesota and South Dakota and to the U. S. Corps of Engineers for their review and analysis, and no construction shall be commenced without their written approval.

(b) Submission to the Minnesota Pollution Control Agency of substantiating evidence by the applicants that the proposed work will in no way violate applicable state water quality standards in accordance with provisions of the Water Quality Improvement Act of 1970 and any other applicable water quality requirements of the State of Minnesota.

4. After completion of the federally authorized Big Stone Lake-Whetstone River Project by the U. S. Corps of Engineers the applicants shall comply with the following requirements:

(a) The applicants must secure written approval from the South Dakota-Minnesota Boundary Waters Commission; the States of Minnesota and South Dakota; and the federal government of the number and location of instruments, and methods of determining the mean water level of Big Stone Lake for use in the computer monitoring program. Further, all aspects of the computer monitoring and gate control system

must be approved by the above agencies.

The applicants must provide emergency alternative plans and means of measuring levels and manipulating the outlet controls in the event of mechanical failure or malfunction of any portion of the automated monitoring and control system.

(b) The applicants must submit a plan of operation of the control structure which is in accordance with a coordinated plan of operation to fulfill the project objectives established by the local sponsoring agencies, the States of Minnesota and South Dakota, the federal government, and the South Dakota-Minnesota Boundary Waters Commission.

(c) The applicants' plans must provide for a minimum discharge of at least two (2) cubic feet per second natural river flow, from the Whetstone River into the Minnesota River channel below the Big Stone Lake outlet control structure at all times when there is available flow in the Whetstone River.

5. This permit shall not release the permittees from any liability or obligation imposed by Minnesota Statutes or local ordinances relating thereto and shall remain in force subject to all conditions and limitations now or hereafter imposed by law.

6. This permit is not assignable except with the written consent of the Commissioner of Natural Resources.

7. The Commissioner of Natural Resources shall be notified at least five (5) days in advance of the commencement of the work authorized hereunder.

8. No change shall be made without written permission previously obtained from the Commissioner of Natural Resources in the hydraulic dimensions, capacity or location of any items of

work authorized hereunder.

9. The permittees shall grant access to the site at all reasonable times during and after construction to authorized representatives of the Commissioner of Natural Resources for inspection of the operation authorized hereunder.

10. This permit may be terminated by the Commissioner of Natural Resources, without notice, at any time he deems it necessary for the conservation of the water resources of the state, or in the interest of public health and welfare, or for violation of any of the provisions of this permit.

11. In all cases where the doing by the permittees of anything authorized by this permit shall involve the taking, using, or damaging of any property, rights or interests of any other person or persons, or of any publicly owned lands or improvements thereon or interests therein, the permittees, before proceeding herewith, shall obtain the written consent of all persons, agencies, or authorities concerned, and shall acquire all property, rights and interests necessary therefor.

12. This permit is permissive only. No liability shall be imposed upon or incurred by the State of Minnesota or any of its officers, agents or employees, officially or personally, on account of the granting hereof or on account of any damage to any person or property resulting from any act or omission of the permittees or any of their agents, employees, or contractors relating to any matter hereunder. This permit shall not be construed as estopping or limiting any legal claims or right of action of any person against the permittees, their agents, employees, or contractors, for any damage or injury resulting from any such act or omission, or as estopping or limiting any legal claim or right of action of the state against the permittees, their agents, employees, or contractors for violation of or failure to comply with the provisions of the

permit or applicable provisions of law.

13. This permit shall not be construed as establishing any priority of use.

14. Before construction thereof, the permittees shall obtain written approval of the Commissioner of Natural Resources of detailed plans for dams, dikes, pumps and other hydraulic structures authorized hereunder.

15. The permittees shall install such measuring devices as may be required by the Commissioner of Natural Resources to measure hydrologic conditions in the area including but not limited to the flows of the Little Minnesota River above Big Stone Lake, the flows of the Minnesota River below the outlet dam, and of the Whetstone River at Big Stone City.

16. The permittees shall keep records of all water pumped from Big Stone Lake under this permit and shall report the same to the Commissioner in such form and frequency as he shall require.

II

That operations of the applicants, subject to the terms and conditions herein set forth, will not interfere with the waters of Big Stone Lake in a manner which will be detrimental to the public use thereof.

III

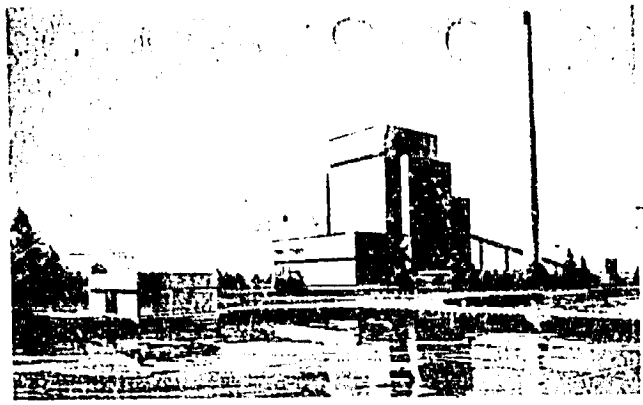
That the plans of the applicants, subject to the terms and conditions herein set forth, provide for practical use of the waters of the state and will adequately protect public safety and promote the public welfare.

ORDER

IT IS HEREBY ORDERED, That a permit be granted pursuant to Minnesota Statutes 1969, Chapter 105, to Northwestern Public Service Company, Montana-Dakota Utilities Company, and Otter Tail Power Company, under the terms and conditions set forth in the Conclusions herein.

Dated at Saint Paul, Minnesota, this 26th day of February, 1971.

ROBERT HERBST
Commissioner of Natural Resources



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMPANY
215 South Cascade Street
Fergus Falls, Minnesota 56537

NORTHWESTERN PUBLIC SERVICE COMPANY
100 Northwestern National Bank Building
Huron, South Dakota 57350

June 30, 1972

STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

Commissioner of Natural Resources
Centennial Office Building
St. Paul, Minnesota 55101
Attention: Mr. Eugene Gere, Director
Division of Waters, Soils and Minerals

Mr. Joseph W. Grimes, Executive Officer
South Dakota Water Resources Commission
State Office Building
Pierre, South Dakota 57501

District Engineer
St. Paul District
Corps of Engineers
1217 U. S. Post Office and Custom House
St. Paul, Minnesota 55101
Attention: Mr. Franklin Ryder, Permit Section

Subject: Big Stone Plant
Big Stone City, South Dakota

Approval of Lake Level
Instrumentation Required by
Minnesota Water Use Permit

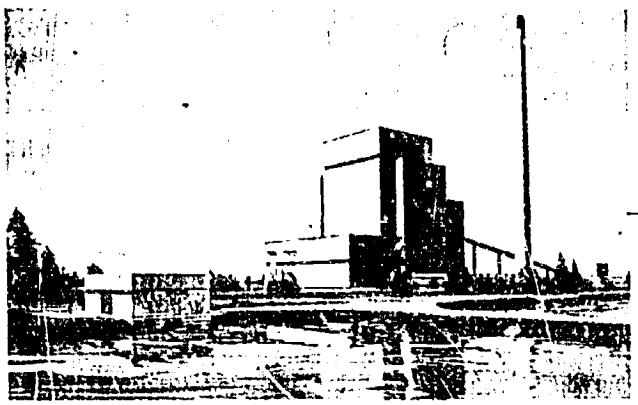
Gentlemen:

The water use permit issued to the Big Stone 440 MW power station by the State of Minnesota, Department of Natural Resources (dated February 25, 1971), requires that before commencement of any pumping the project obtain written approval of the following:

A. The number and location of instruments, and
B. The methods of calculating the mean lake level,

for use in determining the volume of water which may be appropriated during certain periods of time.

Address Reply To: Otter Tail Power Company



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

By this letter, the project requests these approvals from the States of Minnesota and South Dakota and the federal government. Attachment A and its Exhibits set forth in more detail the instrumentation and the methods proposed for measuring the mean lake level. Also shown thereon is the relationship between the U.S.G.S. lake level indicating device which has been used in the published records of the U.S.G.S. publications entitled "Surface Water Supply of the United States, Part 5, Hudson Bay and Upper Mississippi River Basins" [Geological Survey Water-Supply Papers No. 1175 (1950) and No. 1708 (1960)].

We believe that the enclosed information is sufficient to grant the indicated approvals. If additional information is required, please advise.

Based on the present construction schedule, the project plans to start the initial fill of the project's 5,000 acre foot cooling pond early this Fall, beginning about September 15, 1972.

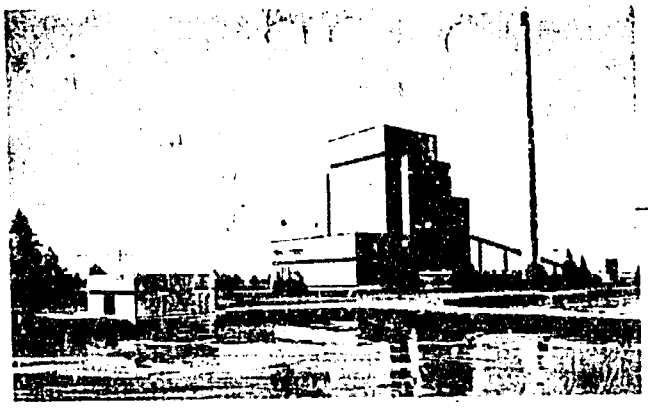
Sincerely yours,

H. R. Cowles
Vice President, Planning
for Otter Tail Power Company
and
Project Manager for the
Big Stone Plant

HRC:ndg

Enclosures

CC: Mr. Robert L. Herbst, Member
South Dakota-Minnesota Boundary Waters Commission
c/o Department of Natural Resources
Centennial Office Building
St. Paul, Minnesota 55101



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

CC: Mr. Robert Hodgins, Member
South Dakota-Minnesota Boundary Waters Commission
c/o Department of Game, Fish and Parks
State Office Building
Pierre, South Dakota 57501

Mr. Joseph W. Grimes, Member
South Dakota-Minnesota Boundary Waters Commission
c/o South Dakota Water Resources Commission
State Office Building
Pierre, South Dakota 57501

Upper Minnesota River Watershed District
Beardsley, Minnesota 56211
Attention: Mr. C. A. Hundeby
Secretary of the Board of Managers

East Dakota Conservancy Sub-District
Brookings, South Dakota 57006
Attention: Mr. Vern Butler

ATTACHMENT A

BIG STONE LAKE INSTRUMENTATION

June 30, 1972

Background

The Big Stone Lake 440 MW electric generation project proposed in their water use applications to instrument the Big Stone Lake characteristics so that the level of the lake could be accurately measured and controlled.

Exhibit 1 to this Attachment A is the basic diagram used to show the project's proposal for instrumenting the lake. The instruments have now been installed and data is being recorded both on the Otter Tail Power Company's Fergus Falls computer printout and at the Otter Tail Power Company's Ortonville Steam Plant.

Details

Three instruments to measure the level of Big Stone Lake are now installed. One is at the upper (north) reaches of the lake, another is approximately halfway down the lake and the third is installed at the lower (south) end of the lake approximately 15 feet east of the existing gage noted on page 179 of U.S. Geological Survey Water-Supply Paper 1708 (U.S.G.S. publication, 1960). U.S.G.S. Water-Supply Paper 1708 notes this gage under Item 2915 entitled "Big Stone Lake at Ortonville, Minnesota." These three (3) gaging stations are hereafter referred to as upper lake station, middle lake station and lower lake station, respectively.

The installed measuring instruments are pressure transducers supplied by the Consolidated Electric Company, identified as Type A-1000, Model 157G. Lake level measurements are converted into electrical impulses which are transmitted over lines leased from Northwestern Bell Telephone Company to Otter Tail's Ortonville Plant and computer at Fergus Falls.

The upper lake station is located on the lake off shore from what is known as "The Randall Farm," (Gov. Lot 1, Section 26, Township 124, Range 49, Roberts County, South Dakota). Exhibit 1 shows the location of the upper station, approximately 2.25 miles south of the north end of Big Stone Lake.

The middle lake station is located near the Minnesota side of the lake at what is known as Bormes Beach (SE corner, Lot 22, Part of Gov. Lot 1, Section 34, Township 123, Range 48, Big Stone County, Minnesota). Exhibit 1 shows the location of the middle station approximately 12.55 lake miles south of the north end of the lake and 14.65 lake miles north of the south end of the lake.

The lower lake station is located near the east side of the circulating water intake structure for the Ortonville Steam Plant of Otter Tail Power Company. This location is on the opposite side of the intake structure to the existing gaging station. The lake levels at the existing gaging stations have been and will continue to be read daily by power plant personnel for the U.S.G.S.

A fourth gaging station will be installed prior to September 1, 1972, at the project's intake structure. This station will be used as a check on the measurements recorded at the lower lake station.

The upper, middle and lower lake level station readings have been transmitted to the computer center at Fergus Falls since February 1, 1972. Hourly records of readings at the three stations since that time are in project files.

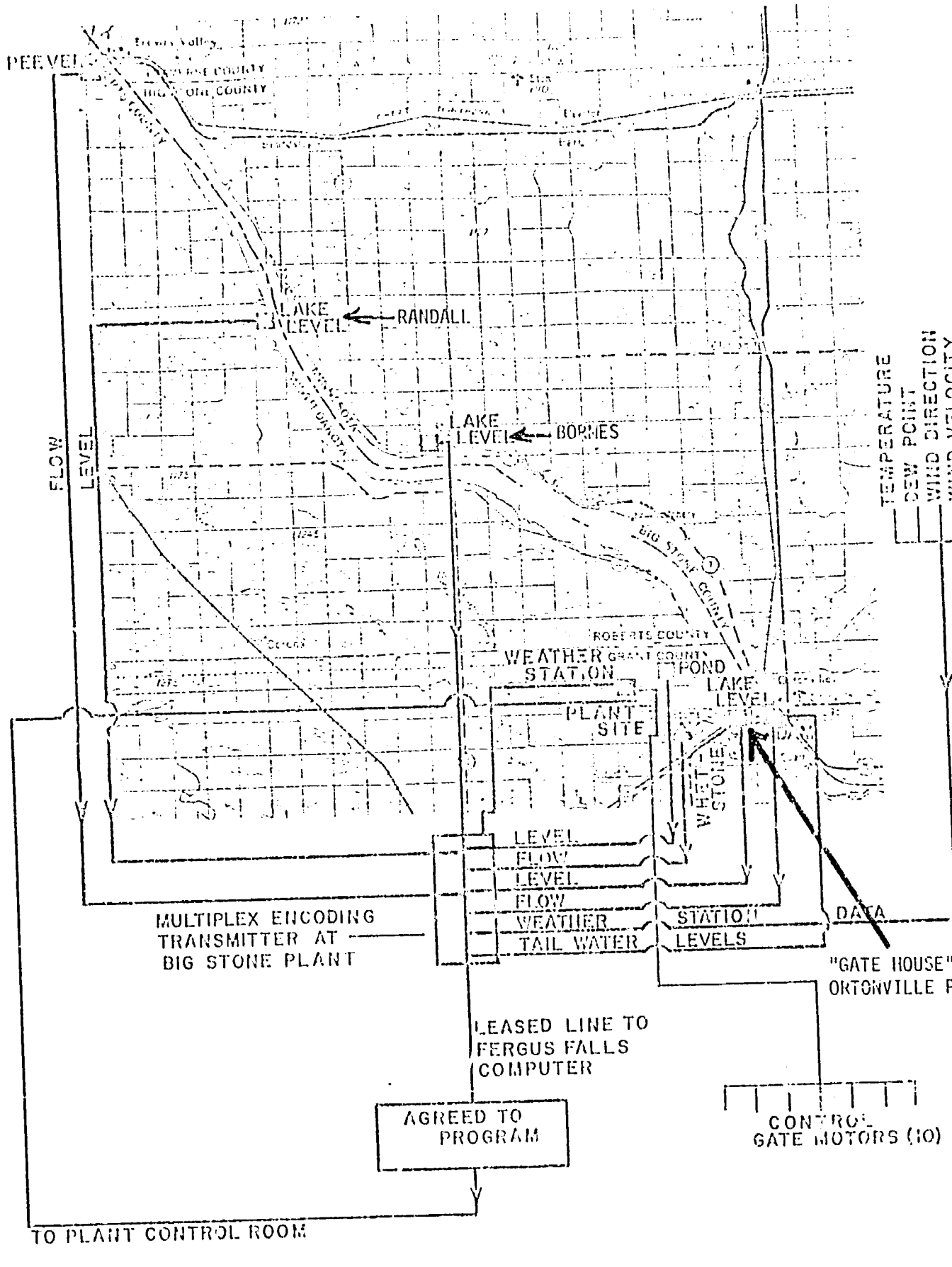
The project proposes

1. To use the hourly lake level printouts to indicate when pumping operations are permitted.

2. To arithmetically average the three (3) level readings as recorded in the Ortonville Power Plant and read by the computer in Fergus Falls. For example, if the upper, middle and lower are 966.99, 967.75 and 968.54 respectively, the average will be 967.76. This illustration is shown on Exhibit 2 to this Attachment A.

Equipment located at the project's intake structure will continuously record pumping rates. A totalizing integrator will supply data on the total amount of water pumped from the lake.

HIBIT
10 ATTACHMENT A
June 30, 1972



△ GAUGING STATION

▣ RECORDING GAUGE

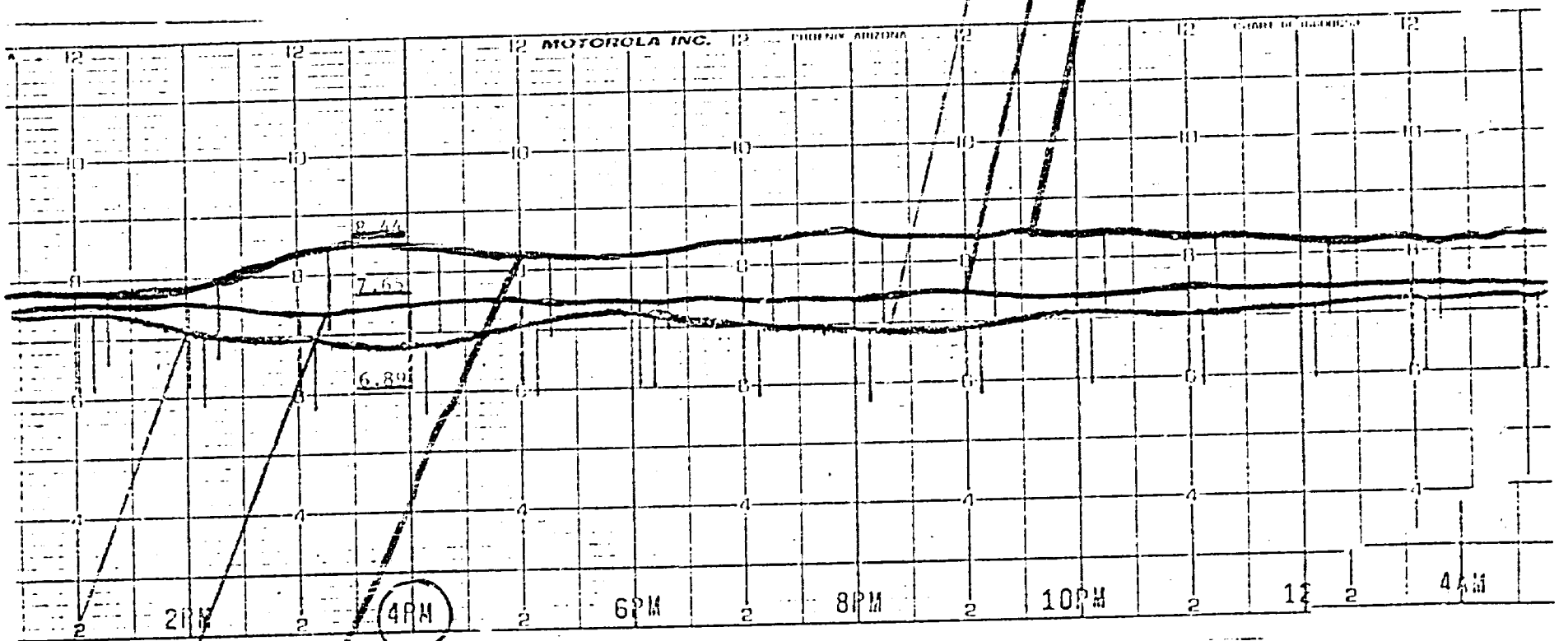
18 AUG. 71

CHART - LOCATED AT ORTONVILLE PLANT

EXHIBIT 2
TO ATTACHMENT A
June 30, 1972

INSTRUMENT LOCATIONS

North - Randall
Mid Lake - Bormes
South - Gate House
Ortonville Plant



WEEKLY AREA PEAK LOAD 547.82 MW 2125 6/17/72
DAILY AREA PEAK LOAD 526.63 MW 1140
HOURLY AREA PEAK LOAD 473.86 MW 1511

DATE 6/29/72 HOUR ENDING -1610

RANDALL	BORMES	GATE HOUSE	DEW POINT	TEMPERATURE	WIND VELOCITY	DIRECTION	PRECIPITATION
6.89	7.65	8.44	53.04	55.59	24.57	102.13	1.02

Computer printout at Fergus Falls

U.S.G.S. benchmark #S-108 zero point is 960.10 project datum.

Example: Average of three readings is 7.66
Gage zero point is 960.10
967.76

August 7, 1972

Mr. H. R. Cowles
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

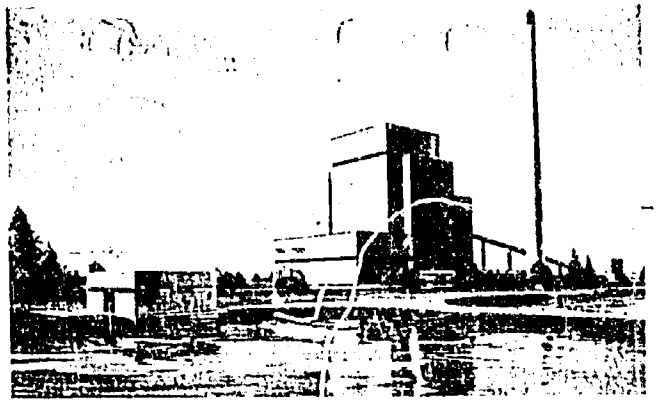
Dear Mr. Cowles:

The monitoring instrumentation and method of determining the mean water surface levels of Big Stone Lake, as set-forth in your letter of June 30, 1972 and its attachments, is approved hereby on behalf of the South Dakota Water Resources Commission.

Sincerely,

J. W. Grimes

JWG:ls



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMPANY
215 South Cascade Street
Fergus Falls, Minnesota 56537

NORTHWESTERN PUBLIC SERVICE COMPANY
100 Northwestern National Bank Building
Huron, South Dakota 57350

October 12, 1972

RECEIVED
OCT 16 1972
STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

Water Resources Commission
State Office Building #2
Pierre, South Dakota 57501

Attention: Mr. J. W. Grimes

Subject: Big Stone Power Plant
Grant County, South Dakota

Re: South Dakota Water Right
Permit #1768-3

Gentlemen:

The Big Stone Power Plant project has now completed the construction work required to take water from Big Stone Lake, the 48" diameter pipeline required to transport the appropriated water and the 5,000 acre foot storage pond located at the point of beneficial use. The construction work is now ready for inspection so that pumping for the initial storage pond fill can commence.

The executed South Dakota Form 10 is enclosed herewith.

A complete set of "as built" construction blueprints are available if the Water Resources Commission requires these prints for completion of the permit file.

The project security system is now in effect. A uniformed watchman is at the project entrance gate, so the State representative will be asked the purpose of the visit. Please have your representative ask for Mr. Al Francis, the owners' site representative, or Mr. George Loizou, Bechtel's Construction Manager.

Sincerely yours,

H. R. Cowles
Project Manager

HRC:ndg

Enclosure

Form 10. No. 1768-3

NOTICE OF COMPLETION OF WORKS AND/OR APPLICATION OF WATER TO BENEFICIAL USE

Post Office Fergus Falls, Minnesota

Date October 12, 1972

TO: Water Resources Commission
State Office Building No. 2
Pierre, South Dakota 57501

Dear Sirs:

This is to inform you that I have completed the construction of the water diversion system and/or that I have put the water to beneficial use to the maximum extent it is going to be used, not exceeding the amounts as specified in Water Right Permit No. 1768-3.

Water Right Permit No. 1768-3 states that the diversion system is to be constructed by September 10, 19 75 and that the water is to be put to beneficial use by September 10, 19 79.

The diversion system was completed on October 10, 19 72. Applying the water for filling and testing the 5,000 acre foot storage pond will begin about October 26, 19 72.

You may schedule an inspection so that the Certificate of Construction and/or the Water License may be issued, thus completing my acquisition of a water right.

(Signature)

Vice President of Otter Tail Power Compar
and duly authorized to sign on behalf of
Northwestern Public Service Company,
Montana-Dakota Utilities Co. and
Otter Tail Power Company

1768-3

October 17, 1972

Mr. H. R. Cowles
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

Dear Mr. Cowles:

Receipt of your letter of October 12, 1972, with attached Notice of Completion of Water Diversion Works under Water Right Permit No. 1768-3 is hereby acknowledged.

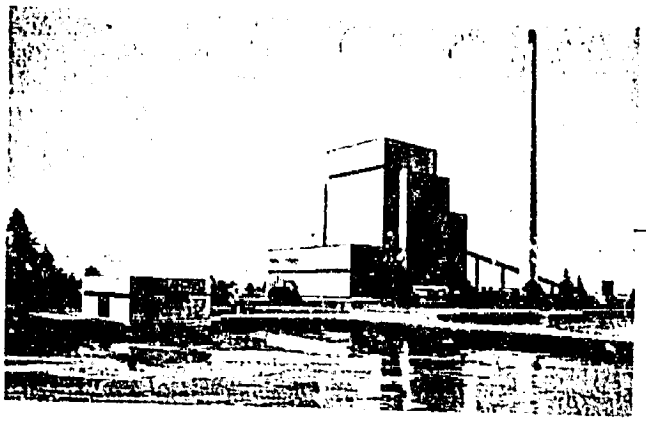
Inspection of the constructed facilities pursuant to SDCL 46-5-27 will be scheduled as soon as possible. If such inspection is not accomplished by the time (about Oct. 26) that you are ready to start pumping water for testing the pumping plant, pipeline, and off-stream storage facilities, you may consider this letter as authorization by this office to proceed with the testing operation. Compliance with the conditions specified in Permit No. 1768-3 for withdrawal of water from Big Stone Lake is expected during such testing of water diversion and storage facilities.

Inspection will be arranged through your Mr. Francis or Mr. Loizou.

Sincerely,

JWG:ls

J. W. Grimes



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMPANY
215 South Cascade Street
Fergus Falls, Minnesota 56537

NORTHWESTERN PUBLIC SERVICE COMPANY
100 Northwestern National Bank Building
Huron, South Dakota 57350

October 18, 1972

RECEIVED
OCT 20 1972
STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

State Water Resources Commission
State Office Building
Pierre, South Dakota 57501

Attention: Mr. J. W. Grimes
Executive Officer and Chief Engineer

Subject: Big Stone Power Plant
Grant County, South Dakota
Permit #1768-3

Gentlemen:

The Big Stone Power Project has been issued two permits covering the annual beneficial use of 7,000 acre feet of water taken from Big Stone Lake. The first is Water Right Permit #1768-3 issued by the State of South Dakota on September 14, 1970. The second is Water Use Permit #P.A.70-1182 issued by the State of Minnesota on February 25, 1971.

These two water permits are similar although several specific qualifying figures are slightly different. The Big Stone Plant Project, via this letter, respectfully requests that the South Dakota Water Resources Commission consider modifying Water Use Permit #1768-3 constraints #2 and #4 to read as follows:

2. At any time during October through April when the water level of Big Stone Lake is above elevation 966 feet project datum but less than elevation 967 feet project datum, the volume of water pumped in any period of seven (7) consecutive days should not exceed 460 acre feet.

4. This permit includes 5,000 acre feet of off-stream storage of water for cooling pond and reserve water supply purposes.

The suggested wording of constraint #2 is taken as written in the State of Minnesota Permit #P.A.70-1182. The request to change this wording, although limiting the water right to lake elevation 966, would permit a more

BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

practical scheduling of pumping operations and supervisions. In addition, the use of the same wording to limit pumping during periods when the lake level is below elevation 967 will eliminate the opportunity for public misunderstanding.

The request to change the 7,000 acre feet storage in constraint #4 to approximately 5,000 acre feet reflects the actual as built reservoir storage capacity. This is a minor detail, but again, both the State and the Project will have eliminated a potential public misunderstanding.

Enclosed for your information is a copy of the Minnesota Department of Natural Resources' Permit #P.A.70-1182. A copy of this permit was sent to the South Dakota State Water Resources Commission via the Project's letter dated February 26, 1971.

Sincerely yours,

H. R. Cowles
Vice President of Otter Tail Power Company and duly authorized to sign on behalf of Northwestern Public Service Company, Montana-Dakota Utilities Co. and Otter Tail Power Company

HRC:ndg

Enclosure

1768-3

1768-3

November 13, 1972

Mr. H. R. Cowles
Vice President
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

Dear Mr. Cowles:

I am sorry that some confusion has occurred regarding the request of the Big Stone Power Plant for the Water Resources Commission to approve a maximum weekly diversion rate of 460 acre feet of water from Big Stone Lake.

At the meeting in my office on November 11, 1972 it was our understanding that the intent was that the request would be for a continuous rate of 10 cubic feet per second or its weekly equivalent. The weekly equivalent would be about 140 acre feet.

For the lake levels involved, the original application was for 10 c.f.s. This diversion rate was approved and the permit (No. 1768-3) further stipulated that the water could be diverted at a daily equivalent of 10 c.f.s. However South Dakota statutes do not allow the Commission to approve a diversion rate larger than the rate applied for in the original application, or its equivalent. This weekly diversion of 140 acre feet could have been approved by the Commission, under the original application, but not the requested weekly 460 acre feet diversion.

As was discussed with Orville B. Johnson, a new application can be made for the additional diversion of water. Mr. Johnson indicated this would be done. If such application is made, this office would prefer that the application be for the additional water needed, rather than a new application for the entire diversion of water. Enclosed for your consideration is a copy of a guideline application.

In the processing of South Dakota water permits inspection is made of the constructed works. Storage capacities as determined in such inspections, not exceeding the original application amounts, become the final water right capacities.

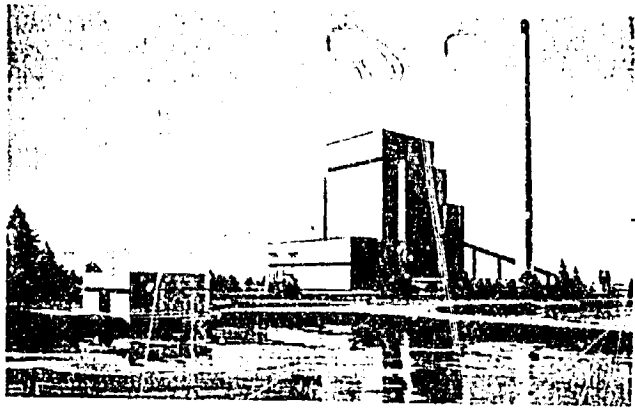
You will soon be receiving notice that the inspection of the water diversion and storage works have been completed and that upon payment of the required fee, the "Certificate of Construction" will be issued to you. This "Certificate of Construction" will state that the storage capacity as constructed is 5000 acre feet. This will clear the record and I do not believe it necessary or advisable to modify the original permit to show this change.

If there are any questions, let me know.

Sincerely,

J.W. GRIMES
Executive Officer and
Chief Engineer
Water Resources Commission

JWG/DD/bw
Encl: As stated
cc: Orville B. Johnson, P.E., Otter Tail Power Co., Fergus Falls, Minn.



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMPANY
215 South Cascade Street
Fergus Falls, Minnesota 56537

NORTHWESTERN PUBLIC SERVICE COMPANY
100 Northwestern National Bank Building
Huron, South Dakota 57350

November 21, 1972

Mr. Burton F. Jones
Water Rights Specialist
South Dakota Water Resources Commission
State Office Building #2
Pierre, South Dakota 57501

Subject: Water Right Permit #1768-3

Re: South Dakota Water Resources Commission's Letter Dated November 15, 1972

Dear Mr. Jones:

In accordance with the referenced letter, we are enclosing herewith an Otter Tail Power Company check in the amount of $20. This $20 check is for the fee required for the inspection and the issuing of the Certificate of Construction.

Sincerely yours,

H. R. Cowles
Project Manager

HRC:ndg

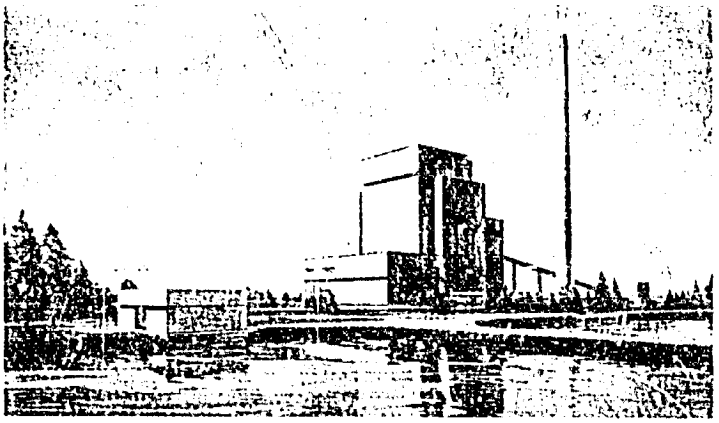
Enclosure

RECEIVED
NOV 24 1972
STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

Address Reply To: Otter Tail Power Company

BIG STONE PLANT

Grant County, South Dakota



PROGRESS REPORT NO. 4

Jointly Owned by:

MONTANA-DAKOTA UTILITIES CO.

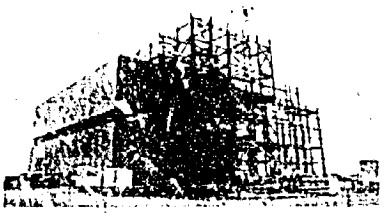
NORTHWESTERN PUBLIC SERVICE COMPANY

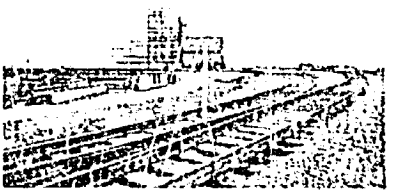
OTTER TAIL POWER COMPANY

440,000 Kilowatts of Added Power for our Three-State Area.

Total Site Size	2,800 Acres
Planned Completion	May, 1975
Cost (present estimate)	Over $120 million
Environmental Controls Cost	Over $15 million
Employees (when operational)	About 55
Engineers-Constructors	Bechtel Corporation
Capability	440,000 Kilowatts

WORK COMPLETED TO DATE





NEARLY FOUR MILLION yards of earth have been moved in completing the railroad spur and cooling pond. Ninety thousand tons of native granite have been installed as riprap along the pond dike and water is now being pumped into the pond.

THE 4¾-MILE RAILROAD SPUR has been completed and is now being used for delivery of plant equipment and materials.

THE MAIN PLANT BUILDING FOUNDATION has been completed, involving approximately 27,000 cubic yards of concrete and 2,500 tons of reinforcing steel. Also completed is the concrete turbine base, which extends to 40 feet above ground floor level.

ERECTION OF STRUCTURAL STEEL has reached the 100-foot level as of November, '72, with more than 3,000 tons of steel now in place. The turbine-generator area of the building has reached its ultimate height of 92 feet and siding is also completed on this portion of the building in order to continue the winter work within this area.

ABOUT 75,000 FEET OF BURIED electrical conduit has been installed and is now ready to accept miles of conductors.

THE CHAIN-LINK SECURITY FENCE is completed, running around the perimeter of the cooling pond and plant site proper. Security guards are on duty 24 hours a day at the main entrance and 8 hours per day at the south (employees') entrance. Proper identification is mandatory in order to gain entrance to the plant site.

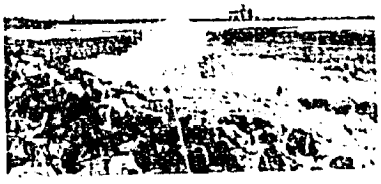
A PUBLIC OBSERVATION POINT, located just outside the security fence at the southeast corner of the cooling pond, has been completed. This impressive overview of the entire site is being developed for the general public's use. An access road and parking lot were finished this fall; landscaping and tree planting will be done in 1973.

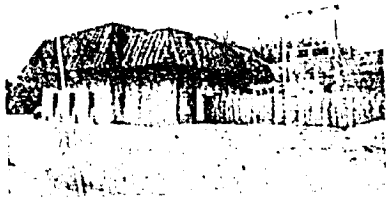
A COMPLETE SANITARY SEWER SYSTEM has been finished and is now in operation. THE POTABLE WATER SYSTEM has also been completed and is operational. These basic utilities are equivalent in size to those necessary to accommodate a small community.

CONTINUED EMPHASIS ON ENVIRONMENTAL concepts is being given by the three companies building the Big Stone Plant By complying with all appropriate standards of the regulatory agencies involved and applying the latest technological know-how available . . the Big Stone Plant is expected to serve as proof that large quantities of electricity can be almost as clean at its point of production as it is at its point of consumption.

APPROXIMATELY 250 WORKERS will continue working during the winter months of 1972-73. Their efforts will be concentrated in two main areas; inside the turbine-generator area (now enclosed and heated) and the continued erection of structural steel. By spring, 1973, the 290-foot height of the boiler area should be finished in order to install the 281-ton boiler drum by that time. Of course, weather will be the big factor which determines the amount of outside work possible.

AS MENTIONED IN PREVIOUS REPORTS, a number of other important projects have been completed. All major plant components have already been ordered (more than $65 million worth); a weather station has been operational for three years; lake level and river flow monitoring stations have been installed; four air quality measuring stations are in service and a ground water testing program has been implemented.





THE LAKE INTAKE PUMPING STRUCTURE and attendant 7,300 feet of buried 48-inch pipeline is now completed and operational. Pumping of water into the cooling pond began on a limited basis in November, '72, although the cooling pond will not be filled until spring runoff occurs in 1973.

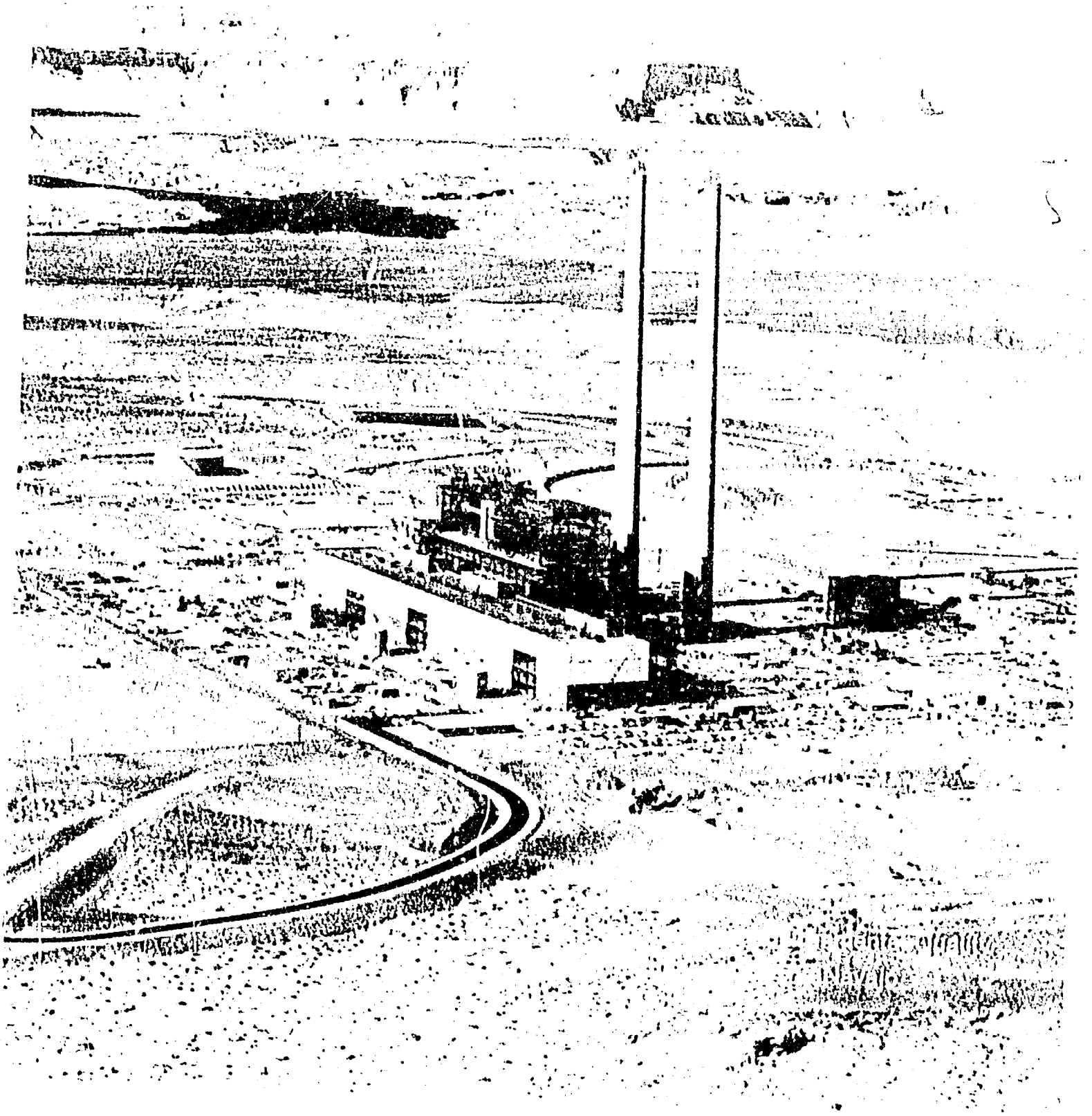
While the present level of Big Stone Lake would allow nearly unlimited pumping, the two large pumps of 1,500-horsepower each are being operated only eight hours per day; the small, 250-horsepower pump is run during the other 16 hours per day. At this rate only a portion of the cooling pond's bottom will be covered this winter. Next year, when the pond is filled, it will have an average depth of 14 feet; certain areas of the pond will be more than 20 feet deep. When full, the pond will hold more than 5,000 acre-feet of water.

AN ORDER FOR ELECTROSTATIC PRECIPITATORS is being determined at this time. It has now been determined that the stack height will be about 500 feet, rather than 600 feet as first estimated.

DURING 1973, NEARLY 600 WORKERS may be employed at the plant site when construction of the impressive coal-handling equipment begins and installation of the electrostatic precipitators is started.

TO DATE, CONSTRUCTION IS CONSIDERED TO BE ON SCHEDULE.

PAMPHLET NO. 4
DECEMBER, 1972
NWPS-3M



Bechtel Briefs

In This Issue

3 Nuclear Standardization

4 The Big Stone Power Plant

6 Building a Team

8 Top Management Title Changes

9 Moments From History

10 Arizona's Navajo Plant

14 The Surigao Nickel Refinery

17 BART Opens The Richmond Line

18 Around Bechtel's World

19 Executive Profiles/ Technical Specialist

VOLUME 28 • NUMBER 3 • MARCH 1973

Paul W. Cane — Manager, Corporate and Community Affairs

William R. Hall — Editor

Denis W. Wade — Assistant Editor

Bryan Remer — Staff Writer

THIS MONTH'S COVER: The Navajo Generating Station is being built amid Arizona's mesas, canyons, and desert plateaus. Unprecedented precautions have been taken to protect this natural setting. The cover photo is by Ray Frayne. The story is on pages 10-13.



PHOTO CREDITS: Bob Wallace, Salt River Project, page 10; U.S. Bureau of Reclamation, pages 11-13.

Published monthly for the employees and friends of the Bechtel group of companies. Permission to reprint from this magazine, in whole or in part, may be obtained by writing to Corporate and Community Affairs Department, Bechtel, P.O. Box 3965, San Francisco, CA 94119.

Standardization For Nuclear Power Plants



HARRY O. REINSCH

The engineer-constructor will always have to bring more than technical ability to the nuclear power field. The legal, environmental, and economic challenges require statesmanlike calm as well as managerial, engineering and construction talent.

While the world energy shortage grows more critical daily, one of the obvious solutions, nuclear power plants, are still being designed and licensed as though each was a totally unique creation, built for the first time from the ground up. This approach, with its changing design criteria and requirements and consequent licensing delays, is resulting in costly schedule extensions and plant modifications. Correcting this situation is a challenge we must undertake.

Starting in 1965 and continuing through the present, the utility industry has made a major commitment to nuclear power. During this period, Bechtel has had design and construction or construction management responsibility for 54 nuclear units, eight of which are now in commercial operation. The "learning curve" from these projects is now clear in many areas and can be translated into a viable standards program which could serve as a starting point for future projects.

We at Bechtel feel this standardization is highly desirable if nuclear power is going to play the predominant role it can in meeting our nation's future energy needs.

The principle behind our standardization proposal is simple. What is accepted at this stage of development in the nuclear field should be accepted for the future unless there are solid reasons for change. The wheel need not be reinvented for each plant.

Bechtel's standards program comprises six key elements, each of which is covered by the highest quality of engineering, procurement, construction and startup operations input. These elements and our approach are:

- Criteria — Participation by senior technical personnel in formulation of codes and standards
- Criteria Application — Generic topical reports
- Basic Systems Design — Generic key design documents
- Physical Layout — Generic-modular plant arrangements
- Licensing — Standard safety analysis reports
- Procurement — Standard specifications

Our standardization program is well under way. And we have apprised the Atomic Energy Commission staff of our efforts and solicited their cooperation in obtaining generic review and approval of those elements over which they have jurisdiction and which could then be applicable to future projects.

Safety, environmental protection and plant reliability require the highest standards of quality control and stringent licensing regulations. However, there is no reason to presume that unwieldy, time-consuming licensing procedures guarantee quality or that nuclear plants cannot be built safely without wasteful reduplication of effort.

We at Bechtel feel our clients should be able to build their plants on the foundation of proven plant designs. Such a starting point would direct more time to refinements and improvements and less time to rediscovering the past.

Standardization makes good sense to a client concerned with improved safety, quality, reliability, reasonable construction schedules and adaptability to varying site conditions. Flexibility is offered within a framework which allows for unique client requirements.

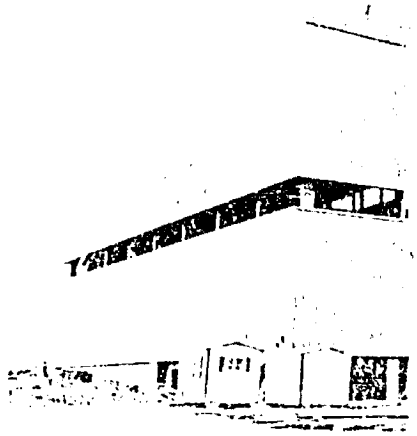
The Atomic Energy Commission and the utility industry are increasingly united in calling for some form of standardization for nuclear power plants. Bechtel's standardization program offers practical solutions to the tangle of problems presently found in nuclear power plant design and construction. □

H. O. Reinsch

Senior Vice President and
Director, Bechtel Power Corporation.



Water froths up in the cooling pond as it is pumped in from nearby Big Stone Lake. The pond will hold more than 5,000 acre-feet of water.



THE BIG STONE POWER PLANT

A determination to meet every ecological requirement as the low sulfur lignite fueled energy source rises on South Dakota's flatlands

Everything about South Dakota's newest electric generating plant is big — including its name.

Big Stone Power Plant, rising 30 stories above the flatlands of eastern South Dakota near Big Stone Lake, is tall because it has to be. The 440,000 kilowatt thermal complex will house one of the biggest boilers ever installed on a Bechtel project and will consume 2½ million tons of lignite annually. The low sulfur lignite must be burned in huge quantities because of its high moisture content and resultant low heating value.

But the Big Stone plant, being designed and constructed by Bechtel's San Francisco Power Division for Otter Tail Power Company, Northwestern Public Service Company and Montana-Dakota Utilities Co., has engineering and architectural refinements that make it big in an environmental sense, too.

"Our clients are determined to meet every ecological requirement," says John Zuttermeister, project engineer for the SF Power Division. The ecological principles guiding construction are simple: leave the lake unchanged, the air clean, the plant quiet and attractive.

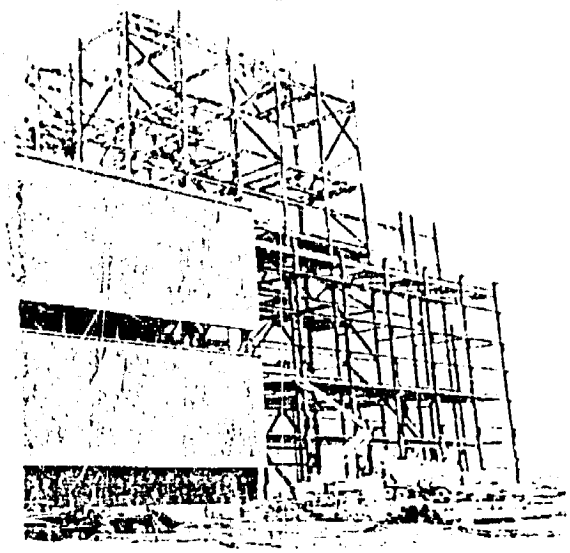
Applications of these principles are imaginative. The lakeside water intake structure, for example, was built behind a curving 200-foot long plastic curtain hung from floats and anchored to the lake bottom like an underwater shower curtain. The innovative curtain prevented any possibility that construction might muddy the lake.

The clients also required a "clean stack" to keep the air clean. As a result, the plant will have a precipitator costing some $9 million to trap fly ash. The 500-foot-tall stack will have essentially no dust plume.

The fly ash itself will not go to waste. The plant is designed to sweep up after itself and transform leavings such as fly ash into useful products — mineral filler for highway construction and concrete additives, for example.

At a time of dwindling energy resources, the use of lignite conserves higher grade fuels. But it also requires huge facilities. "Our clients are very concerned with the architecture of a structure of this size," says Zuttermeister.

The plant will be entirely enclosed to protect it from the severe South Dakota winters, reduce noise and prevent dusting from live coal supplies. Bechtel architects took advantage of the enclosed plant con-



The 30-story high plant will be completely enclosed to reduce noise, prevent dusting from the coal, and to protect against severe winters.



The lake intake structure blends with the nearby lakeside cottages. The roof is of earth-red Cor-ten steel, the walls wood-grain patterned concrete.

cept to give the complex clean lines and a striking highrise effect.

Two horizontal bands of windows, one at the turbine operating floor near the base of the enormous boiler, the other near its top, relieve the mass of the main building. They will give plant personnel a spectacular 20-mile view of Big Stone Lake and the flatlands.

"We designed the lake intake structure to blend with the residential nature of the site," says SF Power architectural group supervisor, Richard Morrison. "The building's 'mansard' sloping roof of earth-red Cor-ten steel and wood-grain patterned concrete walls make it companion to the lakeside cottages. Earth-toned colors were chosen to make the entire complex — plant and auxiliary buildings — compatible with the browns of the Dakota plains."

Plant management plans to enhance the recreational attractions of the lake. "Big Stone Lake has been too high or too low at times," explains Don Milliken, study manager for Bechtel's Hydro & Community Facilities Division. "Part of plant development includes improvement of the lake's dam so that level variations will be much less."

Zuttermeister adds that the project's clients will provide motor operated gates for the lake dam and help maintain the lake level. No water used in the plant will return to the lake. Instead, it will spill into a specially built cooling and storage pond.

Milliken, who conducted a study of the level changes at Big Stone Lake, also helped work out water use agreements with three regulatory agencies. The Lake, straddling the South Dakota-Minnesota border, is governed by agencies of both states and by the Interstate Boundary Water Commission.

"Our clients negotiated complex agreements with these three groups to determine how much water the plant could use at different times and with the lake at different levels. We'll follow the most stringent of the agreements."

Groundbreaking took place at Big Stone Plant last May. During construction, the biggest crane American Hoist and Derrick Company ever built — a Sky Horse with a 350-foot-high boom and an 80-foot-long jib — has loomed next to the growing plant like some great prehistoric animal, a giant tool for a giant project.

But when commercial operation scheduled for May 1975, begins, the plant's clear stack and clean architectural lines and the lake's unclouded waters will show that, at the giant of Big Stone Lake, size isn't everything. □

PERSONNEL

OTTER TAIL POWER COMPANY
R. O. M. Grutle, Vice President, Production and Project Manager.

NORTHWESTERN PUBLIC SERVICE COMPANY
Robert A. Wilkens, Vice President, Operations.

MONTANA-DAKOTA UTILITIES COMPANY
Robert T. Nelson, Superintendent of Power Production.

BECHTEL
Charles F. Hochgesang, project manager; Ronald F. Gibson, engineering manager; John W. Zuttermeister, project engineer; George Loizou, construction manager; Saul Schoenenberger, project superintendent.

First, You Build The Team

The objective is to work in a collaborative, cooperative way within differing systems.



At a team operations seminar in Louisville, Kentucky, Rick Wall (standing) helps managers from Bechtel and its affiliate, C&I/Girdler Incorporated, to clarify their analysis of intercompany practices.

Do companies, like people, have personalities?

Some experts say they do.

These experts also say that companies, like people, can have adjustment periods when they try to work together. Two companies may have different emphasis and practices which take a little understanding before meshing with each other.

Bechtel has introduced a new management concept called Organization Development and Team Training to help the machinery of cooperation and productivity run even smoother.

"On some of our projects, we are seeing the end of an era whereby a services-oriented company like Bechtel can undertake a job and expect the client to sit back while we direct most of the work," says Rick Wall, manpower development manager of the Manpower Planning & Development Department. "For many reasons, an increasingly large number of clients want firsthand involvement in the design and construction of their projects." He continues, "Any two companies' operating differences, if not properly evaluated, may lead to conflicting actions and cross purposes. Our department is now offering Organization Development and Team Training toward a positive objective—building the skills to work in a collaborative, cooperative way."

Social and organization psychology can mold the individuals into a team.

The concept of Organization Development has evolved into a method of applying social and organization psychology to effect change in management skills and to remove barriers to cooperation and productivity. In its present form, Organization Development in general and Team Training in particular help to:

- confront and resolve important organization dilemmas,
- build concrete group problem-solving skills,

FIRST
QUARTERLY PROGRESS REPORT
FOR THE
1973 WATER MONITORING PROGRAM

BIG STONE LAKE POWER PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

April, 1973

Dorand Engineering Services
Brookings, South Dakota

DORAND ENGINEERING SERVICES

James N. Dornbush, DSc
John R. Andersen, PhD

1697 OLWIEN STREET BROOKINGS, SOUTH DAKOTA 57006 605-692-6530

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

April 16, 1973

Gentlemen:

The following is the first quarterly progress report for the second year of the Water Quality Monitoring Program for the Big Stone Power Plant area covering the period, December, 1972, through March, 1973.

1. Samples were collected for analyses on December 18, 1972, January 16, February 19, and March 21, 1973, from 10 wells and 4 surface water sampling stations. The locations of the stations are shown on the enclosed sketch map.

2. The results of the analyses are included in the tables along with a short commentary concerning quality changes that occurred at certain wells during the period.

3. The first of quarterly samples from the plant cooling pond and the small pond northwest of the plant were also collected in February, and results are reported. As expected, the quality of the cooling pond water compares closely with that of Big Stone Lake in December at the time the cooling pond was being filled. The water in the small pond had some rather unusual characteristics as noted in the commentary with the data.

4. In January, power was not connected at Well-1, and, consequently, a sample was not obtained. The February 19 sampling date was a postal holiday, and the delay of shipment resulted in rejection of the bacteriological samples by the laboratory for that month.

5. Air line readings were continued to determine the ground water level elevations at six of the wells sampled. These data are included in an enclosed table. Water levels in Wells 1, 2, 3, and 4 were higher during the quarter than during the previous year. Some quality change was also noted at these wells.

6. Water levels of the well points north of the pond have been measured weekly by company personnel and are included in the report. In recent months, water levels in the three well points toward the west (A,B,C) have not reached the peak elevations observed in June, 1972. Water levels in Well Points D and E have, however, been slightly higher during recent months compared to last year.

Please contact us if there are any questions concerning this report.

Sincerely,

James N. Dornbush
Partner

Enclosures
JND:mfd

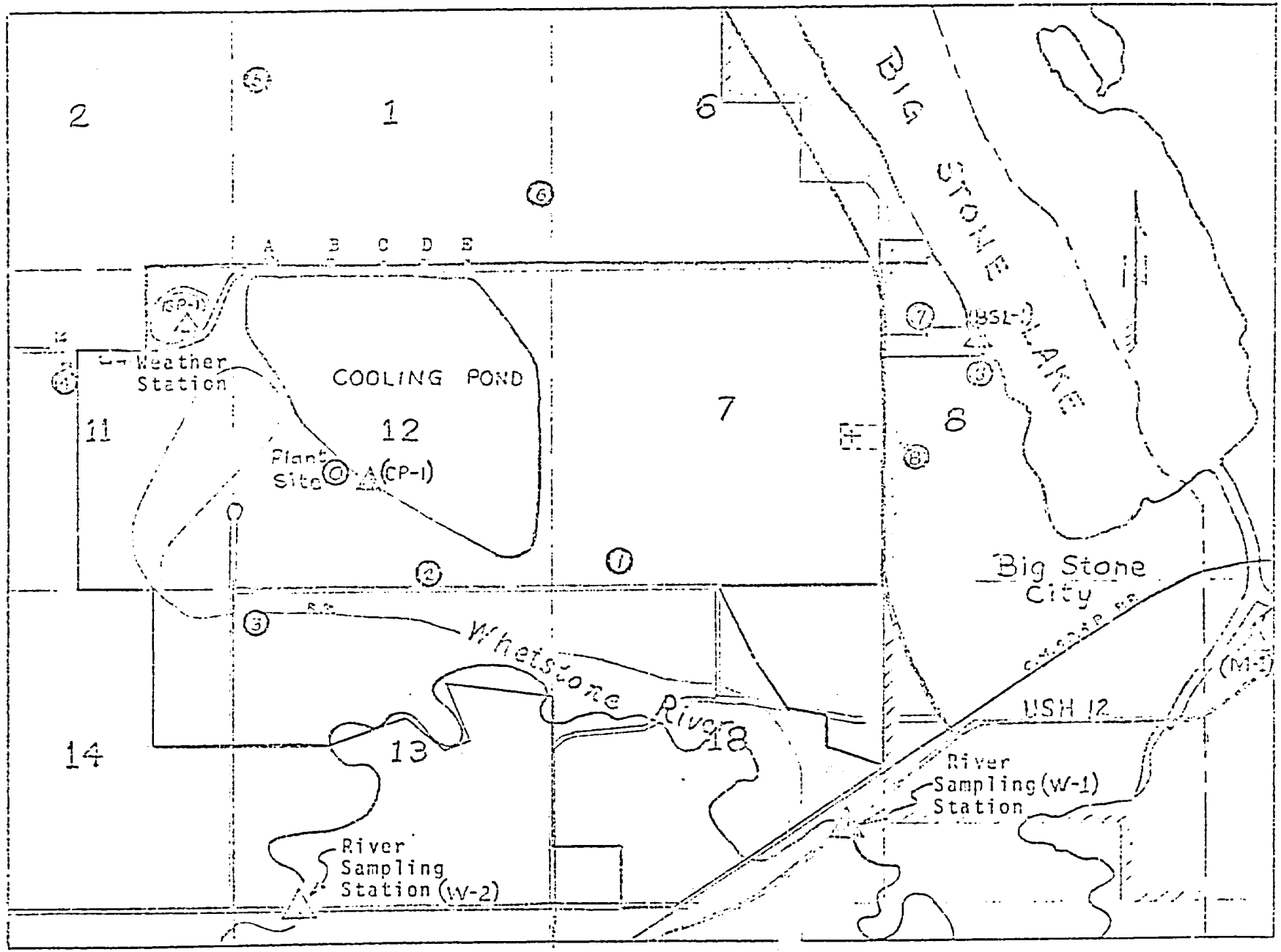


Figure 1 - Sketch map showing water quality monitoring stations at Big Stone power plant site.

Station: Well - 0

PLANT WELL (SW ¼, Sec 12)(Adjacent to cooling pond)

Sampling Dates - (1972-73)

Determinations*	12/18	1/16	2/19	3/21
Temperature - °F	56	53	53	49
pH - units	7.0	7.0	7.0	7.0
Conductivity - µmhos/cm-25°C	1735	1820	1780	1670
Total Hardness	920	870	970	970
Calcium Hardness	630	580	460	620
Sodium		25	31	29
Total Alkalinity	420	424	418	424
Chlorides	1	2	2	2
Sulfates	580	570	580	516
Total Phosphorus	0.03		0.05	
Nitrate Nitrogen	0		0.4	0
Ammonia Nitrogen	1.79		1.60	
Kjeldahl Nitrogen	1.9		1.6	
Total Residue	1326	1389	1361	1359
Coliform Group - MPN/100 ml		5.1		

*Results expressed as mg/l except as noted.

Well - 0 There appeared to be no significant changes in the water quality of this well compared with results from the fall of 1972. Total hardness appeared to have increased slightly.

DERALD HAY FARM (SW ¼, Sec 7)(Southeast of cooling pond on plant site)

Station: Well - 1

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	48	--	47	47
ph - units	7.0	--	7.1	7.1
Conductivity - µmhos/cm-25°C	2040	--	2230	1990
Total Hardness	1040	--	1280	1200
Calcium Hardness	780	--	650	840
Sodium		--	17	11
Total Alkalinity	394	--	416	422
Chlorides	1	--	2	1
Sulfates	780	--	820	680
Total Phosphorus	0.12		0.02	
Nitrate Nitrogen	0		0	0
Ammonia Nitrogen	0.53		0.73	
Kjeldahl Nitrogen	0.6		0.7	
Total Residue	1694	--	1800	1722
Coliform Group - MPN/100 ml		--		

*Results expressed as mg/l except as noted.

Well - 1 The quality of water at this well appeared to be somewhat different from that found during the previous year. Conductivity, total hardness, calcium hardness, sulfates, and total residue values were higher than those found during the previous year. The well is no longer pumped regularly for watering livestock as the tenant moved late last year. This change of water use, that occurred about the same time as the pond was being filled, may have affected water quality.

TRAILER SITE (SE ¼, Sec 12)(South of Cooling Pond)

Station: Well - 2

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	--	49	43	46
pH - units	7.1	6.9	6.9	7.0
Conductivity - μmhos/cm-25°C	2530	3020	3060	2710
Total Hardness	1530	1710	1950	1730
Calcium Hardness	970	1240	1180	1270
Sodium		22	33	28
Total Alkalinity	392	424	406	420
Chlorides	29	37	39	35
Sulfates	1160	1300	1460	1076
Total Phosphorus	0.12		0.00	
Nitrate Nitrogen	0		0	0.1
Ammonia Nitrogen	0.08		1.21	
Kjeldahl Nitrogen	0.9		1.4	
Total Residue	2278	2657	2748	2554
Coliform Group - MPN/100 ml		9.1		

Well - 2 Conductivity, total hardness, sulfates, and total residue values were higher during this quarter than during the previous year. Water from this well has not been used extensively since the water monitoring program began.

*Results expressed as mg/l except as noted.

PARK AT RAILROAD OVERPASS (NW ¼, Sec 13)(Southwest of cooling pond)

Station: Well - 3

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	48	49	50	49
pH - units	7.4	7.2	7.0	7.2
Conductivity - µmhos/cm-25°C	1250	1465	1440	1340
Total Hardness	510	530	600	610
Calcium Hardness	290	310	270	340
Sodium		63	72	80
Total Alkalinity	316	346	336	354
Chlorides	2	3	3	2
Sulfates	260	360	400	304
Total Phosphorus	0.05		0.00	
Nitrate Nitrogen	0		0	0
Ammonia Nitrogen	4.40		4.00	
Kjeldahl Nitrogen	4.4		4.0	
Total Residue	795	1010	1048	1003
Coliform Group - MPN/100 ml		>16		

*Results expressed as mg/l except as noted.

Well - 3 The quality of water from this well determined during the quarter appeared to be quite comparable with the results of the analyses of the first sample collected in February, 1972. Conductivity, total hardness, sulfates, and total residue values during the quarter were, however, higher than those obtained for samples collected during the summer and fall of 1972.

HARRY RUSSMAN FARM (NW ¼, Sec 11)(West of plant site)

Station: Well - 4

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	45	44	47	45
pH - units	6.7	6.8	6.7	6.8
Conductivity - µmhos/cm-25°C	2670	3030	2960	2790
Total Hardness	1620	1670	1850	1760
Calcium Hardness	1200	1260	1140	1370
Sodium		17	23	22
Total Alkalinity	446	436	416	438
Chlorides	40	44	44	42
Sulfates	1240	1130	1240	980
Total Phosphorus	0		0	
Nitrate Nitrogen	17		19	21.5
Ammonia Nitrogen	0.58		1.12	
Kjeldahl Nitrogen	0.9		1.1	
Total Residue	2546	2653	2592	2602
Coliform Group - MPN/100 ml	16	16		

*Results expressed as mg/l except as noted.

Well - 4 Water from this well has been found to be of generally poorer quality than water of most other wells included in the monitoring program. Maximum values for some quality characteristics were found during the quarter, although there does not appear to have been a significant change in quality.

ED LUNDBORG FARM (NW ¼, Sec 1)(North of plant site)

Station: Well - 5

Determination*	Sampling Dates - (1972-73) 12/18	1/16	2/19	3/21
Temperature - °F	47	49	48	47
pH - units	7.0	7.0	7.0	7.0
Conductivity - µmhos/cm-25°C	1725	1770	1770	1670
Total Hardness	840	890	1050	980
Calcium Hardness	580	610	470	610
Sodium		20	22	22
Total Alkalinity	460	452	462	466
Chlorides	3	6	4	5
Sulfates	520	490	520	426
Total Phosphorus	0.02		0	
Nitrate Nitrogen	0.2		0.5	0.2
Ammonia Nitrogen	0.30		0.56	
Kjeldahl Nitrogen	0.4		0.5	
Total Residue	1323	1366	1359	1348
Coliform Group - MPN/100 ml	2.2	<2.2		

*Results expressed as mg/l except as noted.

Well - 5 Water quality at this well appears to be comparable with that found during the previous year. Repeated chlorination of the water system seems to have corrected the unsatisfactory bacteriological quality found in 1972, and nitrates concentrations were also substantially lower.

HENRY KAISER FARM (SE ¼, Sec 1)(Northeast of cooling pond)

Station: Well - 6

Sampling Dates - (1972-73)

Determination	12/18	1/16	2/19	3/21
Temperature - °F	41	46	43	47
pH - units	7.0	7.0	7.0	7.0
Conductivity - μ-mhos/cm-25°C	1420	1570	1550	1470
Total Hardness	820	790	890	860
Calcium Hardness	500	430	390	520
Sodium		20	21	20
Total Alkalinity	436	464	458	462
Chlorides	3	3	3	2
Sulfates	440	440	380	316
Total Phosphorus	0.05		0.02	
Nitrate Nitrogen	0.1		0	0
Ammonia Nitrogen	0.37		0.44	
Kjeldahl Nitrogen	0.4		0.4	
Total Residue	1155	1191	1170	1149
Coliform Group - MPN/100 ml		<2.2		

*Results expressed as mg/l except as noted.

Well - 6 Water quality at this well appears to be comparable to that found in 1972, and no change in water quality is indicated.

UNITED METHODIST CAMP (NW ¼, Sec 8)(Northeast of plant site on Big Stone Lake)

Station: Well - 7

Sampling Dates - (1972-73)

Determinations*	12/18	1/16	2/19	3/21
Temperature - °F	50	49	54	53
pH - units	7.2	7.2	7.1	7.2
Conductivity - µmhos/cm-25°C	1470	1550	1600	1470
Total Hardness	750	720	900	880
Calcium Hardness	440	460	410	510
Sodium		22	28	22
Total Alkalinity	398	432	444	440
Chlorides	1	2	1	2
Sulfates	360	390	380	336
Total Phosphorus	0.07		0.02	
Nitrate Nitrogen	0		0	0
Ammonia Nitrogen	0.72		0.69	
Kjeldahl Nitrogen	1.1		1.1	
Total Residue	1133	1198	1231	1182
Coliform Group - MPN/100 ml		<2.2		

Well - 7 There appears to have been no important quality change at this well during the quarter as the results of analyses are comparable to those obtained in 1972.

*Results expressed as mg/l except as noted.

MRS. MATTIE BENSON FARM (SW ¼, Sec 8)(East of plant site and cemetery)

Station: Well - 8

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	49	46	46	44
pH - units	7.2	7.2	7.1	7.1
Conductivity - micromhos/cm-25°C	1560	1610	1600	1510
Total Hardness	800	730	900	810
Calcium Hardness	550	500	410	560
Sodium		20	28	18
Total Alkalinity	438	438	444	438
Chlorides	1	2	1	1
Sulfates	440	390	380	346
Total Phosphorus	0		0.02	
Nitrate Nitrogen	0		0	0
Ammonia Nitrogen	0.87		0.69	
Kjeldahl Nitrogen	1.0		1.1	
Total Residue	1190	1205	1231	1196
Coliform Group - MPN/100 ml		<2.2		

Well - 8 Water quality at this well appears to be comparable to that found in 1972.

*Results expressed as mg/l except as noted.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec 8)(Near lake - south of intake)

Station: Well - 9

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	51	44	51	50
pH - units	7.1	7.2	7.1	7.0
Conductivity - µmhos/cm-25°C	1170	1220	1210	1145
Total Hardness	540	500	580	590
Calcium Hardness	430	320	290	340
Sodium		36	37	35
Total Alkalinity	258	276	264	268
Chlorides	12	16	20	17
Sulfates	320	280	320	260
Total Phosphorus	0		0	
Nitrate Nitrogen	0.3		0	0.1
Ammonia Nitrogen	0.15		0.30	
Kjeldahl Nitrogen	0.3		0.40	
Total Residue	824	862	851	855
Coliform Group - MPN/100 ml				

Well - 9 Water quality at this well appears to be about the same as that found in 1972.

*Results expressed as mg/l except as noted.

BIG STONE LAKE (at lake intake)

Station: BSL - 1

Sampling Dates - (1972-73)

Determination*	12/18	1/16	2/19	3/21
Temperature - °F	34	34	36	44
pH - units	8.1	7.8	7.7	8.3
Conductivity - μmhos/cm-25°C	1110	1150	1160	760
Total Hardness	430	440	500	290
Calcium Hardness	260	210	230	170
Boron		42	51	25
Total Alkalinity	168	178	198	128
Chlorides	14	15	16	5
Sulfates	300	350	342	144
Total Phosphorus	0.03	0.05	0.02	0.18
Nitrate Nitrogen	0.1	2.0	0	0.2
Ammonia Nitrogen	0.53	0.04	0.47	0.56
Kjeldahl Nitrogen	1.3	1.0	1.9	2.1
Total Residue	752	798	837	451
Total Suspended Matter	1	3	1	15
Dissolved Oxygen	9.4	6.4	7.1	14.5
Biochemical Oxygen Demand	4	2	2	13
Turbidity	5.9	5.8	0.6	2.8
Coliform Group - MPN/100 ml	<5	<5		15
Fecal Coliforms - MPN/100 ml	<3	<3		6

*Results expressed as mg/l except as noted.

BSL - 1 For Big Stone Lake, nearly every water quality value obtained during the quarter fell within the range of values found during the 1972 monitoring year. One exception was the dissolved oxygen concentration of 6.4 found in January which is the minimum value observed during the monitoring program. The water quality on March 21, 1973, when the ice cover was melting, was substantially better than the quality during the winter and compares with that observed in early April, 1972.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Sampling Dates - (1972-73)

Determination*	12/15	1/16	2/19	3/21
Temperature - °F	34	34	38	45
pH - units	6.9	7.6	7.7	7.8
Conductivity - µmhos/cm-25°C	1560	1465	1260	930
Total Hardness	670	520	540	460
Calcium Hardness	450	390	290	220
Sodium		54	53	41
Total Alkalinity	340	354	238	170
Chlorides	31	36	20	9
Sulfates	400	360	320	220
Total Phosphorus	0.30	0.35	0.02	0.13
Nitrate Nitrogen	0.3	2.5	0.2	0.1
Ammonia Nitrogen	0.57	0.04	0.78	0.56
Kjeldahl Nitrogen	1.0	1.0	1.4	1.8
Total Residue	881	1047	894	696
Total Suspended Matter	4	2	10	19
Dissolved Oxygen	10.0	9.7	6.3	9.0
Biochemical Oxygen Demand	2	4	2	4
Turbidity	4.6	11.6	1.5	2.1
Coliform Group - MPN/100 ml	50	75		20
Fecal Coliforms - MPN/100 ml	6	18		<3

*Results expressed as mg/l except as noted.

M - 1 The water quality of the Minnesota River is subject to wide variations. Because the quality reflects that of both the Whetstone River and Big Stone Lake, the relative flow from these sources probably influences the quality at this point. The results of most quality determinations for the Minnesota River during the quarter were within the range observed during the previous year.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City) Station: W - 1

Determination*	Sampling Dates - (1972-73) 12/18	1/16	2/19	3/21
Temperature - °F	32	34	33	46
pH - units	7.6	7.6	7.6	8.1
Conductivity - µmhos/cm-25°C	1500	1485	1440	1015
Total Hardness	660	640	640	570
Calcium Hardness	460	450	390	320
Sodium		63	56	33
Total Alkalinity	346	356	330	236
Chlorides	31	36	21	10
Sulfates	400	350	364	236
Total Phosphorus	0.27	0.37	0.50	0.18
Nitrate Nitrogen	1.4	2.6	0.2	0.8
Ammonia Nitrogen	0.32	0.0	0.16	0.25
Kjeldahl Nitrogen	0.5	0.3	1.4	1.0
Total Residue	1051	1036	924	769
Total Suspended Matter	9	2	7	19
Dissolved Oxygen	11.2	10.5	9.1	11.7
Biochemical Oxygen Demand	4	3	3	4
Turbidity	4.6	14	2.8	4.2
Coliform Group - MPN/100 ml	30	120		65
Fecal Coliforms - MPN/100 ml	30	6		6

*Results expressed as mg/l except as noted.

W - 1 and W - 2 The results of nearly every water quality determination for the Whetstone River during [illegible] quarter fell within the range observed during the previous year.

WHETSTONE RIVER (On county road 1½ miles south of plant site)

Determination*	Sampling Dates - (1972-73) 12/18	1/16	2/19	3/21
Temperature - °F	32	32	32	39
pH - units	7.6	7.6	7.6	8.0
Conductivity - µmhos/cm-25°C	1560	1495	1360	1030
Total Hardness	650	660	670	490
Calcium Hardness	450	380	400	320
Sodium		63	56	34
Total Alkalinity	360	338	334	232
Chlorides	31	37	30	6
Sulfates	400	360	364	238
Total Phosphorus	0.32	0.54	0.62	0.20
Nitrate Nitrogen	1.0	2.62	0.4	0.5
Ammonia Nitrogen	0.33	0.00	0.90	0.28
Kjeldahl Nitrogen	0.5	0.3	1.0	1.1
Total Residue	1066	1051	1056	779
Total Suspended Matter	6	3	6	22
Dissolved Oxygen	9.4	9.2	9.5	11.4
Biochemical Oxygen Demand	4	4	3	4
Turbidity	4	12	2.5	3.2
Coliform Group - MPN/100 ml	45	40		40
Fecal Coliforms - MPN/100 ml	10	20		33

*Results expressed as mg/l except as noted.

SMALL POND (NE ¼, Sec 11)(Northwest of plant)

Station: SP - 1

Sampling Dates - (1972-73)

Determination*	2/19
Temperature - °F	32
pH - units	7.4
Conductivity - µmhos/cm-25°C	785
Total Hardness	320
Calcium Hardness	180
Sodium	5
Total Alkalinity	330
Chlorides	8
Sulfates	3
Total Phosphorus	0.23
Nitrate Nitrogen	0.1
Ammonia Nitrogen	0.27
Kjeldahl Nitrogen	2.3
Total Residue	458
Total Suspended Matter	32
Dissolved Oxygen	1.6
Biochemical Oxygen Demand	11
Turbidity	4.3
Coliform Group - MPN/100 ml	
Fecal Coliforms - MPN/100 ml	

*Results expressed as mg/l except as noted.

SP - 1 The ice cover on the small pond during February was about 18 inches. The water was of substantially better chemical quality than all other surface water samples collected in the area. Sulfates in particular were extremely low. The dissolved oxygen concentration was also low, although low dissolved oxygen is not particularly unusual for a shallow pond with heavy ice cover.

COOLING POND (at plant intake structure)

Determination*	Sampling Dates - (1972-73) 2/19
Temperature - °F	32
pH - units	7.9
Conductivity - μmhos/cm-25°C	1070
Total Hardness	440
Calcium Hardness	190
Sodium	50
Total Alkalinity	165
Chlorides	15
Sulfates	306
Total Phosphorus	0.02
Nitrate Nitrogen	0
Ammonia Nitrogen	0.50
Kjeldahl Nitrogen	1.3
Total Residue	750
Total Suspended Matter	1
Dissolved Oxygen	9.1
Biochemical Oxygen Demand	3
Turbidity	0.3
Coliform Group - MPN/100 ml	
Fecal Coliforms - MPN/100 ml	

*Results expressed as mg/l except as noted.

Elevations of the Ground Water Table*
Big Stone Power Plant Area
Big Stone City, South Dakota

Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
1972						
September 12	1024.91	1055.49	--------	1065.90	1061.61	970.91
October 17	1024.91	1054.82	1034.86	1065.15	1060.44	970.58
November 14	1024.91	1054.74	1035.86	1064.65	1057.86	970.83
December 18	1025.66	1056.07	1036.77	1064.81	1059.94	971.41
1973						
January 16	1025.91	1055.57	1037.11	>1065.71	1059.77	971.66
February 19	1025.49	1056.24	1036.94	1065.65	1058.94	971.33
March 21	1025.41	1056.24	1036.61	1066.15	1059.77	971.41

*All elevations are above "sea level datum."

DATE	WELL POINTS ALONG COUNTY ROAD NORTH OF FIELD									
	A		B		C		D		E	
	Reading From Top	Water Elev. M.S.L.	Reading From Top	Water Elev. M.S.L.	Reading From Top	Water Elev. M.S.L.	Reading From Top	Water Elev. M.S.L.	Reading From Top	Water Elev. M.S.L.
11-14-72		1,110.40		1,111.66		1,109.65		1,107.11		1,106.48
11-28-72	8.92	1,108.96	6.75	1,110.04	7.00	1,109.37	7.58	1,107.76	7.33	1,107.11
12-06-72	9.25	1,108.63	7.03	1,108.71	7.33	1,108.74	7.33	1,105.81	7.00	1,107.44
12-13-72	9.08	1,108.80	7.04	1,109.75	7.37	1,108.70	7.37	1,105.57	8.13	1,105.81
12-19-72	9.17	1,108.71	7.04	1,109.75	7.50	1,108.57	7.61	1,105.53	8.21	1,105.73
12-27-72	9.46	1,108.42	7.50	1,109.29	7.84	1,108.53	8.12	1,105.32	8.50	1,105.44
1-05-73	9.75	1,108.13	6.87	1,109.92	7.12	1,108.95	8.12	1,105.32	8.50	1,105.44
1-10-73	9.33	1,108.55	6.66	1,110.13	7.27	1,108.80	6.17	1,107.27	8.58	1,105.36
1-15-73	9.5[illegible]	1,108.31	6.66	1,110.13	7.25	1,108.82	5.91	1,107.53	8.57	1,105.37
1-23-73	9.50	1,108.38	6.33	1,110.46	6.91	1,109.16	5.57	1,107.87	8.50	1,105.44
1-30-73	9.0[illegible]	1,108.88	5.83	1,110.96	5.42	1,110.65	5.09	1,108.35	8.42	1,105.52
2-06-73	9.1[illegible]	1,108.71	5.66	1,111.13	6.17	1,109.90	4.66	1,108.78	8.42	1,105.52
2-16-73	9.2[illegible]	1,108.63	5.75	1,111.04	6.50	1,109.57	4.42	1,109.02	8.25	1,105.69

NOTE: All water elevations are determined by subtracting the readings from the following elevations:

A. 1,117.88

B. 1,116.79

C. 1,116.77

D. 1,113.44

E. 1,111.94

DATE	Well points along county road north of Cold									
	A		B		C		D		E	
	Head, Feet	Water Elev.	Head, Feet	Water Elev.	Head, Feet	Water Elev.	Head, Feet	Water Elev.	Head, Feet	Water Elev.
2-21-73	8.91	1,103.97	5.33	1,111.46	6.08	1,109.99	4.33	1,109.11	8.17	1,103.77
3-01-73	5.58	1,112.30	4.17	1,112.62	4.92	1,111.16	4.58	1,109.86	2.58	1,109.36
3-06-73	4.33	1,113.55	3.00	1,113.79	4.17	1,111.90	3.17	1,110.27	2.25	1,109.69
3-13-73	3.83	1,114.05	2.66	1,114.13	4.08	1,111.99	3.00	1,110.44	2.33	1,109.61
3-20-73	4.58	1,113.30	3.00	1,113.79	4.08	1,111.99	3.00	1,110.44	2.50	1,109.44

NOTE: All water elevations are determined by subtracting the readings from the following elevations:

A. 1,117.88

B. 1,116.79

C. 1,116.07

D. 1,113.44

E. 1,111.94

* Ditch fill of water

ENVIRONMENTAL IMPACT STATEMENT

FOR WATER APPROPRIATION

PROPOSED BRUSH CREEK DAM, SOUTH COYOTE CREEK DAM

AND TWO POINTS OF DIVERSION FOR WATER FROM THE KNIFE RIVER

MONTANA-DAKOTA UTILITIES CO.

Mercer County, North Dakota

1 March 1974

ENVIRONMENTAL IMPACT STATEMENT

FOR WATER APPROPRIATION

PROPOSED BRUSH CREEK DAM, SOUTH COYOTE CREEK DAM and TWO POINTS OF DIVERSION FOR WATER FROM THE KNIFE RIVER

Mercer County, North Dakota

1 March 1974

This environmental impact statement has been prepared to complement the application of Montana-Dakota Utilities Co., 400 North Fourth Street, Bismarck, North Dakota, 58501, for diversion of 47,628 acre-feet of water in storage to be used as cooling water for the development of a power generating complex near applicant's South Beulah mine, together with an additional 22,500 acre-feet of makeup water, annually, to be taken from Brush Creek, South Coyote Creek, and Knife River (See maps, Exhibits A & B).

The "Plan of Water & Related Land Resources Development for the Knife River Basin", prepared by the North Dakota State Water Commission in 1971, under State Water Commission project #232, is incorporated in this environmental impact statement herewith by reference.

Applicant is the principal power supplier for an area of about 168,100 square miles containing approximately 514,000 people. MDU generates, transmits, and sells power through its distribution systems in communities in North Dakota, South Dakota, Montana, and Wyoming. The distribution systems owned and supplied by MDU consist principally of municipalities in each of the four states including Ellendale, Wishek, Tappen, Beulah, Killdeer, Kenmare, Crosby, Mohall, Watford City, Bowman, Mott, Mandan, Bismarck, Hettinger, New England, Williston, Dickinson,

North Dakota; Glendive, Wolf Point, Miles City, Forsyth, Sidney, Baker, Scobey, Plentywood, Montana; Lemmon, McIntosh, Mobridge, Gettysburg, Ipswich, South Dakota; and Sheridan, Wyoming.

These distribution systems supply 176 communities, serving more than 84,391 electric customers including homes, farms, businesses, and most of the region's industry.

The importance of the MDU power system is by no means limited to electric customers in the area. MDU also buys, produces, transports, and distributes natural gas to 119 communities serving more than 123,388 customers and distributing 61 billion cubic feet of gas annually. The MDU system has 238,800 kilowatts of presently installed generating capacity, and is interconnected at sixteen points with neighboring systems in the MAPP power pool and two systems not associated with MAPP. Thus MDU is part of the power network, and in a time of power emergencies operation of the MDU system can exert an impact on the power supply throughout this region, including states of Minnesota, North Dakota, South Dakota, Montana, Wyoming, and other states.

Increased emphasis has been placed in recent years on installation of fossil fuel plants to meet the growing electric power needs of the region. Nuclear power plants have not yet been considered feasible for this system. Limited use has been made of gas and fuel oil turbine generation but the general shortage of natural gas and fuel oil makes future installations of gas-oil turbines improbable.

Although it is inevitable that there be some impact on the natural environment associated with generation, transmission, and use of electric power, nevertheless the use of electric power has favorable impact on the human environment which more than compensates for the limited unfavorable impact. MDU has in the past taken the necessary steps to comply with all applicable state and federal laws related to protection of the environment, and will continue to do so.

This impact statement is submitted for utilization by the North Dakota Water Commission and relates basically to the impact that the water permit, if granted, will have on the waters and associated environment. MDU will comply fully with all applicable federal and state laws requiring detailed environmental impact statements when it applies for and/or commences construction of generating facilities.

The fuel for MDU's generating facilities as well as the fuel for other companies generating electricity is supplied by the Knife River Coal Mining Company. Knife River Coal Mining Company owns a reliable reserve of low sulfur coal sufficien- to supply the generating requirements contemplated by this project. This fuel is available at the site of the proposed generation facilities. The coal is produced by surface mining methods commonly employed in the state of North Dakota, with full compliance with all reclamation laws. Knife River Coal Mining Company has long been a leader in the region in researching and developing proper methods of mined land reclamation and has extensive programs underway for the full reclamation of lands being disturbed as well as lands disturbed in previous years. In Knife River Coal Mining

Company's reclamation program, all mined lands are reclaimed to equal or exceed the usage of the surface prior to mining, with lands being leveled, topsoil replaced, and vegetation re-established.

The principal area affected by the proposed diversion of water is indicated on Exhibit C and affects an area of 132 square miles in Mercer and Oliver Counties, North Dakota (the entire watershed area). The secondary area affected by this same diversion of water would indirectly include the entire system of MDU because of the availability of additional energy to the entire system and the communities and systems in this vast area. MDU's long term policy is to utilize low sulfur coal in the generation of the necessary electric power to meet the growing energy demands of its system.

SOUTH BEULAH POWER GENERATION COMPLEX

MDU plans to construct a power generating complex having a total capacity of 1,320 megawatts at a site three miles southwest of Beulah, and one and one-half miles west of North Dakota state highway 49. The site is also immediately adjacent to a railroad spur, providing rail access.

The proposed overall plan considers the installation of a three-unit plant with the first unit to be constructed by 1981 and the second unit by 1985.

It is expected that the first unit will be comparable to the 440 megawatt unit being constructed at Big Stone, South Dakota (see picture Exhibit D). A 440 megawatt plant will employ between 50 and 55 people

on a permanent basis. During construction the peak number of construction workers will be approximately 700 people. Planning and actual plant construction will require about eight years.

The plant site is adjacent to the Brush Creek reservoir (see map Exhibit E) and to the Knife River Coal Mining Company's tipple. The Brush Creek reservoir will permit dissipation of heat from the generating plant. The reservoir will also provide water for sanitary purposes, boiler makeup water, and ash handling.

The Brush Creek reservoir will have a drainage area of 33 square miles, but will actually cover an area approximately two and one-half miles long and one and one-eighth miles wide.

The South Coyote Creek reservoir will be approximately two and three-fourths miles long and one mile wide.

The Brush Creek cooling pond with a normal water level at +1905 ft. m.s.l. would be built concurrent with Unit 1 of a 3-unit, 1320 MW plant. This pond would serve as both cooling pond and makeup water storage for Unit 1 and no future increase in the pond level would be contemplated.

Concurrent with the addition of Unit 2, a storage reservoir would be built on South Coyote Creek with sufficient capacity to supply makeup water for the ultimate plant capacity of 1320 MW.

The addition of the South Coyote Creek reservoir would allow the normal water level of the Brush Creek cooling pond to be maintained at +1905, thus allowing it to be operated at its maximum cooling capacity at all times.

Unit 1 will be cooled continuously by the cooling pond. Unit 2 will normally be cooled by the cooling pond with provisions for alternate cooling by cooling towers during periods of high pond temperature. Unit 3 will be cooled continuously by cooling towers.

The proposed plant will be fueled by lignite, supplied by a conveyor belt from Knife River Coal Mining Company's tipple. The lignite consumption will be two and one-half to three million tons per year for each 440 megawatt unit.

The actual design of the power plant is in its most preliminary stages, but the plant will use the most modern technology in providing anti-pollution equipment to assure that stack emissions will meet all federal and state requirements. A comprehensive environmental impact statement will be prepared and submitted prior to construction.

SUPPLY OF WATER FOR SOUTH BEULAH POWER COMPLEX

The entire water needs of this generating complex will be supplied from surface water sources in the Knife River basin. The primary sources will include the intermittent runoff from the Brush Creek and South Coyote Creek drainage areas as supplemented by water from the principal channel of the Knife River iteself. Water supplied from the Knife River will be minimal as compared to the total flow of the Knife River, and will not deplete nor interfere with the water rights or requirements of riparian owners or the downstream communities of Beulah and Hazen. In order to appropriate the water, two dams and two diversion points (pumping stations) on the Knife River will be constructed. These dams are as follows:

Brush Creek Dam:

(Also referred to in the Knife River Basin Plan as the Beulah Dam.)

A. Approximate height of the embankment is 120 feet.

B. Surface area of the impoundment is 635 acres, with capacity of 22,800 acre-feet.

C. Location of the dam and impoundment is in Sections 9, 10, 14, 15, 16, 22, 23, Township 143 North, Range 88 West.

D. The watershed will cover an area of 33 square miles.

The proposed Brush Creek dam was designed by the North Dakota State Water Commission in 1968 and 1969 in studies with MDU, in preplanning for the proposed power generation complex. (North Dakota State Water Commission, Beulah Dam Complex, Project #1464.)

The Brush Creek cooling pond with a normal water level at +1905 would be built concurrent with Unit 1 of the proposed three unit, 1320 megawatt plant. This pond would serve as both cooling pond and makeup water storage for Unit 1 and no future increase in the pond level would be contemplated.

Construction of the Brush Creek dam will commence in 1975, with initial fill of the reservoir expected in 1977. This schedule permits four years for determining the adequacy of the dam construction together with time for any

repairs needed prior to actual use of the reservoir for cooling purposes in 1981.

In addition to this dam a discharge canal will be constructed along the east bank of the reservoir to conduct circulating water to the head of the reservoir.

A small saddle dam or fill will be placed at the east extremity of the Brush Creek reservoir, incorporated with the discharge canal, to assure isolation of the lignite mines and prevent flooding thereof.

It will not be necessary to blowdown the Brush Creek reservoir to control dissolved solids, thereby protecting the Knife River from possible contamination.

According to calculations of our consultant, the concentration of dissolved solids in the Brush Creek reservoir will be low as a result of dilution by runoff from Brush Creek watershed and due to pumping the majority of the makeup water from the Knife River when solids content in the river is below average. No water will be discharged downstream of the Brush Creek dam except as needed in this tributary for stock use or during periods of excessive normal runoff. The generation plant design will include settling ponds or other means of properly disposing of sanitary waste, blowdown of boilers, and cooling towers, and all water containing ash or other contaminents, rather than resorting to discharge of same into the reservoir or the existing drainage system. In

order to lower the consumptive use of water whenever the waste water is freed from settleable solids making the water reusable, such water will be recycled when feasible. The ash transport water may be an example of this.

No plant discharge will reach the South Coyote reservoir, as that reservoir provides only makeup water. Hence there will be no degradation problems.

Plant design and water treatment will assure that water requirements of the State of North Dakota and the federal government are met.

South Coyote Creek Dam:

A. Approximate height of the embankment is 87 feet.

B. Surface area of the impoundment is 828 acres with capacity of 24,828 acre-feet.

C. Location of the dam and impoundment is in Sections 19, 20, 29, 30, 31, 32, Township 143 North, Range 88 West, and Section 24, Township 143 North, Range 89 West.

D. The watershed will cover an area of 99 square miles.

E. The Brush Creek dam will be supplemented by water from the South Coyote Creek dam.

Concurrent with the addition of Unit 2, this storage reservoir would be built on the South Coyote Creek with sufficient capacity to supply makeup water for the ultimate plant capacity (1320 MW). Normal water level would be at 1922 feet elevation. The addition of the South Coyote Creek

reservoir would allow the normal water level of the Brush Creek cooling pond to remain at +1905 feet thus allowing it to be operated at its maximum cooling capacity at all times.

The South Coyote Creek dam will be constructed in 1980 with initial fill in 1981, and anticipated initial demands for makeup water from this reservoir in 1985.

A drawdown pipe and valve will be constructed on both the Brush Creek and the South Coyote Creek dams to permit discharge of water from the reservoir, including sufficient water for stock purposes downstream from the dam and above the Knife River. Agreements will be concluded with local ranchers to assure their supply of stock water in these two tributaries to the Knife River.

The final design of each dam will include adequate spillways to provide safety in the event of heavier than normal runoff. This design, as well as the design of the dams' pumping stations on the Knife River, will have final approval of the North Dakota State Water Commission prior to construction.

It is anticipated that no direct effect will be felt in any of the ground water aquifers in the area as a result of the proposed impoundments of water. None of the aquifers outcrop or seem to receive direct recharge from the surface of the area to be covered by the water impoundments. With the exception of local gravel veins and lignite beds, all

materials outcropping in the impoundment area display low permeability. The lignite seams being mined in the area adjacent to the impoundment area are essentially dry and are not part of the aquifer system being used for water by farmers in the area. The gravels exposed in the Brush Creek and South Coyote Creek channels appear to be very localized deposits and while they will be charged with water, it is not anticipated that they will form an aquifer of any size. In any event, the waters to be impounded will be of a quality not detrimental to any aquifers in the area even if recharge were realized from the impoundment. A flowing well presently located in the proposed Brush Creek reservoir area will be plugged so as to prevent any reverse flow back into the aquifer that presently supplies the well. Thus any potential recharge, though not expected, could be beneficial to the aquifers.

While there may be these local effects on ground water levels in the Brush Creek and South Coyote Creek drainages, there will be no effect on ground water levels in the Knife River drainage as a result of the proposed diversion of water from the Knife River.

Knife River Diversion Point for Brush Creek Reservoir:

This will be a diversion point for the purpose of diverting sufficient water from the Knife River to supply a pump station to pump water during periods of surplus runoff from

the diversion point to the Brush Creek dam reservoir. Water will be pumped from the Knife River only at times of adequate runoff so that water usage will not jeopardize other users of Knife River water. Total water to be pumped from the Knife River through both pump stations will not exceed 300 cubic feet per second (design capacity of the pumps) during periods of maximum usage.

Knife River Diversion Point for South Coyote Creek Reservoir:

This will be a diversion point and pump station on the Knife River (see map Exhibit E) to pump water to the South Coyote Creek reservoir.

The pump stations for both Brush Creek and South Coyote Creek diversion points will be constructed on high ground above the Knife River channel with the pump suction slightly lower than the river bed. The pump facilities will be enclosed and constructed reasonably sound-proof thus avoiding unfavorable environmental effects due to noise.

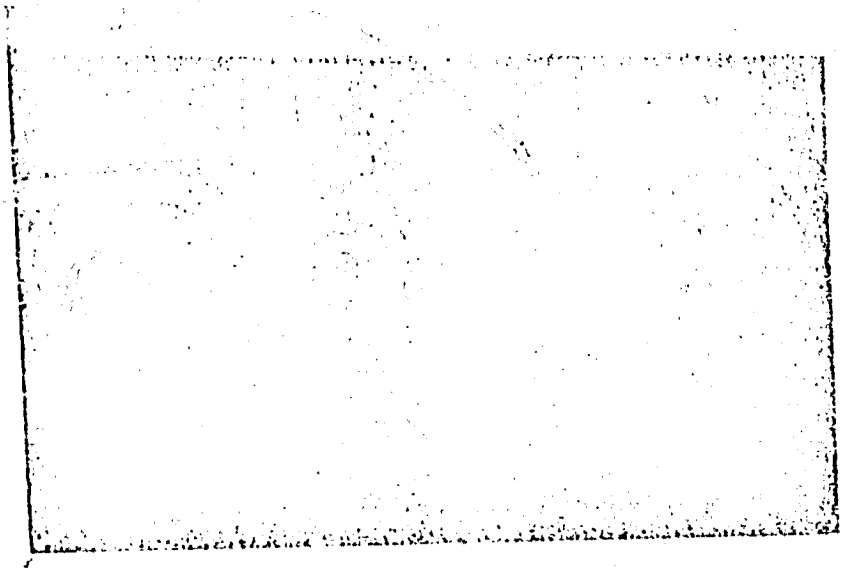
LIGNITE SUPPLY FOR POWER GENERATION COMPLEX

The lignite to fuel the proposed generation complex will be supplied by Knife River Coal Mining Company from its South Beulah mine. This facility is a mine-mouth plant with the mine immediately adjacent to the east. Knife River Coal Mining Company is currently producing approximately 1,700,000 tons per year from its Beulah mines. Engineering consultants agree that the recoverable lignite reserves of Knife River Coal Mining Company are adequate for the normal service life and load.

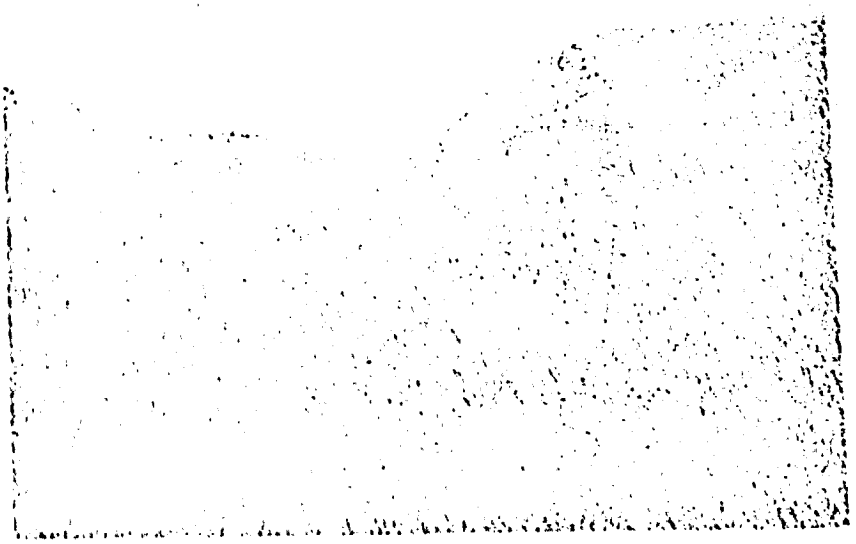
Knife River Coal Mining Company is a recognized leader in mined land reclamation. The present law requires companies to restore mined lands to approximately original conditions by leveling the lands, replacing the topsoil, and re-establishing vegetation. Under Knife River Coal Mining Company's program, lands that were in cultivation are returned to cultivation, grazing lands again become grazing lands, and the surface again is returned to productivity. Under company policy those lands not covered by the current law (mined in previous years) are similarly restored even though previously reclaimed to other uses. This program has been undertaken voluntarily by Knife River Coal Mining Company.

The Beulah area overburden is readily conducive to reclamation. Toxic conditions and acid drainage do not exist. High sodium soils, a problem elsewhere in the state, is not encountered at Beulah. The mines are self-contained, hence no siltation of streams or rivers occurs, nor are ground water supplies adversely affected.

Knife River Coal Mining Company has filed mining and reclamation plans with the North Dakota Public Service Commission. After reviewal of its application by affected state agencies, Knife River Coal Mining Company was granted a mining permit and is currently mining coal for use in power generation.



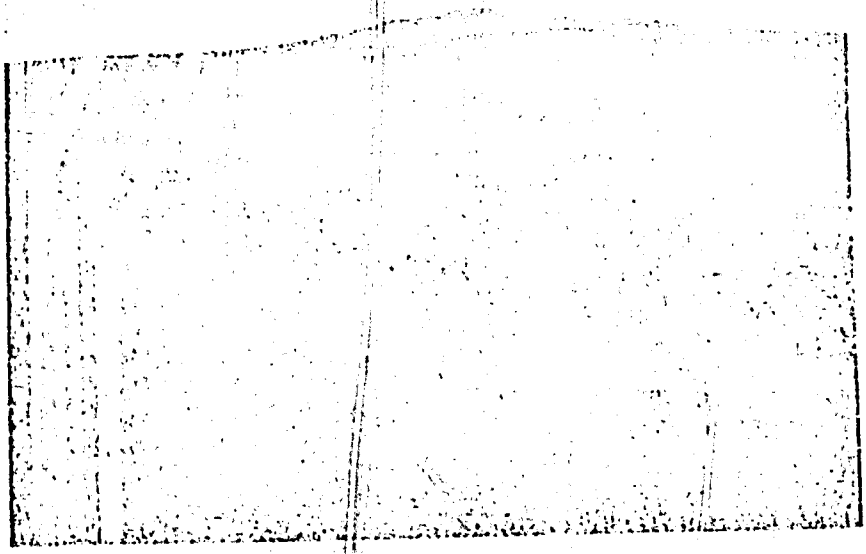
Mined lands are levelled and seedbed prepared at Beulah.



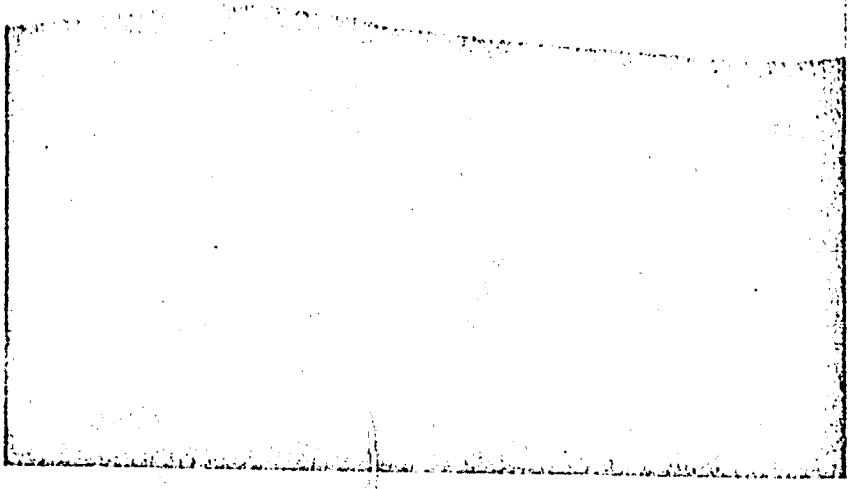
And - heavy stands of native grasses and legumes are re-established.



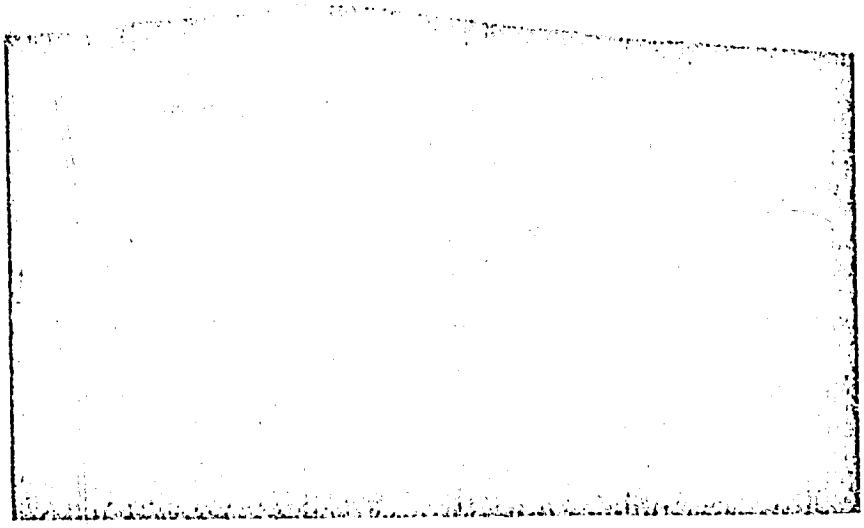
This overburden in July, 1971



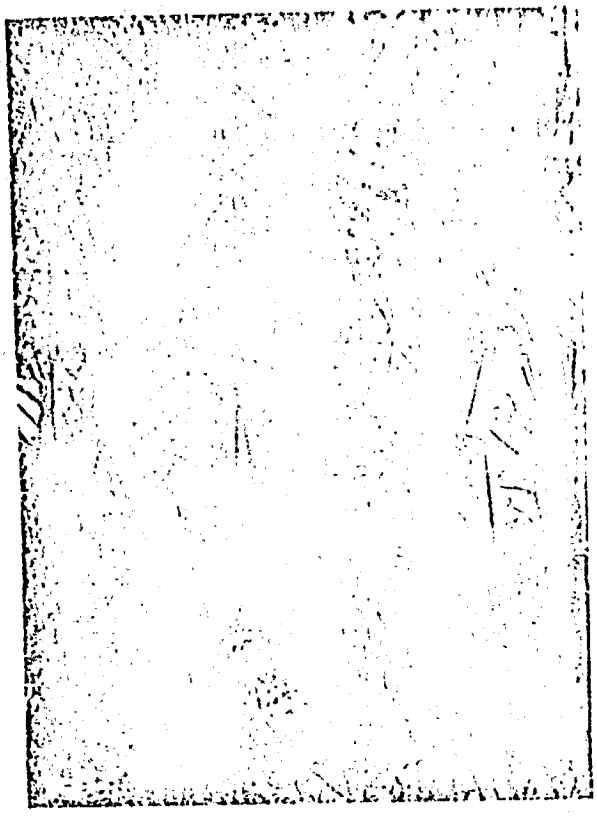
Was levelled and seedbed prepared
in the Fall, 1971



And - vegetation covered the area
by June, 1972.



Area was well on the way to full
restoration by fall, 1972.



Native grasses and legumes become established first year or two, helped by nurse crop of oats



And - are well established within five or six years, and equal the growth of grasses on nearby undisturbed prairie.

CLIMATE

The climate is subject to wide seasonal variations. Mean monthly temperatures vary from 103 degrees in the summer to -32 degrees in the winter. The average date of the last killing frost is May 12, and the earliest is September 16. Prevailing winds are northwest-southeast. The growing season is short, averaging 127 days. The average annual precipitation ranges from 13 to 16 inches, the majority of which is accumulated in early spring thunderstorms. The Yearbook of Agriculture, USDA-41, indicates Beulah, North Dakota to have an annual average precipitation of 13.83 inches. The precipitation for 1971 and 1972 was 16.04 and 20.24 inches respectively, per the U. S. Department of Commerce, National Oceanic and Atmospheric Administration (See Exhibit F).

PHYSIOGRAPHY

Topography:

Attached Exhibit E, a topographic contour map, shows the general topography of the area. Located in the Knife River drainage area the subject lands are principally native grass pastures in rolling terrain with relief that generally discourages use of lands for crops. Most of the area is pastured and is generally overgrazed. Further detail is provided in the section of this study titled "Vegetation".

Soils:

Soils of the area are shown on the map in Exhibit G, and are described in detail in the attached description of soils prepared by the Soil Conservation Service of the U. S. Department of Agriculture. Generally speaking, the soils include the common types: Cabba, Zahl, Flaxton, Williams, and Livona. The present land use of the dam and plant area is almost 100 percent rangeland. The soils range from Class II to VII, with the majority in Classes II and VI. These consist generally of loam and fine sandy loam soils and the various classifications shown on the soil map reflect primarily differences in topography and drainage. The area suited to cropland has many small areas that are hilly or coarse textured. The primary problem involved in managing the soils is maintenance of fertility, control of wind erosion of soil, and control of gullying on slopes over three percent. The area not being cropped is suited to rangeland because of the slopes and drainage ways and the principal concern is control of water erosion and maintenance of fertility. The rangeland in the low, rolling, undulating lands generally has a much thinner veneer of soils than do the more level areas currently being cropped above the dam and reservoir sites. The soil materials vary in depth from approximately six inches to a maximum of two feet.

Bulletins #472 and #473 of the Department of Soils, Agricultural Experiment Station, North Dakota State University, are incorperated herewith by reference for more detailed description of the soil types discussed herein.

Geology--Economic Resources:

(A) Coal. Coal is currently being mined in Sections 1, 2, 11, 12, 13, 14, Township 143 North, Range 88 West, Mercer County; and Sections 6, 7, 18, Township 143 North, Range 87 West, Oliver County, North Dakota. In addition there are reclaimed mined lands immediately east of the dam sites. To the north is a coal mine operated by North American Coal Mining Company. The mines are located in gently rolling to level topography with the result that all pits opened in mining operations are self-contained. Characteristic of most of the region's strip mines, no waters leave the mine area and no siltation or other pollution is possible in the Brush Creek reservoir or South Coyote Creek reservoir as a result of mining operations. A sufficient buffer will be retained between mining operations and the actual reservoirs to protect the mining operations from excessive flooding problems. This will have the double effect of also protecting the reservoirs from any degradation as a result of mining. The mined areas are being reclaimed as soon as practical after mining, usually within two years. After reclamation the spoils tend to absorb almost 100 percent of snow and rainfall with the result that ground water

levels are better than average in the mined areas.

The nature of almost all surface mines in North Dakota, including Knife River Coal Mining Company's South Beulah mine, prevents runoff of any waters from the area mined and subsequently reclaimed, unless the method of reclamation specifically designs such drainage.

North Dakota Century Code Chapter 38-14 requiring reclamation of surface mined lands specifically requires that the areas mined be returned to approximately the same condition and productivity that existed prior to mining. Knife River Coal Mining Company's permit and reclamation plan for the South Beulah mine contemplate return of the area to conditions existing prior to mining, i.e. agricultural uses. As a result it is not contemplated that mining operations at South Beulah will directly or indirectly affect the proposed impoundments of water at Brush Creek and South Coyote Creek.

(B) Oil and gas. The pipeline of the AMOCO Pipeline Company which now crosses the Brush Creek reservoir area will be rerouted to prevent possible pollution of the watershed and the reservoir that could occur should the pipeline rupture. The new route of the pipeline will be far enough away from the proposed reservoir and below the reservoir watershed area so that the waters impounded thereby will never be affected by oil spills of this pipeline. Drilling in the area in the past years has indicated the unlikelihood of commercial oil and gas deposits. It is not considered at

all likely that further drilling for oil and gas will take place, but if it does, the size and shape of the Brush Creek and South Coyote Creek reservoirs is such that drilling and recovery of underlying oil and gas deposits will not be prevented. In some cases it could necessitate off-pattern spacing or possibly directional drilling of the wells. These are both common practices in the oil and gas industry.

(C) Sand and gravel. Sand and gravel deposits exist in the reservoir sites at Brush Creek and South Coyote Creek, and these probably constitute more of a problem than an economic concern. The deposits themselves are a low grade dirty sand and gravel with considerable scoria present. The sand and gravel is not of adequate quality even for use in surfacing mine roads. Accordingly, the primary concern in identifying all the sand and gravel deposits will be to protect the competence of the reservoir itself. Particularly in the location of the dam impoundments it will be necessary to identify and remove the sand and gravel. Elsewhere in the reservoir area these deposits will probably only have local effect, reaching saturation soon after impoundment of water commences. An isopachus map of the sand and gravel deposits will be constructed to identify the extent of potential loss of reservoir water so that if any areas of excessive loss do appear, proper adequate steps including either removal of sand and gravel or blocking with bentonite can be done. All sand and gravel in

in the reservoir areas will be owned by MDU prior to construction of the dams.

Geological investigations have failed to reveal the presence of any other minerals in the area.

VEGETATION

The area on which the power generating complex is proposed for development encompasses a well drained upland terrain dissected by two major natural drainage channels. These extend from the Knife River channel through the bottomland and out beyond the boundary of the development area. This includes the land to be mined with associated cultural structures including roads, water impoundments, constructed water channels, and the electric generation plant site itself.

The prairie terrain is relatively smooth except for the breaks which border the major tributaries of the Knife River. The dominant land slope has about a four to five percent gradient. Surface soils are generally of medium texture, mainly loams and silt loams. There is, however, some acreage of sandy textured wind deposited material of localized placement adjacent to the breaks which descend to the Knife River bottoms. Also, there are localized occurrences of water laid deposits of coarse sand or gravel, deposited as layers or pockets within the soil mass. These are not extensive and display a very intermittent pattern throughout the smoothest portions of the uplands. At times these coarse textured deposits extend close enough to the land surface to be within or near the rooting zone of native prairie plants and common farm crops. Where this is the case the water holding

capacity of the soil is greatly reduced. This results in a drouthy habitat for plant life with a different type of natural plant community being characteristic of those locations.

Another factor of major significance affecting plant life habitat is the relatively steep-sidedness of the drainageways as they pass through the development area. This has had a direct bearing on soil formation over the centuries and is responsible, as well, for very significant differences in the microclimate as compared with the open plains.

These environmental variations and other ecological factors associated with them exert a significant influence on what the potential or climax vegetation is at any given location throughout the development area. Many of the original plant communities have, of course, been eliminated by cultivation. Others have been greatly changed in composition by excessive grazing use.

In general, the remaining native rangeland is concentrated in a band of territory paralleling and on either side of Brush Creek and South Coyote Creek where a "break" type of topography exists; this having been formed by major stream channels and their tributaries. Back and away from these so-called "break" areas (and proposed dam site) much of the land is suitable for crop culture and has been put to cultivation. The proposed dam and plant site is primarily rangeland.

The native grazing lands here are basically of three major types as related to habitat influence. These categories are commonly referred to as range sites by agencies which deal with the use and management of

of rangelands. The well-drained uplands are classed as "Silty" range site where medium textured materials comprise the major soils of influence and as "Sandy" range site where the moderately coarse loams exist. The strongly sloping or steep soils with rapid surface drainage that occupy the breaks are primarily a "Shallow" range site. Basically they have thin effective rooting depths with relatively unweathered materials of residual origin lying a few inches beneath the surface. Most typical of these are the Cabba and Werner series. The breaks also include some excessively drained soils of glacial origin such as the Zahl series. These glaciated areas of hilly and steep topography are classified as "Thin Upland" range site.

Where significant amounts of gravel occur close to the surface the range site is classified as "Shallow to Gravel" or "Very Shallow", depending on the degree of natural drouthiness. However, the existence of these situations is so minor as to be of very little significance from a range site standpoint within the development area.

The potential plant cover in the general territory of central North Dakota is classified by botanists as "mixed prairie". This indicates that the ordinary run of uplands is dominated by midgrasses and medium sized broadleaf plants. It is recognized that plant cover will, of course, vary from place to place due to the inherent factors of soil situation and microclimate. These influences are among the basic factors for separating and classifying the grazing lands into range sites.

The "Silty" range site is dominated by Western wheatgrass in this region with Green needlegrass generally playing a role of sub-dominance

that may reach dominance in places favored by additional moisture accumulation. Prairie junegrass, Blue grama, and Needleandthread grass are important plants generally always present but of secondary rank. A wide variety of broadleaf plants are a natural part of the potential cover on this land as are minor amounts of dryland sedges and a number of other grasses in minor proportion.

The "Sandy" range site is generally dominated throughout by Needleandthread grass except for patches of Prairie sandreed which commonly grow in rather pure stands. Pennsylvania sedge is an important component of this community. Secondary grasses and sedges are Canada wildrye, Prairie junegrass, Blue grama, Threadleaf sedge, Sand dropseed, and Wilcox panicum. Broadleaf plants are abundant. (Where these wind deposited soils are somewhat coarser and contain lesser percentage of fine materials they are classed as the "Sands" range site. Some spots of these occur as inclusions within the basically sandy loam soil type areas. Species composition of the natural plant cover is quite similar to the "Sandy" range site but in different proportion. Prairie sandreed is generally a major dominant with other coarse grasses such as Sand bluestem, Canada wildrye, Sand dropseed, and Schweinitz flatsedge quite high in percent of composition).

The "Shallow" range site as it occurs here is quite variable from one place to another depending primarily on direction of exposure. This has a profound effect on the woody plant component. Major grasses on the site are Little bluestem, Plains muhly, and Sideoats grama. Other important plants are Threadleaf sedge, Penn sedge, and a lesser

variety of broadleaf plants such as Purple prairie clover and Purple coneflower. Secondary plants of local importance are Spike oatgrass, Prairie junegrass, Needleandthread, and Western wheatgrass. Both Brush Creek and South Coyote Creek valleys are relatively deep and very steep sided as are some of the tributaries that join these major drainageways. The result is a north slope microclimate very favorable to the development of woody plant communities. Thus, a thicket type of vegetation occupies much of the north slope within the "break" areas throughout the development area. Brush cover on these slopes is, therefore, quite extensive and widespread throughout this area. Principal species comprising these north slope thickets are Western snowberry (buckbrush), Choke cherry, Wild plum, Buffaloberry, Hawthorne, Woodsrose, and some small trees, mainly Green ash. (The "Thin Upland" range site is quite similar to the "Shallow" site in land form and certain soil characteristics conducive to the perpetuation of these plant community types. Plant cover, therefore, is basically the same for both sites, but, with the "Thin Upland" being slightly higher in production.)

The Knife River bottomland over much of its extent supports a native woodland or timber stand type of vegetation. American elm, Green ash, Cottonwood, and Box elder are the principal tree species. They grow in association with understory shrub type species such as Woodsrose, Western snowberry, Wild currant, Gooseberry, Wild plum, Choke cherry, Viburnum, and others. Grasses and broadleaf plants of the kinds found in rangeland plant communities are very minor.

This wooded acreage is not classified as native grazing land, and, therefore, has no range site designation. There are, however, some open areas where woodland is not the climax or potential kind of vegetation. These open areas are quite comparable to the bottomlands of the larger drainageways, namely, Brush and South Coyote Creeks. Their natural vegetation is basically a cover of tall grasses and tall broadleaf plants with patches of small tree or shrub growth occurring within them. This type of land is classified as the "Overflow" range site. Principal grasses occurring on this site are Prairie cordgrass, Big bluestem, Slender wheatgrass, Canada wildrye, Porcupine grass, and Green needlegrass. Species of secondary importance are Western wheatgrass, Pearded wheatgrass, Little bluestem, and Green muhly. Several species of mid-tall sedges are present in places. Tall-growing broadleaf plants are quite abundant. The woody growth here is primarily of two or three species of willow. The introduced grass, Kentucky bluegrass, has invaded the "Overflow" site quite extensively in places. This tendency is a rather typical occurrence in much of North Dakota. As is usually the case, the "Overflow" site comprises only a small percentage of rangeland area when taken in its entirety. However, its natural productive capacity is very high. In addition, it provides valuable protective qualities for both wildlife and domestic animals.

Planning for implementation of any revegetation of the affected area will be accomplished in cooperation with competent range specialists and the State Game and Fish Department to assure that proper species are introduced and wildlife values are protected. The general

rule of revegetation will be to use native species now present.

ANIMAL COMPONENTS

Limited wildlife was identified at the time of the initial survey, with greater concentrations in the South Coyote Creek area as opposed to the Brush Creek area. This undoubtedly fluctuates with seasons. The overgrazed condition of theBrush Creek area undoubtedly contributed largely to the small quantity of wildlife observed. Nevertheless, the habitat is suitable for and is used by pheasants, sharptailed grouse, Hungarian partridge, deer, and a wide variety of other small mammals including mice, badger, fox, coon, muskrat, weasel, mink, jackrabbits, cottontails, porcupine, coyotes, and skunk. The impact on this wildlife as a result of the construction of the proposed dams will be beneficial as areas presently being farmed will, to the extent feasible, be developed as a game preserve and recreation area. The water filled reservoirs and preserve area adjacent to the reclaimed mines will help provide a balanced habitat with greater sources of food and protection than exist at present. The existing patches of vegetation will be replaced by planned woody plantings, grasses, etc., designed, with the cooperation of the Soil Conservation District, State Game and Fish Department, State Forest Service, and/or State Forester, to support wildlife and recreation in the area. Woody plantings will be replaced at the rate of at least two acres of new habitat for each acre lost in the reservoir areas. Other areas of vegetation lost in the reservoir area will be replaced by planting desirable grass and/or legumes on all lands not flooded by the reservoirs or planted to woody plantings.

The Knife River currently has a population of sauger, catfish, perch, bullheads, goldeye, carp, etc. Construction of the diversion points will create no impoundments. The Knife River near the diversion points will continue to provide fish habitat for desirable species, including sauger and northern pike. The South Coyote Creek dam with a reservoir surface area as great as 828 acres and a maximum depth of up to approximately 75 feet will be used as makeup water only and no plant water will be returned to this reservoir. This reservoir will be very desirable for propagation of fish including northern pike, walleye pike, bass, and bluegill. The Brush Creek reservoir with a surface area of 635 acres and a maximum depth of 105 feet will be used for cooling water for the power complex and as such will have heat discharged back to the lake. While the quality of the water discharged from the plant to Brush Creek reservoir will be controlled to avoid concentrations of pollutants in the lake, it must be expected that this lake will be at least several degrees warmer than South Coyote Creek reservoir.

All habitat, particularly the brush draws destroyed by the creation of these impoundments, will be replaced by properly designed plantings of vegetation prepared in conjunction with the North Dakota State Game and Fish Department.

ARCHAEOLOGICAL AND HISTORICAL VALUES

The area has been examined by Clayton Quinnild and Dave Jordan to determine preliminarily whether any historical or archaeological values exist requiring protection or preservation. No teepee rings, buffalo kills, village sites, or other historical sites were located. Mr. Mick Frank, North Dakota State Archaeologist with the State Historical Society,

was contacted for further reference in this respect, and a survey for archaeological and historical sites will be undertaken. Applicant will take the necessary steps as recommended by the State Historical Society to protect any values ideatified in the area. (See exhibit H)

RECREATIONAL USAGE

The site of the dams is presently subjected to very limited recreational use. In season there is hunting for grouse, pheasant, other upland game birds, and white-tailed deer. This usage is somewhat limited because of the generally overgrazed condition of much of the area. Under the controlled preserve the value of the area for recreational purposes will be vastly increased as was the Heart Butte reservoir area, and further use for picnicking, camping, hunting, and fishing will greatly surpass the present recreational values.

The potential use of this area for recreational purposes was discussed with Mr. Gary Leppart of the Outdoor Recreational Agency and we were informed that any such recreational usages would arrise out of recommendations of other departments, i.e. State Game and Fish Department; and the Outdoor Recreational Agency has no direct recommendations concerning the usage of the Brush Creek--South Coyote Creek area.

AESTHETICS

With the exception of the Brush Creek reservoir, the visual appeal of the area will be comparable to the present conditions with the addition of larger expanses of water and increased area planted to controlled vegetative cover. In addition to this development, the Brush Creek reservoir will have an industrial development on the east bank, including an

electric generation plant to be constructed in two or three stages. This plant will be constructed to complement or blend to the extent possible with the present visual impact of the community. Environmental control equipment will be included in this plant to prevent pollution of air and water and to assure that federal and state standards are met. Ash dumps and coal yards will be adequately screened by protective plantings of trees to prevent wind-borne pollution of the area with these substances. To the extent feasible, this development will be screened by decorative plantings and it is our opinion that the plant will not detract from the recreational values of the Brush Creek reservoir area.

SOCIOECONOMIC

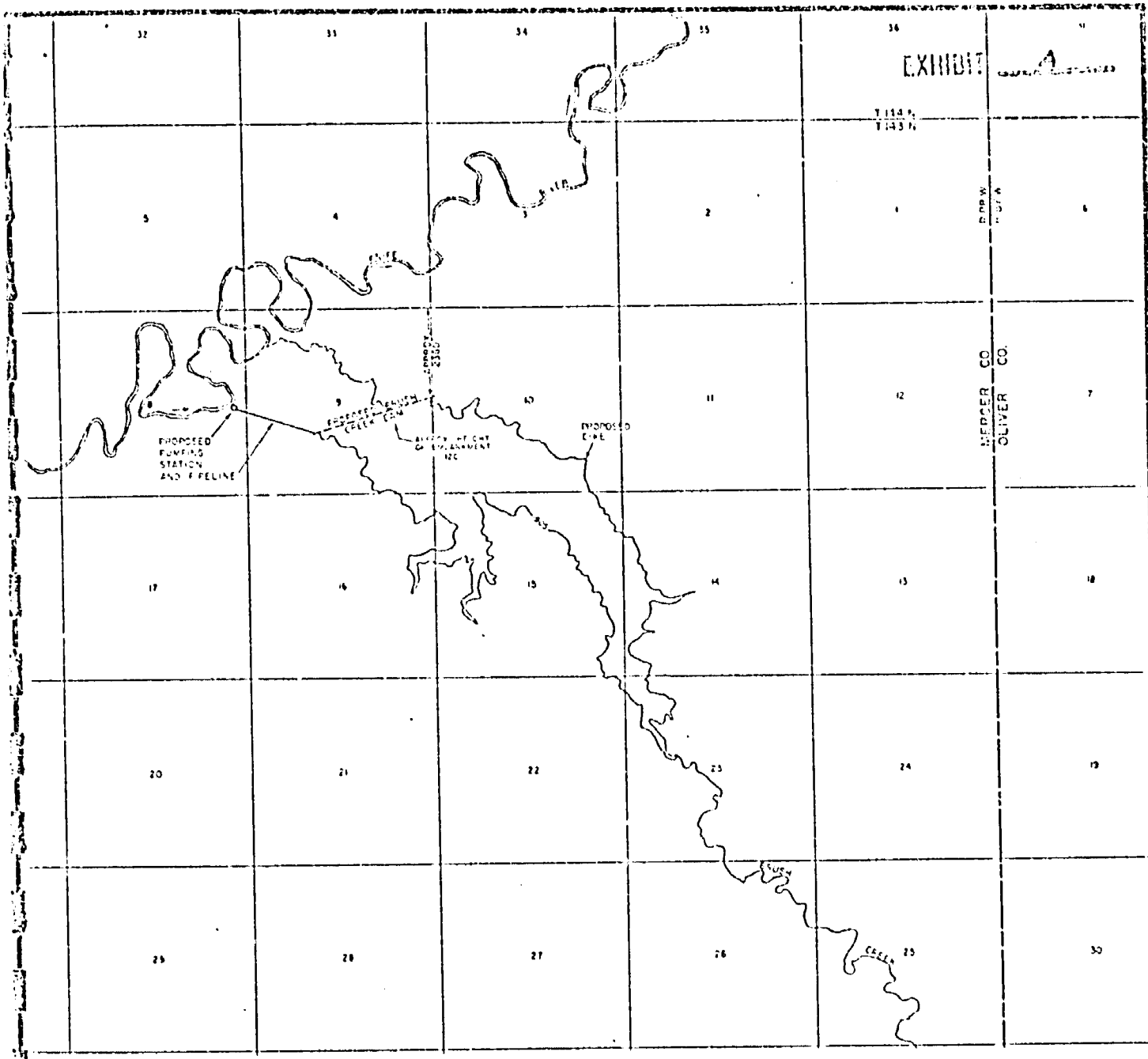
The three communities close to the proposed development are Beulah, three miles northeast; Hazen, ten miles northeast; and Zap, six miles northwest.

According to the 1970 census the population of Beulah was 1,344, Hazen was 1,240, and Zap was 271. The mayors of the three respective communities (Mr. Willmer Wiedrich, Beulah; Mr. Leonard Wohlfeil, Hazen; Mr. Norman Fuchs, Zap) noted an increase in the present population. Beulah increased to 1,550, Hazen to 1,535, and Zap to 275.

The two principal highways servicing the area are North Dakota #49 running north-south and North Dakota #200 running east-west.

The major economy of the area is agriculture and coal mining. Ranching and small grains relate about 50-50 in agricultural development.

The socioeconomic patterns of the three communities will be altered in population by the additional job opportunities that will become available during the construction and operation of this development, but many jobs and opportunities will accrue to the benefit of the immediate area. The economy of these communities is already based partly on the coal development, so a new way of life and philosophy is not being introduced. Beulah has organized a planning commission to prepare its community for future results of the coal development. Hazen intends to establish a planning commission to meet the needs and growth requirements caused by new development in the area.



SCALE 1" = 4000'

STATE OF NORTH DAKOTA)
: ss.
COUNTY OF BURLEIGH)

I, MARK SCARFF of Bismarck, North Dakota, do hereby certify that this map was prepared from the map obtained from the State of North Dakota, Water Commission, having been mapped, edited and published in 1968 by the United States, Department of the Interior Geological Survey, said map being further identified as "Medicine Butte NE Quadrangle 7.5 Minute Series (Topographic)."

It is further certified that said map correctly represents the industrial works for the accompanying Application, together with the water of appropriation, and shows accurately the location of the lands encompassing the industrial works.

Mark Scarff
Montana-Dakota Utilities Co.

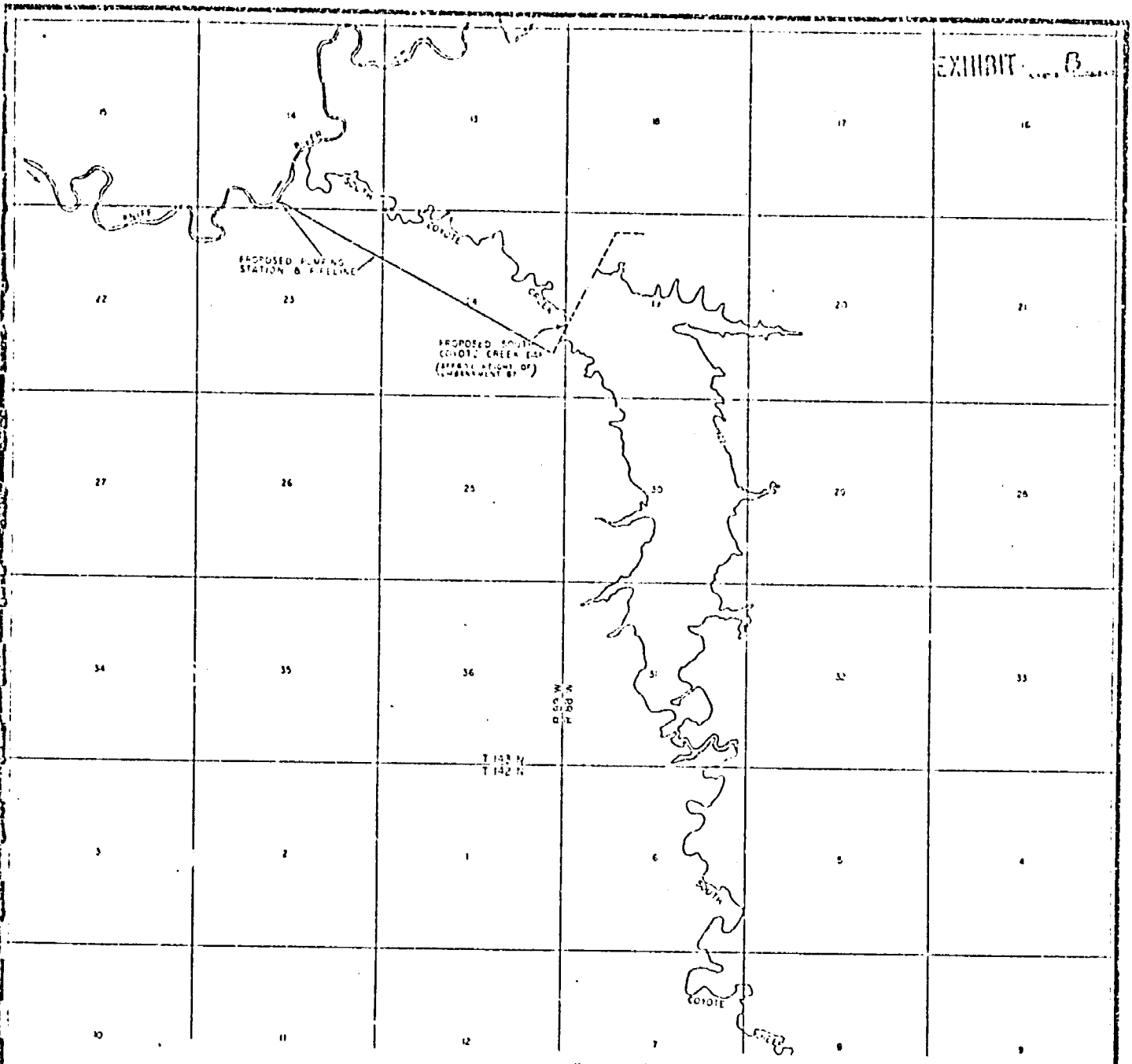
MAP
A
TO ACCOMPANY APPLICATION
NO _____ FOR

PROPOSED BRUSH CREEK DAM

APPLICANT

MONTANA DAKOTA UTILITIES CO.
400 N 4TH ST.
BISMARCK, ND 58501

EXHIBIT B



SCALE 1" = 4000'

STATE OF NORTH DAKOTA)
: ss.
COUNTY OF BURLEIGH)

I, MARK SCARFF, of Bismarck, North Dakota, do hereby certify that this map was prepared from the maps obtained from the State of North Dakota, Water Commission, having been revised, edited and published in 1978 by the United States, Department of the Interior Geological Survey, said maps being further identified as "Medicine Butte NE Quadrangle 7.5 Minute Series (Topographic)" and "Medicine Butte NW Quadrangle 7.5 Minute Series (Topographic)."

It is further certified that said map correctly represents the industrial works for the accompanying Application, together with a number of alternate, and accurately shows the location of the lands and construction of the industrial works.

Mark Scarff, Vice President - Electric
Montana-Dakota Utilities Co.

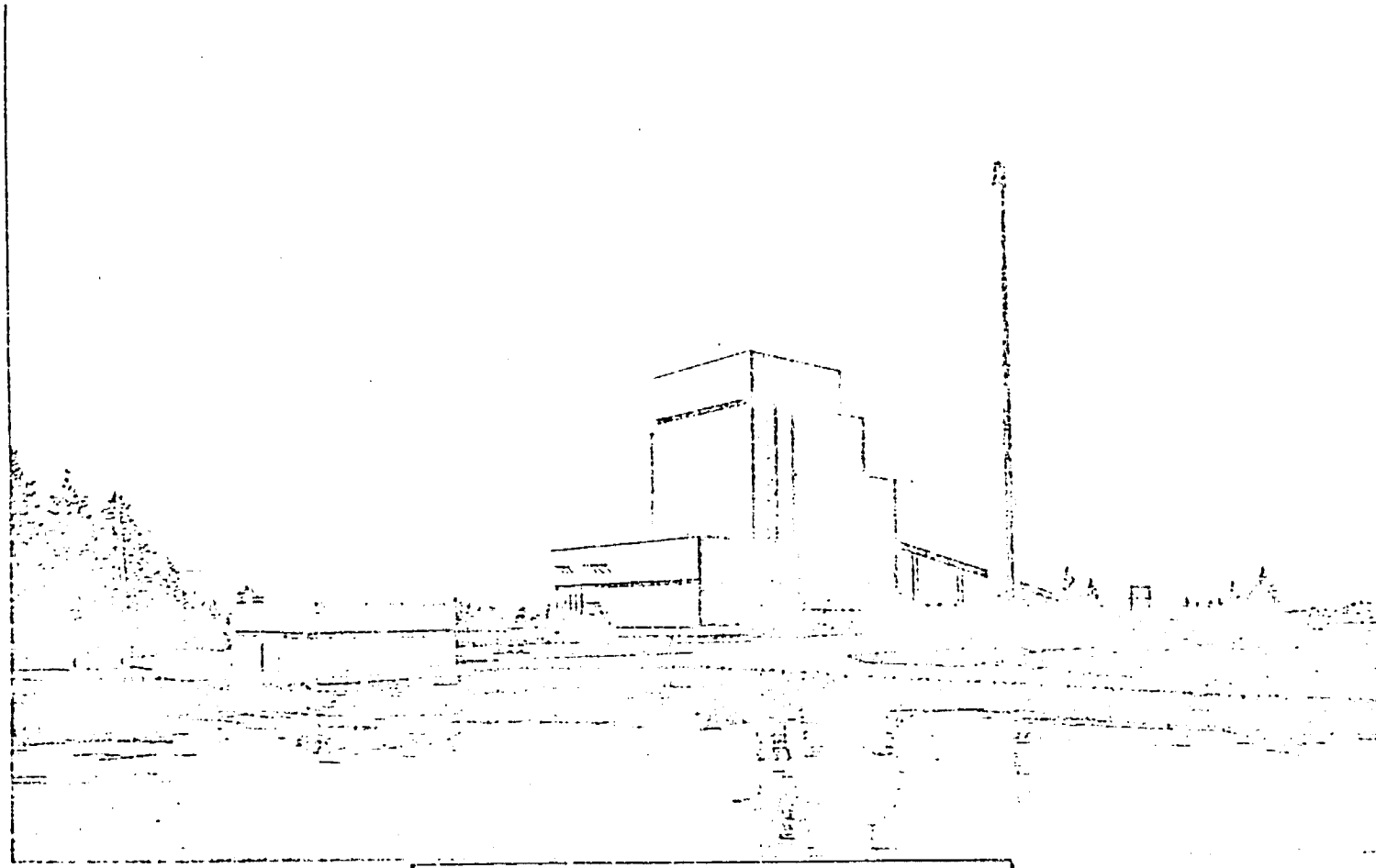
MAP
B
TO ACCOMPANY APPLICATION
NO _____ FOR

PROPOSED
SOUTH COYOTE CREEK DAM

APPLICANT

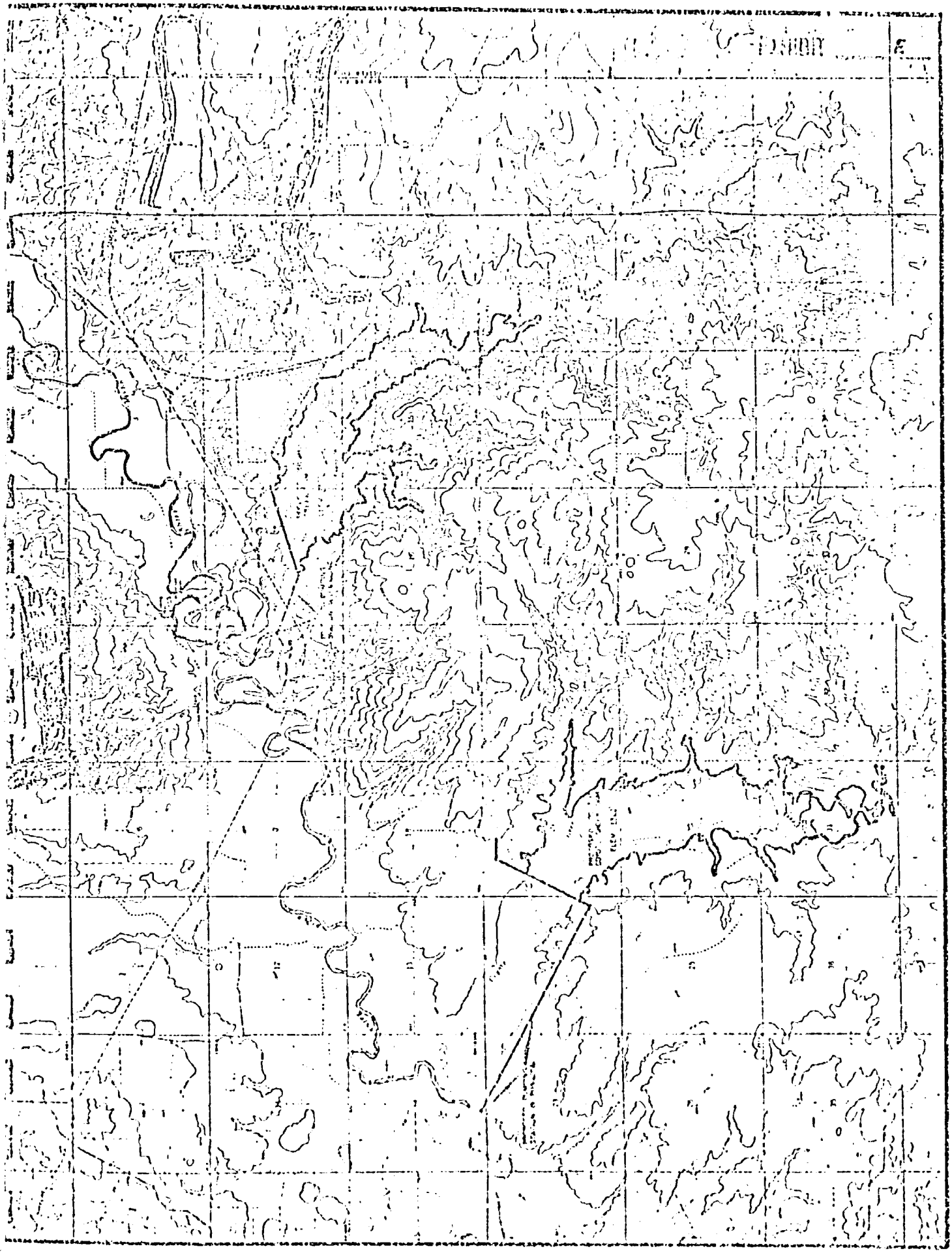
MONTANA DAKOTA UTILITIES CO.
400 N 4TH ST.
BISMARCK, ND 58501

DRAINAGE AREA
KNIFE RIVER
ELM CREEK
OTTER CREEK
MERCER COUNTY
OLIVER COUNTY
R-89-W
R-88-W
R-87-W
R-86-W
T142N
T141N



BIG STONE PLANT

440 Megawatts
Otter Tail - Northwestern Public Service - Montana-Dakota Utilities Co.
On Line May 1975



TEMPERATURE AND PRECIPITATION FOR 1971 - 1972
BEULAH, NORTH DAKOTA

1971

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Average Temperature	3.4	13.4	26.6	41.7	51.9	64.0	65.1	71.2	55.8	---	30.4	9.3
Precipitation	.53	.22	.47	1.96	.89	5.57	.36	.19	2.61	2.41	.48	.30

Temperature Extremes Highest -- 103° on 8/22/71
Lowest -- -32° on 1/16/71

1972

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Average Temperature	---	8.9	25.6	39.4	56.0	64.5	63.5	69.1	53.2	40.1	27.9	9.5
Precipitation	---	.42	.88	1.36	3.91	4.73	2.62	2.58	.99	1.78	.11	.86

(Source of information: U. S. Department of Commerce, National Oceanic and Atmospheric Administration)

EXHIBIT F

EXHIBIT G

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

November 30, 1973

Mr. David A. Jordan, Conservationist
Knife River Coal Mining Co.
400 N. Fourth Street
Bismarck, North Dakota

Dear Dave,

Enclosed is the information we can furnish at this time in the Bush and Coyote Creek areas in Mercer County.

With the limited amount of Soil Survey information available, Francis Wilhelm, Soil Scientist, put this information together for you. It is composed of General Soil Map and a legend of the soil map with the Soil Association Descriptions. These Associations have been prepared on the basis of the county survey now in progress. He also prepared capability classes of soils listed in the Soil Association with a short description of capability classes. The information is tentative and subject to change as the survey progresses.

I have no information available covering percentage of lands in the different land uses for the specific area. There is farming and ranching of varying degrees taking place in the area.

Sincerely,

Kenneth Nye, District Cons.

GENERAL SOILS MAP - SOIL ASSOCIATION DESCRIPTIONS

1.) Cabba-Werner Association
Strongly sloping to very steep, well drained, shallow, loamy soils.

This soil association is mainly on side slopes in soft shales and loam stone. About 40 percent is Cabba soils, 25 percent Werner soils, and 35 percent minor soils.

Cabba soils are on the crests and upper sideslopes and Werner on mid and lower side slopes. Surface layer textures are mainly loam or silt loam. Minor soils in this association are mainly Williams, Morton, and Sen on higher plains and Arnegard and Grail in swales.

This association is suited to range. Fertility and available water capacity are low. Permeability is moderate. Most of the water runs off. The main concerns of management are control of water erosion, low available water capacity, and proper range use.

Nearly all of this association is used for range. Raising beef cattle is the main enterprise.

3.) Cabba-Werner-Rhoades Association
Gently sloping to very steep, well and moderately well drained, shallow and deep, loamy soils.

This soil association is on uplands cut deeply by intermittent streams. Soils are formed in place in soft shales and loamstone or in weathered materials washed down slope. About 35 percent is Cabba soils, 25 percent Werner soils, 20 percent Rhoades soils, and 20 percent minor soils.

Cabba soils are on ridge tops and crests, Werner soils on upper side slopes, and Rhoades soils on lower side slopes and in swales. Surface layer textures are mainly loam and silt loam. Minor soils included are mainly Morton, Sen, and Regent on higher plains and Grail in swales.

This association is best suited to range. Fertility and available water capacity are low. Permeability is moderate except Rhoades soils have very slow permeability. Most of the water runs off. The main concern is control of water erosion, low available water capacity, and proper range use.

Nearly all of this association is used for range. Raising beef cattle is the main enterprise.

5.) Morton-Daglum-Regent Association
Gently sloping and sloping, well and moderately well drained, moderately deep and deep, loamy soils.

This soil association is on uplands. In a few places the slopes are nearly level. Soils are formed in place in loamy or clayey soft shales and siltstone or in weathered materials washed down slope. About 30 percent is Morton soils, 20 percent Daglum soils, 20 percent Regent soils, and 30 percent minor soils.

Morton and Regent soils are on plane and convex slopes and Daglum soils on plane and concave slopes. Surface layer textures are mainly silt loam and silty clay loam. Minor soils included are mainly Cabba, Werner, Moreau, and Pen on some convex slopes and Shoades, Grail, and Belfield on some concave slopes.

This association is suited to cropland. Fertility and available water capacity are moderate. Permeability ranges from moderate to very slow. Much of the water runs off slopes over 3 percent. Main concerns of management are control of water erosion, maintenance of fertility, and impeded permeability.

About two-thirds of this association is cultivated. The main crops are small grain.

6.) Cabba-Zahl Association
Strongly sloping to very steep, well drained, shallow and deep loamy soils.

This soil association is mainly on side slopes along steep drainageways in glacial till uplands. Soils are formed in soft shales and loamstone and in glacial till. About 40 percent is Cabba soils, 30 percent Zahl soils, and 30 percent minor soils.

Cabba soils are on mid and lower side slopes and Zahl on crests and upper side slopes. Surface layer texture is mainly loam. Minor soils in this association are mainly Werner on side slopes, Williams on higher plains, and Arnegard and Grail in swales.

This association is suited to range. Fertility is low, available water capacity is low, and permeability is moderate to moderately slow. Much of the water runs off. The main concerns are control of water erosion, maintenance of fertility. Low available water capacity on Cabba soils is also a concern.

Nearly all of this association is used for range. Raising beef cattle is the main enterprise.

7.) Williams-Morton-Sen Association
Nearly level to sloping, well drained, deep and moderately deep, loamy soils.

This association is mainly on undulating or gently sloping uplands. Soils are formed in glacial till or soft shales or loamstone. About 40 percent is Williams soils, 25 percent Morton soils, 20 percent Sen soils, and 15 percent minor soils.

Williams soils are on short, plane and convex slopes and Morton soils and Sen soils on long, plane and convex slopes. Surface layer texture is loam or silt loam. Minor soils in this association are mainly Zahl and Cabba on extreme convex slopes and Arnegard and Grail soils in swales.

This association is suited to cropland. Fertility and available water capacity are high or moderate. Permeability is moderate except in Williams soils. The main concerns of management are maintenance of fertility and control of water erosion on slopes over 3 percent.

About two-thirds of this assocation is cultivated. The main crops are small grains, alfalfa, and corn.

11.) Flaxton-Williams-Livona Association
Nearly level to hilly, well drained, deep, loamy soils.

This association is on thin sandy mantled glacial till plains. Slopes are mainly undulating. Soils are formed in aeolin sandy material and the underlying glacial till and in glacial till. About 35 percent is Flaxton soils, 25 percent Williams soils, 20 percent Livona soils, and 20 percent minor soils.

Flaxton soils are on plane and concave slopes, Williams soils on extreme convex slopes, and Livona soils on slightly convex slopes. Surface texture is mainly fine sandy loam but includes loam and loamy fine sand. Minor soils are mainly Zahl soils on hill tops, Parshall and Arnegard soils in swales, and Krem soils on some plane and concave slopes.

This association is suited to cropland except for small areas that are hilly or coarse textures. Fertility is moderate or high. Permeability is moderately rapid or rapid through their subsoils and moderately slow below. The main concerns of management are maintenance of fertility, control of soil blowing, and control of gullying on slopes over 3 percent.

About two-thirds of this association is cultivated. The main crops grown are small grains, alfalfa, and corn.

13.) Straw-Korchea Association
Nearly level to gently undulating, well drained, deep, loamy soils.

This association is on bottomlands, low terraces and in glacial trenches. Nearly all of the association has nearly level slopes. Much of it is subject to flooding in most years. About 45 percent is straw soils, 35 percent Korchea soils, and 20 percent minor soils.

Straw soils are on the higher benches least subject to flooding and Korchea soils are on bottomlands. Surface layer texture is mainly loam or silt loam. Minor soils are mainly Velva adjacent to stream channels, Dimmick soils in old oxbows, and Magnus soils in slightly concave positions.

This association is well suited to cropland. Most flooding occurs in spring before annual crops are seeded. Fertility is high or moderate and available water capacity is high. Permeability is moderate. The main concerns of management is drowning or lodging of cultivated crops.

About two-thirds of this association is cultivated. The main crops grown are alfalfa, small grains, and corn.

CAPABILITY CLASSES OF SOILS LISTED IN THE SOIL ASSOCIATION DESCRIPTION

MAJOR SOILS

Soil	Capability Class
Cabba, 9 to 15% slopes	VIe
Cabba, 15 to 35% slopes	VIIe
Darlum, 1 to 6% slopes	IVs
Darlum, 6 to 9% slopes	VIs
Flaxton, 1 to 6% slopes	IIIe
Flaxton, 6 to 9% slopes	IVe
Flaxton, 9 to 15% slopes	VIe
Korchea, 0 to 3% slopes	IIc
Korchea, 3 to 6% slopes	IIe
Livona, 1 to 6% slopes	IIIe
Livona, 6 to 9% slopes	IVe
Livona, 9 to 15% slopes	VIe
Morton, 1 to 3% slopes	IIc
Morton, 3 to 6% slopes	IIe
Morton, 6 to 9% slopes	IIIe
Morton, 9 to 15% slopes	IVe
Regent, 1 to 3% slopes	IIc
Regent, 3 to 6% slopes	IIe
Regent, 6 to 9% slopes	IIIe
Regent, 9 to 15% slopes	IVe
Rhoades, 1 to 15% slopes	VIs
Sen, 3 to 6% slopes	IIe
Sen, 6 to 9% slopes	IIIe
Sen, 9 to 15% slopes	IVe
Straw, 0 to 3% slopes	IIc
Straw 3 to 6% slopes	IIe
Werner, 6 to 9% slopes	IVe
Werner, 9 to 15% slopes	VIe
Werner, 15 to 35% slopes	VIIe
Williams, 1 to 3% slopes	IIc
Williams, 3 to 6% slopes	IIe
Williams, 6 to 9% slopes	IIIe
Williams, 9 to 15% slopes	IVe
Williams, 15 to 30% slopes	VIe
Zahl, 3 to 9% slopes	IVe
Zahl, 9 to 30% slopes	VIe

MINOR SOILS

Soil	Capability Class
Arnegard, 1 to 3% slopes	IIe
Arnegard, 3 to 6% slopes	IIe
Arnegard, 6 to 9% slopes	IIIe
Belfield, 1 to 3% slopes	IIIs
Belfield, 3 to 6% slopes	IIIe
Belfield, 6 to 9% slopes	IVe
Bimmick, 0 to 1% slopes	IIIw (drained)
	Vw (undrained)
Grail, 1 to 3% slopes	IIe
Grail, 3 to 6% slopes	IIe
Grail, 6 to 9% slopes	IIIe
Krem, 1 to 6% slopes	IVe
Krem, 6 to 15% slopes	VIe
Magnus, 0 to 1% slopes	IIc
Moreau, 1 to 3% slopes	IIIs
Moreau, 3 to 6% slopes	IIIe
Moreau, 6 to 9% slopes	IVe
Moreau, 9 to 15% slopes	VIe
Parshall, 1 to 6% slopes	IIIe
Velva, 0 to 6% slopes	IIIe

CAPABILITY CLASS IIe

This class consists of deep and moderately deep, level or nearly level, well drained and moderately well drained soils. They are loam and silt loam soils on uplands, terraces, fans, and in swales and silty clay loam soils on terraces, fans and in swales.

These soils are high or moderate in organic matter content, have high or moderate available water capacity and high or moderate fertility. They have moderate or moderately slow permeability. These soils have a slight wind erosion hazard and a slight water erosion hazard on long slopes.

The major management practices needed are those that maintain organic matter content, fertility, and control erosion on long slopes.

These soils are fairly well suited to corn and well suited to all other crops commonly grown in the county.

CAPABILITY CLASS IIe

This class consists of deep, and moderately deep, nearly level, gently sloping and gently undulating, well drained soils. They are silt loam and loam on uplands, terraces, fans and in swales and silty clay loam on uplands, fans and in swales.

These soils are high or moderate in organic matter content, have high or moderate available water capacity, and high or moderate fertility. They have moderately rapid, moderate, moderately slow, or slow permeability. These soils have a slight or moderate wind erosion hazard and a moderate water erosion hazard on the longer slopes over 3 percent.

The main management practices needed are those that control erosion and maintain organic matter content and fertility.

The soils are suited and well suited to crops commonly grown in the county.

CAPABILITY CLASS IIIe

This class consists of deep and moderately deep, level to sloping, well or moderately well drained soils. They are fine sandy loam, silty clay, loam, silt loam, clay loam, and silty clay loam soils on uplands, terraces, bottomlands, fans and in swales.

These soils are high or moderate in organic matter content, have high or moderate available water capacity and high to low fertility. They have rapid to slow permeability. These soils have moderate and sever wind erosion hazards and a moderate or severe water erosion hazard on long slopes over 3 percent.

The main management practices needed are those that control erosion and maintain organic matter content and fertility.

These soils are fairly well suited to corn and well suited to small grains, alfalfa and grasses commonly grown in the county.

CAPABILITY CLASS IIIs

This class consists of deep or moderately deep, level or nearly level, well or moderately well drained soils. They are loam, silt loam, or clay loam soils on uplands, terraces, fans and in swales and silty clay loam on terraces, fans and in swales.

These soils are high or moderate in organic matter content, have high or moderate available water capacity, and high or moderate fertility. They have moderately slow to very slow permeability. These soils have a slight wind erosion and a moderate water erosion hazard on long slopes.

The major management practices needed are those that control erosion, maintain and improve tilth, and maintain organic matter content and fertility.

These soils are well suited to grasses and well to fairly well suited to all other crops commonly grown in the county.

CAPABILITY CLASS IIIw

This class consists of deep, level, very poorly drained soils that are sometimes diched and drained. They are silty clay soils in basins and oxbows. These soils are moderate in organic matter content, have high available water capacity and moderate fertility. They have slow permeability. These soils have a severe wind erosion hazard in early spring after soils have granulated over winter.

The main management practices needed are those that control erosion, maintain and improve tilth, maintain organic matter content and fertility, and maintain adequate surface drainage.

These soils are well suited to adopted grasses, fairly well suited to small grains and alfalfa, and poorly suited to corn.

CAPABILITY CLASS IVe

This capability class consists of very shallow to deep, level to steep, well to excessively drained soils. They are fine sandy loam, loamy fine sand, loam, silt loam, clay loam, and silty clay loam soils on uplands, terraces, fans and swales.

These soils are moderate or high in organic matter content, have high to low available water capacity and moderate or low fertility. They have very rapid to very slow permeability. These soils have a slight to severe wind erosion hazard and a severe water erosion hazard on long slopes.

The major management practices needed are those that control erosion and maintain organic matter content and fertility.

These soils are well suited to grass and fairly well suited to small grains.

CAPABILITY CLASS IVs

This capability class consists of deep, level to gently sloping well and moderately well drained soils. They are silty clay loam soils on terraces, fans, and swales.

These soils are moderate in organic matter content, have moderate available water capacity, and moderate fertility. They have very slow permeability. These soils have a severe water erosion hazard.

The major management practices needed are those that control erosion, maintain and improve tilth, and maintain organic matter content and fertility.

These soils are well suited to grasses, poorly suited to small grains and legumes, and poorly suited to corn.

CAPABILITY CLASS Vw

This capability class consists of deep, level, very poorly drained soils. They are mainly silt loam and silty clay soils in basins but include soils with other textures on terraces and below seeps.

These soils are high in organic matter content, have high or moderate available water capacity and high or moderate fertility. They have very slow to moderate permeability. These soils are ponded or wet all season in all but the driest years.

The main management practices needed are those that maintain organic matter and fertility.

These soils are suited to late season grazing and haying in the driest years. They are best suited to wildlife.

CAPABILITY CLASS VIe

This capability class consists of deep, moderately deep, or shallow, hilly or steep, excessively to well drained soils. They are fine sandy loam, loam, silt loam, silty clay loam, and silty clay soils on uplands and terraces.

These soils are low or moderate in organic matter content, have low to high available water capacity and low to high fertility. They have moderately rapid to slow permeability. These soils have a slight to severe wind erosion hazard and a severe water erosion hazard.

The major management practices needed are those that control erosion and maintain organic matter content and fertility.

These soils are well suited to native range.

CAPABILITY CLASS VIs

This capability class consists of deep, nearly level to sloping, moderately well drained soils. They are fine sandy loam to silty clay soils on uplands, terraces, fans and in swales.

These soils are moderate in organic matter content, have low available water capacity and low fertility. They have very slow permeability. These soils have a moderate wind erosion hazard and a moderate water erosion hazard on long slopes over 3 percent. Rooting is restricted by a very shallow or shallow claypan.

The major management practices needed are those that control erosion and maintain organic matter content and fertility.

These soils are suited to native range and poorly suited to hay and cultivated crops.

CAPABILITY CLASS VIIe

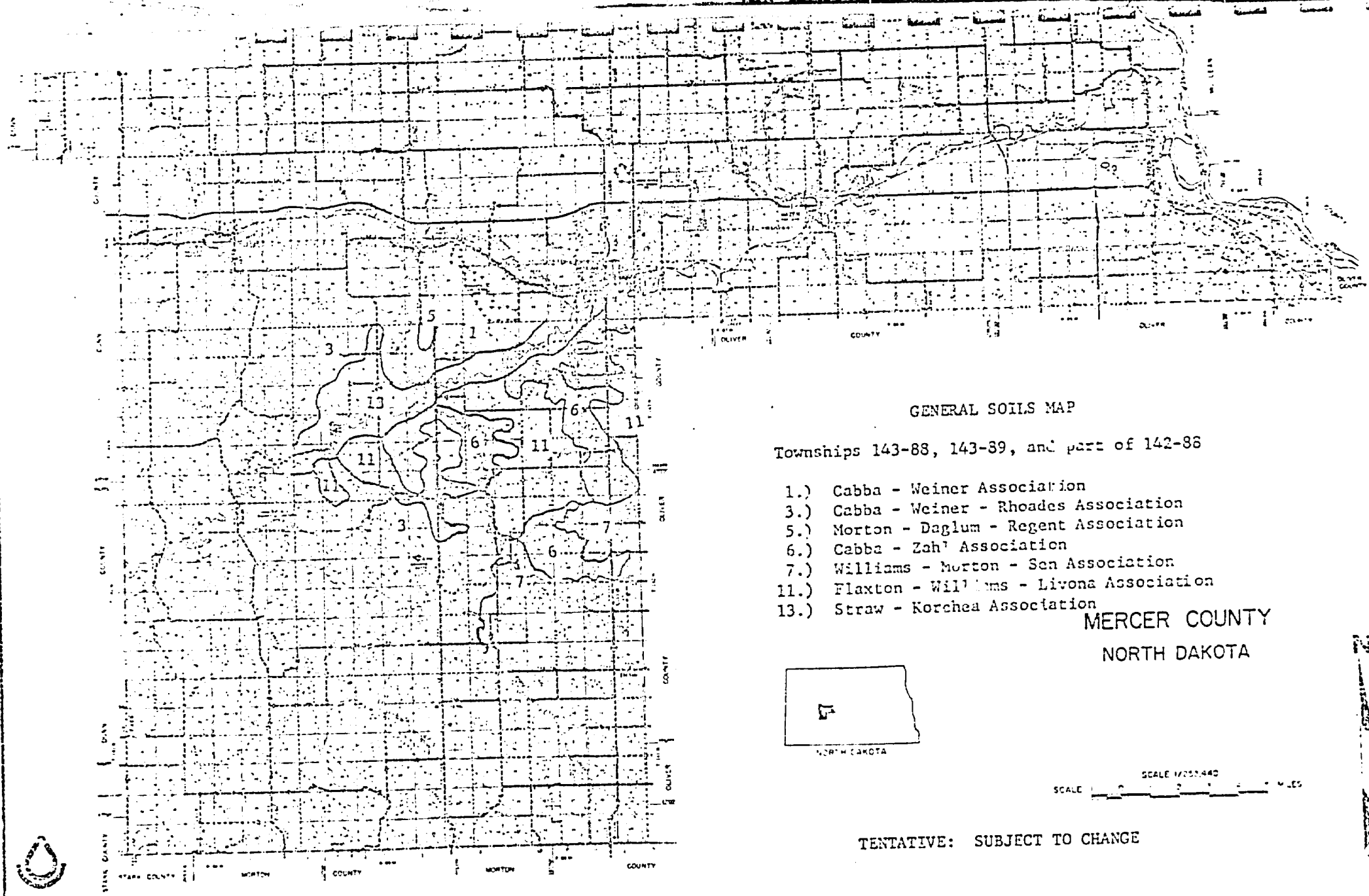
This capability class consists of shallow and moderately deep, steep or very steep, well and excessively drained soils and soft rock outcrops. They are fine sandy loam to silty clay loam soils on uplands.

The soils in this unit are low or moderate in organic matter content, have low available water capacity and low fertility. They have moderately rapid or moderate permeability. These soils have a severe to slight wind erosion hazard and a very severe water erosion hazard.

The main management practices needed are those that control erosion and maintain organic matter content and fertility.

These soils are only suited to native range.

REPRODUCTION REDUCTION ROLL NO
DATE MICROFILMED CAMERA OPERATOR



GENERAL SOILS MAP

Townships 143-88, 143-89, and part of 142-88

1.) Cabba - Weiner Association
3.) Cabba - Weiner - Rhoades Association
5.) Morton - Daglum - Regent Association
6.) Cabba - Zahl Association
7.) Williams - Morton - Sen Association
11.) Flaxton - Williams - Livona Association
13.) Straw - Korchea Association

MERCER COUNTY

NORTH DAKOTA

SCALE 1/253,440

SCALE 0 2 4 MILES

TENTATIVE: SUBJECT TO CHANGE

LAMBERT CONFORMAL PROJECTION

SOURCE: 1970 COUNTY HIGHWAY MAP
USDA-SCS-LINCOLN, NEBR. 1970

SHEET 5,S-3,142

EXHIBIT 11

State Historical Society
of north dakota

December 10, 1973

Mr. David Jordan
Conservationist
Knife River Coal Mining Company
400 N. Fourth Street
Bismarck, North Dakota 58501

Dear Mr. Jordan:
A search of our files shows that no historic or archaeological sites have been reported in the areas shown on the map sent with your letter (Township 143 N., Range 88 W., and Township 143 N., Range 88 W., Mercer County, North Dakota.) Since there is reason to believe there are unreported sites in these areas and since no systematic surveys have been conducted, it is recommended that the areas be surveyed for archaeological and historic sites.

I will be glad to answer any questions you might have.

Sincerely yours,

Nick G. Franko
Research Archaeologist

1975 ANNUAL REPORT
FOR THE
WATER MONITORING PROGRAM

BIG STONE PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

April 5, 1976

Dorand Engineering Services
Brookings, South Dakota

DORAND ENGINEERING SERVICES

James N. Dornbush, DSc
Dwayne A. Rollag, PE

324 DAKOTA AVENUE BROOKINGS, SOUTH DAKOTA 57006 605-692-6681

April 5, 1976

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

Gentlemen:

We are submitting herewith our "1975 Annual Report for the Water Monitoring Program, Big Stone Plant," including data collected during the period, January through December, 1975.

The report includes sections which summarize particular phases of the water monitoring program including ground water quality, ground water elevations, and surface water quality. Comparisons are also made with the data included in the 1972, 1973 and 1974 water monitoring reports. Recommendations for continued water monitoring are included.

It is further suggested that copies of this report be submitted to the appropriate regulatory agencies and, at that time, solicit their concurrence and/or suggestions concerning the proposed continued water monitoring program.

If there are any questions concerning this report, please contact me.

Sincerely,

James N. Dornbush, P.E.

JND:mfd
Enclosures

WATER MONITORING PROGRAM

BIG STONE PLANT - 1975

Scope of Water Monitoring Program

The water monitoring program in the Big Stone Plant area was established by the three power companies in 1971 to obtain background data on water quality and ground water levels in the immediate area of the Big Stone Plant site. Since that time samples have been collected for analyses from 9 wells, 3 river stations and Big Stone Lake at approximately monthly intervals. In addition, samples were collected on a quarterly basis from the plant cooling pond and a small natural pond at the plant site during 1973 and 1974; however, during 1975 sampling from the cooling pond was changed to monthly intervals to more closely evaluate quality changes as the plant went into operation. Ground water elevations have been recorded monthly at 6 wells and 5 well points from 1972 to date. The approximate location of the water monitoring stations is shown on the sketch map of the area (Figure 1).

This summary report on the water monitoring program for the Big Stone Plant includes the data collected during 1975 and makes comparisons with past water monitoring data. The report was prepared at the request of the three power companies and authorized by Purchase Order 49753 dated March 6, 1975.

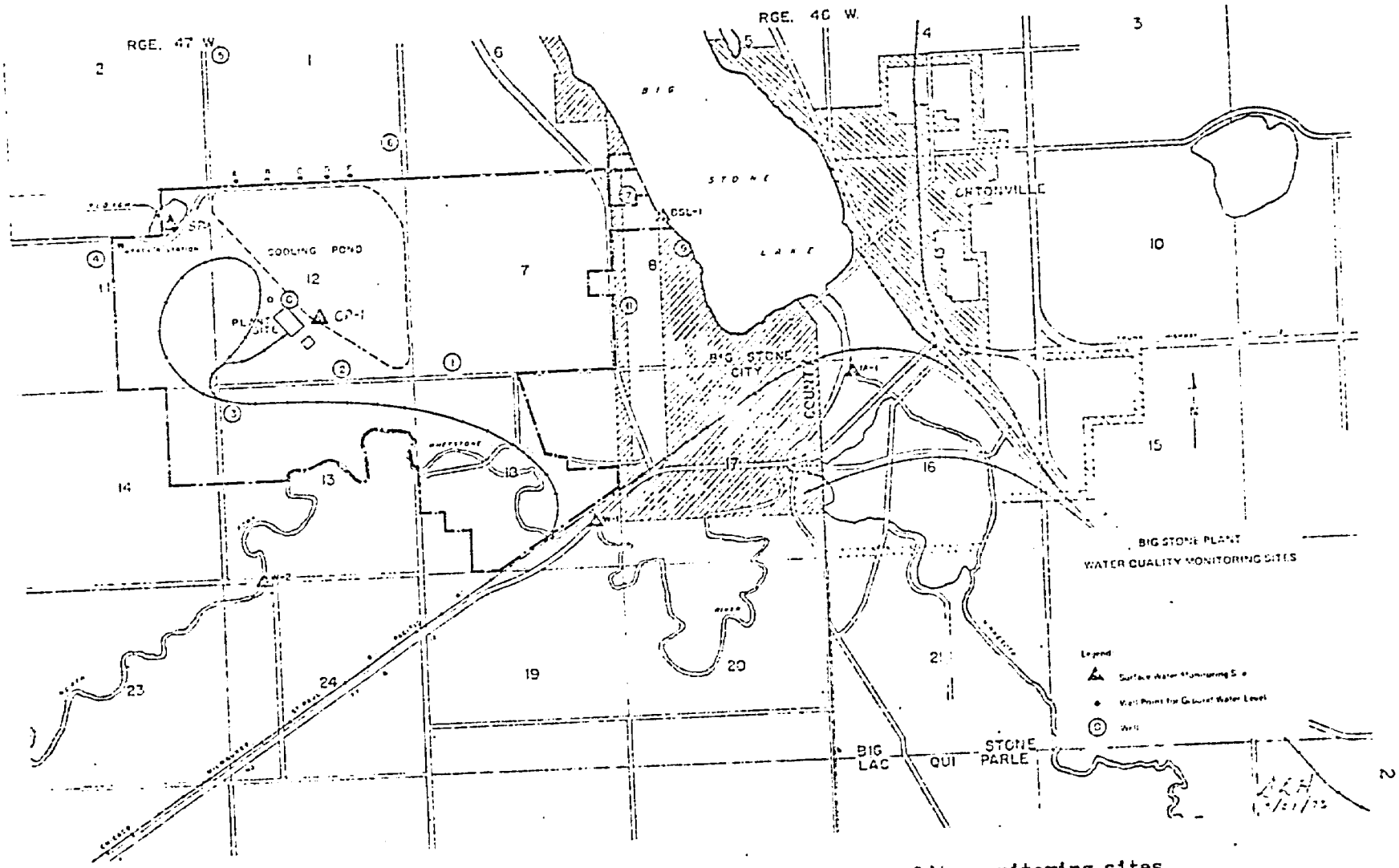


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

Ground Water Quality

During the past three years, it has been established that the chemical quality of the ground water in the Big Stone Plant area varies substantially among the wells sampled in the monitoring program. Past reports in 1972, 1973 and 1974 have compared the chemical quality of the various wells indicating that those wells south and west of the cooling pond (Wells 2 and 4 respectively) were of the poorest chemical quality. Well 3 located southwest of the plant and Well 9 (the Big Stone City municipal well) have the best chemical quality. In general, however, the water in the area as indicated by all wells is quite mineralized, very hard and excessive in sulfates.

The ground water quality monitoring program was established to obtain background data on water quality prior to operation of the plant and to determine if changes in ground water quality might occur with plant operation as a result of the cooling pond. The monitoring program in 1975 was conducted in essentially the same manner as in past years with monthly samples analysed and tabulated. The results of these monthly analyses are included in the Appendix. In 1975, however, several of the wells could not be sampled each month because of lack of power at the pumps or an inoperative pump. Wells 1, 2 and 3 on company property located southeast, south and southwest of the cooling pond were sampled on only 6, 3 and 10 of the months, respectively.

To summarize the monthly data, mean concentrations of the chemical constituents of each of the 9 wells were obtained. By comparing these mean concentrations with similar data compiled in past years, long-term trends of changes in water quality can be determined without considering the minor

variations that might occur seasonally or within the laboratory as a result of analytical techniques. Table 1 includes the overall mean concentrations of the chemical constituents for each of the 9 wells for 1975.

Considering the mean concentrations in Table 1 for 1975 with similar data for the previous three years, the following summaries for each well seem pertinent:

Well 1 - Average concentrations of some constituents (total and calcium hardness and nitrates) were higher than 1974, and other determinations showed little change. For conductivity, sulfates and total residue the averages were lower than in 1973. Since only six samples were collected in 1975 at this well, the changes may not be representative. After missing five samples, the single sample collected in November 1975, using a portable power generator, had concentrations comparable or within the range of past samples for November.

Well 2 - Mean concentrations of several constituents continued to increase at this well as has occurred in the past two years. This well is on plant property and is not used for a household supply and consequently is not pumped regularly. Only seven samples were collected in 1975 because of lack of power; however, all samples revealed a highly mineralized water. Of the wells sampled in the monitoring program, this well is closest to the cooling pond.

Well 3 - Mean concentrations of several constituents at Well 3 were substantially lower in 1975 than in past years. The pump, however, did not function properly for much of the summer and did not have sufficient capacity to assure collection of representative samples of ground water. Nevertheless, there appears to have been a quality improvement at this well which might be related to water level changes. The well is also on company property and not pumped regularly.

Well 4 - Several determinations (conductivity, total and calcium hardness, alkalinity and residue) had lower mean concentrations than in 1973 and 1974. Nitrate concentrations were high for several samples as has occurred in past years. This well is a farmstead well and is pumped regularly.

TABLE 1 - Mean Concentrations of Chemical Constituents
for Samples from Nine Wells
Big Stone Plant Area
January-December 1975

Determination*	Well Number 1**	2**	3**	4	5	6	7**	8	9
Conductivity - μmhos/cm-25°C	1888	3148	810	2360	1486	1392	1289	1338	1206
Total Hardness	1286	2089	433	1522	880	799	759	799	620
Calcium Hardness	957	1665	223	1155	551	543	503	529	361
Sodium	20	31	25	22	22	21	23	21	40
Total Alkalinity	405	397	245	384	457	455	450	426	260
Chlorides	0.9	48	2.3	40	4.4	1.2	0.7	1.0	18
Sulfates	737	1516	220	1180	495	434	398	443	446
Total Phosphorus	0.11	0.17	0.03	0.02	0.26	0.33	0.28	0.03	0.01
Nitrate Nitrogen	7.6	19.7	1.2	18.4	4.4	0.4	0	0	0.06
Ammonia Nitrogen	0.32	0.13	1.98	0.06	0.41	0.56	1.34	1.08	0.78
Kjeldahl Nitrogen	1.3	1.0	2.34	0.7	0.81	1.06	1.71	1.37	1.16
Total Residue	1723	3062	629	2288	1304	1176	1153	1154	1007
pH - units (median)	7.1	6.9	7.6	7.2	7.1	7.1	7.1	7.0	7.5

* Results expressed as mg/l except as noted.
** Mean concentrations based on less than 12 samples.

Well 5 - For several chemical constituents, slightly lower mean concentrations were found in 1975 compared to past years. The chemical quality of the water during the past several years is about the same or slightly improved although difficulty with unsatisfactory bacteriological samples has occurred annually.

Wells 6, 7, and 8 - There appears to have been no significant changes in water quality at these wells during the past four years. Although there has been slight variation in mean concentrations from year to year, no trend of change is apparent.

Well 9 - A new well was installed at Big Stone City adjacent to the well that has been sampled in past years. Mean concentrations of several constituents were slightly higher in 1975 than in past years. Because of the location near Big Stone Lake, it is likely that the quality of the water in the well is influenced by changes in lake water quality.

It should be recognized that the summary statements above were prepared by reviewing mean concentrations of the various constituents of the wells and comparing them with similar data from past reports. Many factors contribute to ground water quality variation; however, the objective of the well monitoring program is to evaluate long-term changes in relation to the operations of the Big Stone plant. Only Well 2, on company property nearest the cooling pond, has revealed a continued trend of increased concentrations of chemical constituents.

Well 2 was renovated in the early stages of plant construction and used to serve sanitary facilities for several mobile construction trailers. Only the Twin City Testing trailer used water after buildings were constructed at the plant site. Presently the well serves only for monitoring purposes. The resulting decreased pumpage from the well throughout the monitoring program could possibly be a factor influencing water quality that is not comparable

to other wells being monitored. Because Well 2 is a large-diameter well, the normal pumping prior to the monthly sampling may be insufficient to obtain samples that are representative of ground water variations.

Well 4 which is west of the plant showed a slight improvement in water quality in 1975. This well, which has been shown to be more highly mineralized than the other wells, except Well 2, also showed continued increases in chemical concentrations in 1973 and 1974 similar to Well 2. Since this farmstead well is pumped regularly, representative samples of ground water would seem to be assured.

Although the above comparison of quality changes at Well 2 and Well 4 may not be related, the circumstances suggest that routine pumping may be important, particularly at Well 2. It is recommended that additional pumping of Well 2 be initiated after power is reconnected to Wells 1 and 2.

Trace Metals. In addition to the analyses conducted on a monthly basis, samples were also collected from the 9 wells for analysis of 13 trace metals. These samples were collected on April 24 and September 22, 1975, to represent spring and fall ground water quality comparable to 1973 and 1974 data.

The analyses of all trace metals except selenium, barium and silver were performed at the State Chemical Laboratory, Vermillion, South Dakota. Selenium concentrations were determined at Station Biochemistry Laboratories at South Dakota State University, Brookings, South Dakota. Barium and silver concentrations were determined by Dr. James J. Norman, Associate Professor of Chemistry, South Dakota State University. The results of the analyses for trace metals are included in Table 2.

Results of Analyses of Trace Metals for Ten Wells
Big Stone Power Plant Area - 1975

Determination	Date	Well Number 1	2	3	4	5	6	7	8	9
Arsenic - ppm	4/24	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	9/22	-	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium - ppm	4/24	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	9/22	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium - ppm	4/24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	9/22	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cobalt - ppm	4/24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	9/22	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Copper - ppm	4/24	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
	9/22	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury - ppm	4/24	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	9/22	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nickel - ppm	4/24	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
	9/22	-	-	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Zinc - ppm	4/24	0.1	0.2	0.3	0.06	0.03	0.05	0.1	0.5	0.02
	9/22	-	-	0.4	<0.1	<0.1	<0.1	0.4	0.4	<0.1
Cyanide - ppm	4/24	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	9/22	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Lead - ppm	4/24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	9/22	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Selenium - ppb	4/24	3.6	6.9	1.1	1.1	0.5	0.8	1.1	1.2	0.7
	9/22	-	-	0.5	1.0	0.2	0.4	1.0	1.0	0.7
Barium - ppm	4/24	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
	9/22	-	-	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Silver - ppm	4/24	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	9/22	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

It will be noted that most of the concentrations of trace metals are reported as less than (<) some specific concentration which represents the lowest detectable limit based on the analytical procedure, equipment and size of sample used. Because the trace elements that were determined occur in extremely low concentrations, the samples need to be concentrated prior to analysis, and the highly mineralized ground waters of the Big Stone area create problems during the concentration process. In 1975, the State Chemist, D. J. Mitchell, reported that the results were "based on the lowest detectable unit based on the sample size used" with "water concentrated 5 times except for mercury and cyanide determination." For the cyanide determination, water was concentrated about 10 times, and the mercury determination was made on the water as received.

Although most trace metal concentrations have been determined semi-annually since 1973, the analyses of barium and silver were started in 1974. The minimum detectable limit has varied from 1.0 to 0.1 for barium and from 0.05 to 0.01 for silver. Although only four sets of data have been collected for these two metals (six sets for the other trace metals), all results for barium and silver have been reported as less than the detectable limit.

During 1975, only three of the trace metals (copper, selenium and zinc) were determined in quantities greater than the minimum detectable limits of the test. For copper, a single sample from Well 9 on April 24, 1975, had a detectable copper content of 0.2 mg/l. Big Stone City installed a new well in 1975 at the site of Well 9, and the increase in copper may have occurred from new fittings installed with this well. This single sample was the only

sample in the entire monitoring program that has exceeded the 0.1 mg/l detectable limit for copper. Selenium and zinc have been measured in excess of the detectable limit frequently throughout the monitoring program. In the case of selenium, the analysis has a minimum detectable limit of 0.1 parts per billion, several orders of magnitude lower than the detectable limits of some of the other trace metals.

When the water monitoring program was initiated, the monitoring of trace metals was undertaken to establish background data for those metals that were included in the drinking water standards with some additions. In 1974 it was recognized that relatively little information was being obtained as to the actual concentration of these metals because most results were reported as below the detectable limit for the particular determination. Table 3 reveals that of 688 determinations of trace metals 587 were below the detectable limit. Zinc and selenium as discussed above account for all but two of the analyses that detected actual concentrations. The 1975 copper determination for Well 9 and a chromium determination in 1973 (probably a contaminated sample) were the other two.

The Environmental Protection Agency (EPA) has recently published National Interim Primary Drinking Water Regulations in the December 24, 1975, Federal Register. Water supplied to communities with a public water supply will need to meet certain requirements including a maximum allowable contaminant level for certain constituents. Table 3 includes the maximum allowable contaminant level for those trace metals as established in the primary standards. It should be noted that, in several cases, the maximum limit is lower than the

TABLE 3
Summary of Trace Metal Determinations
Showing Number of Samples with Concentrations
Reported Below the Detectable Limit of the Analysis
Big Stone Plant Area - 1973 through 1975

Determination	Maximum Allowable Contaminant[1] Level - mg/l	Lowest Detectable Limit - mg/l	Total Number of Samples Analysed	Total Number of Samples Below Detectable Limit
Arsenic	0.05	0.02	56	56
Cadmium	0.010	0.1	56	56
Cobalt		0.2	56	56
Copper		0.1	56	55
Lead	0.05	0.2	56	56
Mercury	0.002	0.005	56	56
Nickel		0.4	56	56
Cyanide		2.0	56	56
Chromium	0.05	0.2 & 0.4	56	55*
Zinc		variable	56	12
Selenium**	0.01	0.1**	56	1
Barium***		0.1-1.0	36	36
Silver***	0.05	0.01-0.5	36	36
		Totals	688	587

* Single sample reported at 20.4 ppm in 1973 report was probably contaminated from cleaning solution.

** Reported in parts per billion (ppb). The maximum concentration reported is 8.6 ppb at Well 2 in 1974.

*** Analyses performed in 1974 and 1975 only.

1. Applicable to community water supplies from National Interim Primary Drinking Water Regulations, Federal Register, Part IV: Environmental Protection Agency, December 24, 1975.

lowest detectable limit reported for the laboratories testing water samples from the Big Stone Plant area. It should not be interpreted that these sample concentrations exceed the allowable limit but rather that more sensitive testing procedures will be needed in the future. With the highly mineralized waters in the Big Stone Plant area, reaching these very low limits without interferences may prove difficult. EPA and the State will be certifying laboratories in the future according to the above Federal Register.

Iron. During 1975 iron concentrations were measured at the nine wells employing a field test kit in a manner similar to past years. Iron concentrations determined semiannually in 1975 are included in Table 4 along with comparable data from past years.

High iron concentrations are common in ground waters of South Dakota. It is also possible that corrosion of well casings, screens, piping, etc. may contribute iron to the water. From Table 4, it can be noted that most of the wells have an iron content above the generally recommended standard (0.3 mg/l) for domestic purposes. Only Well 2, the well which has the most highly mineralized water, has a low concentration of iron. As pointed out previously, Well 2 is a large-diameter well with a wooden casing, and it is possible that the iron in the water becomes oxidized and settles in the well. Frequent pumping of Well 2 would probably reduce the probability of iron oxidation and cause an increase in iron concentration since most ground waters in the area have considerably higher iron concentrations.

Although the iron content of the water varies significantly between wells, there has been comparatively little variation for the same well with time

TABLE 4
Results of Field Tests for Iron
Big Stone Plant Area, 1973-1975
Big Stone City, South Dakota

Well Number	Iron Concentration - mg/l					
	5/21/73	10/8/73	5/21/74	10/15/74	5/28/75	10/20/75
0	1.8	2.9	2.8	3.0	-	-
1	5	5	5	-	5	-
2	0.9	0.2	0.2	0.6	0.2	-
3	2.4	2.8	8	7.5	5	7
4	8	8	9	1.5	0.6	0.9
5	1.0	1.1	1.2	1.0	1.0	1.0
6	2.0*	1.7	0.3	2.0	2.0	2.3
7	10	10	7	7.5	5	8
8	8.5	10	8	5	7.5	5
9	0.8	1.0	0.7	0.9	0.6	0.6

* Determined on June 18, 1973.

except for Wells 3 and 4. Water from Well 4 had substantially less iron in 1975 compared to 1973 while water from Well 3 nearly doubled in iron during the same period. No reason can be offered for these changes unless they are related to changes in pumping and corrosion. If Well 3 is pumped more frequently, the iron concentration may be reduced as water containing corrosion products is replaced with native ground water.

Ground Water Elevations

Ground water levels are monitored by two methods. In 1972, five well points were installed in gravel-packed holes to depths of about 25 feet along the county road north of the cooling pond (See Figure 1). These well points were installed to determine the water levels in the saturated soil and measurements were made in 1975 at about monthly intervals when the samples were collected. In addition, six farmstead wells (Wells 1, 2, 3, 4, 5 and 7) were fitted with air lines in 1972 to determine water levels on a monthly basis when samples were collected. The recorded water levels for 1975 are included in the Appendix.

Figure 2 is a plot of the ground water levels recorded at the well points during 1975. As in past years, the water levels in the well points varied considerably and in a seasonal nature. From November 1972 through mid-June 1974, water levels in these well points were measured by company personnel on a weekly basis, and it was shown that peak water levels in the well points generally were associated with periods of precipitation. Water was also standing in the adjacent ditch when water levels in the well points were high. Although the monthly readings in 1975 cannot be expected to reflect the

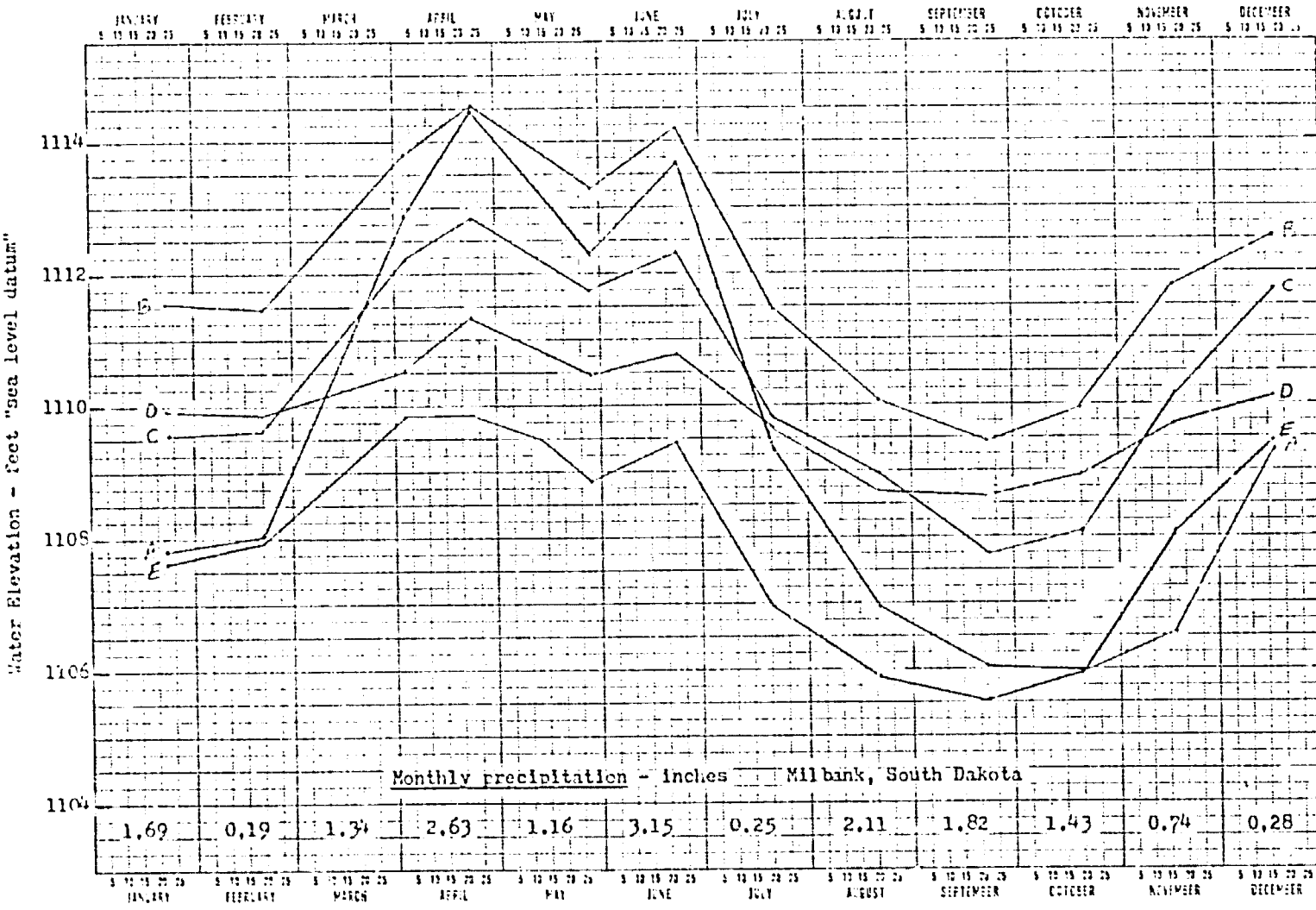


Figure 2 - Water Levels in Well Points Along County Road North of Cooling Pond - Big Stone Plant Area - 1975.

variation that was noted when weekly readings were taken, the plots reveal a similarity with past data. High water levels were again recorded in the spring and early summer with the water levels receding in the summer until late fall. Monthly precipitation for 1975 included on Figure 2 seems to correlate with the change in water levels in the well points.

In 1974, it was noted that well point D, located in one of the sand lens areas near the north dike, exhibited a more uniform water level with substantially less seasonal variation compared to the other well points. Figure 2 with the 1975 data shows a similar pattern for well point D. Since the spring thaw in 1973, shortly after the cooling pond was filled, the water level in well point D has varied only about 2.75 feet (the 1975 variation). Before the cooling pond was filled in 1972, from April through December, the water level varied 4.83 feet. It would appear that the water in the cooling pond combined with the sand lens in the area influences the water level in well point D.

Table 5 was compiled from water level data collected at the well points since they were installed in 1972. From Table 5, it will be noted that well point A exhibits the greatest difference in water level during a calendar year. Furthermore, well points A, B, and C had a greater water level difference in 1975 than in previous years. By contrast, well point D has had substantially less water level difference in the past two years. In addition, the slightly higher minimum water levels recorded in well point E during the past two years would tend to indicate that this well point may also reflect a slight influence of the cooling pond.

TABLE 5
Maximum and Minimum
Water Levels in Five Well Points
North of Cooling Pond, 1972-1975
Big Stone Plant Area
Big Stone City, South Dakot

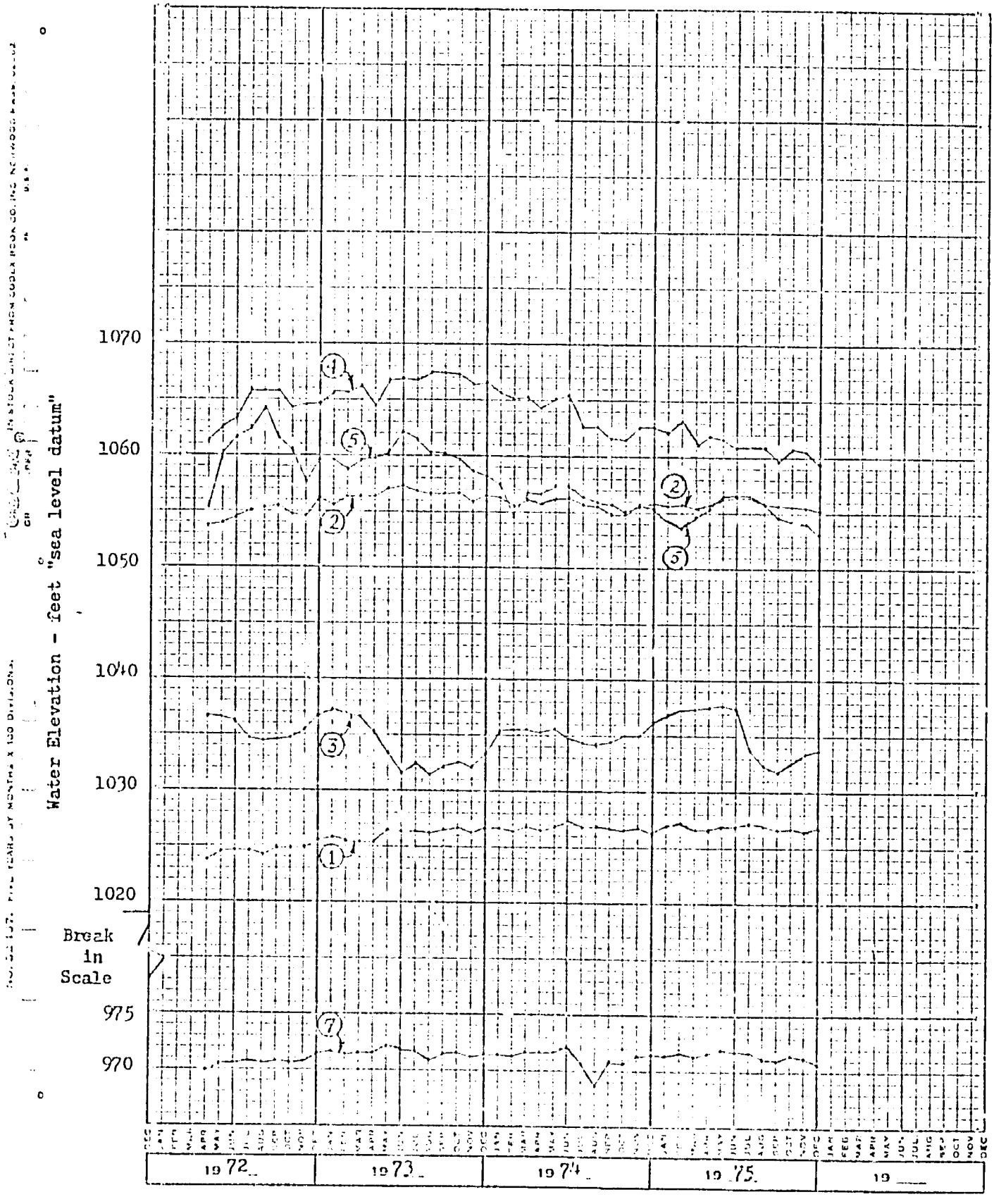
Well Point	Year	Number of Readings	Maximum Water Level	Minimum Water Level	Difference - feet
A	1972	15	1115.03	1108.42	6.61
	1973	50	1113.63	1106.63	7.00
	1974	29	1112.97	1106.11	6.86
	1975	12	1114.46	1105.96	8.50
B	1972	15	1114.25	1109.29	4.96
	1973	50	1114.21	1109.37	4.84
	1974	29	1113.54	1109.18	4.36
	1975	12	1114.54	1109.46	5.08
C	1972	15	1112.97	1108.36	4.61
	1973	50	1112.49	1107.57	4.92
	1974	29	1112.07	1107.51	4.56
	1975	12	1112.82	1107.74	5.08
D	1972	15	1110.15	1105.32	4.83
	1973	50	1110.53	1105.32	5.21
	1974	29	1110.36	1109.02	1.34
	1975	12	1111.36	1108.61	2.75
E	1972	15	1108.32	1103.44	4.88
	1973	50	1109.77	1103.36	6.41
	1974	29	1109.19	1106.52	2.67
	1975	12	1109.86	1105.52	4.34

Figure 3 shows the ground water levels recorded at the six farmstead wells during the past four years. It is apparent that Wells 4 and 5 located west and north of the plant site have experienced a general lowering of the water table during the past two years. Consequently, it would appear that the filling of the cooling pond in late 1972 has not been an influencing factor with respect to water levels at these wells. These wells are used regularly at the farmstead, and it would appear that recharge of ground water from precipitation is the major factor determining the ground water level in these wells.

Wells 1 and 2, located nearest the cooling pond to the southeast and south respectively, have maintained an almost uniform water level during the past two years. These wells on company property are not in service except as monitoring wells. By contrast, Well 3 also on company property and not in use except for monitoring purposes experienced a substantial change in water level during 1975. Well 3 located to the southwest at a greater distance from the cooling pond does not appear to be influenced by the potential recharge from that source, however.

The total precipitation recorded at Milbank, South Dakota, during 1975 was 16.79 inches, the third consecutive year when precipitation was 5 to 6 inches below the normal of 22.49 inches for that station. Thus, it is not unusual that minimum water levels were recorded during 1975 for Wells 4 and 5 since precipitation appears to be the major factor controlling the water level in these wells. By contrast, the water level in Well 7 near Big Stone Lake has remained relatively constant and may be influenced primarily by the lake level.

Figure 3 -
Ground Water Levels Recorded at Six Wells
Big Stone Plant Area



Based upon the water level information that has been collected during the monitoring program to date, it would appear that the construction and filling of the cooling pond has not adversely influenced the water level of wells in the surrounding area. Considering the location, surrounding topography, and the soils in the area, the comparatively uniform water level of Wells 1 and 2 which are not used would not appear to be significant at this time.

Surface Water Quality

Although the Big Stone Plant is not expected to influence surface water quality in the plant area, sampling stations have been established on Big Stone Lake, the Minnesota River and the Whetstone River to obtain information on surface water quality in the immediate area. On the Whetstone River, two stations were selected at bridges upstream and downstream from points where surface drainage from the plant site would enter the river. The results of the analyses of the monthly samples collected at these stations are appended to this report.

Table 6 contains the mean concentration and the range of concentrations of constituents obtained in 1975 for the lake and river sampling stations. As in past years, wide variations in concentrations were noted at all sampling stations with much of the variation attributed to seasonal climatic conditions.

Mean concentrations of chemical constituents for the samples from Big Stone Lake were higher for most chemical constituents in 1975 compared to 1974. Because mean concentrations were also higher in 1974 than the previous two years, it would seem that the increases reflect the influence of lower

TABLE 6 - Mean and Range of Concentrations of Chemical Constituents for Samples from Four Surface Water Stations
Big Stone Plant Area - January-December 1975

	Big Stone Lake		Minnesota River		W-1 Whetstone River		W-2	
Determination*	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Temperature - °C		1-26		0-27		0-24.5		0-24
pH - units		7.4-8.9		7.5-8.4		7.0-8.2		7.4-8.4
Conductivity - µmhos/cm-25°C	1174	997-1475	1182	1013-1464	1191	999-1433	1255	986-1963
Total Hardness	522	418-698	528	447-726	525	446-589	557	445-1000
Calcium Hardness	300	230-411	337	279-432	364	295-451	388	296-825
Sodium	60	40-73	58	30-81	60	29-86	71	31-165
Total Alkalinity	196	125-259	261	178-399	299	254-422	313	233-593
Chlorides	16	7-24	33	6-86	43	8-81	44	5-123
Sulfates	459	330-574	339	230-496	328	258-426	355	244-630
Total Phosphorus	0.13	0-0.23	0.18	0-0.47	0.22	0-0.53	0.37	0.1-0.6
Nitrate Nitrogen	0.16	0-0.3	0.09	0-0.4	0.19	0-0.5	0.11	0-0.4
Ammonia Nitrogen	0.56	0.23-1.42	0.55	0.05-2.82	0.54	0.07-2.85	0.74	0.04-3.41
Kjeldahl Nitrogen	1.96	0.85-3.2	1.55	0.9-3.7	1.31	0.7-3.59	1.50	0.66-3.7
Total Residue	990	720-1269	966	857-1428	956	832-1268	1022	794-1988
Total Suspended Matter	17	4-36	42	1-217	29	8-67	27	2-88
Dissolved Oxygen	8.4	5.3-12.0	8.6	3.7-13.0	8.5	5.2-11.9	7.8	4.3-11.6
Biochemical Oxygen Demand	5	2-14	5	2-11	5	2-9	4	1-9
Turbidity	2	1-4	4	1-10	3	1-5	3	1-7
Coliform Group - MPN/100ml		< 5-1500		15-1600		15-2700		5-2800
Fecal Coliforms - MPN/100ml		< 3-60		< 3-190		< 3-200		< 3-270

*Results expressed as mg/l except as noted.

than normal precipitation in the area for the past two years. Maximum concentrations were also noted extending the range of concentrations upward for Big Stone Lake during 1975. In most cases, the maximum concentrations occurred in the winter or early spring when ice cover concentrated the dissolved constituents.

In general, the Minnesota River experienced mean concentrations of chemical constituents in 1975 that were quite comparable to mean values of past years considering the wide variability of quality because it receives flow from both Big Stone Lake and the Whetstone River. In contrast with Big Stone Lake, however, the range of concentrations of the various constituents was not extended upward for most constituents. The maximum values for total residue and suspended matter were noted in the December sample and may have been caused from disturbing the bottom when chopping through the ice. That particular sample was noted to have a large amount of black suspended matter and an atypical odor.

The two sampling stations on the Whetstone River had mean concentrations that would indicate comparable water quality at the two stations. There was, however, a greater difference between mean concentrations at the two stations in 1975 than has been noted in past years with similar monitoring. The physical characteristics of the two stations is somewhat different in that the upstream station (W-2) has a ponded flow channel and comparatively still water under the bridge while the downstream station has more rapidly moving water. With these conditions, collecting comparable samples, particularly under ice cover, is difficult.

The January 1975 samples from the two Whetstone River stations had quite different characteristics which accounts to a large degree for the difference in mean concentrations and many of the maximun values shown (Table 6) in the range of concentrations for station W-2. As quoted in the first quarterly report, the field notes for station W-2 stated "there was no apparent water movement in the stream--seemed as though it was frozen to the bottom with kind of a slush." Since station W-2 is upstream from the drainage area of the power plant, the higher concentrations at this station would not cast suspicions on the Big Stone plant.

Cooling Pond. In 1973 and 1974 the cooling pond was sampled on a quarterly basis to obtain background data on the quality changes prior to operation. Comparatively slight changes in chemical quality were observed as a result of seasonal changes. The water in the cooling pond was found to be comparable in quality to that of Big Stone Lake from which it was filled and substantially better in quality than the ground water in the surrounding area.

In anticipation of quality changes in the cooling pond when the plant was put into operation, monthly samples were included in the monitoring program for 1975. The results of these monthly analyses are included in Table 7. From this data it can be seen that there was not much change in concentration of constituents in the cooling pond water during 1975. The data provided by the monthly samples will provide an excellent base for comparison with similar data collected after a complete year of plant operation when increased evaporation from the pond can be expected to result

COOLING POND (at plant intake structure)

TABLE 7

Station: CP - 1

Determination*	Sampling Dates - 1975 1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	1	3	3.5	10	25.5	29	29	27	13	11.5	18	5
pH - units	8.1	8.1	7.7	8.5	8.8	8.5	8.6	8.0	8.2	8.6	8.3	8.6
Conductivity - µmhos/cm-25°C	945	1205	1163	1092	1111	1205	1136	1185	1283	1214	1332	1214
Total Hardness	500	445	504	571	578	462	502	448	542	498	531	508
Calcium Hardness	239	256	280	251	273	239	254	281	280	230	249	268
Sodium	51	76	77	68	21	48	96	79	95	80	82	80
Total Alkalinity	182	182	186	174	174	159	165	153	160	152	160	156
Chlorides	19	19	18	16	15	19	12	18	10	25	24	17
Sulfates	402	397	435	414	387	412	482	516	578	570	568	585
Total Phosphorus	0	0	0	0.24	0	0.05	0.08	0.07	0.08	0.04	0.13	0.04
Nitrate Nitrogen	0	0	0	0.0	0	0	0.21	0	0	0	0.03	0.03
Ammonia Nitrogen	0.17	0.19	0.11	0.14	0.24	0.39	0.16	0.22	0.10	0.14	0.27	0.10
Kjeldahl Nitrogen	1.0	1.6	1.5	1.6	1.6	1.3	1.3	1.3	1.1	1.55	1.42	0.59
Total Residue	886	987	875	906	953	885	956	1050	1061	1042	1113	1139
Total Suspended Matter	16	1.5	33	33	18	8	4	7	3	2	2	12
Dissolved Oxygen	13.7	12.6	13.9	10.0	7.4	7.0	6.7	7.3	11.4	10.9	9.4	12.4
Biochemical Oxygen Demand	2	3	4	2	2	2	3	5	4	3	3	3
Turbidity	1	1	1	4	3	1	0	0	0	1	1	2
Coliform Group - MPN/100 ml	<5	5	<5	95	35	330	5	70	60	50	10	10
Fecal Coliforms - MPN/100 ml	<3	3	<3	3	<3	<3	<3	3	<2	<3	<3	3

*Results expressed as mg/l except as noted.

in substantially higher concentrations of chemical constituents. The average chemical quality of the cooling pond was very similar to the average quality of Big Stone Lake in 1975.

Small Pond. The small pond or slough west of the cooling pond has been sampled on a quarterly basis since 1973. The resulting data has revealed that the chemical quality of the water is substantially better than other surface water or ground water in the area. Because of the shallow depth, the winter sample collected under ice cover has been shown to be about twice the concentration of chemical constituents that is normal for the pond. Other seasonal variations have also been apparent.

The chemical data for samples collected from the small pond in 1975 is shown in Table 8. These data reveal essentially the same information that has been determined in previous years--comparatively good chemical quality with a wide quality variation occurring seasonally. The sulphates concentration that was noted to be very low in previous years was somewhat higher in some 1975 samples.

The original purpose of monitoring the small pond was to determine if seepage from the pond might be a factor to account for the better quality of water found in Well 3 located southwest of the cooling pond. Sufficient background has been obtained to indicate that this pond might serve as a source for the better water quality at Well 3. Continued water monitoring of this station would appear to be an unnecessary expense, and it is recommended that the sampling and analyses be discontinued. The available data should be sufficient for comparison in the event that quality changes may be evaluated at a future date.

SMALL POND (NE ¼, Sec. 11)(Northwest of plant)

TABLE 8

Station: SP - 1

Determination*	Sampling Date - 1975 2/20	5/28	8/21	11/17	Average
Temperature - °C	0	18	23	3.5	
pH - units	7.5	8.1	7.7	8.1	
Conductivity - µmhos/cm-25°C	1277	415	544	524	690
Total Hardness	580	204	230	258	318
Calcium Hardness	344	133	143	166	197
Sodium	44	44	11	14	28
Total Alkalinity	640	233	143	251	317
Chlorides	2	11	11	11	9
Sulfates	315	80	16	294	176
Total Phosphorus	0.42	0	0.57	0.02	0.25
Nitrate Nitrogen	0	0.1	0	0.02	0.03
Ammonia Nitrogen	2.5	0.18	0.53	0.10	0.83
Kjeldahl Nitrogen	4.5	1.34	2.0	2.31	2.54
Total Residue	1010	320	437	486	563
Total Suspended Matter	256	6	15	107	96
Dissolved Oxygen	0	6.2	4.7	11.7	5.7
Biochemical Oxygen Demand	68	1	5	8	21
Turbidity	85	1	0	2	22
Coliform Group - MPN/100 ml	20	10	25	20	
Fecal Coliforms - MPN/100 ml	10	<3	23	6	

*Results expressed as mg/l except as noted.

Recommendations for Continued Monitoring

Although the agreement for continued water monitoring for 1976 was made prior to completion of this report, the elements to be continued and the rationale for eliminating certain aspects from the water monitoring program are included in this report. The purpose of the water monitoring program is to determine if changes in water quality or ground water conditions occur as a result of plant operation and to determine the significance of these changes to provide information for corrective action if necessary. The background of data that was collected prior to plant operation can be used to evaluate changes as operations continue.

For 1976 it is recommended that the monitoring program be conducted in essentially the same manner that has been used in past years. Water level measurements, sampling and analyses of surface and ground water would provide continuity to the program to detect long-term changes that might occur. Continued monthly sampling of the cooling pond is indicated in order to evaluate quality changes with continued operation.

Two deletions to the monitoring program that were offered as alternatives in last years report but continued for 1975 were omitted for 1976. These deletions which slightly reduce the scope of the program but substantially reduce monitoring costs are:

1. Omitting the trace metals analyses for the nine wells because the detection limit seems to be the controlling factor for most analyses, and
2. Omitting the quarterly sampling and analyses for the small pond.

Background data has been collected for several years in both of the above instances; and should questions arise, similar data could be collected in the future for comparison.

Three wells included in the monitoring program are on plant property (Wells 1, 2 and 3). Because of lack of power or pump problems, samples were not collected from these wells during some months in 1975. The strategic location of these wells between the cooling pond and the Whetstone River and the close proximity to the cooling pond would make these wells particularly important to the monitoring program. Well 2 seems to be the only well which might be experiencing a quality change, and as discussed previously, this change may be related to lack of pumping. As a result, it is recommended that Well 2 be pumped rather extensively immediately after power is available.

APPENDIX

DERALD HAY FARM (SW ¼, Sec. 7)(Southeast of cooling pond on plant site)

Determination*	Sampling Dates - 1975											
	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	8	8.5	9	9	11						10	
pH - units	7.1	7.1	7.0	7.1	7.0						7.2	
Conductivity - μmhos/cm-25°C	1713	1942	1817	2347	1744	NO	NO	NO	NO	NO	1763	NO
Total Hardness	1160	1251	1000	1663	1560						1084	
Calcium Hardness	781	781	789	13[illegible]	1324	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	736	SAMPLE
Sodium	16	23	22	17	17						23	
Total Alkalinity	398	398	391	386	410						444	
Chlorides	2	0.2	0.7	0.6	0.7						1.2	
Sulfates	720	625	824	802	753						696	
Total Phosphorus		0.06			0						0.27	
Nitrate Nitrogen	0.1	0.0	0.0	0.1	44						1.4	
Ammonia Nitrogen		0.42			0.16						0.37	
Kjeldahl Nitrogen		1.7			1.2						1.1	
Total Residue	1670	1379	1584	2287	1653						1767	
Coliform Group - MPN/100 ml												

*Results expressed as mg/l except as noted.

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond) Station: Well - 2

Sampling Date: - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	8	8.5	9	9	10	11	9.5				10	
pH - units	6.9	7.9	6.9	6.9	6.9	6.9	6.9				7.0	
Conductivity - µmhos/cm-25°C	3022	3219	3323	3271	3063	3266	2899	NO SAMPLE	NO SAMPLE	NO SAMPLE	3134	NO SAMPLE
Total Hardness	2026	2062	2210	2204	2265	1982	1905				2056	
Calcium Hardness	1746	1379	1780	1756	1720	1692	1582				1662	
Sodium	29	39	33	31	32	22	31				33	
Total Alkalinity	414	397	388	397	398	389	355				434	
Chlorides	51	47	49	51	47	52	48				35	
Sulfates	1504	1205	1652	1684	1545	1500	1488				1548	
Total Phosphorus		0.26			0.08						0.17	
Nitrate Nitrogen	1.5	10.9	31.6	51.4	0.17	4.00	6.7				51.4	
Ammonia Nitrogen		0.15			0.15						0.10	
Kjeldahl Nitrogen		1.3			1.0						0.6	
Total Residue	2915	2916	2990	3267	3045	3249	2851				3261	
Coliform Group - MPN/100 ml						< 1						

*Results expressed as mg/l except as noted.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Sampling Date: - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C		8	9	9	11.5	13.5	13	11.5		9.5	10	
pH - units		7.3	7.6	7.6	7.6	7.6	7.7	7.1	7.4	7.5	7.7	
Conductivity - µmhos/cm-25°C	NO	898	924	981	769	841	793	715	715	754	705	NO
Total Hardness		462	481	568	539	361	375	389	399	389	368	
Calcium Hardness	SAMPLE	299	265	287	255	187	180	185	189	184	203	SAMPLE
Sodium		31	29	27	26	17	26	23	23	20	24	
Total Alkalinity		229	376	231	247	214	219	259	202	252	216	
Chlorides		2	2	2	0.5	3	3	3	3	2	2	
Sulfates		220	278	236	247	220	192	194	208	206	198	
Total Phosphorus		0			0			0.09			0.02	
Nitrate Nitrogen		0.2	0.2	0.2	6.5	0.0	0.0	0.33	0.36	0.24	3.60	
Ammonia Nitrogen		2.57			2.18			1.88			1.29	
Kjeldahl Nitrogen		3.2			2.6			1.95			1.62	
Total Residue		698	693	701	680	587	599	606	575	547	604	
Coliform Group - MPN/100 ml						2.2						

*Results expressed as mg/l except as noted.

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site) Station: Well - 4

Sampling Dates - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	8	7.5	8	8.5	9.5	10	10.5	10	10	8.5	9.0	8.0
pH - units	7.7	7.2	7.5	7.3	7.1	7.2	7.2	6.8	7.0	7.2	7.5	7.5
Conductivity - umhos/cm-25°C	2284	2596	2441	2574	2440	2399	2263	2254	2469	2233	1930	2432
Total Hardness	1482	2164	1520	1320	1289	1616	1489	1380	1498	1540	1522	1440
Calcium Hardness	1116	1332	1210	1172	1205	1136	1193	1124	1096	1116	1120	1044
Sodium	21	24	24	21	23	15	26	20	23	19	24	21
Total Alkalinity	272	352	348	321	353	424	439	434	446	412	407	394
Chlorides	42	41	33	37	39	40	41	38	39	37	54	36
Sulfates	1240	1152	1320	1160	1230	1156	1108	1212	1168	1136	1140	1142
Total Phosphorus		0			0			0.06			0.02	
Nitrate Nitrogen	46.2	46.9	35.1	4.5	4.5	2.3	4.3	27	36	3.7	5.4	4.8
Ammonia Nitrogen		0.05			0.08			0.07			0.05	
Kjeldahl Nitrogen		0.9			0.8			0.5			0.6	
Total Residue	2203	2287	2365	2401	2431	2359	2202	2247	2248	2230	2254	2227
Coliform Group - MPN/100 ml			< 1			< 1		2.2			< 2.2	

*Results expressed as mg/l except as noted.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site)

Station: Well - 5

Sampling Dates - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	9	9	8	9	11	12.5	11.5	11.5	9	9	9	8.5
pH - units	7.2	7.1	7.1	7.1	7.1	7.2	7.2	6.7	6.9	7.1	7.4	7.4
Conductivity - µmhos/cm-25°C	1454	1610	1610	1686	1412	1620	1528	1460	1479	1254	1293	1430
Total Hardness	895	1025	878	1021	987	845	930	771	880	781	792	849
Calcium Hardness	295	574	542	589	556	618	611	595	564	540	593	537
Sodium	24	25	24	22	25	17	23	23	21	19	22	20
Total Alkalinity	422	448	447	450	458	480	482	453	464	448	463	470
Chlorides	4	0.2	0.9	0.5	0.8	12	12	5	4	4	6	3
Sulfates	586	500	550	538	532	426	482	496	486	324	507	513
Total Phosphorus		0.03			0			1.00			0.02	
Nitrate Nitrogen	9.0	0.1	6.5	2.7	0	9.3	10.2	5.0	1.5	2.4	2.7	3.0
Ammonia Nitrogen		0.42			0.24			0.65			0.32	
Kjeldahl Nitrogen		1.0			0.90			0.89			0.43	
Total Residue	1307	1425	1263	1373	1342	1297	1278	1246	1306	1193	1329	1291
Coliform Group - MPN/100 ml			<1			<1		5.1	u		2.2	

*Results expressed as mg/l except as noted.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond)

Station: Well - 6

Sampling Dates - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	7	8	8	7	11	12	13	13	10	9	9.5	8.0
pH - units	7.2	7.0	7.1	7.1	6.9	7.1	7.2	6.7	6.9	7.2	7.3	7.5
Conductivity - µmhos/cm-25°C	1163	1496	1516	1479	1444	1449	1366	1460	1386	1391	1205	1352
Total Hardness	824	850	763	838	823	860	795	771	810	730	750	775
Calcium Hardness	255	456	720	669	675	540	545	595	509	501	538	509
Sodium	18.5	24	23	23	22	18	21	23	21	18	18	18
Total Alkalinity	434	452	446	452	463	473	421	453	471	457	467	466
Chlorides	2.4	0.6	0.6	0.5	0.6	0.6	0.8	5.0	0.9	1.0	0.7	1.1
Sulfates	426	415	450	450	434	404	420	496	418	444	426	435
Total Phosphorus		0.09			0.10			1.00			0.11	
Nitrate Nitrogen	0	0	0	0	0	0	0	5.0	0	0	0.0	0
Ammonia Nitrogen		0.66			0.56			0.65			0.38	
Kjeldahl Nitrogen		1.3			1.1			0.89			0.9	
Total Residue	1064	1133	1083	1257	1183	1224	1201	1246	1221	1149	1180	1171
Coliform Group - MPN/100 ml			<1			<1		<2.2			< 2.2	

*Results expressed as mg/l except as noted.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake) Station: Well - 7

Sampling Dates - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C		8		9	10	10.5	10	9	10	8.5	10	9
pH - units		7.1		7.0	7.1	7.1	7.2	6.7	7.0	7.2	7.4	7.6
Conductivity - µmhos/cm-25°C	NO SAMPLE	1392	NO SAMPLE	1402	1340	1289	1216	1302	1308	1244	1136	1259
Total Hardness		708		780	794	871	761	778	735	699	739	725
Calcium Hardness		432		580	587	513	537	479	470	453	509	465
Sodium		22		24	25	17	27	23	24	21	23	19
Total Alkalinity		432		447	440	442	468	448	454	452	451	461
Chlorides		0.3		0.6	0.6	0.5	0.7	0.6	1.1	1.1	0.9	0.6
Sulfates		382		416	424	382	408	408	374	408	388	392
Total Phosphorus		0.08			0			1.00			0.04	
Nitrate Nitrogen		0		0	0	0	0	0	0	0	0	0
Ammonia Nitrogen		1.58			1.15			1.43			1.19	
Kjeldahl Nitrogen		1.95			1.64			1.87			1.38	
Total Residue		1114		1168	1173	1142	1165	1194	1156	1116	1147	1150
Coliform Group - MPN/100 ml					< 2.2	<2.2		< 2.2			< 2.2	

*Results expressed as mg/l except as noted.

BERNARD FRENSKO FARM (SW ¼, Sec. 8)(East of plant site and cemetery) Station: Well - 8

Sampling Dates - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	8	8.5	9	8.5	10	10	10.5	10	10	9.5	10	8
pH - units	7.0	6.9	6.9	7.0	6.9	7.0	7.1	6.6	6.9	7.0	7.1	7.4
Conductivity - µmhos/cm-25°C	1148	1475	1485	1422	1442	1360	1283	1312	1352	1283	1166	1322
Total Hardness	942	799	701	890	865	867	787	769	761	690	740	760
Calcium Hardness	270	495	580	610	605	563	555	569	536	510	530	520
Sodium	21	19	22	21	21	14	34	21	20	19	16	19
Total Alkalinity	422	413	416	417	422	431	428	444	440	419	434	430
Chlorides	1.2	1	0.4	0.5	0.5	1.4	1.5	1.4	1.4	0.6	0.8	0.7
Sulfates	454	450	480	454	432	428	444	438	434	442	434	426
Total Phosphorus		0.06			0			0			0.06	
Nitrate Nitrogen	0	0	0	0	0	0	0	0	0	0	0	0
Ammonia Nitrogen		1.07			0.94			1.26			1.03	
Kjeldahl Nitrogen		1.6			1.4			1.3			1.19	
Total Residue	1061	1151	1114	1201	1186	1133	1173	1196	1201	1109	1163	1167
Coliform Group - MPN/100 ml			2.2		< 2.2	2.2	< 2.2	5.1	< 2.2		< 2.2	

*Results expressed as mg/l except as noted.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake)

Station: Well - 9

Sampling Date: - 1975

Determination*	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	12	11	13	12	11	10.5	11.5	11.5	11	11.5	10.5	2.5
pH - units	7.5	7.5	7.3	7.2	7.2	7.3	7.6	7.0	7.4	7.4	7.6	7.6
Conductivity - µmhos/cm-25°C	1122	1267	1345	1237	1059	1376	1298	1264	1166	1156	1058	1127
Total Hardness	540	521	574	795	802	681	602	587	598	540	580	621
Calcium Hardness	185	386	400	365	354	420	403	375	341	348	400	360
Sodium	42	46	47	49	50	32	47	24	46	20	36	42
Total Alkalinity	254	252	250	258	268	262	264	268	270	251	268	252
Chlorides	24	20	14	16	17	17	17	19	19	19	15	17
Sulfates	386	441	519	498	470	472	408	416	410	432	444	448
Total Phosphorus		0			0			0			0.03	
Nitrate Nitrogen	0.1	0	0	0.1	0	0	0	0	0.1	0.1	0.19	0.16
Ammonia Nitrogen		1.19			0.58			1.00			0.36	
Kjeldahl Nitrogen		1.6			1.3			1.3			0.44	
Total Residue	955	921	983	1094	963	1100	1058	1024	1014	931	1028	1013
Coliform Group - MPN/100 ml			<1		<2.2	<1		<1			<2.2	

*Results expressed as mg/l except as noted.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Determination*	Sampling Dates - 1975											
	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	1	0.5	1	6	18.5	25	27	23	13	10	3	0
pH - units	7.7	7.9	7.5	7.9	8.3	8.3	8.4	7.7	8.3	8.1	8.2	8.2
Conductivity - µmhos/cm-25°C	1272	1288	1220	1106	1121	1184	1116	1013	1078	1136	1190	1464
Total Hardness	612	563	482	512	492	480	483	447	469	536	530	726
Calcium Hardness	349	358	361	360	343	319	328	295	279	308	310	432
Sodium	66	86	68	30	34	38	60	51	70	50	63	81
Total Alkalinity	218	343	270	178	195	256	201	263	226	296	285	399
Chlorides	32	21	45	6	8	23	22	22	16	47	72	86
Sulfates	496	349	317	230	284	332	376	346	318	312	294	418
Total Phosphorus	0	0	0	0.47	0.24	0.17	0.26	0.18	0.11	0.18	0.13	0.47
Nitrate Nitrogen	0.4	0.1	0	0.2	0.2	0	0	0	0	0	0.06	0.14
Ammonia Nitrogen	0.46	2.82	0.47	0.26	0.27	0.42	0.22	0.58	0.09	0.13	0.05	0.81
Kjeldahl Nitrogen	1.2	3.7	1.8	0.9	1.1	1.3	2.0	1.1	0.9	1.41	1.68	1.46
Total Residue	1097	951	973	903	890	876	857	858	896	891	973	1428
Total Suspended Matter	13	9	12	84	48	25	11	1	33	30	20	217
Dissolved Oxygen	7.0	8.9	8.6	9.5	7.4	7.4	7.0	3.7	11.8	6.5	13.0	12.3
Biochemical Oxygen Demand	3	4	2	3	4	3	10	7	5	6	4	11
Turbidity	4	10	3	1	3	1	2	4	1	7	5	1
Coliform Group - MPN/100 ml	30	60	25	1600	35	330	60	140	65	35	110	15
Fecal Coliforms - MPN/100 ml	<3	3	<3	190	6	110	25	57	<3	6	3	3

*Results expressed as mg/l except as noted.

BIG STONE LAKE (at lake intake to pumping station)

Station: BSL - 1

Determination*	Sampling Dates - 1975											
	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	1	1	2	5	20	24	26	22	13	10	4	2
pH - units	7.6	7.8	7.4	7.8	8.1	8.0	8.9	8.0	8.5	8.4	8.3	8.2
Conductivity - μmhos/cm-25°C	1298	1475	1306	1256	997	1174	1107	1018	1058	1097	1136	1170
Total Hardness	612	698	549	551	559	418	440	426	480	489	469	578
Calcium Hardness	344	295	411	308	324	283	238	236	244	230	283	400
Sodium	70	73	67	40	65	42	61	59	66	55	52	56
Total Alkalinity	183	194	180	258	251	178	259	231	125	145	157	187
Chlorides	24	22	24	10	14	16	11	16	7	17	20	11
Sulfates	574	574	473	330	353	426	432	464	460	468	470	487
Total Phosphorus	0	0	0.23	0.22	0.08	0.14	0.18	0.23	0.17	0.12	0.09	0.12
Nitrate Nitrogen	0.2	0.3	0.1	0.2	0.2	0.0	0	0.03	0.09	0.20	0.28	0.26
Ammonia Nitrogen	0.54	1.42	0.72	0.23	0.61	0.45	0.54	0.73	0.48	0.36	0.26	0.41
Kjeldahl Nitrogen	1.5	3.2	2.3	1.6	1.9	1.4	2.2	2.4	2.9	1.7	1.62	0.85
Total Residue	1100	1289	1051	1083	720	892	895	908	942	905	977	1112
Total Suspended Matter	8	7	16	24	32	12	17	4	36	10	7	29
Dissolved Oxygen	5.9	5.3	6.4	8.5	8.3	6.5	9.6	6.0	11.4	9.6	11.7	12.0
Biochemical Oxygen Demand	2	5	3	4	2	3	6	7	14	12	4	3
Turbidity	1	1	4	4	4	1	1	1	3	2	2	4
Coliform Group - MPN/100 ml	<5	20	<5	1500	330	25	<5	55	55	<5	5	<5
Fecal Coliforms - MPN/100 ml	<3	<3	<3	60	6	<3	<3	7	6	<3	<3	<3

*Results expressed as mg/l except as noted.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Station: W - 1

Determination*	Sampling Dates - 1975											
	1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	0	0	0.5	6	18.5	24.5	24	22	11	9	3	0
pH - units	7.4	7.7	7.5	7.3	8.2	8.2	8.2	7.7	7.0	7.9	8.0	8.0
Conductivity - µmhos/cm-25°C	1256	1433	1168	1162	1038	1288	1215	999	1112	1038	1195	1391
Total Hardness	531	580	519	539	523	535	539	498	515	446	485	589
Calcium Hardness	400	295	430	415	401	372	333	324	321	329	296	451
Sodium	58	86	67	29	48	55	59	54	65	59	61	83
Total Alkalinity	300	345	258	254	285	256	281	278	297	318	288	422
Chlorides	48	60	45	8	10	30	30	33	52	54	64	81
Sulfates	368	348	327	276	305	426	310	258	292	300	302	424
Total Phosphorus	0	0.10	0.14	0.53	0.15	0.25	0.42	0.28	0.23	0.13	0.21	0.22
Nitrate Nitrogen	0.5	0.3	0.2	0.2	0.2	0.1	0	0.11	0	0.15	0.15	0.34
Ammonia Nitrogen	0.12	2.85	0.41	0.07	0.25	0.57	0.12	0.46	0.12	0.24	0.24	1.03
Kjeldahl Nitrogen	1.0	3.59	1.4	0.9	1.0	1.4	1.3	1.0	0.7	0.75	1.05	1.59
Total Residue	1024	1098	924	905	833	980	868	832	939	882	921	1268
Total Suspended Matter	8	36	12	67	45	36	22	18	53	10	9	30
Dissolved Oxygen	8.7	8.9	8.7	9.0	8.1	7.2	7.0	5.2	10.0	7.4	11.9	9.8
Biochemical Oxygen Demand	2	9	2	3	3	4	7	6	6	5	4	4
Turbidity	3	4	1	3	4	5	1	2	1	2	4	1
Coliform Group - MPN/100 ml	15	210	15	2700	200	600	80	160	200	65	40	45
Fecal Coliforms - MPN/100 ml	<3	6	3	170	67	200	75	77	57	6	<3	17

*Results expressed as mg/l except as noted.

WHETSTONE RIVER (On county road 1½ miles south of plant site)

Determination*	Sampling Dates - 1975 1/23	2/20	4/3	4/24	5/28	6/23	7/21	8/21	9/22	10/20	11/17	12/17
Temperature - °C	0	0	0.5	6	16.5	22.5	24	22.5	11	9	3	0
pH - units	7.8	7.7	7.7	7.4	8.1	8.0	8.4	7.8	8.2	8.2	8.1	8.0
Conductivity - µmhos/cm-25°C	1963	1454	1246	1220	986	1225	1155	1014	1038	1146	1205	1411
Total Hardness	1000	545	537	550	537	518	530	445	472	472	461	612
Calcium Hardness	825	322	389	361	375	360	321	335	310	296	320	439
Sodium	165	98	74	31	48	48	56	53	66	67	58	88
Total Alkalinity	593	340	262	233	275	248	273	251	287	299	292	398
Chlorides	123	65	45	5	9	28	29	28	20	60	54	57
Sulfates	630	435	314	278	296	448	276	244	244	300	374	426
Total Phosphorus	0.69	0.50	0.5	0.8	0.1	0.24	0.44	0.32	0.16	0.14	0.18	0.34
Nitrate Nitrogen	0.4	0.1	0.2	0.2	0.1	0.0	0.0	0.04	0.0	0.0	0.05	0.29
Ammonia Nitrogen	0.53	3.41	0.37	1.98	0.22	0.46	0.12	0.44	0.04	0.09	0.05	1.19
Kjeldahl Nitrogen	1.4	3.7	1.95	2.40	1.0	1.3	1.3	1.0	0.66	0.67	0.73	1.88
Total Residue	1988	1178	957	939	794	974	820	846	834	846	838	1246
Total Suspended Matter	88	4	14	55	42	25	16	26	20	6	2	22
Dissolved Oxygen	9.1	5.6	6.6	8.2	6.9	4.4	7.0	4.3	10.5	8.4	11.6	11.4
Biochemical Oxygen Demand	4	3	1	4	4	3	9	9	3	4	3	3
Turbidity	3	7	3	4	4	4	3	4	2	1	3	1
Coliform Group - MPN/100 ml	45	20	5	2800	400	450	230	460	150	35	180	55
Fecal Coliforms - MPN/100 ml	18	<3	3	160	140	270	200	270	90	10	20	6

*Results expressed as mg/l except as noted.

Elevations of the Ground Water*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
1975						
January 23	1026.99	1055.57	1036.92	1062.06	1054.19	971.33
February 20	1027.07	1055.82	1037.09	1063.15	1053.61	971.58
April 3	1026.57	1055.24	1037.17	1061.06	1054.69	971.16
April 24	1026.57	1055.82	1037.42	1061.90	1055.44	971.66
May 28	1026.99	1056.07	1037.75	1061.48	1056.44	971.99
June 23	1026.99	1056.40	1037.59	1060.90	1056.61	971.83
July 21	1027.07	1056.32	1033.75	1060.90	1056.61	971.74
August 21	1026.99	1055.90	1032.25	1060.90	1055.94	971.08
September 22	1026.57	1055.77	1031.84	1059.65	1054.65	970.99
October 20	1026.82	1055.65	1032.59	1060.81	1054.19	971.49
November 17	1026.49	1055.49	1033.42	1060.48	1054.02	971.16
December 17	1025.82	1055.07	1033.84	1059.40	1053.02	970.83

At Well Points Along County Road North of Pond:

1975	A	B	C	D	E
January 23	1107.80	1111.54	1109.57	1109.94	1107.61
February 20	1108.05	1111.46	1109.65	1109.86	1107.94
April 3	1112.88	1113.87	1112.24	1110.52	1109.86
April 24	1114.46	1114.54	1112.82	1111.36	1109.86
May 28	1112.30	1113.29	1111.74	1110.44	1108.86
June 23	1113.71	1114.21	1112.32	1110.77	1109.44
July 21	1109.30	1111.46	1109.82	1109.69	1106.94
August 21	1105.96	1110.04	1108.49	1108.69	1105.88
September 22	1106.03	1109.46	1107.74	1108.61	1105.52
October 20	1105.96	1109.96	1108.01	1108.94	1105.94
November 17	1106.55	1111.79	1110.15	1109.69	1108.02
December 17	1109.30	1112.54	1111.74	1110.11	1109.44

*All elevations are above "sea level datum."

C-12-74

Meeting with representatives of
Ottawa Power Co.

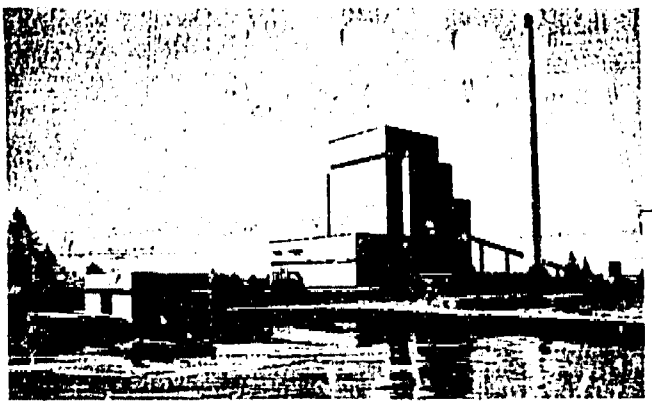
New plans made in
1951 1956 and 1967

Note plans to be 940,000 watts

May be 2 Bulb KP
or 4 Big Ones

If 4 Big ones follows
would be applied for

Note
Existing use is 150 cfs
Weekly use varies at 96 cfs
Total diversion varied from 7000
acre feet to 13,500 acre feet



BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMPANY
215 South Cascade Street
Fergus Falls, Minnesota 56537

NORTHWESTERN PUBLIC SERVICE COMPANY
100 Northwestern National Bank Building
Huron, South Dakota 57350

August 29, 1975

1975
STATE WATER RIGHTS COMM.
PIERRE, SOUTH DAKOTA

Mr. Donald Driscoll
Division Director
Division of Water Rights
Department of Natural Resources
State of South Dakota
State Office Building #2
Pierre, SD 57501

Subject: Water Appropriation Permits - Numbers 1768-3, 1983-3 and 1982-3

Dear Mr. Driscoll:

I am presently in the process of reviewing our permit files for Big Stone Plant. In my review, I have found the Big Stone Plant Water Appropriation Permits file contains the following documents:

1. Application for Permit to Appropriate Water within the State of South Dakota - Permit No. 1768-3
2. Notice of Completion of Works and/or Application of Water to Beneficial Use for Permit No. 1768-3
3. Report of Examination of Works and/or Application of Water to Beneficial Use dated November 7, 1972 signed by Donald Driscoll
4. Certificate of Construction dated November 28, 1972 signed by J. W. Grimes
5. Application for Permit to Appropriate Water within the State of South Dakota - Permit No. 1983-3
6. Notice of Completion of Works and/or Application of Water to Beneficial Use for Permit No. 1983-3
7. Application for Permit to Appropriate Water within the State of South Dakota - Permit No. 1982-3
8. Notice of Completion of Works and/or Application of Water to Beneficial Use for Permit No. 1982-3

According to all copies of the Notices's of Completion of Works and/or Application of Water to Beneficial Use, we were to receive a Certificate of Construction and/or Water License for permit numbers 1768-3, 1983-3 and 1982-3. To date, our records indicate a Certificate of Construction has been issued only for permit number 1768-3.

BIG STONE PLANT

GRANT COUNTY, SOUTH DAKOTA

Our concern is the lack of either a Certificate of Construction or a Water License for permit numbers 1983-3 and 1982-3. Perhaps our records are incomplete or perhaps a Certificate of Construction or a Water License is not required for either of these permits; if so, please inform me of this. However, if a Certificate of Construction or a Water License is required for either of, or both permits 1983-3 and 1982-3, please inform me indicating any additional obligations needed to complete our requirements for permits 1983-3 and 1982-3.

Big Stone Plant went into commercial operation May 1, 1975. Water is being appropriated as makeup to the cooling pond under authority of permits 1768-3 and 1983-3. The plant well, permit number 1982-3 is presently capped and not being used.

I appreciate your time and consideration on these matters.

Sincerely,

Terry Graumann

Terry Graumann
Environmental Assistant

TG:ckk

SOUTH DAKOTA
Department of Natural Resource Developmen
WATER RIGHTS COMMISSION
Office Building Number 2, Pierre, South Dakota 57501
Phone 605/224-3151

September 8,1975

Terry Graumann
Environmental Assistant
Ottertail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

Dear Mr. Graumann:

Reference is made to your letter regarding the completion of Water Permit No. 1768-3, 1982-3 and 1983-3. We will try and make an inspection of the permits as soon as possible, with a view to issuing the final papers.

However, because of prior work commitments there may be a considerable interval of time.

You have thus far complied with all of the requirements and the intervening time between your notifying this office and the performance of the inspection will not affect the completing of your Water Right.

Should you have future questions, please feel free to contact this office.

Sincerely,

BURTON F. JONES
Water Rights Specialist

BFJ/bw

Big Stone Plant
September 17, 1976

R. G. Johnson
Plant Manager
O F F I C E

Subject: Cooling Pond Water Losses

On May 7, 1976 the cooling pond make - up pumps were all stopped with a pond surface elevation of 1121.40 feet. At that level the water surface elevation was 0.40 feet above Bechtels design maximum water surface elevation of 1121.00 feet. During the four month period from May 7 to September 7, the water level in the cooling pond dropped 6.60 feet to an elevation of 1114.80 feet. That drop in level amounted to a loss of 2155 acre-feet of water or an average evaporation of 8.83 CFS.

Attached is a copy of a letter from O.B. Johnson dated March 27, 1974 summarizing Bechtel's cooling pond evaporation predictions. According to Bechtel's predictions the highest evaporation should have been 7.2 CFS in the month of July. Actual evaporation from the cooling pond for the month of July 1976 was 9.38 CFS. This figure was based on recorded rainfall, pond level and a graph of pond level vs. capacity, which was developed from data taken during the initial fill of the pond. A smaller copy of the graph is attached. The evaporation rate for the month of August was 10.41 CFS as compared to the predicted rate of 6.5 CFS. For any time period during which evaporation data was gathered during this past summer, the actual evaporation from the cooling pond exceeded Bechtel's predictions. During this time span the plant was operated on an average of 83.8% of its nameplate capacity. Had the plant not been on reduced load, the actual evaporation would certainly have been even higher.

Attached are copies of graphs of Big Stone Lake water level and monthly precipitation from April 1972 to mid-September 1976. All figures for the graphs were taken from our reports to the Minnesota Department of Natural Resources concerning the operation of the Big Stone Lake outlet control works. The lake levels used were from calm days or days of little wind. From the graphs it can be seen that the rainfall to date in 1976 has been considerably lower than for the previous years. It can also be seen that the general trend in Big Stone Lake level is from a high level in late spring to a low level in October or November and a gradual rise during the winter. If the coming fall and winter follow past trends we can expect the level of Big Stone Lake to drop to an elevation of 965 feet in October and gradually rise to an elevation of 965.8 feet in March 1977. If a normal spring runoff were experienced, the Lake could be expected to rise to 968 feet in late March. Since our pumping permit allows us to appropriate water from Big Stone Lake whenever the lake level is above 966 feet from October 1 to April 30 and above 967 feet from May 1 to September 30, it appears that we will be able to appropriate water from the lake in late March 1977. These expectations are based on a fall and a winter with normal precipitation. If this years dry spell continues

the lake will undoubtedly be lower.

On September 14, 1976 the cooling pond water level was 1114.70 feet. During the months of September and October 1973 the water level in the cooling pond dropped by 0.57 feet due strictly to natural evaporation, since the plant was under construction at the time. Since the plant is now shut down for overhaul, it is anticipated that the pond level will drop by 0.36 feet from September 14 to October 22, the last day of the overhaul. This would yield a water level of 1114.34 feet on October 22. The predicted evaporation losses from the cooling pond for the months of May, June, July, and August according to Bechtel's computer study total 1646 acre-feet. Actual observed evaporation losses from May 7, 1976 to September 7, 1976 totalled 2155 acre-feet. That is an increase over Bechtel's prediction of 31%. By applying the 31% increase to Bechtel's predictions, more realistic predictions for monthly evaporation are as follows: October 23 through 31 - - 112 acre-feet; November - - 296 acre-feet; December - - 233 acre-feet; January - - 201 acre-feet; February - - 218 acre-feet; and March - - 345 acre-feet. It should be remembered that the 31% scaling factor was developed from data taken when the plant was operating at 83.8% of its nameplate capacity and, since the plant is expected to operate at full capacity following this overhaul, the actual monthly evaporation for the winter months could exceed these upscaled predictions. The minimum cooling pond water level, at which we can operate according to the manufacturer of our circulating water pumps, is 1112.0 feet. This would leave us with 655 acre-feet of water above elevation 1112.0 feet, on October 22, 1976 based on our cooling pond capacity chart. Using the upscaled monthly evaporation predictions we will reach the 1112.0 foot low water level about January 3, 1977 assuming that no water being added to the pond. In order to operate until the end of March, when we anticipate being able to appropriate water from Big Stone Lake we will require an emergency allocation of water of at least 750 acre - feet.

Dana L. Holter
Results Supervisor
rp

Attachments

Fergus Falls
March 27, 1974

A. D. Francis
Resident Engineer
Big Stone Plant

BIG STONE PLANT
COOLING POND EVAPORATION
COMPUTER STUDIES

Bechtel computer studies show that the following total evaporation would occur from the plant cooling pond in an average year.

	CFS	Acre Feet
JAN	2.5	154
FEB	3.0	167
MAR	4.3	264
APR	5.5	327
MAY	6.3	387
JUN	7.0	416
JUL	7.2	443
AUG	6.5	400
SEP	5.8	345
OCT	4.8	295
NOV	3.8	226
DEC	2.9	178
	Total	3602

Pond blowdown is predicted as approximately 600 acre feet per year and boiler makeup 0.2 CFS or 146 acre feet per year. It would appear that total makeup requirements will be around 4500 acre feet per year.

The computer study shows that at water surface elevation of 1121.0 ft. we have a surface area of 340 acres with 4898 acre feet storage. With minimum water surface elevation of 1110.0 ft., we have an effective cooling area of 150 acres with storage of less than 1600 acre feet. A more reasonable operating level would be a minimum level of 1115.0 ft. with 324 acre surface and 2912 acre feet storage. Below 1115.0 ft. the effective cooling area decreases quite rapidly. Consequently, we have an effective storage capacity of approximately 2000 acre feet.

O. B. Johnson, Supt.
Production, Engineering & Construction
lam

R. O. M. Grutle
W. L. Doebbert
R. F. Johnson
V. H. Menze
D. L. Johnson

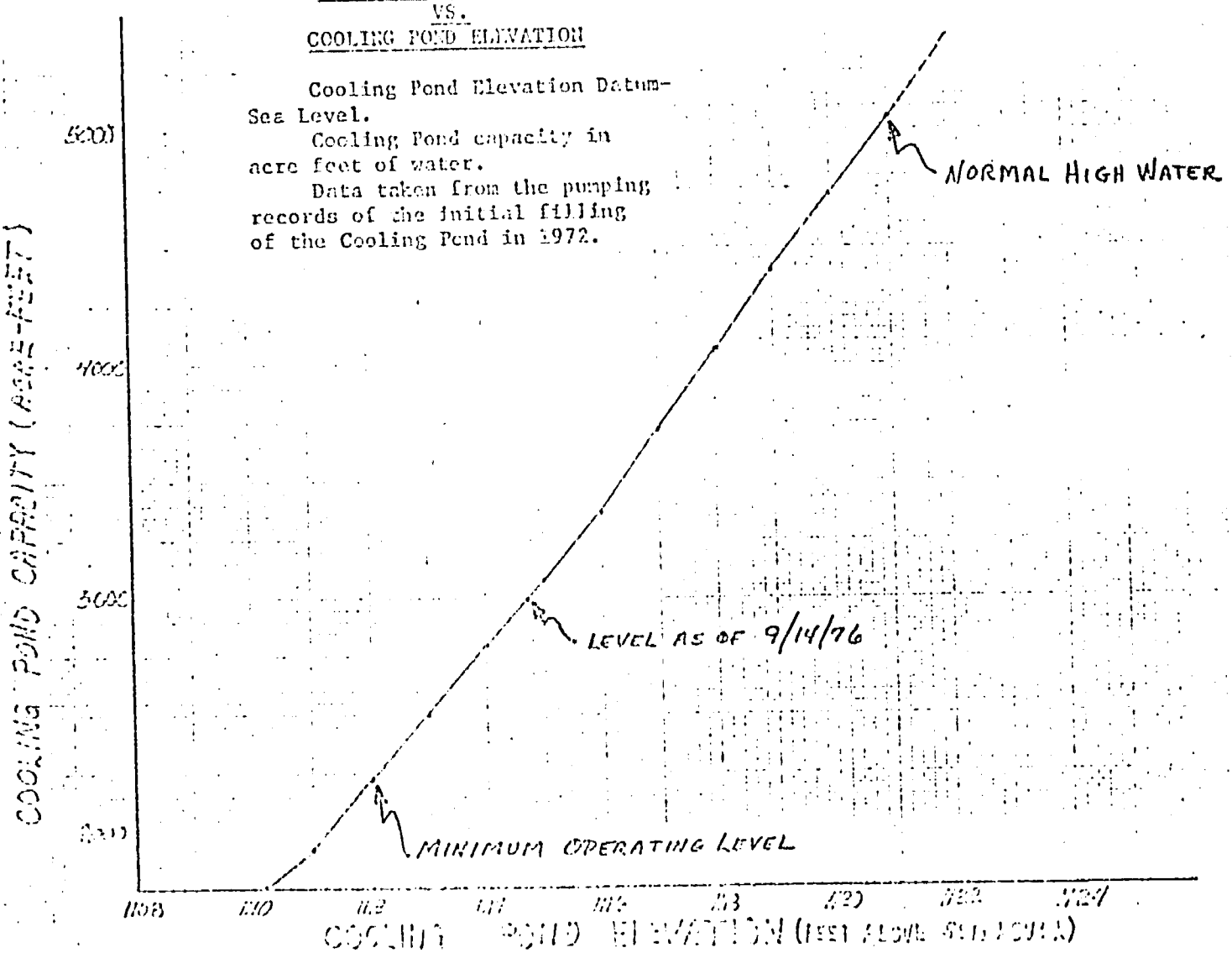
BIG STONE PLANT

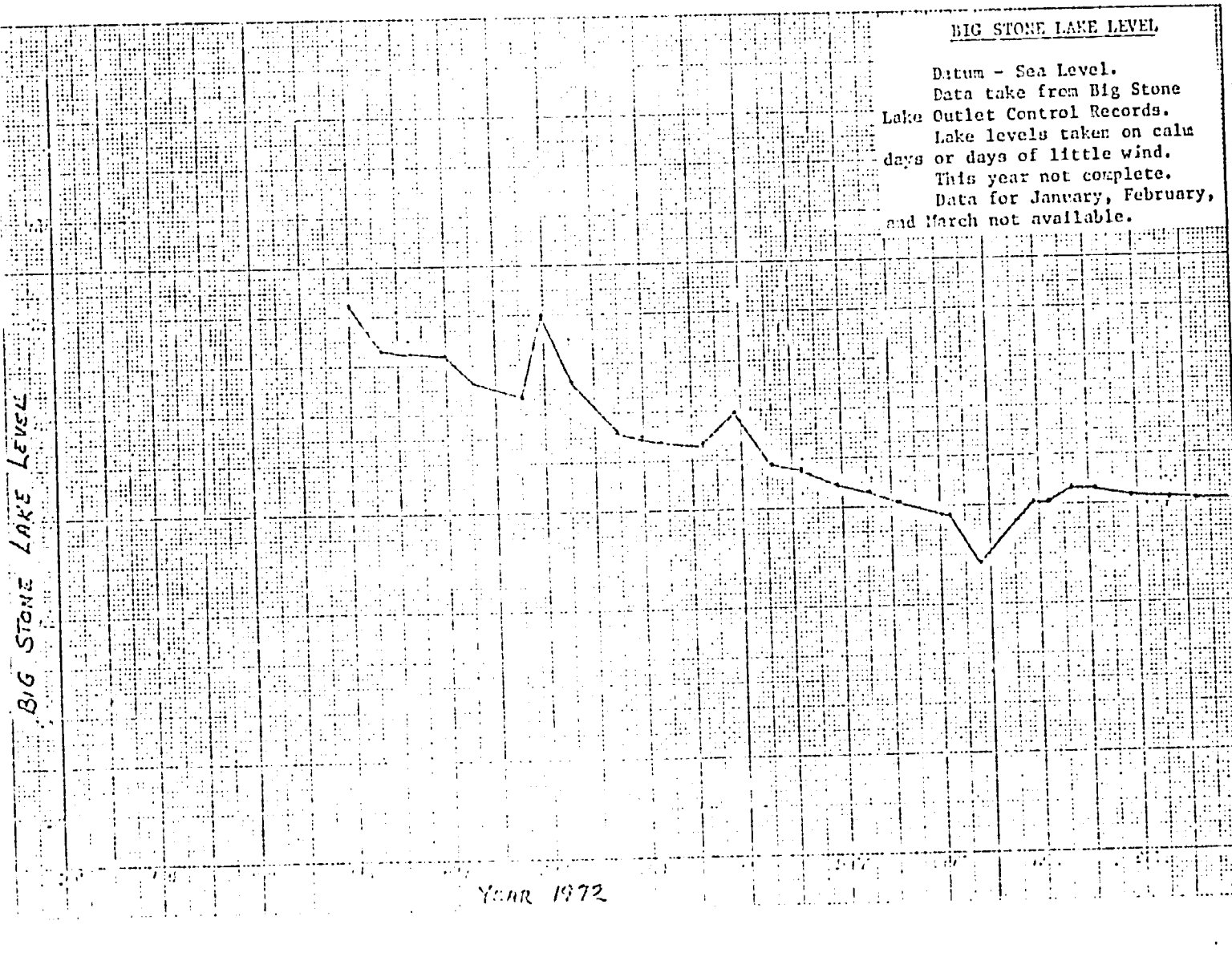
COOLING POND CAPACITY
VS.
COOLING POND ELEVATION

Cooling Pond Elevation Datum-Sea Level.

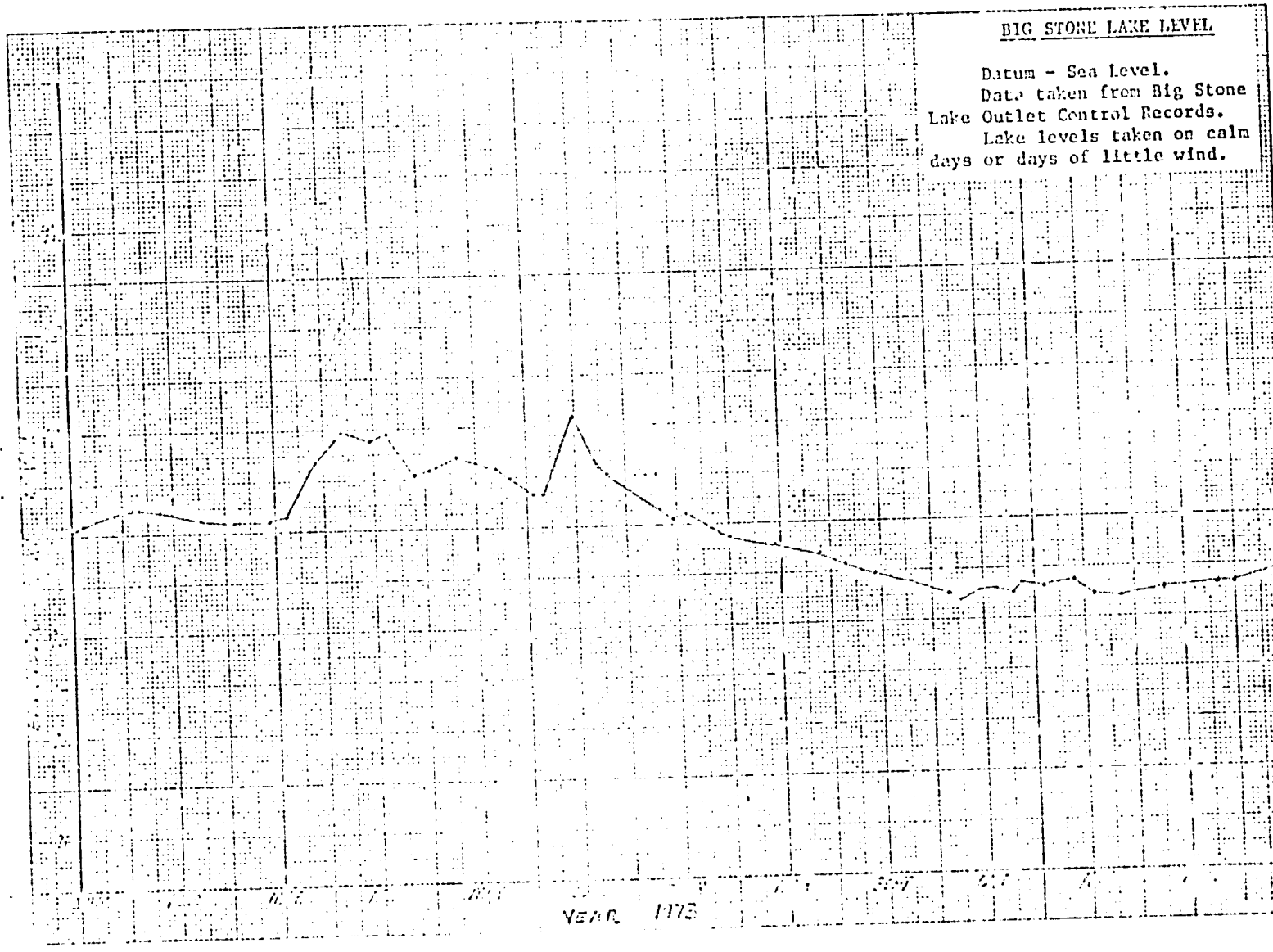
Cooling Pond capacity in acre feet of water.

Data taken from the pumping records of the initial filling of the Cooling Pond in 1972.




BIG STONE LAKE LEVEL
Datum - Sea Level.
Data take from Big Stone Lake Outlet Control Records.
Lake levels taken on calm days or days of little wind.
This year not complete.
Data for January, February, and March not available.
BIG STONE LAKE LEVEL
YEAR 1972

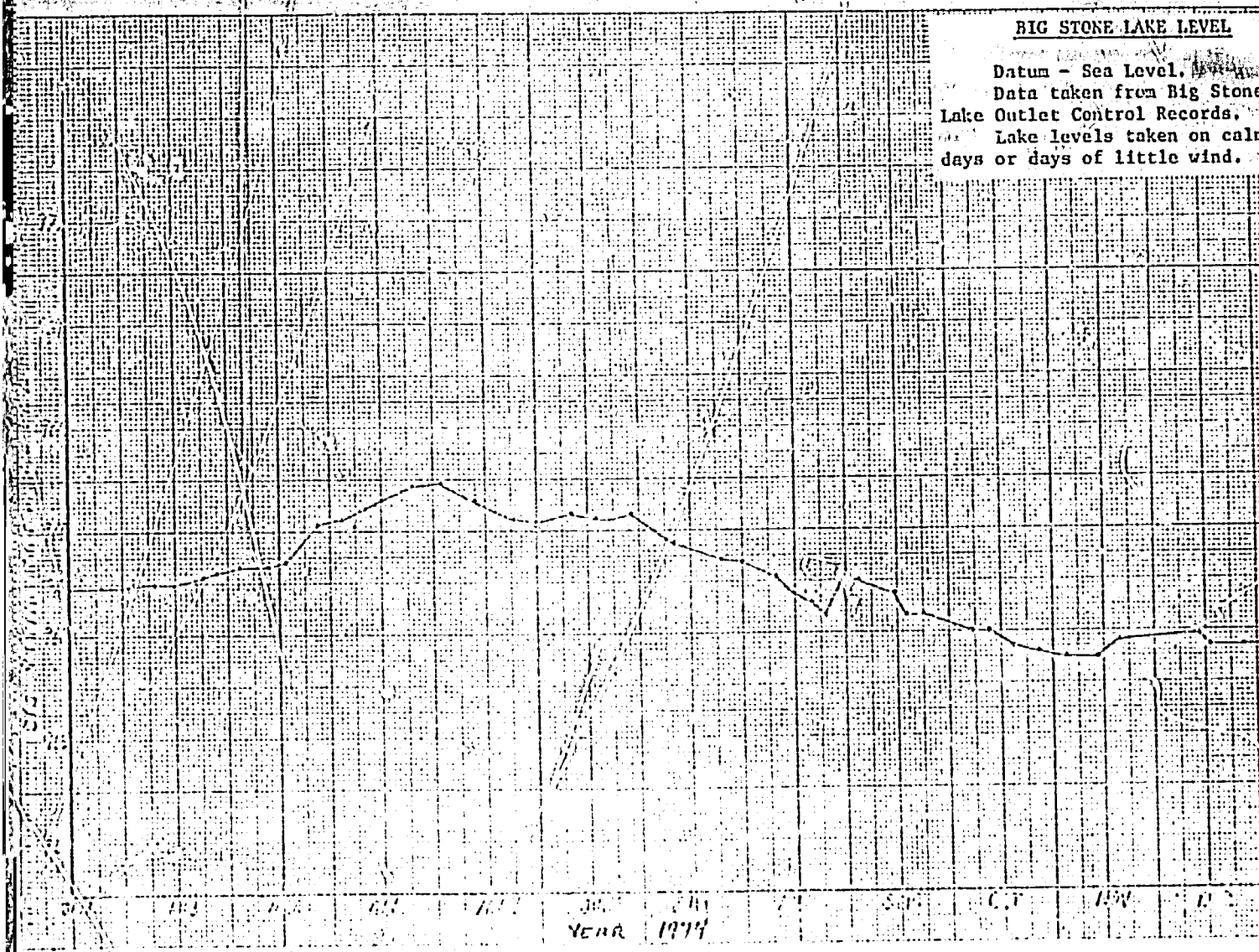
EUGENE DIETZGEN CO.
MADE IN U. S. A.



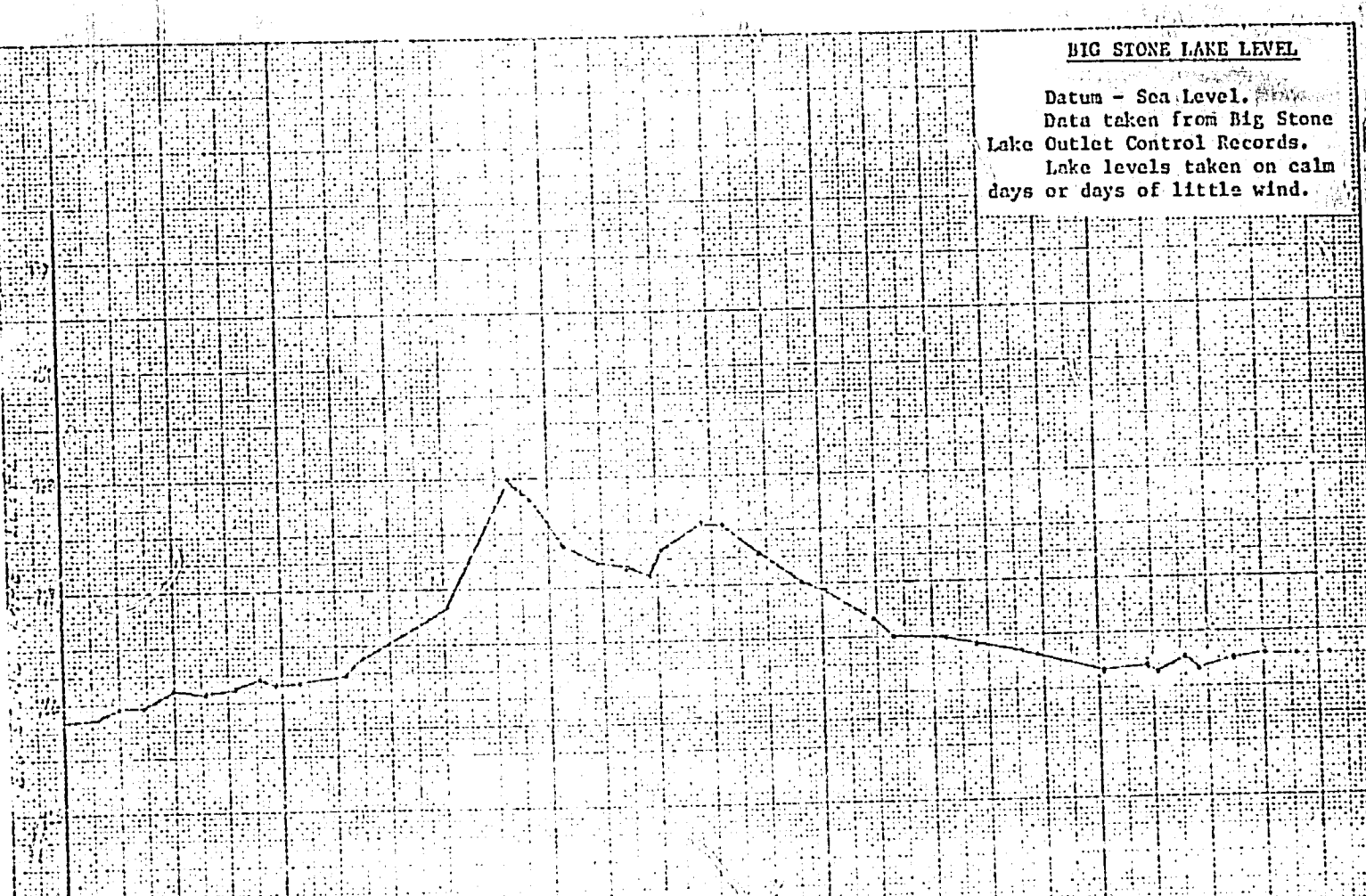
NO. 340-M DIETZGEN GRAPH PAPER
MILLIMETER
EUGENE DIETZGEN CO.
MADE IN U. S. A.

BIG STONE LAKE LEVEL

Datum - Sea Level.
Data taken from Big Stone Lake Outlet Control Records.
Lake levels taken on calm days or days of little wind.



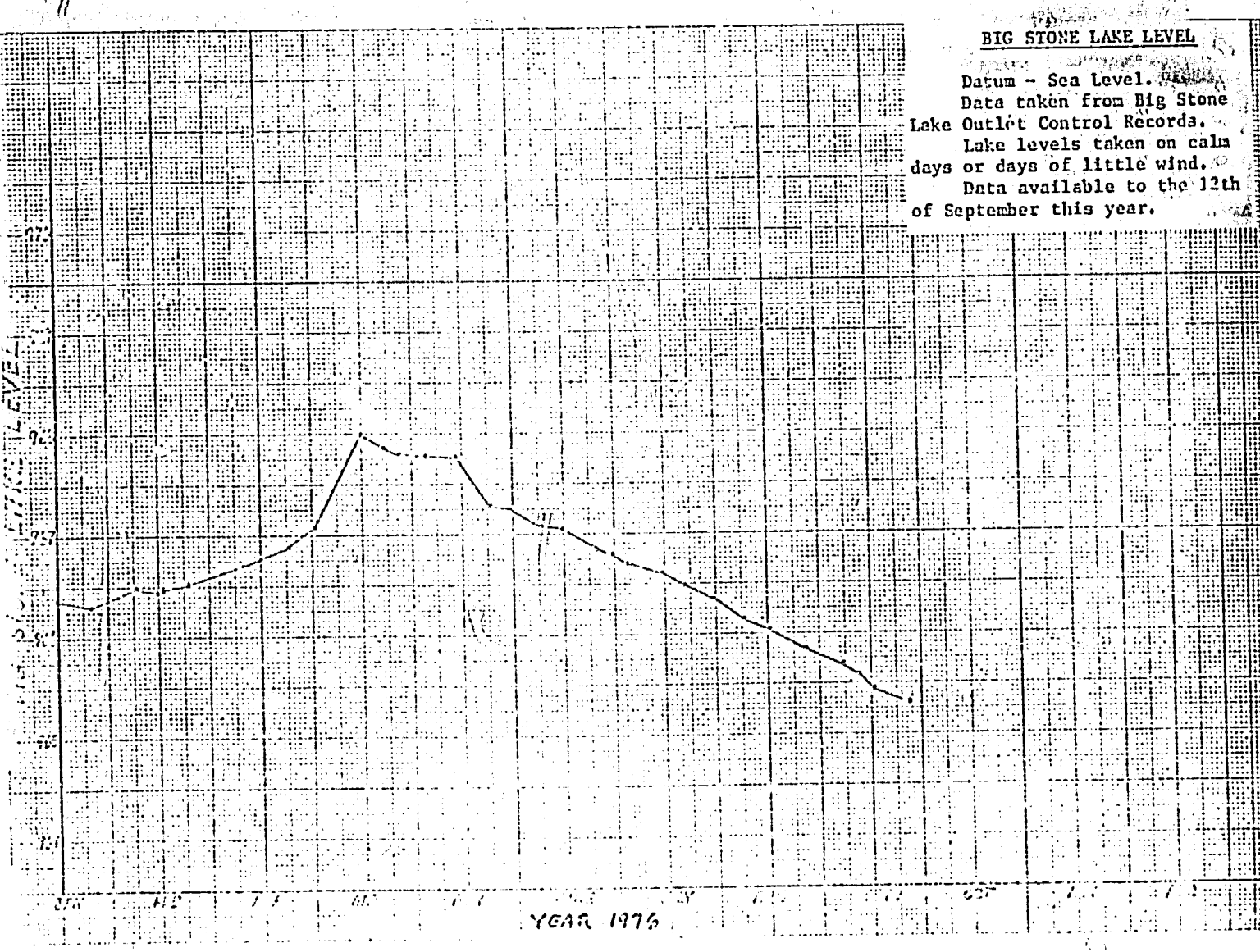
EUGENE DIETZGEN CO.
MADE IN U. S. A.

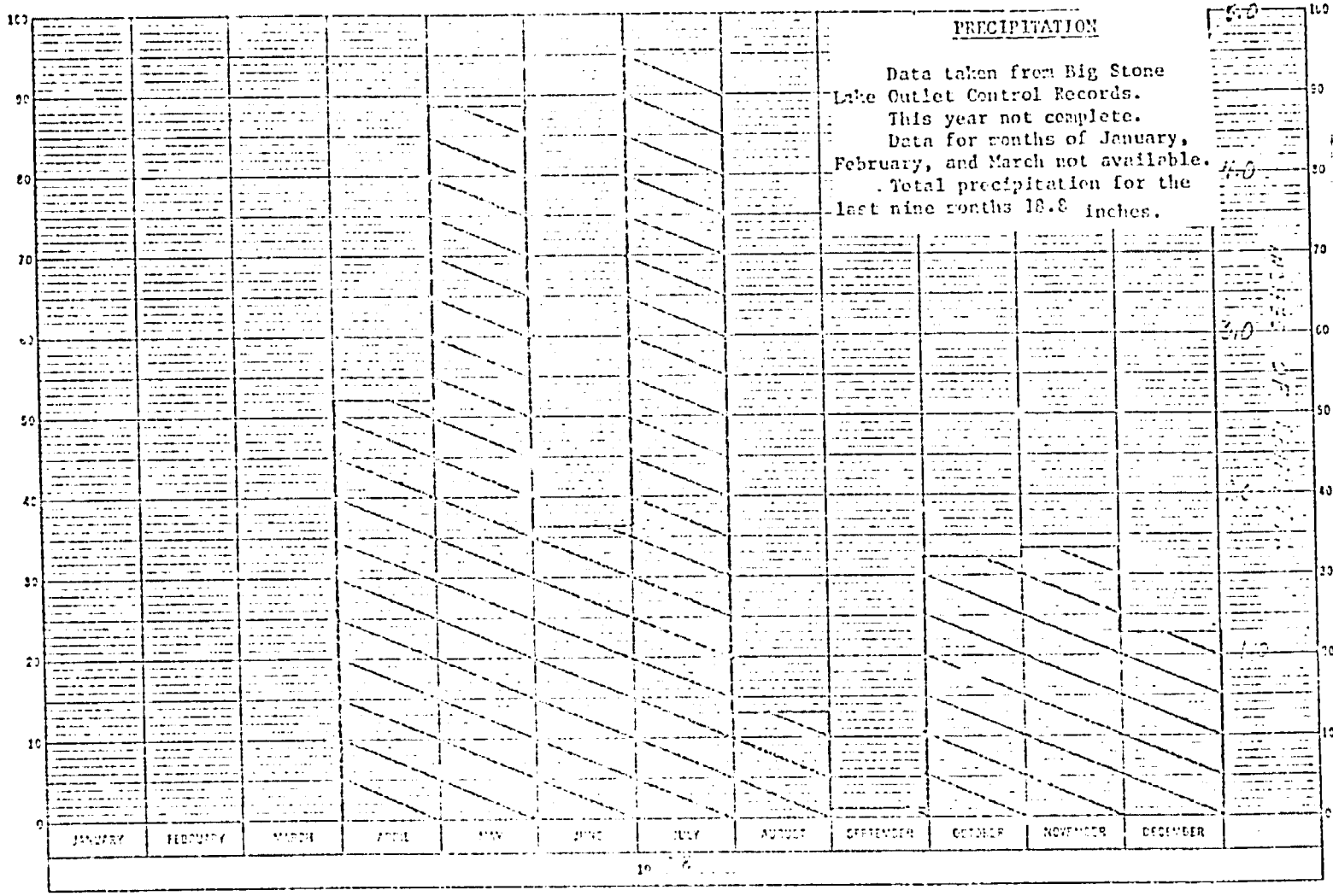


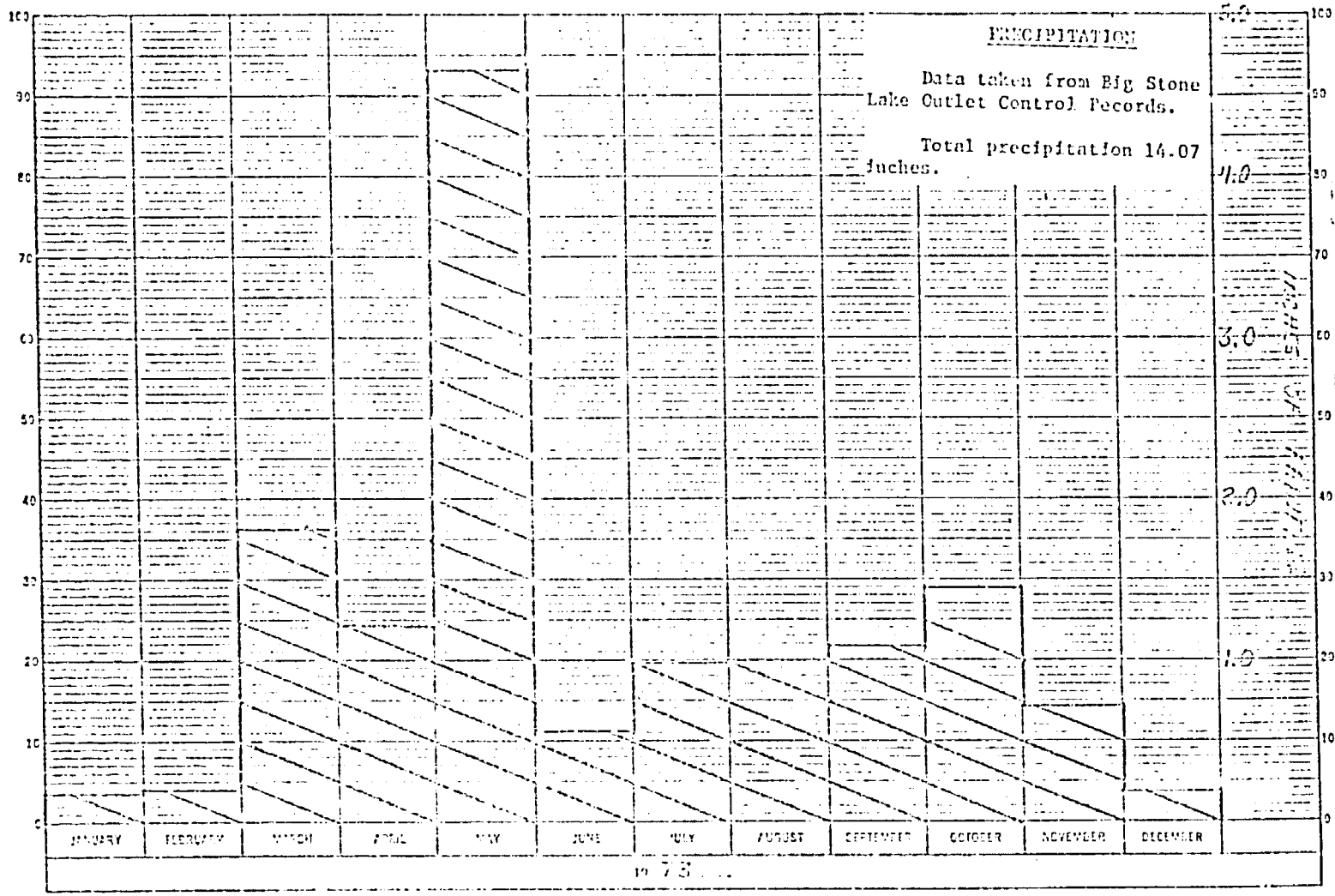
NO 340-M DIETZGEN CROSS SECTION PAPER
MILLIMETER
EUGENE DIETZGEN CO.
MADE IN U. S. A.

BIG STONE LAKE LEVEL

Datum - Sea Level.
Data taken from Big Stone Lake Outlet Control Records.
Lake levels taken on calm days or days of little wind.
Data available to the 12th of September this year.




PRECIPITATION
Data taken from Big Stone Lake Outlet Control Records.
This year not complete.
Data for months of January, February, and March not available.
Total precipitation for the last nine months 18.8 inches.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER


PRECIPITATION
Data taken from Big Stone Lake Outlet Control Records.
Total precipitation 14.07 inches.
5.0
4.0
3.0
2.0
1.0
100
90
80
70
60
50
40
30
20
10
0
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
19 73

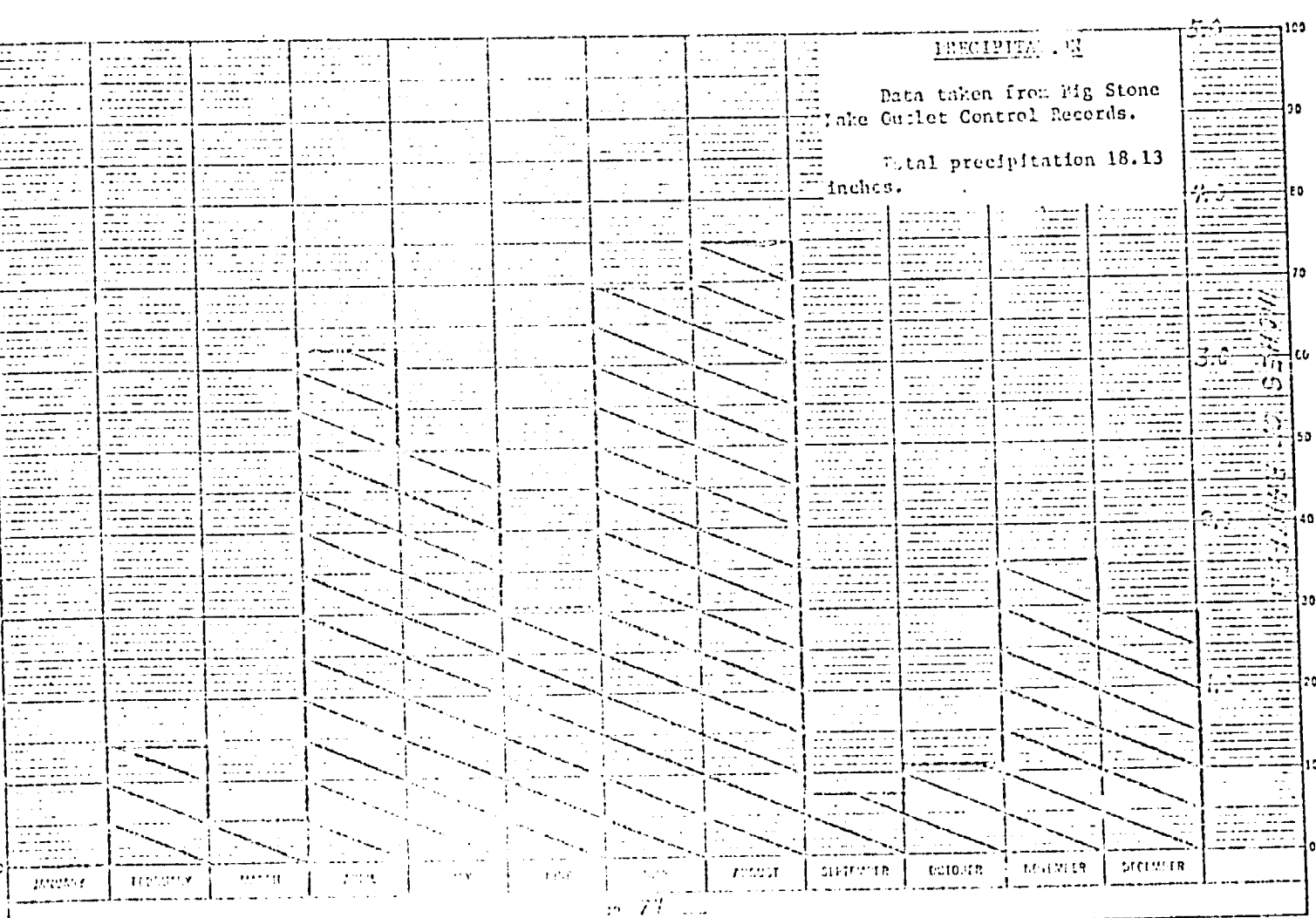
TIONS. REDUCTION 25:1 ROLL NO. 52 DATE MICROFILMED CAMERA

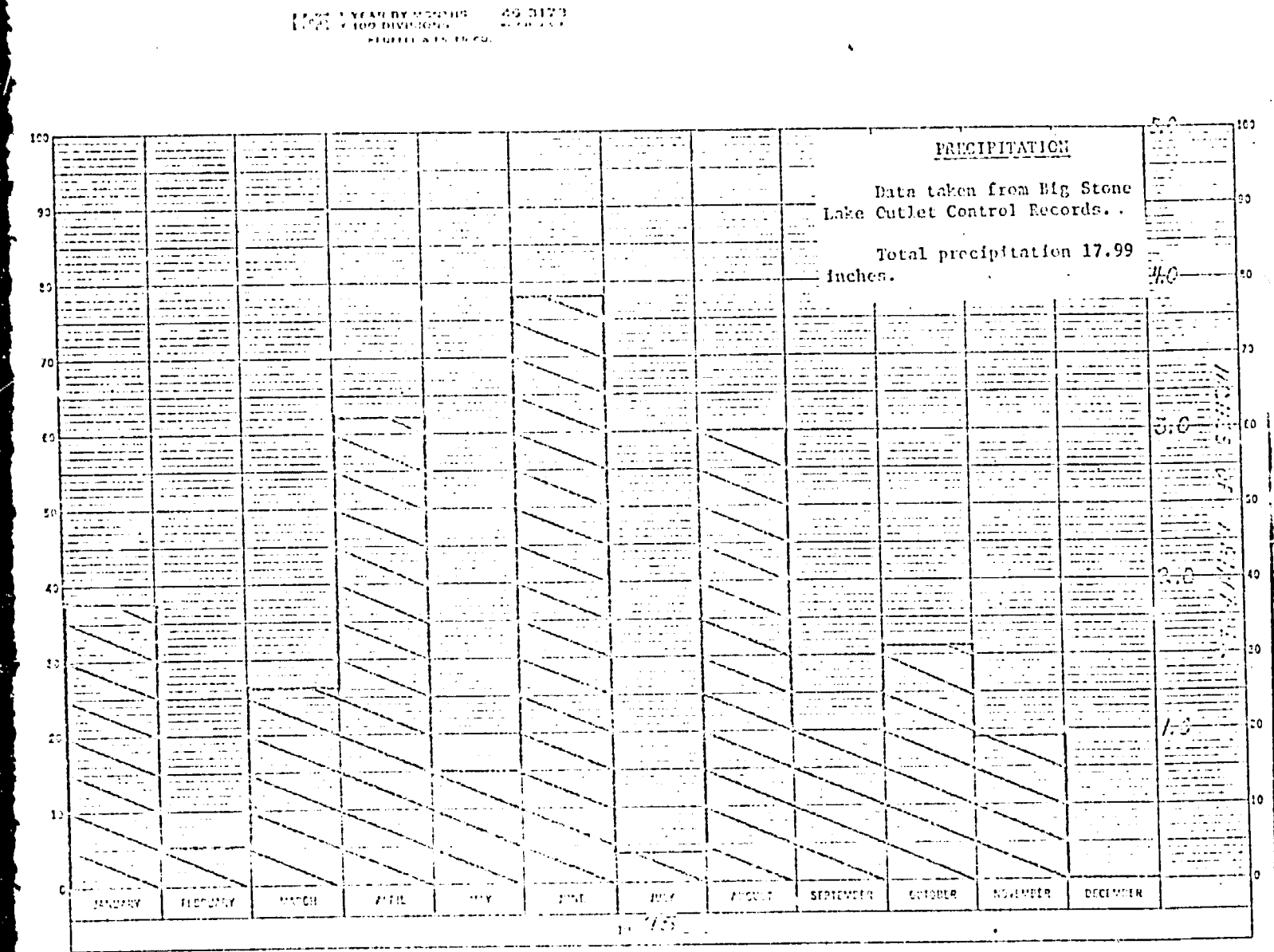
KEUFFEL & ESSER CO. 46 3173

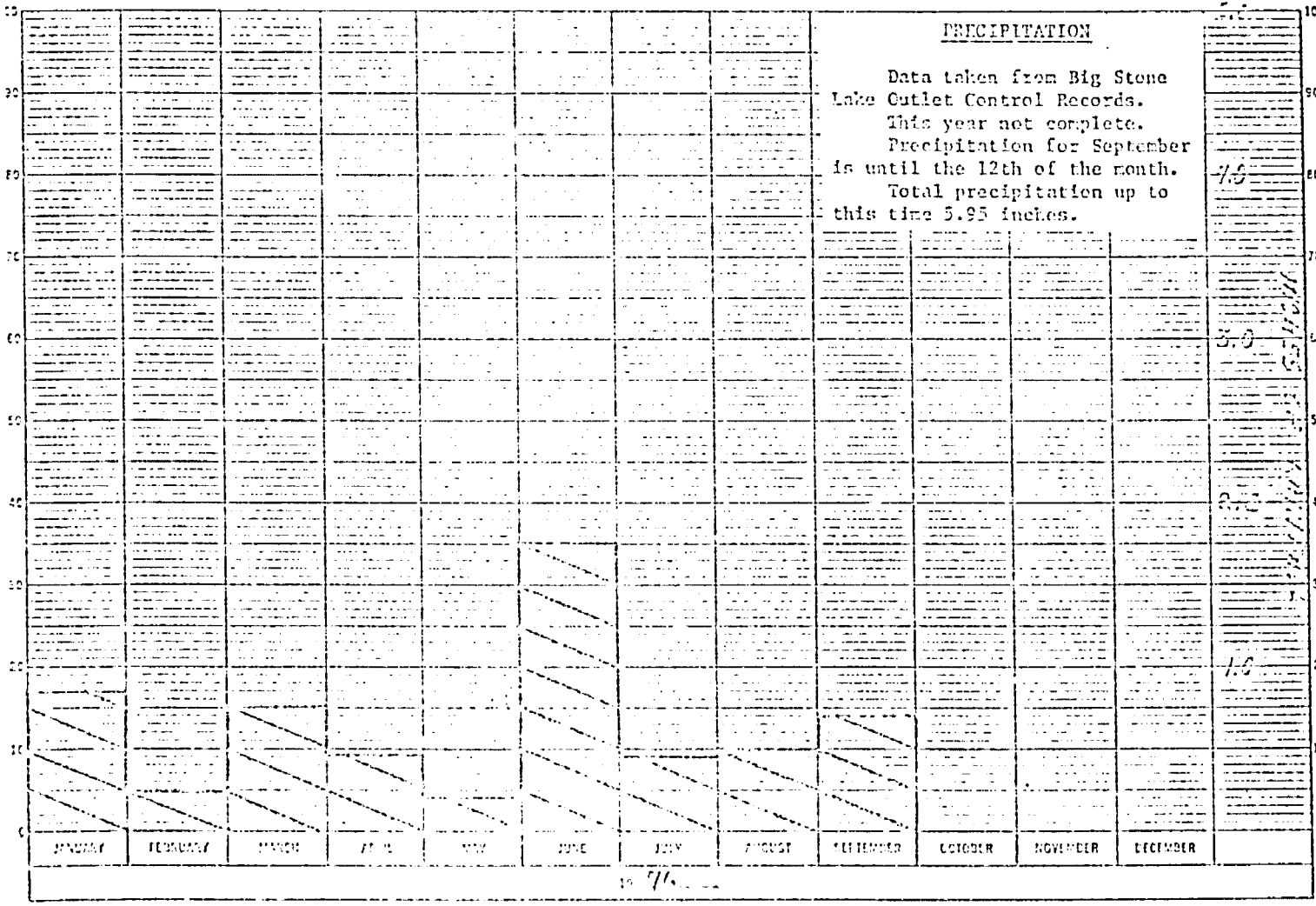
PRECIPITATION

Data taken from Pig Stone Lake Outlet Control Records.

Total precipitation 18.13 inches.




PRECIPITATION
Data taken from Big Stone Lake Outlet Control Records. .
Total precipitation 17.99 inches.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER


PRECIPITATION
Data taken from Big Stone Lake Outlet Control Records.
This year not complete.
Precipitation for September is until the 12th of the month.
Total precipitation up to this time 5.95 inches.
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1.0
5.0
1.6

215 South Cascade Street

Otter Tail
POWER COMPANY

Fergus Falls, Minnesota 56537

Phone 218-736-5411

September 21, 1976

RECEIVED
SEP 27 1976
DEPT. OF NATURAL
RESOURCE DEVELOPMENT

Mr. Gerald Seinwill
Director, Division of Waters
Minnesota Department of Natural Resources
Centennial Office Building
St. Paul, MN 55155

Mr. Vern Butler, Secretary
Department of Natural Resources Development
Joe Foss Building
Pierre, SD 57501

Subject: Request for Emergency Allocation of Water From Big Stone Lake

Gentlemen:

The 440 MW Big Stone Power Plant, jointly owned by Montana-Dakota Utilities Co., Northwestern Public Service Company and Otter Tail Power Company, began commercial operation May 1, 1975, and has been generating at approximately 60% of maximum capability since that time. It is the largest generating unit owned by any of the three companies and, as such, it is vital to the task of supplying adequate and reliable electric service to the companies' customers.

The plant utilizes a 340 acre man-made pond for cooling purposes with makeup water being supplied from Big Stone Lake whenever lake levels, as specified in our water appropriation permits, will allow. (The permits referred to are Permit Number PA 70-1182 issued February 25, 1971, by the Minnesota Department of Natural Resources; and Permit Numbers 1768-3 and 1983-3 issued July 23, 1970, and June 13, 1973, respectively, by the South Dakota Water Resources Commission.)

Briefly, the permits authorize the appropriation of up to 7,000 acre-feet of water annually, from Big Stone Lake - provided that pumping is restricted to the times when the lake level exceeds project datum elevation of 967 feet during the period from May 1 through September 30, and 966 feet during the period October 1 through April 30.

Our records show that, so far in 1976, we have pumped 353,462,912 gallons or 1084.6 acre-feet, approximately 15.5% of our permitted annual appropriation. The last day of pumping was May 7 of this year, at which time the cooling pond was at elevation 1121.4 feet - 0.4 feet above the design maximum water surface elevation.

Because of the small amount of spring runoff, the severe drought, the low humidities and high temperatures which have been occurring all summer, the level of Big Stone Lake declined rapidly and by the early days of June it had dropped below the 967 foot level required to allow pumping. The level has been declining steadily since April 1 and has now dropped to 963.3, well below the minimum level of 966 feet required to permit pumping during the winter months. There seems little prospect of any significant improvement in lake levels before normal snowfall runoff next spring.

Concurrent with the drop in lake level, the level of the cooling pond has also dropped at an alarming rate. (See the attached report by Mr. Dana Holter) On September 7, 1976, the cooling pond elevation was 1114.8 feet, down 6.6 feet from May 7. That drop represents a loss of 2155 acre-feet, an average of 8.83 cubic feet per second (CFS). By contrast, our engineering consultants, Bechtel Power Corporation, had predicted 6.75 CFS evaporation from the plant cooling pond for the May - September period during an <u>average</u> year. This illustrates that the past year has certainly been an abnormal one, a point made even more vivid when one considers that during this time the plant has operated at less than 85% of its nameplate capacity, which means less heat rejected to the cooling pond and, hence, less evaporation required than would be the case during normal full load operation.

A second problem area is the matter of the boiler makeup pond (an isolated portion of the cooling pond) which provides higher quality water for boiler makeup and sanitary purposes and which serves as the potable water supply for the plant. This pond, approximately 5 acres in surface area and containing a maximum of 75 acre-feet of water, is also extremely low at this time. An adequate supply of water in this pond is absolutely necessary for continued operation of the plant. There is serious concern that there may not be sufficient water now contained in the makeup pond to allow the plant, which was shutdown on September 3 for scheduled maintenance, to be put back in service on October 22 as planned unless additional water is made available from Big Stone Lake.

<u>Request</u>

We respectfully request an emergency allocation of up to 1000 acre-feet of water from Big Stone Lake. Our intention would be to appropriate 500 acre feet immediately upon approval of our request and to take the remaining 500 acre-feet of the allocation in smaller increments throughout the winter on a "when and if needed" basis. (Big Stone Lake has a surface area of approximately 13,000 acres at a pool elevation of 965 feet. Therefore, withdrawal of 500 acre-feet would lower the level by less than 0.5 inch.)

This allocation, if granted, would enable the Big Stone Plant to continue operation until the spring runoff when we anticipate a rise in lake level sufficient to enable us to pump under terms of our existing permits. In the event of continued subnormal precipitation which may preclude a spring runoff sufficient enough to result in a rise in lake level above the minimum requirements to allow normal appropriations it would become necessary for us to make another request for an emergency allocation of water at that time. We sincerely hope that such a situation does not become reality.

Summary

A. Unusual and abnormal weather conditions have combined to result in water consumption of 30% or more above predicted amounts for average years.

B. The level of the Big Stone Plant cooling pond is now at an elevation of 1114.7 feet. Normal high level as of May 7, 1976, the last day water was added to the pond, was 1121.4 feet. Minimum pond level for operation of the circulating water pumps is 1112.0 feet.

C. If additional water is not made available, the minimum operational level of the cooling pond will be reached in January, 1977.

D. Continued operation of the Big Stone Plant is essential to the health and well being of customers of the three utility companies who own the plant.

E. An emergency allocation of 1000 acre-feet of water to be appropriated from Big Stone Lake is urgently needed. An immediate requirement of 500 acre-feet is to be withdrawn from the lake as soon as approval is granted. An additional withdrawal of up to 500 acre-feet would be accomplished at various times throughout the winter, when and if needed.

F. If spring, 1977, runoff is inadequate to permit pumping in conformance with permits now in effect, an additional allocation may be requested at a later date.

G. Priority consideration of this request is of vital importance.

Otter Tail
POWER COMPANY

Please contact us at once if more information or clarification is needed concerning this urgent matter. Our telephone number is (218) 736-5411.

Yours very truly,

W. L. Doebbert
Manager of Production

WLD:VHM:ckk

Enclosure

CC: Mr. A. V. Hartl
Mr. R. M. Bigwood
Mr. Warren K. Nye
Mr. R. O. M. Grytle
Mr. C. R. Gustafson
Mr. H. C. Johnson
Mr. Dennis Emmen
Mr. J. b. Lillestol
Mr. J. Myster
Mr. R. T. Nelson
Mr. R. A. Wilkens
Mr. R. F. Middleton
Mr. R. G. Johnson
Mr. O. F. Johnson
Mr. V. H. Menze
Mr. L. Geisen
Mr. V. Zeiher

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING • ST. PAUL, MINNESOTA • 55155

September 29, 1976

RECEIVED
OCT 5 1976
DEPT. OF NATURAL RESOURCE DEVELOPMENT

Mr. W. L. Doebbert
Manager of Production
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, MN 56537

Dear Mr. Doebbert:

PERMIT 70-1182, BIG STONE LAKE

This will acknowledge your September 21, 1976 letter requesting an emergency allocation of water from Big Stone Lake under DNR permit no. 70-1182.

Your request to appropriate 500 acre-feet at this time and an additional amount up to 500 acre-feet, if and when needed throughout the winter, is hereby approved provided the lake level remains at or above elevation 965.0.

In reviewing the Findings, Conclusions and Order of the Commissioner in this matter, one question did arise in relation to Finding No. 9, which quotes as follows:

> 9. That during prolonged drought periods when levels of Big Stone Lake are low, the applicants would provide for means of obtaining water supply other than by pumping from the lake for the plant operation, such as utilizing stored water or other authorized sources.

Presumably, such a finding would have been based on statements made by applicants' witnesses during the public hearing. If this is correct, then it would appear that the company should now initiate some long-range planning to increase their water storage capability. We invite your comment on this.

Very truly yours,

Division of Waters

Lawrence D. Seymour, Supervisor
Development Section

LDS:ps
cc: Vern Butler
Ray Nyberg

AN EQUAL OPPORTUNITY EMPLOYER

INTER-DEPARTMENT CORRESPONDENCE

State of South Dakota

From Dept. of Game, Fish and Parks To Dept. of Natural Resource Development

Subject Big Stone Power Plant Date Sept. 30, 1976

Vern Butler:

We have reviewed Otter Tail Power Company's request for 1,000 acre feet of water from Big Stone Lake with 500 acre feet to be taken immediately and the additional 500 acre feet taken at intervals during the winter of 1976-77. We understand that part of this water can be taken as provided by their existing water right but some may have to be taken in exception to the provisions of the water right if the lake level drops another 0.3 feet. We have no objections to the amounts of the water to be taken.

It was also verbally pointed out that Otter Tail Power Company wishes to obtain an exception to the provisionthatprovides a maximum rate of withdrawal of 10 c.f.s. continuous daily rate when lake levels are between 967 & 965 during October to April inclusive.

They state in their letter that 500 Acre feet of water is needed before October 22, 1976. Thus they have over 20 days to pump the 500 acre feet. At a continuous rate of 12.5 c.f.s., that amount of water could be moved in 20 days. Therefore we do not believe a complete exemption from a continous daily rate is necessary. To give them a 100% margin, we suggest that a 25 c.f.s. continous daily rate be authorized for the first 500 acre feet, but the 10 c.f.s. rate be complied with for the latter 500 acre feet Our reason for this is the approach velocities of the waters at the intake could be too rapid for young fish to avoid.

Sincerely,

John Popowski
Secretary

JP:rmh

RECEIVED
OCT 5 1976
DEPT. OF NATURAL
RESOURCE DEVELOPMENT

Verlin.
Menze — Otter Tail Res.

Cooling Pond 5' low
Emergency Permit to Pump from Big Stone Lake — Lake little over reg. winter level. —
966 is lowest level to pump from B. Stone Lake. —
Qualifications are either for spilling or no pumping. —

Return flows:
1) Evaporation Pond.
2) Spray & Land Treatment
3) Irrigation Water to surrounding farms
4) Pump back into streams.

1768-3

Department of Natural Resource Development

WATER RIGHTS COMMISSION
Joe Foss Building, Pierre, South Dakota 57501
Phone 605/224-3151

October 4, 1976

W.L. Doebbert
Manager of Production
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

Dear Mr. Doebbert:

This will acknowledge your letter requesting additional water from Big Stone Lake. During a telephone conversation October 1, 1976 between Mr. V.H. Menze of your Company and Mr. Vern Butler, Secretary, Department of Natural Resource Development, Mr. Butler advised that the Water Rights Commission had approved your request as follows:

> That Otter Tail Power Company, operator of the Big Stone Power Plant be authorized on a temporary basis in accordance with provisions of Water Right No. 1768-3 to increase diversions from Big Stone Lake from the authorized 10 cubic feet per second (c.f.s.) to 100 c.f.s. until 500 acre feet of water have been diverted at which time the diversion rate will return to the authorized 10 c.f.s. when lake surface levels are between project datum elevations 967 and 965 during the annual period October 1st to April 30th inclusive.

If additional requests become necessary, you may wish to take note of the following Water Rights Commission dates - November 17-18, 1976 and January 26-27, 1977. Dates have not been set for the March or May, 1977 meetings.

Very truly yours,

JOHN HATCH, Chief Engineer
Water Rights Commission

JH/bw
cc: V.H. Menze

PROGRESS REPORT
FOR THE THIRD QUARTER
1976 WATER MONITORING PROGRAM

BIG STONE POWER PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

November, 1976

Dorand Engineering Services
Brookings, South Dakota

DORAND ENGINEERING SERVICES

James N. Dornbush, DSc
Dwayne A. Rollag, PE

324 DAKOTA AVENUE
Elm

BROOKINGS, SOUTH DAKOTA 57006

605-692-6681

November 29, 1976

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

Gentlemen:

The following report covers the third quarter of the fifth year of the Water Monitoring Program for the Big Stone Plant representing the data collected during the months of July through September, 1976.

1. Samples were collected for analyses from 9 wells and 5 surface water sampling stations on July 21, August 24 and September 20, 1976. The location of the sampling stations is shown on the enclosed map.

2. The results of the analyses along with previous results for 1976 are included in the enclosed tables along with commentary notations concerning sampling or quality changes when applicable.

3. Air line readings to determine ground water elevations were continued at the 6 wells, and these data are included in a table along with a graph for comparison with past water level variations. From the graph, it will be noted that water levels at the wells were within the ranges established by past data.

4. Water levels measured at the 5 well points north of the cooling pond are also included in the enclosed table. At each of these well points, water levels dropped 3 to 5 feet during the quarter. Except for well point D, these water levels are the lowest that have been recorded since 1972 when the measurements began. In the 1975 annual report (pages 14-17), it was shown that the water levels of well point D were influenced by the cooling pond.

Please contact us if there are any questions concerning this report.

Sincerely,

James N. Dornbush, P.E.

JND:mfd
Enclosures

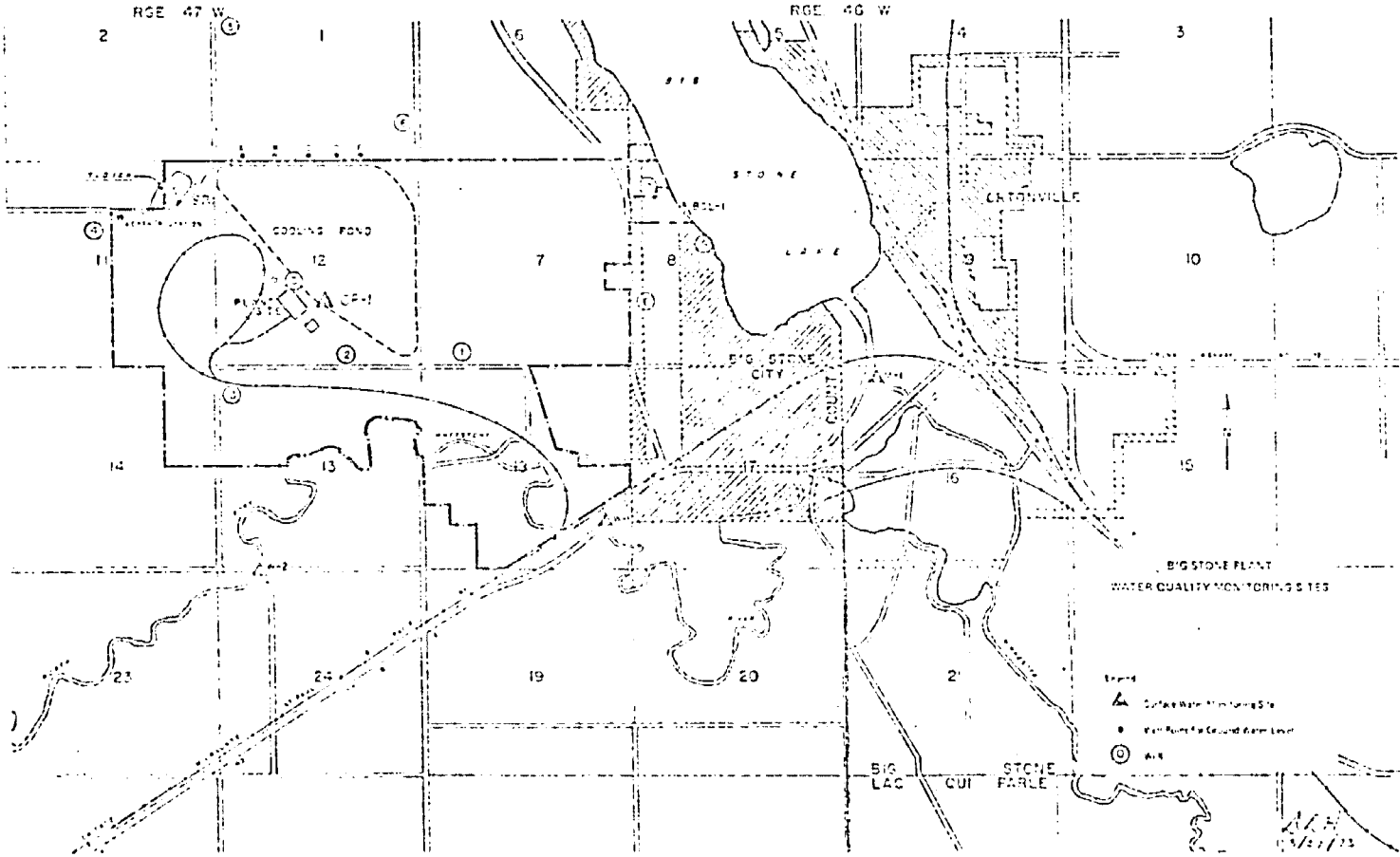


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

DERALD HAY FARM (SW ¼, Sec. 7) (Southeast of cooling pond on plant site)

Station: Well - 1

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/23
Temperature - °C					10.0	11.0	10.0	10.0	9.5
pH - units					7.1	7.0	7.0	6.7	7.0
Conductivity - μmhos/cm-25°C	N O	N O	N O	N O	1861	1793	1454	1881	1717
Total Hardness					1087	1134	1143	1100	1165
Calcium Hardness	S A	S A	S A	S A	840	850	840	770	901
Sodium	M P	M P	M P	M P	10	10	16	10	10
Total Alkalinity	L E	L E	L E	L E	422	414	410	406	414
Chlorides					2	1	0.5	2.3	1.3
Sulfates					924	844	808	756	740
Total Phosphorus							0.01		
Nitrate Nitrogen					0	0	0.02	0.06	0
Ammonia Nitrogen							0.54		0.56
Kjeldahl Nitrogen							0.54		
Total Residue					1710	1704	1392	1689	1686
Coliform Group - MPN/100 ml									

*Results expressed as mg/l except as noted.

Well - 1 The concentrations of dissolved chemicals are within the limits established by past data. Sufficient samples have now been collected in 1976 to demonstrate that a major change of quality did not occur during the period when the power to the well was disconnected.

DATE MICROFILMED

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond)

Station: Well - 2

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C					10.5	10.0	9.5	10.0	9.5
pH - units					8.2	7.0	6.3	6.6	6.9
Conductivity - micromhos/cm-25°C	NO	NO	NO	NO	2145	2383	2131	2670	2980
Total Hardness					1340	1544	1720	1718	1872
Calcium Hardness	SAMPLE	SAMPLE	SAMPLE	SAMPLE	1080	1166	1316	1394	1476
Sodium					16	17	20	21	21
Total Alkalinity					452	528	417	417	426
Chlorides					29	30	33	43	41
Sulfates					1100	1264	1380	1456	1408
Total Phosphorus							0		
Nitrate Nitrogen					3.2	4.5	12.75	0.05	24.5
Ammonia Nitrogen							0.14		0.78
Kjeldahl Nitrogen							0.50		
Total Residue					2180	2407	2102	2823	3146
Coliform Group - MPN/100 ml									

*Results expressed as mg/l except as noted.

Well - 2 Although there have been increases in chemical concentrations compared to the two samples collected during the previous quarter, the observed concentrations do not represent maximums. Water quality of samples collected during the previous year had substantially more mineral content. The September sample from this well had some suspended matter (about 100 mg/l) in it when collected.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Sampling Dates - 1976

Determination*		1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C			9.5	9.0	9.5	10.5	10.5	10.0	10.5	9.5
pH - units			7.2	7.3	7.3	7.5	7.5	7.4	7.2	7.5
Conductivity - µmhos/cm-25°C			877	882	700	980	887	842	959	923
Total Hardness	NO SAMPLE		490	388	366	409	410	426	381	408
Calcium Hardness			230	199	220	219	219	217	220	215
Sodium			25	25	17	25	33	30	35	36
Total Alkalinity			244	244	238	258	260	252	248	250
Chlorides			3	3	35	34	32	2	3	3
Sulfates			243	308	256	248	274	292	270	285
Total Phosphorus			0.11		0			0		
Nitrate Nitrogen			0	0.05	0.05	0.06	0.15	0.03	0.05	0
Ammonia Nitrogen			3.05		3.10			3.51		3.99
Kjeldahl Nitrogen			3.79		3.23			3.81		
Total Residue			672	697	644	680	744	734	702	655
Coliform Group - MPN/100 ml										

*Results expressed as mg/l except as noted.

Well - 3 Concentrations of constituents fell within the range established by previous data. Chlorides concentrations that were unexplainably high last quarter were in the usual range again.

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site)

Station: Well - 4

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	8.0	8.5	7.0	9.0	10.5	11.5	12.0	10.5	10
pH - units	7.3	7.1	6.9	7.0	7.6	7.0	6.8	6.7	7.0
Conductivity - µmhos/cm-25°C	2292	2253	2292	2386	2361	2400	2471	2433	2279
Total Hardness	1498	1542	1422	1448	1520	1498	1498	1516	1560
Calcium Hardness	1080	1062	1000	1100	1080	1074	1136	1116	1162
Sodium	15	13	14	14	15	15	14	15	15
Total Alkalinity	402	410	436	451	457	439	460	453	450
Chlorides	39	33	38	39	40	39	44	41	40
Sulfates	1196	1162	1184	1348	1232	1164	1152	1208	904
Total Phosphorus		0.04		0.06			0		
Nitrate Nitrogen	12.4	9.3	2.3	1.3	1.1	0.6	0.15	0	1.33
Ammonia Nitrogen		0.15		0.35			0.43		0.17
Kjeldahl Nitrogen		0.23		0.75			0.54		
Total Residue	2224	2187	2288	2246	2334	2358	2351	2430	2381
Coliform Group - MPN/100 ml		< 2.2			9.1			2.2	

*Results expressed as mg/l except as noted.

Well - 4 The analyses revealed no significant changes of water quality for this well during the quarter. The results of the determinations fell within the range that was established in the past.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site) Station: Well

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	9.0	10.5	6.5	9.0	10.0	10.0	10.0	10.5	10
pH - units	7.1	7.0	7.0	7.2	7.4	7.3	7.0	6.8	7.2
Conductivity - μmhos/cm·25°C	1435	1509	1479	1487	1548	1519	1357	1598	1598
Total Hardness	850	892	829	880	882	902	876	779	859
Calcium Hardness	590	620	530	558	575	519	610	564	570
Sodium	13	13	13	14	14	14	13	14	13
Total Alkalinity	466	484	473	465	472	458	459	456	461
Chlorides	1.4	1.5	4.1	1.6	4.6	0.6	1.0	4.5	0.5
Sulfates	520	507	504	580	554	532	524	538	510
Total Phosphorus		0.08		0.18			0.01		
Nitrate Nitrogen	4.5	2.3	1.8	1.6	0.8	0.6	0.25	0	0.68
Ammonia Nitrogen		0.21		0.44			0.47		0.76
Kjeldahl Nitrogen		0.27		0.90			0.53		
Total Residue	1296	1283	1322	1257	1318	1334	1349	1354	1297
Coliform Group - MPN/100 ml		<2.2			<2.2			<2.2	

*Results expressed as mg/l except as noted.

Well - 5 The chemical quality of the water during th quarter was within the range established by past data except for the September ammonia concentration which was a new maximum.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond) Station: Well

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	8.0	8.5	8.0	9.0	10.0	11.5	13.0	12.0	12.5
pH - units	7.2	7.0	7.0	7.2	7.3	7.2	7.0	6.7	7.3
Conductivity - umhos/cm-25°C	1391	1371	1371	1348	1313	1362	1239	1278	1526
Total Hardness	812	772	706	805	735	610	772	716	765
Calcium Hardness	545	549	400	527	495	470	543	520	489
Sodium	13	13	12	14	8	14	13	15	14
Total Alkalinity	469	467	472	465	468	462	460	454	465
Chlorides	2	0.3	0.4	4.2	1.9	0.6	0.6	3.4	1.5
Sulfates	442	430	430	456	432	430	408	446	400
Total Phosphorus		0.09		0.31			0.01		
Nitrate Nitrogen	0	0	0.2	0	0	0	0	0.01	0
Ammonia Nitrogen		0.46		0.66			0.73		0.74
Kjeldahl Nitrogen		0.55		1.08			0.77		
Total Residue	1170	1147	1180	1116	1194	1173	1176	1173	1128
Coliform Group - MPN/100 ml		<2.2			<2.2			<2.2	

*Results expressed as mg/l except as noted.

Well - 6 The chemical quality of the water during th quarter was comparable to past quality data.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake)

Station: Well -

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/22	5/19	6/22	7/21	8/24	9/20
Temperature - °C	9.0	10.0	13	9.5	10.0	11.5	10.0	12.5	10.5
pH - units	7.3	7.0	7.2	7.3	7.3	7.3	7.1	6.8	7.4
Conductivity - µmhos/cm-25°C	1322	1253	1313	1284	1244	1302	1180	1356	1469
Total Hardness	752	729	706	765	698	722	738	749	717
Calcium Hardness	506	534	444	478	462	459	507	476	466
Sodium	16	15	11	16	14	16	15	16	16
Total Alkalinity	456	439	456	450	455	444	444	448	454
Chlorides	1	0.5	0.5	1.6	1.1	0.9	1.0	1.5	0.6
Sulfates	398	400	456	426	398	394	418	386	370
Total Phosphorus		0.10		0.26			0.01		
Nitrate Nitrogen	0	0	0	0	0	0	0	0	0
Ammonia Nitrogen		1.18		0.35			1.51		2.42
Kjeldahl Nitrogen		1.30		1.64			1.67		
Total Residue	1162	1169	1161	1107	1154	1154	1135	1173	1136
Coliform Group - MPN/100 ml		< 2.2			< 2.2			< 2.2	

*Results expressed as mg/l except as noted.

Well - 7 The chemical quality of the water during th quarter was within the range established by past data except for the September ammonia concentration which was a new maximum.

BERNARD FRENSKO FARM (SW ¼, Sec. 8)(East of plant site and cemetery)

Station: Well -

Sampling Dates - 1976

Determination*	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
emperature - °C	8.0	8.5	8.0	9.0	10.0	11.0	11.0	12.5	10
i - units	7.1	6.9	7.?	7.1	7.0	7.1	6.9	6.8	7.0
onductivity - µmhos/cm-25°C	1316	1302	1351	1367	1400	1352	1185	1319	1403
otal Hardness	746	763	782	762	750	763	750	609	770
alcium Hardness	539	554	480	520	534	461	550	540	530
odium	14.5	12	12	14	14	13	13	14	13
otal Alkalinity	428	431	432	434		429	428	424	430
hlorides	0.5	0.8	0.5	2.4	2.0	0.8	0.5	1.3	0.5
ulfates	425	423	408	462	468	446	446	436	402
otal Phosphorus		0.08		0.14			0		
itrate Nitrogen	0	0	0	0	0	0	0	0	0
mmonia Nitrogen		0.83		1.29			1.13		1.34
jeldahl Nitrogen		1.06		1.50			1.14		
otal Residue	1191	1141	1178	1136	1154	1165	1167	1177	1138
oliform Group - MPN/100 ml		< 2.2			< 2.2			< 2.2	

*Results expressed as mg/l except as noted.

Well - 8 There appears to have been no significant change in water quality at this well. The August tot hardness concentration was about equivalent to the pa minimum value. A new owner or tenant lives in this farm home.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake)

Station: Well - 9

Sampling Dates - 1976

Determination*	1/22	3/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	13	13.5	12	12.5	10.0	11.0	10.0	13.0	11
pH - units	7.5	7.2	7.5	7.4	7.5	7.4	7.2	7.0	7.4
Conductivity - µmhos/cm-25°C	1087	1229	1210	1263	1313	1107	1092	1314	1196
Total Hardness	639	600	592	645	606	630	642	609	654
Calcium Hardness	390	382	368	389	378	380	420	371	371
Sodium	31	32	27	18	39	16	31	34	40
Total Alkalinity	272	267	293	281		260	260	251	250
Chlorides	23	22	21	22	32	23	18	18	22
Sulfates	360	372	470	566	510	508	486	474	352
Total Phosphorus		0.07		0.08			0		
Nitrate Nitrogen	0.1	0.05	0.28	0.15	0.01	0.09	0.06	0	0.03
Ammonia Nitrogen		0.67		0.98			0.77		0.97
Kjeldahl Nitrogen		0.90		1.55			1.08		
Total Residue	1035	1006	1032	1034	1056	1090	1082	1049	1034
Coliform Group - MPN/100 ml		2.2			<2.2			<2.2	

Well - 9 The chemical quality of the water during the quarter was within the range established by past data.

*Results expressed as mg/l except as noted.

Station: CF -

COOLING POND (At plant intake structure)

Determination*	Sampling Dates - 1976								
	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	10.5	15.5	15.5	14.0	22.0	26.5	29.5	28	16.5
pH - units	8.1	8.1	8.2	8.3	8.4	8.4	8.4	7.7	8.0
Conductivity - µmhos/cm-25°C	1430	1445	1420	1486	1577	1602	1749	2330	2526
Total Hardness	575	650	601	651	637	630	790	880	961
Calcium Hardness	305	306	272	309	286	323	471	401	450
Sodium	71	74	90	99	130	107	119	151	176
Total Alkalinity	156	169	155	165	147	170	155	152	154
Chlorides	27	16	28	30	31	27	37	42	48
Sulfates	650	660	758	850	890	890	916	984	1010
Total Phosphorus	0.03	0.07	0.15	0	0.09	0	0	0.10	0.03
Nitrate Nitrogen	0	0	0.04	0	0	0	0.01	0.05	0
Ammonia Nitrogen	1.22	0.95	0.77	0.14	0.17	0.10	0.21	0	0.18
Kjeldahl Nitrogen	1.50	1.44	1.50	1.70	1.65	1.53	1.01	2.35	1.77
Total Residue	1195	1257	1362	1359	1416	1599	1616	1651	2389
Total Suspended Matter	2	8	22	9	4	11	6	19	22
Dissolved Oxygen	11.2	10.0	9.5	9.2	7.7	8.0	7.3	7.4	8.4
Biochemical Oxygen Demand	2	3	7	3	2	3	3	4	3
Turbidity	2	1	1	1	1	2	1	3	<1
Coliform Group - MPN/100 ml	25	<5	20	10	15	5		480	15
Fecal Coliforms - MPN/100 ml	<3	<3	3	<3	<3	3		3	3

*Results expressed as mg/l except as noted.

Cooling Pond: The trend of increased concentrations of dissolved constituents continued throughout the quarter. Maximum concentrations for many determinations were recorded in September. A special section concerning cooling pond water quality is planned for the annual report.

BIG STONE LAKE (at lake intake to pumping station)

Station: B3I

Determination*	Sampling Dates - 1976 1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	3.0	4.0	4.5	13.0	18.0	21.5	24.0	25	16
pH - units	7.8	7.6	8.0	8.1	8.5	8.6	8.6	7.3	7.6
Conductivity - µmhos/cm-25°C	1362	1284	940	1012	1117	1166	1082	1196	1275
Total Hardness	609	696	396	498	500	546	501	457	510
Calcium Hardness	377	354	211	278	280	284	235	228	279
Sodium	47	43	32	40	56	40	38	46	51
Total Alkalinity	224	191	158	173	166	186	122	102	114
Chlorides	26	10	17	17	20	21	18	23	24
Sulfates	598	490	336	444	536	508	488	502	518
Total Phosphorus	0.12	0.21	0.29	0.22	0.78	0.02	0.01	0.15	0.09
Nitrate Nitrogen	0.31	0.26	0.52	0.04	0.01	0.01	0.04	0.09	0.17
Ammonia Nitrogen	1.23	1.50	1.27	0.28	0.29	0.17	0.24	0.53	0.34
Kjeldahl Nitrogen	1.76	1.98	1.45	1.73	1.58	1.45	0.56	2.10	2.59
Total Residue	1148	1051	798	898	996	1012	952	987	1057
Total Suspended Matter	1	7	30	14	29	15	10	10	39
Dissolved Oxygen	9.8	6.8	13.2	8.2	9.1	5.9	9.2	2.3	7.7
Biochemical Oxygen Demand	2	3	8	2	3	3	6	2	4
Turbidity	5	1	3	2	3	1	3	2	2
Coliform Group - MPN/100 ml	<5	<5	530	<5	100	15		50	150
Fecal Coliforms - MPN/100 ml	<3	<3	33	<3	3	6		<3	13

*Results expressed as mg/l except as noted.

Big Stone Lake The field notes reveal that there was a dense algae growth in the lake for each of the three sampling dates during the quarter. The concentrations of chemical constituents, however, were within the range established by past data although alkalinity values were about the minimum range.

MINNESOTA RIVER (At lake outlet control structure)

Station: X -

Determination*	Sampling Dates - 1976 1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
Temperature - °C	0	0.5	1.0	11.5	19.5	23.0	24.0	24	12
pH - units	7.8	7.6	7.9	8.2	8.2	8.4	8.9	7.3	7.4
Conductivity - µmhos/cm-25°C	1292	882	479	935	1137	1068	1092	1315	1469
Total Hardness	630	508	224	491	497	468	518	495	607
Calcium Hardness	419	283	148	312	289	280	238	240	320
Sodium	46	30	14	32	37	32	44	52	65
Total Alkalinity	356	240	115	190	224	210	118	120	140
Chlorides	54	17	5.5	30	27	29	25	24	29
Sulfates	376	229	147	424	452	430	528	546	603
Total Phosphorus	0.20	0.63	0.42	0.25	0.38	0.06	0.01	0.22	0.22
Nitrate Nitrogen	0.15	0.33	1.04	0.01	0.03	0	0.02	0.17	0.02
Ammonia Nitrogen	1.08	2.86	1.02	0.09	0.09	0.13	0.25	0.14	0.38
Kjeldahl Nitrogen	1.20	3.16	1.03	1.27	1.29	1.22	0.93	2.44	2.56
Total Residue	1015	778	468	847	1024	953	1004	1135	1385
Total Suspended Matter	2	112	169	73	106	123	13	85	160
Dissolved Oxygen	9.9	7.6	10.4	10.0	6.3	9.6	6.6	2.9	5.3
Biochemical Oxygen Demand	4	31	4	5	4	4	3	3	9
Turbidity	6	5	8	1	6	11	2	2	4
Coliform Group - MPN/100 ml	50	120	700	230	120	40		380	3500
Fecal Coliforms - MPN/100 ml	< 3	6	20	10	7	33		140	380

*Results expressed as mg/l except as noted.

Minnesota River Except for a very high pH in July, the concentrations of constituents during the quarter were within the range established by past data. Water levels were very low at the spillway with little or no discharge downstream.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Station: W - 1

Determination*	Sampling Dates - 1976								
	1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/20
perature - °C	1.0	1.0	1.0	10.5	19.5	22.5	23.0	24.5	13.5
- units	7.7	7.5	7.8	8.1	8.1	8.0	7.9	7.4	7.8
luctivity - rhos/cm-25°C	1293	686	485	947	1107	916	1053	1402	1196
al Hardness	588	472	223	490	513	531	507	445	548
cium Hardness	381	219	154	330	337	329	348	376	350
ium	50	25	12	29	32	34	25	44	26
al Alkalinity	351	168	115	260	292	290	296	330	298
orides	96	11	5.9	26	34	36	29	29	24
fates	345	173	156	406	403	318	304	422	316
al Phosphorus	0.38	0.78	0.49	0.16	0.17	0.05	0.01	0.29	0.09
rate Nitrogen	0.36	0.18	1.01	0.03	0.01	0	0.04	0.15	0.34
onia Nitrogen	1.76	2.05	1.94	0.25	0.22	0.18	0.20	0.08	0.32
ldahl Nitrogen	1.99	2.83	2.36	1.05	0.95	1.17	0.80	1.19	0.89
al Residue	1014	567	451	796	908	881	936	1057	913
al Suspended Matter	17	25	168	14	8	22	28	33	11
solved Oxygen	9.4	9.0	11.9	9.1	8.3	5.5	5.8	5.9	5.7
chemical Oxygen Demand	3	36	7	3	2	3	4	2	5
rbidity	4	3	15	4	2	1	1	2	2
liform Group - PN/100 ml	55	150	600	60	200	150		450	175
al Coliforms - PN/100 ml	13	100	30	10	20	130		420	40

*Results expressed as mg/l except as noted.

W - 1 and W - 2 The flow in the Whetstone River was very low, and the field sheets report "no noticable velocity" for each sampling date during the quarter. Water quality was unusually uniform during the quarter. Except for a low dissolved oxygen concentration (2.5 mg/l) for W-2 in August, the concentrations generally fell within the range of the previous part of the year. Although bacteriological samples were collected from all surface water stations in July, they must have been delay in the mail because when the laboratory received them, the samples were too

WHETSTONE RIVER (On county road 1½ miles south of plant site) Station: 2 -

Determination*	Sampling Dates - 1976 1/22	2/24	3/25	4/27	5/19	6/22	7/21	8/24	9/30
Temperature - °C	0	1.0	0.5	10.5	18.0	21.5	21.0	23	12
pH - units	7.7	7.6	7.9	8.1	8.2	8.1	8.2	7.7	8.1
Conductivity - µmhos/cm-25°C	1283	735	490	963	1043	940	970	948	892
Total Hardness	521	319	200	480	495	480	490	439	455
Calcium Hardness	402	242	144	371	320	290	299	290	300
Sodium	57	25	15	31	35	44	26	21	20
Total Alkalinity	349	181	111	248	289	272	277	273	254
Chlorides	64	19	5.4	29	33	35	30	21	22
Sulfates	362	174	166	376	410	266	268	274	232
Total Phosphorus	0.74	0.43	0.33	0.07	0.22	0.13	0.03	0.29	0.06
Nitrate Nitrogen	0.21	0.33	0.99	0.02	0.01	0	0.02	0.17	0
Ammonia Nitrogen	1.87	1.96	0.86	0.06	0.07	0.12	0.22	0.06	0.16
Kjeldahl Nitrogen	2.07	2.35	1.5	0.80	0.95	1.10	0.56	1.50	0.85
Total Residue	1051	562	465	301	882	792	826	766	741
Total Suspended Matter	45	11	95	15	12	26	32	39	21
Dissolved Oxygen	7.6	9.5	11.8	8.5	6.7	4.0	5.3	3.6	7.9
Biochemical Oxygen Demand	4	6	6	3	2	2	3	4	5
Turbidity	6	3	9.1	11	2	3	1	1	3
Coliform Group - MPN/100 ml	180	45	850	30	20	90		1100	300

Elevations of the Ground Water*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

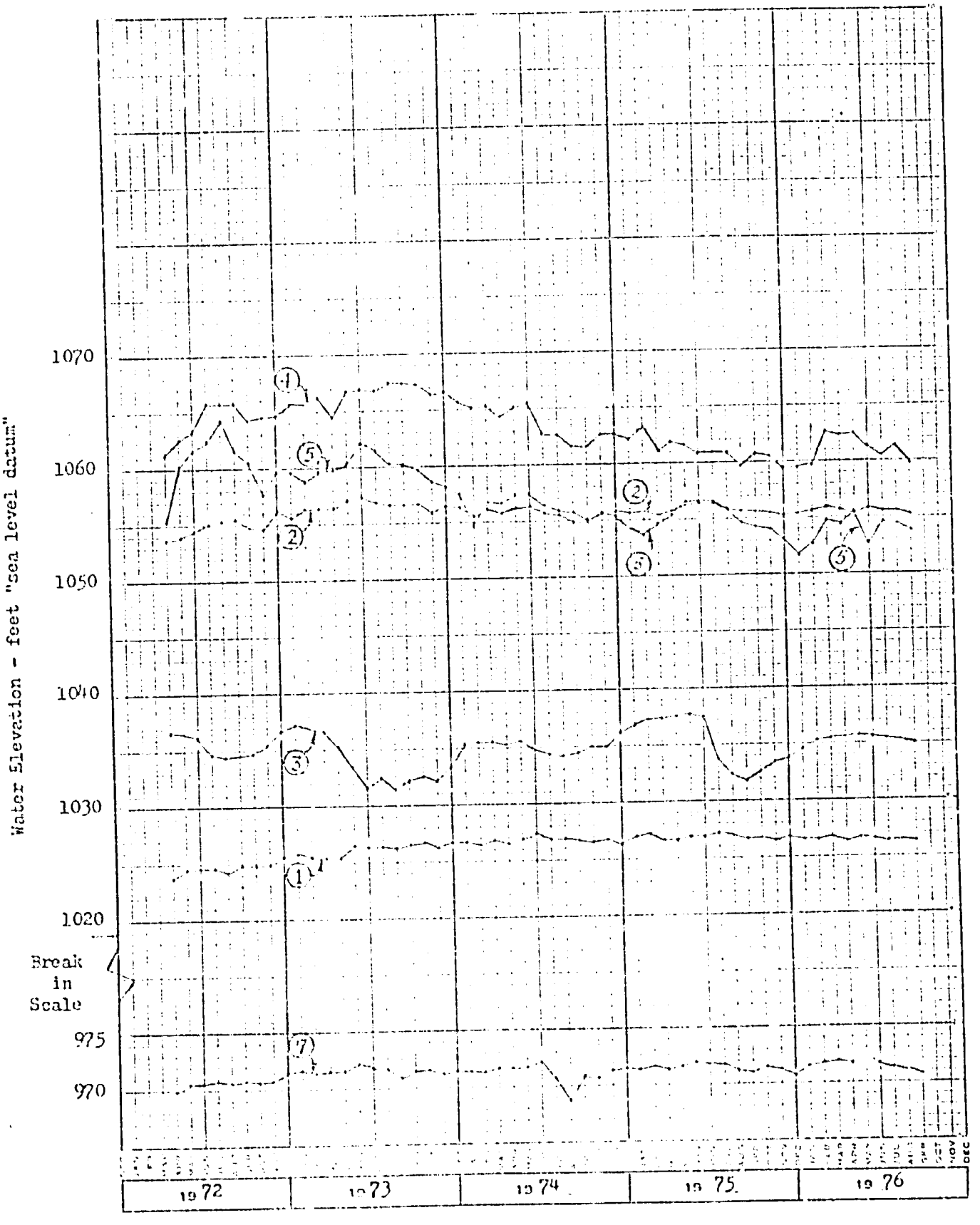
Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
1976						
January 22	1026.49	1055.??	1034.50	1059.40	1051.86	971.49
February 24	1026.49	1055.65	1035.17	1059.81	1052.86	971.74
March 25	1026.82	1055.99	1035.42	1062.56	1054.77	971.99
April 27	1026.24	1055.65	1035.59	1062.15	1054.34	971.58
May 19	1026.74	1055.24	1035.75	1062.31	1055.52	972.16
June 22	1026.57	1055.90	1035.50	1061.23	1052.94	971.66
July 21	1026.32	1055.57	1035.42	1060.48	1054.57	971.24
August 24	1026.40	1055.40	1035.25	1061.15	1054.44	971.08
September 20	1026.32	1055.15	1035.00	1059.98	1053.94	970.91

At Well Points Along County Road North of Pond:

1976	A	B	C	D	E
January 22	1109.38	1112.37	1110.49	1110.19	1108.77
February 24	1113.96	1114.79	1112.74	1110.11	1109.94
March 25	1113.88	1114.21	1112.24	1110.86	1109.69
April 27	1111.55	1112.71	1111.15	1110.32	1108.77
May 19	1110.30	1112.12	1110.49	1110.32	1108.02
June 22	1109.21	1111.46	1109.32	1109.44	1106.69
July 21	1106.80	1110.74	1107.99	1108.02	1105.11
August 24	1104.88	1107.54	1105.90	1106.86	1103.52
September 20	1103.80	1107.04	1105.65	1106.52	1103.02

*All elevations are above "sea level datum."

Figure 3 -
Ground Water Levels Recorded at Six Wells
Big Stone Plant Area



PROGRESS REPORT
FOR THE THIRD QUARTER
1977 WATER MONITORING PROGRAM

BIG STONE POWER PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

November, 1977

Dorand Engineering Services
Brookings, South Dakota

DORAND ENGINEERING SERVICES

James N. Dornbush, DSc
Dwayne A. Rollag, PE

324 Elm Avenue
BROOKINGS, SOUTH DAKOTA 57006
605-692-6681

November 30, 1977

Otter Tail Power Company
Northwestern Public Service Company
Montana-Dakota Utilities Company

Gentlemen:

The following report covers the third quarter of the sixth year of the Water Monitoring Program for the Big Stone Plant representing the data collected during the months of July through September, 1977.

1. Samples were collected on July 27, August 24, and September 21, 1977. Although 9 wells and 5 surface water sampling stations were to be sampled, one of the pumps (at the Methodist Camp) was inoperative during the quarter and, consequently, could not be sampled. The location of the sampling stations is shown on the enclosed map.

2. The results of the analyses along with the previous results for 1977 are included in the enclosed tables along with commentary notations concerning sampling or quality changes when applicable.

3. Groundwater elevations measured at the well points north of the cooling pond and at the six wells as determined by the air line readings are included in the enclosed table. Commentary notations are also included with the table.

Please contact us if there are any questions concerning the report.

Sincerely,

James N. Dornbush, P.E.

JND:mfd
Enclosures

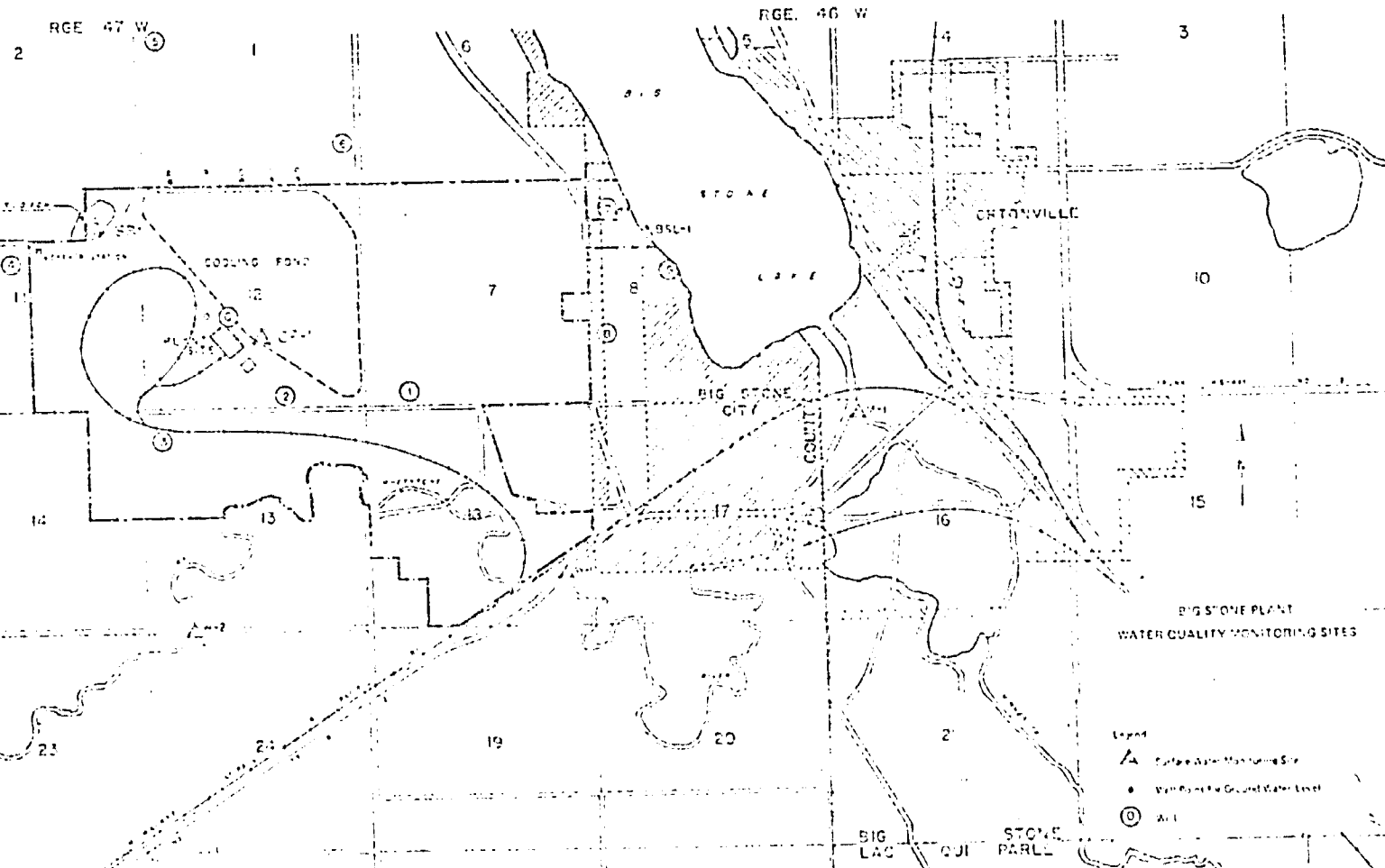


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

DERALD HAY FARM (SW ¼, Sec. 7) (Southeast of cooling pond on plant site) Station: Well -

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
emperature - °C	8	8.5	8	10	10	11	10	10	9
i - units	6.9	6.8	6.7	6.8	6.7	6.8	6.8	6.7	7.0
onductivity - µmhos/cm·25°C	2211	2131	2234	2205	2003	1993	1924	2085	1941
otal Hardness	1248	1248	1182	1146	1214	1220	1268	1240	1145
alcium Hardness	880	820	860	840	824	896	816	870	850
odium	12	11	14	12	15	25	13	16	14
otal Alkalinity	402	402	403	406	410	408	412	410	410
hlorides	0.5	3.0	0.2	0.6	0.1	0.2	0.9	5	2.5
ulfates	808	752	796	800	824	804	840	830	855
otal Phosphorus	0.18			0.09			0.01		
itrate Nitrogen	0.1	0.1	0.1	0.0	0.0	0	0	0	0
mmonia Nitrogen	0.27			0.43			0.56		
eldahl Nitrogen	0.30			0.94			0.87		
otal Residue	1724	1739	1711	1713	1774	1725	1752	1802	1742
oliform Group - MPN/100 ml						<2.2			

*Results expressed as mg/l except as noted.

Well - 1 The concentrations of dissolved chemicals were within the range established by past data. There does not appear to have been any unusual variation in water quality of this well.

Station: Well - 2

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond)

Determination*	1/25	2/17	Sampling Dates - 1977 3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	NO SAMPLE	NO SAMPLE	8	10	9.5	11	10	10	9
pH - units			6.7	6.7	6.8	6.7	6.8	6.7	6.9
Conductivity - µmhos/cm-25°C			3628	3619	3094	3304	3147	2820	3042
Total Hardness			2100	2072	2178	2152	2118	1980	2000
Calcium Hardness			1782	1514	1384	1510	1460	1560	1565
Sodium			26	26	27	27	29	23	27
Total Alkalinity			427	424	418	416	422	420	420
Chlorides			44	46	48	43	45	43	40
Sulfates			1632	1748	1689	1699	1500	1620	1575
Total Phosphorus				0.05			0.05		
Nitrate Nitrogen			16.2	16.6	16.2	0	14.6	9.0	7.0
Ammonia Nitrogen				0.09			0.31		
Kjeldahl Nitrogen				0.93			1.09		
Total Residue			3109	3168	3022	3135	3092	3192	3003
Coliform Group - MPN/100 ml									

*Results expressed as mg/l except as noted.

Well - 2 There appears to have been no significant change in the water quality at this well as defined by the chemical quality. The water has been discolored at this well since September with the brownish color possibly being due to deterioration of the wood curbing at the well. Caving of the well curbing was sufficient to cause discontinuation of extensive pumping to evaluate changes in water quality in 1976.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	9	8	6	9.5	10.5	11	10.5	10.5	10
pH - units	7.6	7.4	7.3	7.4	7.4	7.4	7.2	7.4	7.4
Conductivity - µmhos/cm-25°C	944	1031	1026	1054	949	913	881	915	886
Total Hardness	390	388	354	371	365	370	372	356	405
Calcium Hardness	205	195	160	173	170	195	162	212	220
Sodium	35	35	34	34	40	35	34	38	43
Total Alkalinity	241	242	232	230	238	234	228	220	226
Chlorides	2.2	3.0	0.5	0.8	2.0	5.0	6.4	6	3
Sulfates	220	214	236	240	258	301	236	235	240
Total Phosphorus	.68			0.04			0.06		
Nitrate Nitrogen	0	0.4	0.0	0	0	0	0.1	0.1	0.2
Ammonia Nitrogen	2.01			3.62			3.21		
Kjeldahl Nitrogen	2.30			4.16			3.35		
Total Residue	674	679	632	647	644	633	664	644	641
Coliform Group - MPN/100 ml						<2.2			

*Results expressed as mg/l except as noted.

Well - 3 Concentrations of the various constituents fell within the range established by previous data. The better quality of water at this well compared to all other wells in the monitoring program continues to be quite unusual.

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site)

Station: Well - 4

Determination*	Sampling Dates - 1977								
	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	8	5	7	10	13	12	11	10.5	11
pH - units	6.9	7.0	6.8	6.8	6.8	6.7	6.8	7.0	7.0
Conductivity - µmhos/cm-25°C	2593	2914	2880	2638	2601	2622	2560	2484	2528
Total Hardness	1702	1620	1586	1546	1600	1640	1660	1630	1620
Calcium Hardness	1168	1124	1036	1062	1020	1136	962	1240	1372
Sodium	18	17	18	18	18	20	19	19	20
Total Alkalinity	449	448	444	455	462	465	478	450	365
Chlorides	41	38	40	41	41	42	48	44	40
Sulfates	1204	1168	1140	1163	1129	1156	1216	1165	1200
Total Phosphorus	0.21			0.05			0.05		
Nitrate Nitrogen	19.0	0.1	0.1	0.1	0.2	0	0.3	0.1	0.0
Ammonia Nitrogen	0.16			0.42			0.43		
Kjeldahl Nitrogen	0.29			1.12			1.32		
Total Residue	2370	2380	2321	2349	2339	2339	2365	2360	2473
Coliform Group - MPN/100 ml		old				<2.2			2.2

*Results expressed as mg/l except as noted.

Well - 4 A maximum value of alkalinity was obtained at this well during July after somewhat high results in the previous two months. The September alkalinity appears to be slightly low for 1977 but is substantially above the low values of 1975. Overall the water quality during the quarter appears to be comparable to past data.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site)

Station: Well - 5

Determination*	Sampling Dates - 1977								
	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	9.5	9	8	10.5	11.5	16	30	11	10
pH - units	7.2	7.0	6.9	6.9	6.9	6.9	6.8	6.9	7.3
Conductivity - µmhos/cm-25°C	1508	1820	1831	1820	1594	1530	1542	1587	1500
Total Hardness	926	914	915	911	915	919	897	940	925
Calcium Hardness	557	580	505	547	502	480	300	623	713
Sodium	17	16	16	18	17	18	17	19	20
Total Alkalinity	458	464	456	457	460	462	463	460	464
Chlorides	0.3	0.4	0.3	0.6	0.1	3.1	4.5	7	5
Sulfates	538	496	538	524	547	532	510	540	540
Total Phosphorus	0.04			0.08			0.07		
Nitrate Nitrogen	5.5	0.2	0.5	0	0	0.1	3.10	2.3	1.7
Ammonia Nitrogen	0.32			0.33			0.52		
Kjeldahl Nitrogen	0.35			0.34			1.01		
Total Residue	1318	1323	1307	1267	1284	1288	1294	1290	1363
Coliform Group - MPN/100 ml		old	<2.2			<1			<1

*Results expressed as mg/l except as noted.

Well - 5 In July a new well was dug to a depth of 82 feet close to the old well, and the August sample was the first collected from the new well. The air line for measuring water depth is still in the old well. Except for calcium hardness which might be slightly higher, the water quality of the new well appears quite comparable to past data.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond)

Station: Well - 6

Determination*	Sampling Dates - 1977								
	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	8	7.5	8	9	10	12	12	13.5	11
pH - units	7.1	6.9	6.9	6.9	6.9	6.9	6.9	6.9	7.0
Conductivity - umhos/cm-25°C	1508	1636	1647	1641	1458	1427	1395	1462	1306
Total Hardness	819	846	797	779	816	769	795	826	805
Calcium Hardness	475	509	449	479	441	398	454	500	629
Sodium	19	16	16	16	16	18	15	17	18
Total Alkalinity	460	460	453	460	463	472	471	460	462
Chlorides	0.1	0.3	0.3	0.6	0.3	1.3	2.2	2	2
Sulfates	382	376	382	412	400	374	396	380	360
Total Phosphorus	0.04			0.06			0.06		
Nitrate Nitrogen	0	0.2	0	0	0	0	0	0	0
Ammonia Nitrogen	0.47			0.62			0.74		
Kjeldahl Nitrogen	0.59			1.00			1.21		
Total Residue	1147	1135	1121	1112	1109	1121	1139	1065	1114
Coliform Group - MPN/100 ml		old	<2.2			THTC			<1.1

*Results expressed as mg/l except as noted.

Well - 6 The concentrations of the various chemical constituents determined during the period for this well were within the range of data from past samples. No change was indicated.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake) **Station:** Well - 7

Determination*	Sampling Dates - 1977								
	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	9	9	7	11	10	12			
pH - units	7.6	7.0	7.3	7.1	7.1	7.0			
Conductivity - µmhos/cm-25°C	1163	1468	1209	1427	1427	1406	NO	NO	NO
Total Hardness	660	672	524	739	777	792			
Calcium Hardness	275	370	218	422	505	408	SAMPLE	SAMPLE	SAMPLE
Sodium	16	18	18	21	18	19			
Total Alkalinity	351	404	334	417	446	444			
Chlorides	0.5	0.3	0.2	0.1	0.3	0.6			
Sulfates	290	292	240	388	327	250			
Total Phosphorus	0.04			0.12					
Nitrate Nitrogen	0.0	0.2	0.1	0	0	0			
Ammonia Nitrogen	0.71			1.04					
Kjeldahl Nitrogen	0.75			1.79					
Total Residue	907	993	800	1085	1111	1124			
Coliform Group - MPN/100 ml		old	< 2.2			< 2.2			

*Results expressed as mg/l except as noted.

Well - 7 The pump at this well has been inoperative since July. Because the air line to measure water levels at this well was broken off too, we have contacted the plant personnel about this condition. According to a letter from Edward Johnson, Results Engineer, the well was to be cleaned by a commercial well driller and the air line repaired about October 1, and it was anticipated that the unit would be operative after that. As of November 21, 1977, the pump and air line were still inoperative.

PAUL THIELE FARM (SW ¼, Sec. 8)(East of plant site and cemetery)

Station: Well - 8

Determination*	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
			Sampling Dates - 1977						
Temperature - °C				11		13.5	12	19	15
pH - units			6.9	7.0	7.0	6.9	6.9	6.9	7.1
Conductivity - µmhos/cm-25°C	NO SAMPLE	NO SAMPLE	1687	1503	1143	1290	1348	1197	1322
Total Hardness			793	771	725	798	800	814	805
Calcium Hardness			451	491	240	461	478	510	590
Sodium			15	15	20	16	16	17	18
Total Alkalinity			436	428	176	433	435	421	430
Chlorides			0.3	0.3	2.1	0.8	1.0	2	1.0
Sulfates			444	440	480	501	496	475	450
Total Phosphorus				0.09			0.07		
Nitrate Nitrogen			0	0	0	0	0	0	0
Ammonia Nitrogen				0.93			0.90		
Kjeldahl Nitrogen				1.26			0.97		
Total Residue			1151	1169	1107	1153	1141	1135	1197
Coliform Group - MPN/100 ml			5.1	<2.2		<2.2			<2.2

*Results expressed as mg/l except as noted.

Well - 8 The concentrations of the various chemical constituents determined during the quarter for this well were within the range of data established from past samples.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake)

Station: Well - 9

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	6.5	7	12	12	17	16	11	13	13
pH - units	7.2	7.0	7.1	6.9	6.9	7.0	7.0	6.9	7.2
Conductivity - µmhos/cm-25°C	1520	1589	1561	1659	1311	1337	1327	1310	1385
Total Hardness	680	650	662	685	651	648	625	640	645
Calcium Hardness	384	396	355	379	369	318	360	455	490
Sodium	46	40	41	44	43	44	43	43	51
Total Alkalinity	278	288	268	262	256	252	255	250	244
Chlorides	34	34	31	22	35	34	34	34	24
Sulfates	430	420	522	502	528	512	496	690	750
Total Phosphorus	0.06			0.04			0.04		
Nitrate Nitrogen	0.1	0.5	0.2	0.2	0	0	0.1	0.1	0.1
Ammonia Nitrogen	0.97			0.64			0.99		
Kjeldahl Nitrogen	1.15			1.43			2.61		
Total Residue	1072	10[illegible]	1083	1109	1083	1043	1061	1148	1084
Coliform Group - MPN/100 ml		o[illegible]	5.1			< 1			< 2.2

*Results expressed as mg/l except as noted.

Well - 9 Several constituents appear to have somewhat increased concentrations during the quarter. Calcium hardness, sulfates, chlorides and total residue had maximum values during either August or September. The cause of these changes is not known at this time. Water quality at this station has been related to Big Stone Lake quality in the past, but changes in pumping as well as changes in precipitation might account for the change.

COOLING POND (At plant intake structure)

Station: CP - 1

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	11	8	12	21	27.5	28	24	26	16
pH - units	7.5	7.6	7.2	7.9	7.7	7.8	7.7	7.9	7.9
Conductivity - µmhos/cm-25°C	2869	3420	2787	2661	2549	2570	2748	2756	2780
Total Hardness	1260	1311	1068	924	1010	1158	1168	1220	1170
Calcium Hardness	584	548	486	442	496	524	518	740	618
Sodium	234	235	187	159	161	179	200	196	240
Total Alkalinity	218	110	113	124	126	136	116	120	122
Chlorides	59	62	47	45	47	56	71	46	30
Sulfates	1440	1490	1290	980	1189	1320	1610	1470	1640
Total Phosphorus	0.69	0.57	0.11	0.10	0.07	0.06	0.15	0.01	0.11
Nitrate Nitrogen	0	0	0.0	0	0	0	0	0	0
Ammonia Nitrogen	0.12	0.10	0.19	0.25	0.34	0.83	0.56	0.32	0.36
Kjeldahl Nitrogen	0.33	0.49	2.13	2.63	1.05	1.00	1.69	0.50	2.15
Total Residue	2672	2860	2402	2066	2244	2459	2621	2696	2817
Total Suspended Matter	13	12	36	12	26	14	26	16	18
Dissolved Oxygen	10.4	10.3	8.6	7.4	6.6	7.1	9.2	7.8	7.4
Biochemical Oxygen Demand	3	4	7	3	3	4	4	6	3.8
Turbidity	1	1	1	3	3	2	1	2	5.8
Coliform Group - MPN/100 ml	95	old	50	old	80	100	15	25	1600
Fecal Coliforms - MPN/100 ml	<3	old	7	old	<3	<3	<5	<3	7

*Results expressed as mg/l except as noted.

CP - 1 A slight increase in salinity of the cooling pond water was noted during the quarter although maximum values were noted only for calcium hardness, sodium and sulfates in September. Although water was added to the pond this fall, slightly higher concentrations of some constituents might be expected this winter.

BIG STONE LAKE (at lake intake to pumping station)

Station: BSL - 1

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	1	2.5	2	13.5	22.5	24	23	19.8	15
pH - units	7.6	7.4	7.1	8.1	8.1	7.9	8.0	7.5	8.0
Conductivity - µmhos/cm-25°C	1660	1958	1289	1267	1170	1290	1196	1165	1280
Total Hardness	832	812	480	509	540	512	552	600	505
Calcium Hardness	417	422	247	258	252	250	269	430	
Sodium	88	95	42	47	53	57	61	64	
Total Alkalinity	211	216	149	134	149	129	147	170	174
Chlorides	35	34	19	20	22	31	22	30	10
Sulfates	752	740	408	468	486	544	550	604	
Total Phosphorus	0.31	0.17	0.17	0.18	0.16	0.17	0.18	0.14	0.20
Nitrate Nitrogen	0.01	0.40	0.67	0	0	0.03	0	0.07	0.10
Ammonia Nitrogen	2.6	2.6	2.2	0.14	0.86	0.67	1.41	1.38	0.48
Kjeldahl Nitrogen	4.1	3.3	2.8	2.4	1.54	1.34	2.96	1.75	1.95
Total Residue	1528	1539	905	956	997	1003	1130	1188	1164
Total Suspended Matter	2	5	42	19	35	20	24	28	41
Dissolved Oxygen	5.1	6.6	7.4	8.3	7.6	4.3	3.9	5.9	6.1
Biochemical Oxygen Demand	5	5	6	7	2	8	5	9	4.3
Turbidity	[illegible]	1	4	2	2	4	3	3	
Coliform Group - MPN/100 ml	10	old	50	old	30	5	O.G.	200	60
Fecal Coliforms - MPN/100 ml	7	old	7	old	3	<3	260	7	17

*Results expressed as mg/l except as noted.

BSL - 1 Concentrations of chemical constituents for the quarter were well within the range established by past data for Big Stone Lake. Compared to the summer quarter of 1976, the sodium, ammonia nitrogen and total residue concentrations were slightly higher in 1977. The lake water had heavy algae concentrations, and an offensive odor was noted in August and September. The missing data for September was the result of a change in analyst, and with the frequent repetitions of some tests, he simply ran out of sample.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Determination*	Sampling Dates - 1977								
	1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	0	0	3	14.5	21	24	23	18.5	16
pH - units	7.8	7.5	7.3	7.9	8.0	8.0	8.0	7.7	8.0
Conductivity - µmhos/cm-25°C	1601	2015	1134	1382	1120	1259	1301	1265	1243
Total Hardness	796	882	436	569	512	510	548	588	480
Calcium Hardness	465	540	278	360	320	318	265	326	428
Sodium	69	90	24	32	42	59	64	47	51
Total Alkalinity	408	430	166	236	260	272	155	255	236
Chlorides	61	87	14	18	34	64	21	80	35
Sulfates	383	472	318	398	320	334	568	412	370
Total Phosphorus	0.07	0.10	0.10	0.52	0.38	0.30	0.27	0.09	0.27
Nitrate Nitrogen	0.0	0.3	0.6	0	0	0	0	0	0.0
Ammonia Nitrogen	0.67	0.66	1.26	0.27	0.19	0.16	0.45	0.18	0.28
Kjeldahl Nitrogen	0.75	1.28	2.06	2.23	0.95	0.64	1.34	0.60	1.25
Total Residue	1178	1516	764	1108	864	880	1069	1052	936
Total Suspended Matter	16	16	39	141	30	26	19	24	1.0
Dissolved Oxygen	7.8	9.6	10.4	3.1	5.2	6.4	4.6	5.0	5.1
Biochemical Oxygen Demand	2	8	6	6	2	4	3	5	3.0
Turbidity	1	1	2	5	4	3	1	2	5.8
Coliform Group - MPN/100 ml	35	old	50	old	200	530	200	80	50
Fecal Coliforms - MPN/100 ml	3	old	10	old	163	23	23	63	13

*Results expressed as mg/l except as noted.

M - 1 The water quality of the Minnesota River is highly variable depending upon whether the major portion of the flow is from Big Stone Lake or the Whetstone River. During the quarter, the concentrations of the chemical constituents were within the range established by past data.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Station: W - 1

Determination*	Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C	0	1	3	14	19.5	22	21	17.8	15
pH - units	7.5	7.6	7.7	8.0	7.4	7.3	7.6	7.7	7.5
Conductivity - µmhos/cm-25°C	1566	1465	944	1261	1196	1337	1112	1000	1217
Total Hardness	713	606	398	568	530	532	486	530	515
Calcium Hardness	449	430	258	388	329	351	292	393	360
Sodium	44	40	23	32	42	59	39	50	59
Total Alkalinity	394	341	154	229	280	296	292	244	298
Chlorides	20	35	13	19	35	70	22	31	51
Sulfates	328	248	326	408	330	336	306	325	250
Total Phosphorus	0.14	0.08	0.08	0.22	0.27	0.21	0.22	0.11	0.58
Nitrate Nitrogen	0.1	0.4	0.7	0	0	0	0	0	0
Ammonia Nitrogen	0.96	0.64	0.48	0.13	0.24	0.28	0.22	0.19	0.31
Kjeldahl Nitrogen	1.05	1.53	2.52	1.65	1.02	0.87	2.50	0.75	0.90
Total Residue	1078	993	700	933	862	963	886	954	873
Total Suspended Matter	14	9	36	4	28	32	34	26	3
Dissolved Oxygen	6.0	7.3	10.7	8.7	6.0	4.6	4.2	5.9	4.6
Biochemical Oxygen Demand	2	5	5	2	5	10	6	5	1.2
Turbidity	4	4	4	1	2	3	4	4	8.5
Coliform Group - MPN/100 ml	195	old	170	old	120	2500	50	500	430
Fecal Coliforms - MPN/100 ml	<10	old	13	old	97	500	10	100	130

*Results expressed as mg/l except as noted.

W - 1 and W - 2 Flow for the Whetstone River was low during the summer as noted on the field sheets for each of the three months. Compared to the same period in 1976, the chemical data overall were quite similar although sodium concentrations were slightly higher and total residue was slightly lower this year. Dissolved oxygen concentrations at Station W - 1, the downstream station, were also somewhat lower than would be expected. Concentrations of the various constituents, however, fell within the range established by past data.

WHETSTONE RIVER (On county road 1½ miles south of plant site)

Station: W - 2

Determination*		Sampling Dates - 1977 1/25	2/17	3/29	4/26	5/23	6/29	7/27	8/24	9/21
Temperature - °C			0	4	13.5	18.5	21	21	17.2	14
pH - units			7.7	7.4	7.9	8.0	8.1	7.9	7.6	8.0
Conductivity - µmhos/cm-25°C	NO SAMPLE		1468	962	1273	1191	1222	1049	1072	1196
Total Hardness			568	384	561	510	515	459	501	500
Calcium Hardness			378	242	372	312	321	273	358	375
Sodium			64	20	33	50	47	38	63	74
Total Alkalinity			356	156	230	278	280	286	235	292
Chlorides			55	12	19	41	61	17	29	16
Sulfates			282	264	376	310	340	242	355	360
Total Phosphorus			0.36	0.36	0.22	0.23	0.25	0.20	0.09	0.33
Nitrate Nitrogen			0.6	0.7	0	0	0	0	0	0
Ammonia Nitrogen			1.50	0.52	0.12	0.23	0.18	0.24	0.19	0.35
Kjeldahl Nitrogen			2.07	2.05	1.65	0.98	0.76	2.53	2.4	1.45
Total Residue			1004	666	937	858	983	823	906	891
Total Suspended Matter			26	21	2	27	24	30	28	0
Dissolved Oxygen			8.3	10.2	8.1	5.0	5.6	5.0	5.8	5.1
Biochemical Oxygen Demand			4	3	3	4	2	3	9	4
Turbidity			2	4	1	3	3	5	3	9
Coliform Group - MPN/100 ml			old	200	old	310	680	O.G.	380	480
Fecal Coliforms - MPN/100 ml			old	33	old		13	73	87	93

*Results expressed as mg/l except as noted.

Elevation of the Groundwater*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

Date 1977	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
January 25	1026.07		1034.59	1059.98	1051.19	970.49
February 17	1026.57		1034.67	1059.98	1051.77	971.08
March 29	1026.45		1035.00	1059.56	1053.36	971.41
April 26	1026.65		1035.67	1060.90	1052.44	971.74
May 23	1026.15		1035.67	1061.73	1051.61	971.49
June 29	1026.40		1035.00	1061.23	1052.77	971.66
July 27	1026.24		1035.00	1060.56	1050.19	
August 24	1025.90	1055.24	1028.25	1061.06	1052.52	
September 21	1026.07	1055.24	1031.25	1059.48	1053.11	

The water level at Well 2 was about the same as it was about seven months ago when the air line was plugged. The air line at Well 7 is broken and was to be repaired when the well was to be cleaned this fall. In August, an unusual drop in the water level was noted at Well 3, but the water level has risen since that time.

At Well Points Along County Road North of Pond:

1977	A	B	C	D	E
January 25	1102.46	1107.96	1106.07	1108.02	1105.77
February 17		1109.71	1106.57	1108.36	1106.94
March 29	1114.13	1113.96	1111.82	1110.94	1109.19
April 26	1112.55	1113.12	1111.65	1110.86	1108.77
May 23	1110.96	1112.71	1111.28	1110.65	1108.73
June 29	1108.36	1111.21	1109.40	1110.44	1108.86
July 27	1106.77	1109.25	1108.32	1110.03	1106.94
August 24	1107.05	1111.62	1109.82	1110.27	1107.77
September 21	1106.63	1111.46	1109.74	1110.02	1107.77

With increased rainfall in 1977, the water level at the well points did not drop as much during the summer months as has been noted in past years. In September this year, the water level at the well points was about 3 feet higher than it was last year at the same time.

*All elevations are above "sea level datum."

215 South Cascade Street

Otter Tail
POWER COMPANY

Fergus Falls, Minnesota 56537

Phone 218-736-5410

March 15, 1977

RECEIVED
MAR 17 1977
DEPT. OF NATURAL
RESOURCE DEVELOPMENT

Mr. Gerald Seinwill
Director, Division of Waters
Minnesota Department of Natural Resources
Centennial Office Building
St. Paul, MN 55155

Mr. Vern Butler, Secretary
Department of Natural Resources Development
Joe Foss Building
Pierre, SD 57501

Subject: Appropriation of Water
From Big Stone Lake

Gentlemen:

With the intention of keeping this letter as brief and concise as possible, it is respectfully suggested that you make reference to the following: my letter dated September 21, 1976, requesting an emergency allocation of water from Big Stone Lake; Permit Number PA 70-1182 issued February 25, 1971, by the Minnesota Department of Natural Resources; and Permit Numbers 1766-3 and 1983-3 issued July 23, 1970, and June 13, 1973, respectively, by the South Dakota Resources Commission.

Extreme drought conditions along with high temperature, high winds and low humidity had resulted in a shortage of water available for operation of the Big Stone Power Plant. Our request for an emergency allocation of up to 1000 acre-feet of water from Big Stone Lake received your very prompt attention and favorable action for which we are most appreciative. That allocation - 492 acre-feet taken in October 1976 and the remainder taken in February 1977 - enabled the plant to continue operation at near full capacity throughout the winter period when energy supply was a critical factor in most of the United States.

We had anticipated that spring runoff would be sufficient to increase the lake level to an elevation of 966 feet or more which would allow us to refill our cooling pond under terms of the existing permits. Although the level of the Big Stone Lake has increased steadily within the last week (being at 965.7 as of 3/15/77 compared to a low of approximately 964.8 in January of this year) we are not altogether certain that the increase will be sufficient to allow us to fill our cooling pond to the level which would be required to carry through another year if we should experience climatic conditions comparable to the summer of 1976.

Otter Tail
POWER COMPANY

Mr. Gerald Seinwill
Mr. Vern Butler

March 15, 1977

Request

Therefore, we respectfully request that permission be granted to appropriate up to 2500 acre-feet of water from Big Stone Lake when the lake level is above 965.0 prior to May 1, 1977. (This amount, 2500 acre-feet, is equivalent to less than 2.5 inches off the surface of the lake.)

This request is made with the understanding that flow and level conditions may subsequently eliminate the necessity for this special permission to pump. However, the uncertainty of the situation has prompted us to make this request as a matter of insuring that customers of the owners of the plant will be assured of the continued availability of adequate supplies of electrical energy to the best of our ability to provide it.

Your prompt consideration of this matter is most appreciated.

If more information or clarification is required please feel free to contact me or Mr. Verlin Menze. Our telephone number is (218)736-5411.

Yours truly,

W. L. Doebbert
Manager of Production

WLD:VM:ckk

STATE OF MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

File 70-1182, Tail Water
1768-3

DNR INFORMATION
(612) 296-6157

April 4, 1977

RECEIVED
APR 7 1977
DEPT. OF NATURAL RESOURCE DEVELOPMENT

W. L. Doebbert
Manager of Production
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, MN 56537

Dear Mr. Doebbert:

PERMIT 70-1182, BIG STONE LAKE

This will acknowledge your March 15, 1977 letter requesting an emergency allocation of water from Big Stone Lake under DNR permit no. 70-1182.

Your request to appropriate up to 2500 acre-feet of water from Big Stone Lake when the lake level is above elevation 965.0 prior to May 1, 1977 is hereby approved provided that:

1) You comply with all restrictions that the South Dakota Department of Natural Resources Development may impose on such appropriation.

2) You record, on a daily basis, the total volume of water appropriated and the mean elevation of the lake. Such records shall be forwarded to this office no later than May 13, 1977.

Mr. Verlin Menze of your company has reported to us that the elevation of the lake was above 966.0 as of March 31, 1977. We request that you appropriate water at maximum system capacity whenever the elevation of the lake is above 966.0 during the month of April.

Enclosed is a copy of our September 30, 1976 letter granting a similar emergency request as a reminder to Otter Tail Power to initiate long-range planning in regards to your water supply problem during drought periods. Again, we invite your comment on this.

Very truly yours,

DIVISION OF WATERS

Gerald D. Seinwill, Director

GDS:bss
Encs.
cc: Region IV Hydrologist

John Larson, Area Fisheries Manager

Mr. Vern Butler, Secretary
Dept. of Natural Resources Development

AN EQUAL OPPORTUNITY EMPLOYER

April 6, 1977

W.L. Doebbert
Manager of Production
Otter Tail Power Company
215 South Cascade Street
Fergus Falls, Minnesota 56537

Dear Mr. Doebbert:

This will acknowledge your request to withdraw up to 2500 acre feet of water from Big Stone Lake prior to May 1, 1977.

March 23, 1977, the Water Rights Commission passed a motion which authorized Otter Tail Power Company to withdraw up to 2500 acre feet from Big Stone Lake prior to May 1, 1977.

Withdrawals are to be completed, if possible, by April 15, 1977 as requested by the Game, Fish and Parks Department. If withdrawals are not completed by April 15th, area Game, Fish and Parks representatives and this office should be contacted.

Very truly yours,

JOHN HATCH, Chief Engineer
Water Rights Commission

JH/bw

215 South Cascade Street

Otter Tail
POWER COMPANY

Fergus Falls, Minnesota 56537

Phone 218-736-5411

April 14, 1977

Mr. Gerald Seinwill
Director, Division of Waters
Minnesota Department of Natural Resources
Centennial Office Building
St. Paul, MN 55155

Mr. Vern Butler, Secretary
Department of Natural Resources Development
Joe Foss Building
Pierre, SD 57501

Subject: Appropriation of Water
From Big Stone Lake
MN Permit #PA 70-1182
SD Permits #1768-3 and 1983-3

Gentlemen:

Your individual letters of affirmative response to our March 15, 1977, request for permission to appropriate up to 2500 acre-feet of water from Big Stone Lake when the lake level is above elevation 965.0 prior to May 1, 1977, have been received and are gratefully acknowledged.

At the time our request was made, it appeared that the spring runoff would not be adequate to increase the lake level above the 966.0 elevation required to permit pumping under the terms of our existing permit. However, subsequent to our request, rather substantial amounts of precipitation have occurred in the area, resulting in a lake level in excess of 966.0 elevation. (At the date of this letter the level is 966.5.) Consequently, pumping has been conducted under the terms and conditions of the original permits, including the limitations on rates of withdrawal.

Inasmuch as we have complied with the pumping limitations stipulated in the original permits, we assume that the recording and reporting outlined in item (2) of Mr. Seinwill's letter will not be necessary. The normal reporting procedure will be followed, however.

We anticipate the cooling pond will be filled to its maximum level by April 20, 1977. Pumping will then be terminated until on or about April 28 at which time we expect to resume pumping long enough to "top off" the pond level just prior to the 967.0 lake elevation requirement that becomes effective on May 1.

Otter Tail
POWER COMPANY

In the event the lake level should be at or above 967.0 at any time during the May 1 through September 30 period or above 966.0 after October 1, we would continue to pump as may be necessary to keep the cooling pond near its maximum level. If lake levels will not be adequate to allow pumping under the above conditions we will again be forced to request special permission to appropriate sufficient water to allow continuation of plant operation throughout the winter. However, should we encounter normal precipitation this summer it is hoped that additional requests for special permission can be avoided.

As a matter of information, Otter Tail Power has been involved for some time in long-range planning regarding water supply during extended drought periods. This is a difficult problem to solve and although some alternatives are still being explored no immediate solutions are apparent. We are aware of local sentiment favoring the maintenance of a higher control level on Big Stone Lake, perhaps to an elevation of 968.0. If this proposal, which would add some 13,000 acre-feet to the storage capacity of the lake, should ever develop to the point of serious consideration we would very likely give it our endorsement. Meanwhile, efforts continue in the investigation of additional sources of supply.

Your prompt, courteous, and favorable actions on our various requests during this difficult period are very, very much appreciated. You and the members of your staff have been most understanding of our situation, for which we extend our sincere thanks.

Yours truly,

Verlin Menze for
W. L. Doebbert
Manager of Production

WLD:VHM:ckk

DORAND ENGINEERING, INC.

James N. Dornbush, DSc
Dwayne A. Rollag, PhD

324 ELM AVENUE • BROOKINGS, SOUTH DAKOTA 57006

605/692-6681

November 15, 1978

Otter Tail Power Company
Northwestern Public Service Company
Montana-Dakota Utilities Company

Gentlemen:

The following report covers the third quarter of the seventh year of the Water Monitoring Program for the Big Stone Plant representing the data collected during the months of July through September, 1978.

1. Samples were collected on July 19, August 22 and September 20, 1978. Although 9 wells and 5 surface water sampling stations were to be sampled, pumps at two of the sampling stations (Wells 2 and 3) were inoperative and could not be sampled. The locations of the sampling stations are shown on the enclosed map.

2. The results of the analyses along with previous results for 1978 are included in the enclosed tables along with commentary notations concerning sampling or quality changes where applicable.

3. Groundwater elevations measured at the well points north of the cooling pond and at five wells as determined by the air line readings are included in the enclosed table.

4. As per the companies' accepted water monitoring option, samples were also collected on August 22, 1978, from seven wells and the plant water supply for analysis of chemicals included in "The National Interim Primary Drinking Water Regulations." Samples could not be collected from Wells 2 and 3. The results of the analyses as performed by the State Department of Health Laboratory are included in the enclosed table. It will be noted that the concentrations in the plant water supply were far below the maximum allowable contaminant level as were analyses for most wells. Three wells had individual concentrations that exceeded one of the standards, and these wells have been sampled for a recheck of those constituents.

If there are any questions concerning this report, please contact us. It might be advantageous to have a meeting in the near future to discuss aspects about the water monitoring program, particularly in light of the difficulties with Wells 2 and 3.

Sincerely,

James N. Dornbush, P.E.

JND:mfd
Enclosures

RECEIVED
DEC 11 1978
DEPT. OF NATURAL
RESOURCE DEVELOPMENT

PROGRESS REPORT
FOR THE THIRD QUARTER
1978 WATER MONITORING PROGRAM

BIG STONE POWER PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

November, 1977

Dorand Engineering, Inc.
Brookings, South Dakota

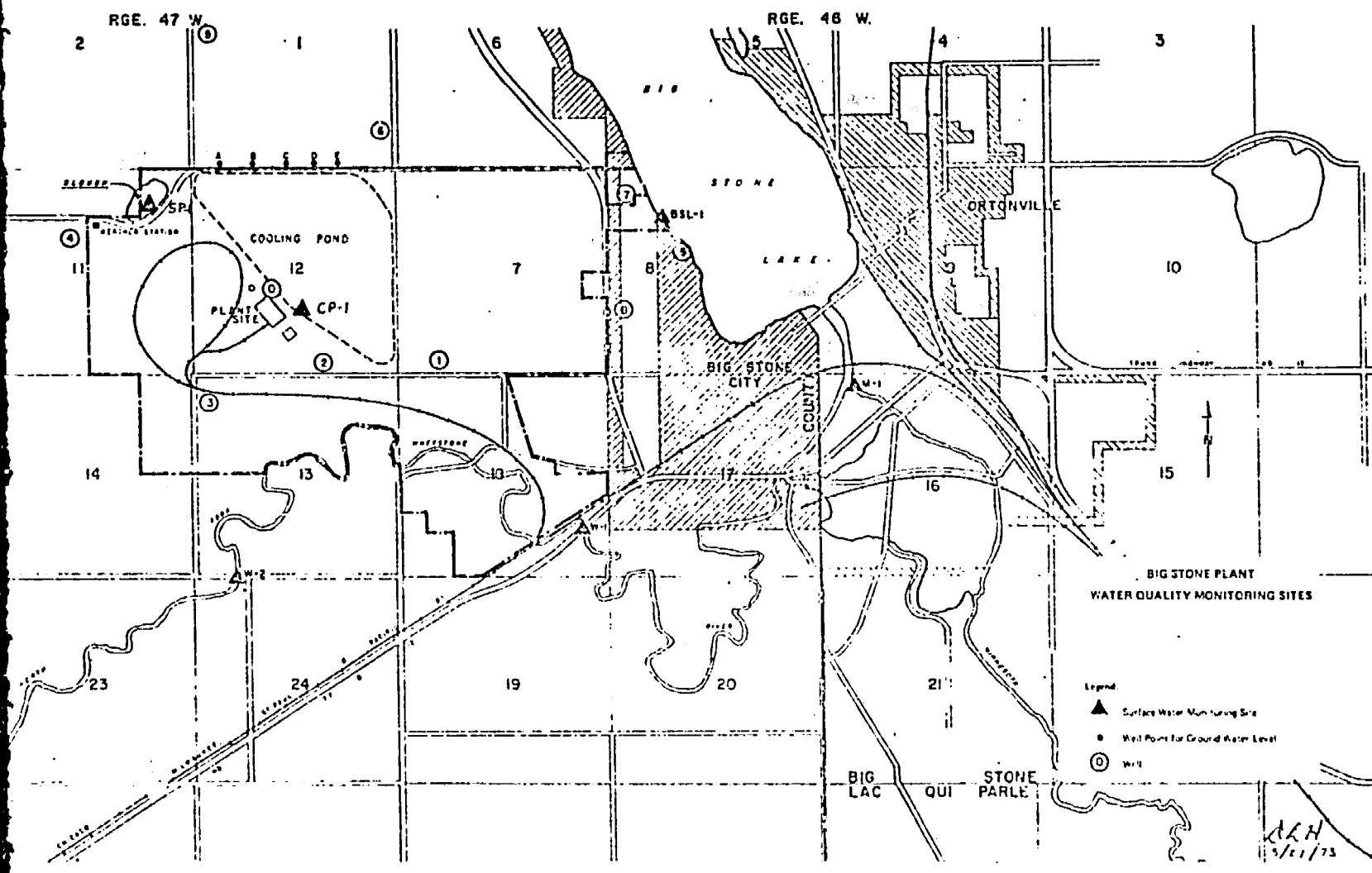


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

Drinking Water Supply Chemical Analysis Data
Big Stone Power Plant Area
August 22, 1978

Determination	Maximum Allowable Contaminant Level*	Concentration - units comparable to maximum contaminant level									
		Plant Supply	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7	Well 8	Well 9
Fluoride	2.4 mg/l	0.10	0.24			0.22	0.23	0.26	0.22	0.26	0.76
Nitrate as N	10 mg/l	0.1	5.5			1.4	1.3	< 0.1	< 0.1	< 0.1	0.6
Arsenic	50 µg/l	<1.0	<1.0			<1.0	1.0	157**	5.7	<1.0	<1.0
Barium	1000 µg/l	< 20	32			45	36	20	36	34	56
Cadmium	10 µg/l	1.2	8			14**	7.0	4.5	9.7	5.5	3.5
Chromium	50 µg/l	< 10	< 10			< 10	<10	< 10	11	< 10	< 10
Lead	50 µg/l	4.4	3.1			5.4	2.1	2.8	140**	2.4	1.2
Mercury	2 µg/l	< 0.20	0.51			< 0.20	< 0.20	0.29	0.53	0.20	< 0.20
Selenium	10 µg/l	< 1.0	<1.0			< 1.0	< 1.0	< 1.0	<1.0	1.0	< 1.0
Silver	50 µg/l	2.0	22			11	10	8.0	11	17	6.5

*Except for Nitrate and Fluoride (both in mg/l), the numbers denote the maximum contaminant levels in micrograms/l (µg/l) as set forth by the Federal Drinking Water Standards.

**Measured concentration exceeds maximum allowable contaminant level. Recheck samples collected.

Station: CP - 1

COOLING POND (At plant intake structure)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	11.2	8.7	16	11.7	25.0	28.5	30	26.5	14.2
pH - units	7.7	8.0	6.7	8.1	8.3	7.3	8.1	7.9	8.3
Conductivity - µmhos/cm-25°C	2203	2720	2620	2287	2450	2370	2555	2845	2460
Total Hardness	1095	1135	1181	1016	922	1028	1025	1130	1180
Calcium Hardness	650	545	600	510	502	526	500	530	545
Sodium	190	155	210	165	153	133	144	203	205
Total Alkalinity	136	138	124	135	142	129	135	134	133
Chlorides	53	55	57	50	52	52	52	59	58
Sulfates	1200	1150	1350	940	980	1200	1120	1310	1340
Total Phosphorus	0.04	0.04	0.05	0.11	0.03	0.03	0.03	0.06	0.04
Nitrate Nitrogen	0.08	0.07	0.02	0.06	0.02	0	0.01	0.03	0
Ammonia Nitrogen	0.14	0.10	0.10	0.18	0.22	0.10	0.12	0.11	0.10
Kjeldahl Nitrogen	1.50	1.45	1.55	1.55	1.45	1.8	1.6	1.4	1.2
Total Residue	2218	2265	2319	2049	1976	2167	2225	2435	2475
Total Suspended Matter	6	8	32	65	19	17	15	30	30
Dissolved Oxygen	11.6	11.4	8.7	8.8	8.6	7.4	7.0	7.3	8.3
Biochemical Oxygen Demand	5.5	3.4	2.2	6.0	5.8	3.3	3.0	5.3	2.5
Turbidity	5.6	3.3	8.3	12	6.2	4.8	4.6	6.5	6.4
Coliform Group - MPN/100 ml	< 5	55	< 5		old	4300	450	650	1200
Fecal Coliforms - MPN/100 ml	< 3	33	3		old	2	27	130	< 3

*Results expressed as mg/l except as noted.

Cooling Pond - Although concentrations generally increased during the quarter, the overall quality of the water in the pond was substantially better than during a comparable period in 1977. The sulfates concentration for June is now reported as 1200 after a recheck following the last quarterly report. Maximum concentrations did not occur during the quarter.

BIG STONE LAKE (at lake intake to pumping station)

Station: BSL - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/29	8/22	9/20
Temperature - °C	2.3	2.6	2.5	3.0	21.0	24.1	26.5	21.9	16.3
pH - units	7.5	7.8	7.3	7.9	8.1	8.4	7.9	8.6	8.6
Conductivity - µmhos/cm-25°C	1322	1835	320	973	1000	1082	1032	1082	1017
Total Hardness	810	850	119	449	454	476	445	443	451
Calcium Hardness	520	465	91	350	268	260	233	221	218
Sodium	87	88	10	41	51	40	44	48	47
Total Alkalinity	243	238	90	140	162	169	164	153	167
Chlorides	33	34	7.1	18	18	10	21	20	16
Sulfates	580	800	84	376	396	424	354	342	354
Total Phosphorus	0.13	0.21	0.47	0.17	0.05	0.1	0.12	0.17	0.16
Nitrate Nitrogen	0.33	0.28	1.12	0.56	0.08	0.04	0.02	0.07	0.02
Ammonia Nitrogen	0.37	0.34	1.51	0.09	0.30	0.10	0.25	0.36	0.28
Kjeldahl Nitrogen	1.35	1.50	2.60	1.40	0.95	1.2	1.3	1.8	1.1
Total Residue	1356	1453	268	871	833	888	800	912	830
Total Suspended Matter	9	33	37	173	14	19	22	42	23
Dissolved Oxygen	10.7	10.4	8.7	11.7	7.5	8.4	9.1	8.1	7.7
Biochemical Oxygen Demand	5.5	4.0	5.0	7.5	3.0	2.4	6.0	10.3	4.9
Turbidity	2.5	6.5	5.7	43	5.0	10.5	8.4	14.3	12.6
Coliform Group - MPN/100 ml	< 5	300	550		old	1400	200	50	55
Fecal Coliforms - MPN/100 ml	< 3	< 3	< 3		old	20	7	3	3

*Results expressed as mg/l except as noted.

Big Stone Lake - Concentrations of chemical constituents were substantially lower during the 1978 summer compared to 1977. For example, total residue levels averaged about 25% lower than in 1977. The higher pH for the August and September samples was probably caused by algae. The concentrations during the quarter were easily within the range established by past data and many concentrations were comparable to minimum values of 1977.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Determination*	Sampling Dates - 1978								
	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	0	0	3.0	3.1	21.4	24.9	26	22.3	16.8
pH - units	7.4	6.7	7.7	7.8	8.0	8.4	8.4	8.3	8.5
Conductivity - µmhos/cm-25°C	1300	1470	375	986	1110	1004	1072	1152	1017
Total Hardness	730	705	162	426	502	472	446	500	459
Calcium Hardness	505	445	111	325	306	288	260	299	227
Sodium	72	64	13	43	47	37	44	41	48
Total Alkalinity	367	349	116	136	210	223	171	284	184
Chlorides	45	46	5.7	18	7.6	8.4	10	28	12
Sulfates	420	330	104	386	360	422	362	302	340
Total Phosphorus	0.32	0.40	0.74	0.58	0.11	0.24	0.17	0.25	0.22
Nitrate Nitrogen	0.95	0.67	1.05	0.57	0.08	0.03	0.18	0.14	0.01
Ammonia Nitrogen	1.13	1.33	0.95	0.33	0.31	0.12	0.21	0.18	0.42
Kjeldahl Nitrogen	1.35	1.55	2.15	1.70	0.90	1.4	1.5	0.4	1.3
Total Residue	1158	1072	632	1007	835	819	800	887	834
Total Suspended Matter	8	3	350	312	30	39	17	31	29
Dissolved Oxygen	9.6	10	9.9	11.5	6.0	6.1	8.0	5.9	7.8
Biochemical Oxygen Demand	8.2	4.0	6.8	4.8	4.3	4.7	7.8	5.6	11.3
Turbidity	5.1	5.2	40	43	9.0	11.4	6.8	8.8	13.1
Coliform Group - MPN/100 ml	75	1100	4300		old	4600	500	130	330
Fecal Coliforms - MPN/100 ml	10	10	50		old	400	20	23	110

*Results expressed as mg/l except as noted.

Minnesota River - During the quarter, the concentrations of chemical constituents were well within the range established by past data. Flows from the dam were high in July as would occur with a runoff condition from the Whetstone River, but water quality was more comparable to Big Stone Lake quality than that of the Whetstone.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Station: W - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	0.5	0	4.0	4.8	21.2	23.1	25.2	21.2	14.3
pH - units	7.5	7.7	7.3	8.0	8.1	8.2	8.2	8.1	8.0
Conductivity - µmhos/cm-25°C	1285	1490	380	940	1170	1047	1258	1142	1017
Total Hardness	715	700	198	467	686	508	486	509	452
Calcium Hardness	500	450	140	319	370	364	322	301	280
Sodium	73	66	11	29	44	36	33	41	40
Total Alkalinity	368	345	107	240	291	262	320	298	259
Chlorides	45	45	6.1	13	9.6	10	20	28	28
Sulfates	375	336	120	396	454	329	284	269	260
Total Phosphorus	0.38	0.54	0.62	0.32	0.14	0.20	0.25	0.26	0.21
Nitrate Nitrogen	0.97	0.69	1.03	0.60	0.07	0.05	0.03	0.06	0.02
Ammonia Nitrogen	1.16	1.60	1.02	0.27	0.16	0.10	0.17	0.27	0.16
Kjeldahl Nitrogen	1.45	1.60	2.20	0.90	0.80	1.2	1.1	0.7	0.4
Total Residue	1140	1052	517	726	907	916	866	917	765
Total Suspended Matter	7	6	250	36	15	14	22	36	18
Dissolved Oxygen	9.6	9.6	10.0	10.2	7.2	6.1	5.8	6.3	8.4
Biochemical Oxygen Demand	3.7	2.7	6.1	13.1	4.1	3.9	3.5	5.1	3.5
Turbidity	7.3	8.8	55	11	6.4	7.5	12	11.7	7.1
Coliform Group - MPN/100 ml	200	2400	1400		old	20000	10000	28000	1500
Fecal Coliforms - MPN/100 ml	13	80	20		old	3800	180	70	160

*Results expressed as mg/l except as noted.

W-1 and W-2 - Flows in the Whetstone River were generally low except in July when flows were higher than normal. Quality at the two stations was quite comparable although suspended and total residues were slightly higher at station W-1. The greater slope of the river at W-1 and, consequently, higher velocity would be conducive to higher suspended solids and total coliform concentrations. Concentrations of all constituents fell within the range of past data.

Station: W - 2

WHETSTONE RIVER (On county road 1½ miles south of plant site)

Determination*	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
			Sampling Dates - 1978						
Temperature - °C			3.0	4.1	19.8	22.5	24.2	21.8	15
pH - units			7.1	8.0	8.0	8.2	8.0	7.9	8.0
Conductivity - µmhos/cm-25°C			360	944	1160	1157	1243	1142	1027
Total Hardness			151	490	548	518	518	507	460
Calcium Hardness			106	360	368	330	322	309	283
Sodium			9.8	25	44	37	37	38	43
Total Alkalinity			113	236	285	264	312	295	257
Chlorides			5.8	13	5.0	12	23	25	30
Sulfates			90	286	364	338	282	276	252
Total Phosphorus			0.57	0.18	0.11	0.21	0.24	0.24	0.21
Nitrate Nitrogen			1.06	0.74	0.07	0.05	0.09	0.04	0.03
Ammonia Nitrogen			1.00	0.31	0.19	0.08	0.10	0.27	0.21
Kjeldahl Nitrogen			2.10	1.05	1.35	1.1	1.1	0.7	0.5
Total Residue			466	693	878	887	838	883	756
Total Suspended Matter			225	33	11	28	22	13	15
Dissolved Oxygen			9.8	10.5	6.72	5.7	5.3	6.5	7.3
Biochemical Oxygen Demand			6.1	1.8	1.7	2.1	4.6	4.4	2.6
Turbidity			50	15	5.3	8.9	6.2	12.0	5.8
Coliform Group - MPN/100 ml			3300		old	1700	1300	600	2200
Fecal Coliforms - MPN/100 ml			67		old	320	110	60	330

NO SAMPLE

NO SAMPLE

*Results expressed as mg/l except as noted.

DERALD HAY FARM (SW ¼, Sec. 7)(Southeast of cooling pond on plant site)

Station: Well - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	10.0	9.0	9.5	8.9	11.1	10.4	11.0	9.9	9.7
pH - units	7.0	7.0	7.0	7.0	7.3	7.0	6.9	6.9	7.0
Conductivity - µmhos/cm-25°C	1768	2150	1950	1836	2080	1563	1964	1994	1854
Total Hardness	1250	1610	1188	1184	1536	1168	1190	1249	1245
Calcium Hardness	950	715	679	685	778	886	796	818	845
Sodium	20	22	20	23	23	13	15	17	17
Total Alkalinity	398	386	360	350	373	414	425	418	407
Chlorides	21.8	30	44	73	124	14	6.7	20	7.0
Sulfates	740	665	735	650	645	775	790	845	830
Total Phosphorus	0.02			0.02			0.14		
Nitrate Nitrogen	9.80	15.6	24	37	51	2.8	1.3	7.9	1.38
Ammonia Nitrogen	0.16			0.09			0.34		
Kjeldahl Nitrogen	0.43			0.45			0.40		
Total Residue	1670	1733	1695	1621	1927	1815	1772	1820	1824
Coliform Group - MPN/100 ml								<1	
Iron									

*Results expressed as mg/l except as noted.

Well 1 - The August sample had higher than normal concentrations of chlorides and nitrates. Higher concentrations of these constituents were first noted this spring when the quality apparently changed. Overall, the concentrations of constituents was within the range established by past data.

Station: Well - 2

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	8.8	8.0	9.0	8.6	13	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE
pH - units	6.8	6.7	6.7	6.8	7.0				
Conductivity - µmhos/cm-25°C	2633	3240	2935	2885	2780				
Total Hardness	2105	2195	2119	2022	1992				
Calcium Hardness	1530	1485	1495	1491	1374				
Sodium	25	29	29	30	28				
Total Alkalinity	490	465	467	467	541				
Chlorides	45	45	45	44	44				
Sulfates	1310	1280	1580	1510	1340				
Total Phosphorus	0.20			0.14					
Nitrate Nitrogen	0.27	0.44	0.29	0.29	0.07				
Ammonia Nitrogen	1.30			1.50					
Kjeldahl Nitrogen	3.10			1.55					
Total Residue	2861	2929	2891	2934	2876				
Coliform Group - MPN/100 ml									
Iron									

*Results expressed as mg/l except as noted.

Well 2 - The curbing of the well failed before the June sample. Although company personnel apparently worked on the pump and removed the air line which was plugged, the pump has not operated so that a sample can be collected. Well 2 is the closest to the ponds and represents an important location in the monitoring program.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Determination*	1/24	Sampling Dates - 1978 2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	8.0								
pH - units	7.6								
Conductivity - µmhos/cm-25°C	787	NO	NO	NO	NO	NO	NO	NO	NO
Total Hardness	430								
Calcium Hardness	195	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE
Sodium	41								
Total Alkalinity	228								
Chlorides	3.3								
Sulfates	213								
Total Phosphorus	.03								
Nitrate Nitrogen	.02								
Ammonia Nitrogen	3.26								
Kjeldahl Nitrogen	3.45								
Total Residue	522								
Coliform Group - MPN/100 ml									
Iron									

*Results expressed as mg/l except as noted.

Well 3 - The pump has been removed from this well and consequently samples cannot be collected. Water level readings have been collected on sampling dates.

Station: Well - 4

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	5.0	5.5	6.8	6.2	10.4	10.9	15.7	13.6	13.2
pH - units	7.9	6.9	6.9	6.9	6.9	7.0	6.9	6.9	7.0
Conductivity - µmhos/cm-25°C	2308	2740	2560	2544	2270	2415	2666	2685	2455
Total Hardness	1700	1735	1705	1692	1654	1658	1628	1630	1641
Calcium Hardness	1205	1205	1187	1280	1118	1152	1110	1101	1111
Sodium	22	22	22	22	22	18	22	22	22
Total Alkalinity	480	478	475	474	517	502	503	500	478
Chlorides	45	46	47	46	48	47	48	50	49
Sulfates	1000	1020	1220	1160	900	1050	1000	1120	1100
Total Phosphorus	0.04			0.06			0.02		
Nitrate Nitrogen	0	0.01	0	0	0.03	0.12	0.04	0.4	0.4
Ammonia Nitrogen	0.93	0.91		0.55			0.43		
Kjeldahl Nitrogen	0.55	0.65		.5			0.43		
Total Residue	2295	2390	2346	2366	2322	2531	2413	2388	2443
Coliform Group - MPN/100 ml			5.1		old			2.2	
Iron									

*Results expressed as mg/l except as noted.

Well 4 - The results of the analyses during the quarter fell within the range established by past data. Alkalinity values were still in the higher ranges in July and August after having a new maximum value in May.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site)

Station: Well - 5

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	9.6	8.3	8.0	7.0	10.8	11.5	15.7	12.3	10.6
pH - units	7.0	7.1	7.1	7.1	7.2	7.0	7.1	7.0	7.2
Conductivity - µmhos/cm-25°C	1427	1657	1625	1615	1650	1643	1699	1523	1653
Total Hardness	990	960	985	968	996	936	943	941	886
Calcium Hardness	625	595	741	601	560	576	569	562	613
Sodium	21	20	19	24	23	18	20	21	21
Total Alkalinity	462	448	454	456	475	460	475	472	456
Chlorides	5.2	5.6	5.2	9.7	10	10	5	4.9	5.5
Sulfates	690	500	540	495	470	545	495	580	515
Total Phosphorus	0.04			0.04			0.03		
Nitrate Nitrogen	1.22	0.84	1.24	6.34	6.74	4.8	1.24	1.24	1.84
Ammonia Nitrogen	0.46			0.36			0.36		
Kjeldahl Nitrogen	0.55			0.50			0.36		
Total Residue	1241	1276	1271	1317	1256	1374	1326	1398	1355
Coliform Group - MPN/100 ml			<2.2		old			<1	
Iron									

*Results expressed as mg/l except as noted.

Well 5 - The concentrations of the various chemical constituents determined for this well during the quarter were within the range established by past samples. The water quality in August seemed to be quite comparable to the other samples although the depth reading appeared unusually low at that time.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond)

Station: Well - 6

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	6.2	7.0	7.2	7.3	9.0	11.3	14.0	13.0	12.1
pH - units	7.1	7.0	7.0	7.0	7.2	7.1	7.1	7.1	7.3
Conductivity - µmhos/cm-25°C	1238	1425	1390	1275	1230	1248	1493	1292	1298
Total Hardness	825	825	800	802	750	746	745	740	787
Calcium Hardness	500	485	553	482	452	458	446	436	382
Sodium	20	19	20	20	18	15	18	20	19
Total Alkalinity	465	470	464	462	452	460	477	475	456
Chlorides	3.3	2.5	3.6	3.5	6.2	4.6	2.5	2.2	2.5
Sulfates	400	396	364	364	324	344	330	352	336
Total Phosphorus	0.08			0.26			0.11		
Nitrate Nitrogen	0.01	0.02	0.02	0.01	0.01	0	<0.01	0.02	<.01
Ammonia Nitrogen	0.57			0.60			0.56		
Kjeldahl Nitrogen	0.70			0.65			0.56		
Total Residue	1013	1028	1044	1038	1050	1133	1063	1123	1015
Coliform Group - MPN/100 ml			<2.2		old			<2.2	
Iron									

*Results expressed as mg/l except as noted.

Well 6 - The results of the analyses during the quarter fell within the range established by past data. In general, however, the values were nearer the minimum values of past years.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake) Station: Well - 7

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	9.2	9.2	9.5		9.4	10.2	11.0	10.6	10.0
pH - units	7.6	7.4	7.5		7.1	7.2	7.0	7.3	7.3
Conductivity - µmhos/cm-25°C	991	1240	975	NO	1580	1308	1463	1042	1408
Total Hardness	625	690	512		966	828	785	493	764
Calcium Hardness	348	350	226	SAMPLE	554	494	491	209	474
Sodium	23	20	22		25	18	21	22	22
Total Alkalinity	374	356	284		444	443	458	276	439
Chlorides	2.6	2.6	3.2		5.2	2.4	1.9	2.4	2.0
Sulfates	235	274	270		630	396	386	326	416
Total Phosphorus	.04						0.07		
Nitrate Nitrogen	.01	0.01	0.05		0.02	0	0	0.01	<.01
Ammonia Nitrogen	1.10						1.25		
Kjeldahl Nitrogen	1.25						1.25		
Total Residue	716	905	714		1498	1168	1160	798	1127
Coliform Group - MPN/100 ml			< 2.2		old			<2.2	
Iron									

*Results expressed as mg/l except as noted.

Well 7 - The camp was in session during July and with increased water use the sample should have been very representative. The chemical concentrations were higher than normal for some constituents in July but somewhat lower than May when maximum values were found for some constituents. The August sample had comparatively low concentrations with minimum total and calcium hardness values. In September, the values were in the higher range again. This is more variation in quality than has been experienced in past years.

PAUL THIELE FARM (SW ¼, Sec. 8)(East of plant site and cemetery)

Station: Well - 8

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	6.1	5.6	5.0	7.0	10.6	14.0	18	15.7	15.9
pH - units	6.8	7.0	6.9	7.0	7.1	7.1	7.0	7.0	7.1
Conductivity - umhos/cm-25°C	1222	1365	1470	1406	1400	1468	1473	1523	1444
Total Hardness	830	845	841	850	758	832	795	819	807
Calcium Hardness	580	560	561	527	534	524	570	520	512
Sodium	19	19	19	20	18	15	17	19	19
Total Alkalinity	438	434	438	428	470	427	452	452	434
Chlorides	1.9	1.9	3.0	2.9	4.8	2.0	2.4	1.7	2.1
Sulfates	340	456	458	450	432	456	440	456	428
Total Phosphorus	0.02			C.02			0.01		
Nitrate Nitrogen	0	0.01	0	0	0.02	0	0	0.01	0
Ammonia Nitrogen	1.42	1.67		1.1			0.94		
Kjeldahl Nitrogen	1.11	1.05		0.9			0.94		
Total Residue	1088	1122	1122	1129	1141	1254	1181	1219	1164
Coliform Group - MPN/100 ml			<2.2		old			<2.2	
Iron									

*Results expressed as mg/l except as noted.

Well 8 - The concentrations of chemical constituents measured at this well during the quarter were within the range established by past monitoring data. In October, the owner asked about bacteriological quality and was informed by letter of the past satisfactory results for our samples. They had apparently sent in a sample and obtained an "unsatisfactory" report.

Station: Well - 9

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20
Temperature - °C	8.0	7.0	5.2	9.2	18.0	18	19.5	17.3	10.8
pH - units	7.2	7.1	7.2	7.2	7.3	7.3	7.1	7.3	7.7
Conductivity - µmhos/cm-25°C	1201	1485	1455	1229	1440	1523	1308	1553	1488
Total Hardness	680	740	721	780	852	770	706	759	805
Calcium Hardness	395	410	420	430	528	490	369	431	463
Sodium	51	56	55	50	17	30	48	41	31
Total Alkalinity	268	257	279	254	322	285	266	290	332
Chlorides	25	46	38	36	9.8	20	37	20	16
Sulfates	450	575	550	510	532	550	470	564	518
Total Phosphorus	0.03			0.03			0.04		
Nitrate Nitrogen	0.01	0.09	0.03	0.12	0.06	0.23	0.19	0.43	0.21
Ammonia Nitrogen	1.21			0.77			0.88		
Kjeldahl Nitrogen	1.45			0.92			1.00		
Total Residue	1070	1122	1103	1110	1179	1076	1100	1221	1223
Coliform Group - MPN/100 ml			<2.2		old			<1	
Iron									

*Results expressed as mg/l except as noted.

Well 9 - The September sample represents new maximum concentrations of alkalinity and total residue. Previous maximum values before this quarter were determined in May. Occasionally it has been necessary to collect samples from the distribution system, but the September samples were collected from the pump station. The more mineralized water at the city wells seems unusual with the improving quality in Big Stone Lake.

Elevation of the Groundwater*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
1978						
January 24		1056.15	1034.00	1062.15	1054.52	
February 22	1027.32	1056.24	1034.84	1061.06	1054.77	
March 28	1026.74	1056.15	1034.67	1061.15	1054.61	
April 19	1027.07	1056.49	1034.00	1061.40	1055.86	
May 24	1027.57		1029.42	1061.73	1058.02	
June 27			1031.50	1061.40		
July 19	1027.65		1033.17	1062.73	1058.77	
August 22			1034.42	1062.56	1051.52	
September 20	1027.65		1034.75	1062.81	1056.77	

Regarding Water Levels at Sampling Wells - With the present sampling schedule, Well 1 is sometimes pumping automatically when the samplers arrive. Consequently, the depth readings at this well are omitted because the drawdown in the well would cause erroneous comparative readings. The air line at Well 2, which was plugged after a curbing failure in April, was removed between the July and August sampling dates. Also, samples could not be obtained from this well. The depth reading at Well 5 for August seems to be erroneous; however, the field sheets were checked and the depth reading shown is in agreement with the field measurements. In July 1977 the water level at Well 5 was measured at 1050.19, the lowest in the past seven years. The air line at Well 7 was broken during well repairs in July 1977 and depth readings have not been possible since that time. Water level data at this well during 1978 would have been very helpful in interpreting recent quality data from this well.

At Well Points Along County Road North of Pond:

1978	A	B	C	D	E
January 24	1111.88		1111.40	1110.77	
February 22	1110.63		1111.15	1106.77	
March 28	1115.13	1114.62	1113.40	1111.52	1110.23
April 19	1114.63	1114.62	1112.99	1111.69	1109.52
May 24	1112.76	1113.63	1112.15	1111.36	1108.69
June 27	1111.71	1113.46	1112.24	1111.11	1108.77
July 19	1112.88	1113.46	1111.78	1111.36	1108.44
August 22	1109.55	1111.54	1109.82	1110.69	1107.11
September 20	1109.13	1112.24	1110.65	1110.61	1108.52

Regarding Water Levels at the Well Points - In general the water levels at the well points were higher during the quarter than during similar months in 1977. Minimum water levels in 1978 to date have been substantially higher than minimum levels experienced at most well points in past years.

*All elevations are above "sea level datum."

FIRST SIX MONTHS REPORT
FOR THE
1978 WATER MONITORING PROGRAM

BIG STONE POWER PLANT

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

August 1978

Dorand Engineering, Inc.
Brookings, South Dakota

DORAND ENGINEERING, INC.

James N. Dornbush, DSc
Dwayne A. Rollag, PhD

324 ELM AVENUE • BROOKINGS, SOUTH DAKOTA 57006

605/692-6681

August 7, 1978

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

Gentlemen:

The following progress report covers the first two quarters of the seventh year of the Water Monitoring Program for the Big Stone Plant. During the negotiations for the continuation of the monitoring program, it was decided that a single report covering the first six months of data would provide adequate reporting on the project. During the period of January through June, the following items were completed:

1. Samples were collected for analyses, or sampling attempted, at about monthly intervals from 9 wells and 5 surface sampling stations. The specific dates for sampling are noted on the enclosed tables of analytical data. The location of the sampling stations is shown on the enclosed map.

2. As has occurred in the past, some data was not collected as planned for various reasons. Some well pumps were inoperative on the sampling dates. Also, at one river sampling station, samples were missed during the winter because the ice was frozen to the ground. Bacteriological samples were delayed in the mail and too old to obtain accurate data when they reached the lab. More details concerning this missed data can be found in the explanatory notations included with the analytical data.

3. The results of the analyses performed on the samples are included in the enclosed tables along with the commentary notations concerning sampling information and quality changes when applicable. It will be noted that these data reveal several changes in quality compared to last year.

4. Groundwater elevations as determined by the air line readings at the wells and the water levels measured at the well points north of the pond are also included in an enclosed table. Notations about comparative water levels etc. are also included with the data.

Please contact us if there are any questions concerning this report.

Sincerely,

James N. Dornbush, P.E.

JND:nfd
Enclosures

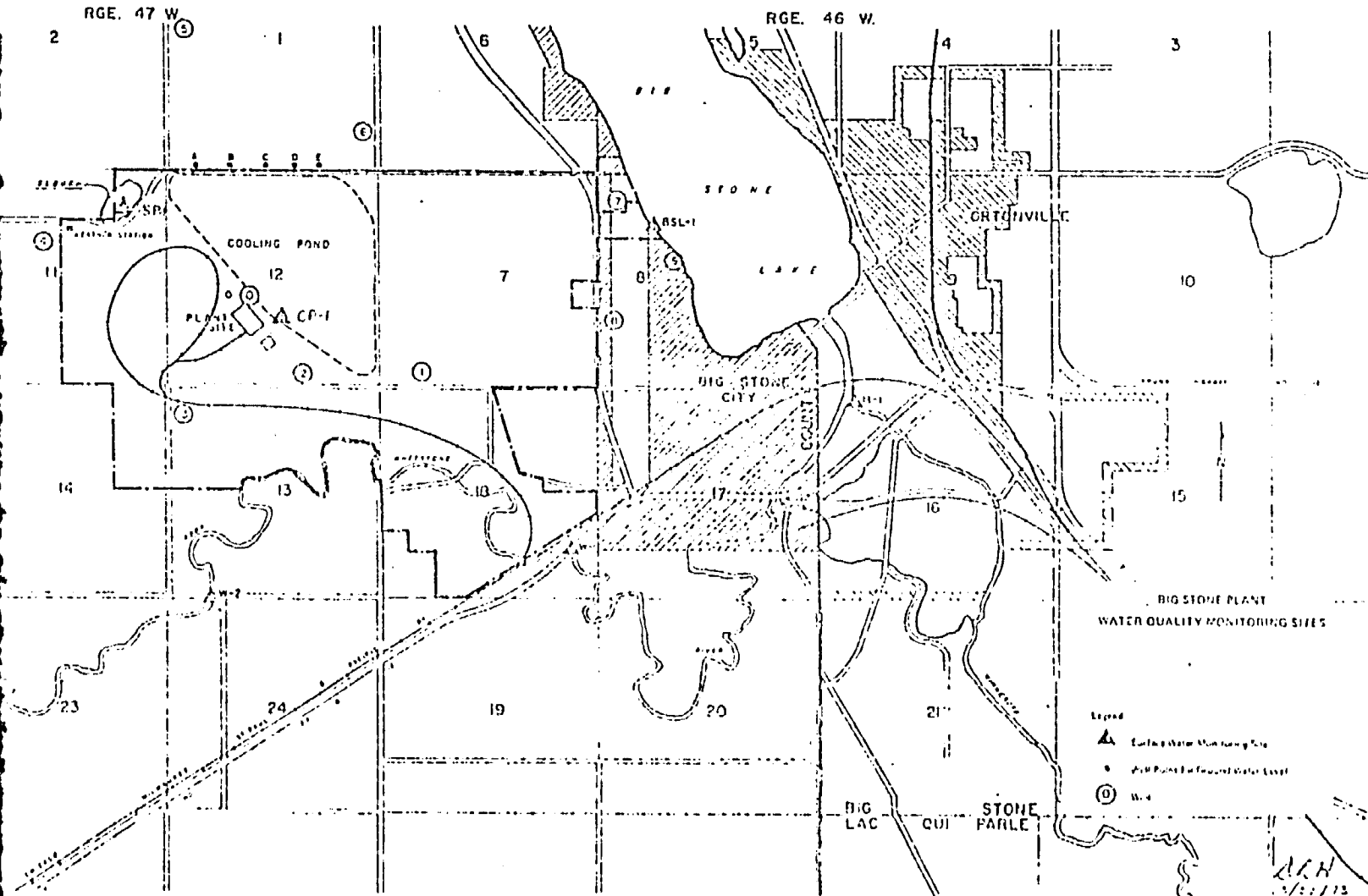


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

COOLING POND (At plant intake structure)

Station: CP - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	11.2	8.7	16	11.7	25.0	28.5
pH - units	7.7	8.0	6.7	8.1	8.3	7.3
Conductivity - µmhos/cm-25°C	2203	2720	2620	2287	2450	2370
Total Hardness	1095	1135	1181	1016	922	1028
Calcium Hardness	650	545	600	510	502	526
Sodium	190	155	210	165	153	133
Total Alkalinity	136	138	124	135	142	129
Chlorides	53	55	57	50	52	52
Sulfates	1200	1150	1350	940	980	1600
Total Phosphorus	0.04	0.04	0.05	0.11	0.03	0.03
Nitrate Nitrogen	0.08	0.07	0.02	0.06	0.02	0
Ammonia Nitrogen	0.14	0.10	0.10	0.18	0.22	0.10
Kjeldahl Nitrogen	1.50	1.45	1.55	1.55	1.45	1.8
Total Residue	2218	2265	2319	2049	1976	2167
Total Suspended Matter	6	8	32	65	19	17
Dissolved Oxygen	11.6	11.4	8.7	8.8	8.6	7.4
Biochemical Oxygen Demand	5.5	3.4	2.2	6.0	5.8	3.3
Turbidity	5.6	3.3	8.3	12	6.2	4.8
Coliform Group - MPN/100 ml	< 5	55	< 5		old	4300
Fecal Coliforms - MPN/100 ml	< 3	33	3		old	2

*Results expressed as mg/l except as noted.

Cooling Pond. Although the April sample reveals a substantial reduction of some chemical constituents, concentrations remain high. The overall quality of the cooling pond water is substantially better, however, than during the summer of 1977. There were no new maximum values during the period. Information concerning the quality of the cooling pond water was submitted in early June by telephone to Dana Holter to forward to your consultants for the study of the overall water quality management program for the plant.

BIG STONE LAKE (at lake intake to pumping station) Station: BSL - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	2.3	2.6	2.5	3.0	21.0	24.1
pH - units	7.5	7.8	7.3	7.9	8.1	8.4
Conductivity - µmhos/cm-25°C	1322	1835	320	973	1000	1082
Total Hardness	810	850	119	449	454	476
Calcium Hardness	520	465	91	350	268	260
Sodium	87	88	10	41	51	40
Total Alkalinity	243	238	90	140	162	169
Chlorides	33	34	7.1	18	18	10
Sulfates	580	800	84	376	396	424
Total Phosphorus	0.13	0.21	0.47	0.17	0.05	0.1
Nitrate Nitrogen	0.33	0.28	1.12	0.56	0.08	0.04
Ammonia Nitrogen	0.37	0.34	1.51	0.09	0.30	0.10
Kjeldahl Nitrogen	1.35	1.50	2.60	1.40	0.95	1.2
Total Residue	1356	1453	(268 ?)	871	833	888
Total Suspended Matter	9	33	37	173	14	19
Dissolved Oxygen	10.7	10.4	8.7	11.7	7.5	8.4
Biochemical Oxygen Demand	5.5	4.0	5.0	7.5	3.0	2.4
Turbidity	2.5	6.5	5.7	43	5.0	10.5
Coliform Group - MPN/100 ml	< 5	300	550		old	1400
Fecal Coliforms - MPN/100 ml	< 3	< 3	< 3		old	20

*Results expressed as mg/l except as noted.

Big Stone Lake. There appears to be a definite trend of improved chemical quality for Big Stone Lake, particularly since the spring snowmelt in March. The March sample which had some minimum values for the monitoring program probably is not representative as the ice was only partially melted on the lake, and mixing by wind action had not occurred. High inflows from the Whetstone River were occurring in March. Substantial flows were still leaving the lake in late July suggesting continued improvement of chemical quality. There were no new maximum values during the first half of the year. Quality information concerning the lake was also forwarded to Dana Holter when cooling pond data was provided.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	0	0	3.0	3.1	21.4	24.9
pH - units	7.4	6.7	7.7	7.8	8.0	8.4
Conductivity - µmhos/cm-25°C	1300	1470	375	986	1110	1004
Total Hardness	730	705	162	426	502	472
Calcium Hardness	505	445	111	325	306	288
Sodium	72	84	12	43	47	37
Total Alkalinity	367	349	116	136	210	223
Chlorides	45	46	5.7	18	7.6	8.4
Sulfates	420	330	104	386	360	422
Total Phosphorus	0.32	0.40	0.74	0.58	0.11	0.24
Nitrate Nitrogen	0.95	0.67	1.05	0.57	0.08	0.03
Ammonia Nitrogen	1.13	1.33	0.95	0.33	0.31	0.12
Kjeldahl Nitrogen	1.35	1.55	2.15	1.70	0.90	1.4
Total Residue	1158	1072	632	1007	835	819
Total Suspended Matter	8	3	350	312	30	39
Dissolved Oxygen	9.6	10	9.9	11.5	6.0	6.1
Biochemical Oxygen Demand	8.2	4.0	6.8	4.8	4.3	4.7
Turbidity	5.1	5.2	40	43	9.0	11.4
Coliform Group - MPN/100 ml	75	1100	4300		old	4600
Fecal Coliforms - MPN/100 ml	10	10	50		old	400

*Results expressed as mg/l except as noted.

Minnesota River Since the flow at the Minnesota River station can reflect outflow from the lake as well as flow from the Whetstone River, a very wide range of constituent values has been recorded in the past. Nevertheless, the March sample reflecting a flood stage on the Whetstone River contained minimum values for conductivity, total and calcium hardness, sodium and sulfates. A maximum value for suspended matter and higher-than-usual concentrations of phosphorus and nitrates were also recorded. These concentrations would be expected with a snowmelt runoff situation causing the flood.

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Station: W - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	0.5	0	4.0	4.8	21.2	23.1
pH - units	7.5	7.7	7.3	8.0	8.1	8.2
Conductivity - µmhos/cm-25°C	1285	1490	380	940	1170	1047
Total Hardness	715	700	198	467	586	508
Calcium Hardness	500	450	140	319	370	364
Sodium	73	66	11	29	44	36
Total Alkalinity	368	345	107	240	291	262
Chlorides	45	45	6.1	13	9.6	10
Sulfates	375	336	120	396	454	329
Total Phosphorus	0.38	0.54	0.62	0.32	0.14	0.20
Nitrate Nitrogen	0.97	0.69	1.03	0.60	0.07	0.05
Ammonia Nitrogen	1.16	1.60	1.02	0.27	0.16	0.10
Kjeldahl Nitrogen	1.45	1.60	2.20	0.90	0.80	1.2
Total Residue	1140	1052	517	726	907	916
Total Suspended Matter	7	6	250	36	15	14
Dissolved Oxygen	9.6	9.6	10.0	10.2	7.2	6.1
Biochemical Oxygen Demand	3.7	2.7	6.1	13.1	4.1	3.9
Turbidity	7.3	8.8	55	11	6.4	7.5
Coliform Group - MPN/100 ml	200	2400	1400		old	20000
Fecal Coliforms - MPN/100 ml	13	80	20		old	3800

*Results expressed as mg/l except as noted.

W - 1 and W - 2 Samples were not collected at W - 2 during January and February because the Whetstone River was frozen to the ground. Field sheets indicate about 3 feet of ice at two locations. The March sample, collected at a high flow condition, showed minimum values for the entire monitoring program for conductivity, total and calcium hardness, sodium, alkalinity and sulfates. Suspended solids was recorded at a maximum value which would be typical of a high flow condition. Quality of water at both stations was generally similar for periods when data was available considering the relative nature of the sampling stations although the April samples revealed an increase in BOD at the downstream station (W - 1). Photos were taken in March at the high flow condition.

Station: W - 2

WHETSTONE RIVER (On county road 1½ miles south of plant site)

Determination*	1/24	2/22	3/28	4/19	5/24	6/22
			Sampling Dates - 1978			
Temperature - °C	NO SAMPLE	NO SAMPLE	3.0	4.1	19.8	22.5
pH - units			7.1	8.0	8.0	8.2
Conductivity - µmhos/cm-25°C			360	944	1160	1157
Total Hardness			151	490	548	518
Calcium Hardness			106	360	368	330
Sodium			9.8	25	44	37
Total Alkalinity			113	236	285	264
Chlorides			5.8	13	5.0	12
Sulfates			90	286	364	338
Total Phosphorus			0.57	0.18	0.11	0.21
Nitrate Nitrogen			1.06	0.74	0.07	0.05
Ammonia Nitrogen			1.00	0.31	0.19	0.08
Kjeldanl Nitrogen			2.10	1.05	1.35	1.1
Total Residue			466	693	878	887
Total Suspended Matter			225	33	11	28
Dissolved Oxygen			9.8	10.5	6.72	5.7
Biochemical Oxygen Demand			6.1	1.8	1.7	2.1
Turbidity			50	15	5.3	8.9
Coliform Group - MPN/100 ml			3300		old	1700
Fecal Coliforms - MPN/100 ml			67		old	320

*Results expressed as mg/l except as noted.

DONALD HAY FARM (SW ¼, Sec. 7)(Southeast of cooling pond on plant site)

Station: Well - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	10.0	9.0	9.5	8.9	11.1	10.4
pH - units	7.0	7.0	7.0	7.0	7.3	7.0
Conductivity - µmhos/cm-25°C	1768	2150	1950	1836	2080	1563
Total Hardness	1250	1610	1188	1184	1536	1168
Calcium Hardness	950	715	679	685	778	886
Sodium	20	22	20	23	23	13
Total Alkalinity	398	386	360	350	373	414
Chlorides	21.8	30	44	73	124	14
Sulfates	740	665	735	650	645	775
Total Phosphorus	0.02			0.02		
Nitrate Nitrogen	9.80	15.6	24	37	51	2.8
Ammonia Nitrogen	0.16			0.09		
Kjeldahl Nitrogen	0.43			0.45		
Total Residue	1670	1733	1695	1621	1927	1815
Coliform Group - MPN/100 ml						
Iron						

*Results expressed as mg/l except as noted.

Well - 1 An unusual change in quality occurred at this well during the period in that both chlorides and nitrates increased substantially during the first 5 months to maximum values in May. Both clorides and nitrates decreased again in June. During the period, other constituents were within the range established by past data except a minimum alkalinity value was recorded. The nitrates and chlorides increase could be from percolation through old animal waste deposits in the vicinity of the well. Chlorides, however, have never been more than 6 mg/l at this well in the past. The generally recommended maximum level of chlorides for drinking water is 250 mg/l although high chlorides is not considered a health factor.

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond)

Station: Well - 2

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	
Temperature - °C	8.8	8.0	9.0	8.6	13		
pH - units	6.8	6.7	6.7	6.8	7.0		
Conductivity - µmhos/cm-25°C	2633	3240	2935	2885	2780		N
Total Hardness	2105	2195	2119	2022	1992		O
Calcium Hardness	1530	1485	1495	1491	1374		S
Sodium	25	29	29	30	28		A
Total Alkalinity	490	465	467	467	541		M
Chlorides	45	45	45	44	44		P
Sulfates	1310	1280	1580	1510	1340		L
Total Phosphorus	0.20			0.14			E
Nitrate Nitrogen	0.27	0.44	0.29	0.29	0.07		
Ammonia Nitrogen	1.30			1.50			
Kjeldahl Nitrogen	3.10			1.55			
Total Residue	2861	2929	2891	2934	2876		
Coliform Group - MPN/100 ml							
Iron							

*Results expressed as mg/l except as noted.

Well - 2 Except for a maximum alkalinity value in May, the results of the various analyses fell within the range established by past analyses. This well has a history of curbing failure (an old two-foot diameter wooden curbing) which was the apparent cause when samples could not be obtained in June. The May sampling showed signs of curbing failure. The air line was also plugged in May and June so water level readings could not be obtained. Plant personnel have been informed of these problems. Because of the strategic location, the well should be repaired for future monitoring, if possible.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	8.0					
pH - units	7.6					
Conductivity - µmhos/cm-25°C	787	NO	NO	NO	NO	NO
Total Hardness	430					
Calcium Hardness	195	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE
Sodium	41					
Total Alkalinity	228					
Chlorides	3.3					
Sulfates	213					
Total Phosphorus	.03					
Nitrate Nitrogen	.02					
Ammonia Nitrogen	3.26					
Kjeldahl Nitrogen	3.45					
Total Residue	522					
Coliform Group - MPN/100 ml						
Iron						

*Results expressed as mg/l except as noted.

Well - 3 The lamp burned out in the pump pit, and the pump froze prior to February. It appears that a new pump was installed by April, but it has not been properly primed or some other difficulty remains so that samples could not be collected. Plant personnel have been informed of these problems. Water levels took another unusual drop in May at this well.

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site)

Station: Well - 4

Determination*	Sampling Dates - 1978					
	1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	5.0	5.5	6.8	6.2	10.4	10.9
pH - units	7.9	6.9	6.9	6.9	6.9	7.0
Conductivity - µmhos/cm-25°C	2308	2740	2560	2544	2270	2415
Total Hardness	1700	1735	1705	1692	1654	1658
Calcium Hardness	1205	1205	1187	1280	1118	1152
Sodium	22	22	22	22	22	18
Total Alkalinity	480	478	475	474	517	502
Chlorides	45	46	47	46	48	47
Sulfates	1000	1020	1220	1160	900	1050
Total Phosphorus	0.04			0.06		
Nitrate Nitrogen	0	0.01	0	0	0.03	0.12
Ammonia Nitrogen	0.93	0.91		0.55		
Kjeldahl Nitrogen	0.55	0.65		.5		
Total Residue	2295	2390	2346	2366	2322	2531
Coliform Group - MPN/100 ml			5.1		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 4 In most cases, the results of the analyses during the period fell within the range established in the past. Comparatively high alkalinity values have, however, been recorded during the entire six months, and the May alkalinity was a new maximum value for the monitoring program. By contrast, sulfates concentrations were lower than usual, and the May sulfates value was a new minimum for the monitoring program.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site)

Station: Well - 5

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	9.6	8.3	8.0	7.0	10.8	11.5
pH - units	7.0	7.1	7.1	7.1	7.2	7.0
Conductivity - µmhos/cm-25°C	1427	1657	1625	1615	1650	1643
Total Hardness	990	960	985	968	996	936
Calcium Hardness	625	595	741	601	560	576
Sodium	21	20	19	24	23	18
Total Alkalinity	462	448	464	456	475	460
Chlorides	5.2	5.6	5.2	9.7	10	10
Sulfates	690	500	540	495	470	545
Total Phosphorus	0.04			0.04		
Nitrate Nitrogen	1.22	0.84	1.24	6.34	6.74	4.8
Ammonia Nitrogen	0.46			0.36		
Kjeldahl Nitrogen	0.55			0.50		
Total Residue	1241	1276	1271	1317	1256	1374
Coliform Group - MPN/100 ml			<2.2		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 5 The well from which the samples are now collected at this farmstead was dug in 1977 adjacent to the previous sampling well. The air line is still in the old well. The water quality at the new well appears to be comparable to that of the old well in that all chemical concentrations fell within the range established by past analyses. Nitrate nitrogen concentrations increased in the spring but were still far lower than past annual maximum values.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond)

Station: Well - 6

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	6.2	7.0	7.2	7.3	9.0	11.3
pH - units	7.1	7.0	7.0	7.0	7.2	7.1
Conductivity - µmhos/cm-25°C	1238	1425	1390	1275	1230	1248
Total Hardness	825	825	800	802	750	746
Calcium Hardness	500	485	553	482	452	458
Sodium	20	19	20	20	18	15
Total Alkalinity	465	470	464	462	452	460
Chlorides	3.3	2.5	3.6	3.5	6.2	4.6
Sulfates	400	396	364	364	324	344
Total Phosphorus	0.08			0.26		
Nitrate Nitrogen	0.01	0.02	0.02	0.01	0.01	0
Ammonia Nitrogen	0.57			0.60		
Kjeldahl Nitrogen	0.70			0.65		
Total Residue	1013	1028	1044	1038	1050	1133
Coliform Group - MPN/100 ml			< 2.2		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 6 The concentrations of the various chemical constituents determined during the period for this well were within the range of data established from past samples. It would appear, however, that the general quality is slightly improved compared to 1977 data for the same period.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake) Station: Well - 7

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	9.2	9.2	9.5		9.4	10.2
pH - units	7.6	7.4	7.5		7.1	7.2
Conductivity - µmhos/cm-25°C	991	1240	975	NO	1580	1308
Total Hardness	625	690	512		966	828
Calcium Hardness	348	350	226	SAMPLE	554	494
Sodium	23	20	22		25	18
Total Alkalinity	374	356	284		444	443
Chlorides	2.6	2.6	3.2		5.2	2.4
Sulfates	235	274	270		630	396
Total Phosphorus	.04					
Nitrate Nitrogen	.01	0.01	0.05		0.02	0
Ammonia Nitrogen	1.10					
Kjeldahl Nitrogen	1.25					
Total Residue	716	905	714		1498	1168
Coliform Group - MPN/100 ml			< 2.2		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 7 During the past year (1977), the mean concentrations of many constituents were the lowest recorded in the monitoring program. Comparatively low concentrations of many constituents continued through March when a new minimum hardness concentration was recorded. In April the pump was disconnected from the power supply so a sample could not be collected. The May and June samples, however, show marked increases in concentrations with maximum values for the monitoring program being recorded for total hardness, sulfates, and total residue in May. Previous maximum values were recorded in 1972 and 1973 at this well before the plant was in operation. Unfortunately, the air line has not been reinstalled at this well to record changes in water level that may have occurred.

PAUL THIELE FARM (SW ¼, Sec. 8)(East of plant site and cemetery) Station: Well - 8

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	6.1	5.6	5.0	7.0	10.6	14.0
pH - units	6.8	7.0	6.9	7.2	7.1	7.1
Conductivity - µmhos/cm-25°C	1222	1365	1470	1475	1400	1468
Total Hardness	830	845	841	850	758	832
Calcium Hardness	580	560	561	527	534	524
Sodium	19	19	19	20	18	15
Total Alkalinity	438	434	438	428	470	427
Chlorides	1.9	1.9	3.0	2.9	4.8	2.0
Sulfates	340	456	458	450	432	456
Total Phosphorus	0.02			0.02		
Nitrate Nitrogen	0	0.01	0	0	0.02	0
Ammonia Nitrogen	1.42	1.67		1.1		
Kjeldahl Nitrogen	1.11	1.05		0.9		
Total Residue	1088	1122	1122	1129	1141	1254
Coliform Group - MPN/100 ml			<2.2		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 8 There appears to have been no significant change in water quality at this well. Although the alkalinity in May was a new maximum concentration, the value is only slightly above previous maximum values.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake)

Station: Well - 9

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27
Temperature - °C	8.0	7.0	5.2	9.2	18.0	18
pH - units	7.2	7.1	7.2	7.2	7.3	7.3
Conductivity - µmhos/cm-25°C	1201	1485	1455	1229	1440	1523
Total Hardness	680	740	721	780	852	770
Calcium Hardness	395	410	420	430	528	490
Sodium	51	56	55	50	17	30
Total Alkalinity	268	257	279	254	322	285
Chlorides	25	46	38	36	9.8	20
Sulfates	450	575	550	510	532	550
Total Phosphorus	0.03			0.03		
Nitrate Nitrogen	0.01	0.09	0.03	0.12	0.06	0.23
Ammonia Nitrogen	1.21			0.77		
Kjeldahl Nitrogen	1.45			0.92		
Total Residue	1070	1122	1103	1110	1179	1076
Coliform Group - MPN/100 ml			<2.2		old	
Iron						

*Results expressed as mg/l except as noted.

Well - 9 The May sample represents maximum concentrations for the monitoring program for total and calcium hardness, alkalinity and total residue. In the past, the water quality at the Big Stone City wells has been related to the quality in nearl Big Stone Lake. With the improved quality of Big Stone Lake in 1978, better water quality might be expected at this well in the near future.

Elevation of the Groundwater*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

Date 1978	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
January 24		1056.15	1034.00	1062.15	1054.52	
February 22	1027.32	1056.24	1034.84	1061.06	1054.77	
March 28	1026.74	1056.15	1034.67	1061.15	1054.61	
April 19	1027.07	1056.49	1034.00	1061.40	1055.86	
May 24	1027.57		1029.42	1061.73	1058.02	
June 27			1031.50	1061.40		
July 19	1027.65		1033.17	1062.73	1058.77	

In January and June, the pump at Well 1 which is on a time clock was in operation before the samplers arrived, and depth readings were not taken to avoid recording abnormal water level readings. Caving of the curbing at Well 2 plugged the air line and prevented the collection of water level data after April. Well 7, at the church camp, still has not had the air line installed, and water levels have not been recorded since June 1977. These problems have been discussed with plant personnel recently. Only Well 5 seems to have had a significant increase in water level in recent months, but water levels are still more than 5 feet lower than in 1972.

At Well Points Along County Road North of Pond:

1978	A	B	C	D	E
January 24	1111.88		1111.40	1110.77	
February 22	1110.63		1111.15	1106.77	
March 28	1115.13	1114.62	1113.40	1111.52	1110.23
April 19	1114.63	1114.62	1112.99	1111.69	1109.52
May 24	1112.76	1113.63	1112.15	1111.36	1108.69
June 27	1111.71	1113.46	1112.24	1111.11	1108.77
July 19	1112.88	1113.46	1111.78	1111.36	1108.44

In general, the water levels were substantially higher at all well points compared to the similar period in 1977. In fact, the maximum readings for Well points A and D in this period represent the maximums for the entire monitoring period. Maximum water levels in 1977 occurred at the well points in December, and this condition could have contributed to the inability to obtain accurate level readings in January and February 1978 at Well points B and E when the water was frozen in the pipes. An abnormal reading was also recorded at Well point D in February. This level could be an error (Field notes were checked however.) or might possibly be the result of frost penetration to the sand lens suspected of maintaining a uniform water level in this well point.

*All elevations are above "sea level datum."

RECEIVED
JUL 23 1979
DEPT. OF WATER &
NATURAL RESOURCES

1978 ANNUAL REPORT FOR THE WATER MONITORING PROGRAM

BIG STONE PLANT

Montana- Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

July 2, 1979

Dorand Engineering, Inc.
Brookings, South Dakota

DORAND ENGINEERING, INC.

James N. Dornbush, DS
Dwayne A. Roliag, PhD

324 ELM AVENUE • BROOKINGS, SOUTH DAKOTA 57006

605 692-6681

July 2, 1979

Montana-Dakota Utilities Company
Northwestern Public Service Company
Otter Tail Power Company

Gentlemen:

We are submitting herewith our "1978 Annual Report for the Water Monitoring Program, Big Stone Plant," including data collected during the period, January through December, 1978.

The report includes sections which summarize particular phases of the water monitoring program including groundwater quality, trace elements, groundwater elevations, cooling pond, and surface water quality. Comparisons are also made with the data included in the previous water monitoring reports. Recommendations for the continued water monitoring program are included.

It is further suggested that copies of this report be submitted to the appropriate regulatory agencies and, at that time, solicit their concurrence and/or suggestions concerning the proposed continued water monitoring program.

If there are any questions concerning this report, please contact me.

Sincerely,

James N. Dornbush, P.E.

JND:mfd
Enclosures

WATER MONITORING PROGRAM

BIG STONE PLANT - 1978

Scope of Water Monitoring Program

The water monitoring program was established by the three power companies in 1971 to obtain background data on water quality and groundwater levels in the area of the Big Stone Plant. Through 1978, samples have been collected for analyses from 9 wells, 3 river stations and Big Stone Lake at approximately monthly intervals. In addition, samples were collected on a quarterly basis from a small natural pond from 1973 to 1975. Sampling from the cooling pond was initiated on a quarterly basis in 1973 soon after the pond was filled and was changed to a monthly frequency in 1975 to more closely evaluate quality changes after the plant was in operation. Groundwater elevations were recorded monthly at 6 wells and 5 well points from 1972 through 1978. The approximate locations of the water monitoring stations are shown on the sketch map of the area (Figure 1).

This summary report on the water monitoring program for the Big Stone Plant includes the data collected during 1978 and makes comparisons with past monitoring data. The report was prepared at the request of the three power companies and authorized by Purchase Order 65449 dated December 29, 1977.

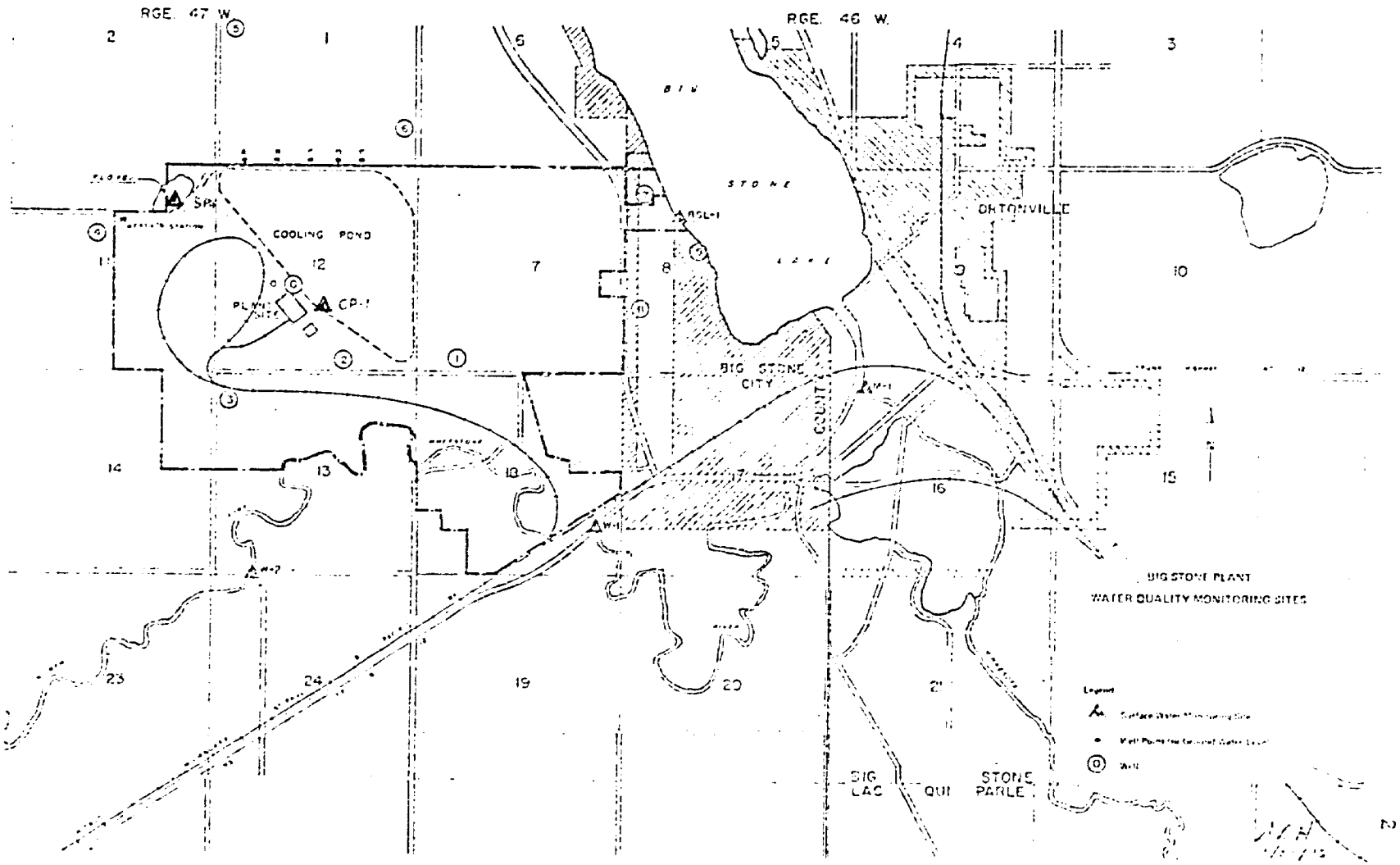


Figure 1 - Map of Big Stone Plant Area showing location of water quality monitoring sites.

Groundwater Quality

When the water monitoring program was established in 1971, little information was available concerning the quality of groundwater in the power plant area. During the initial years, it was determined that wide variations in water quality existed between the various wells sampled in the monitoring program. In general, the water in the area as indicated by all wells is quite mineralized, very hard and excessive in sulfates.

Past reports have shown that Well 3 southwest of the plant and the Big Stone City wells (Well 9) have the best quality of water; whereas, Wells 2 and 4 located south and west of the plant had the poorest chemical quality. The other wells located north and east of the plant have water with similar characteristics with slightly better quality for those wells located nearer to Big Stone Lake.

The groundwater monitoring program was established to obtain background data on water quality prior to operation of the plant and to determine if changes in groundwater quality might occur with plant operation particularly as a result of the cooling pond. The land disposal of blowdown water also began in 1978 and became a factor in evaluating future water quality at some wells. The 1978 monitoring program was conducted in much the same manner as in past years with monthly samples analysed and tabulated. The results of these analyses of monthly samples are included in the Appendix. In 1978, Well 2 on company property was sampled only five times because of well problems and an inoperative pump. Well 3, also on company property, had an inoperative pump after January 1978. Well 7 at the church camp could not be sampled in April because the pump was disconnected.

To summarize the 1978 monthly data, mean concentrations of the chemical constituents of each of the 9 wells were determined and included in Table 1. By comparing these mean concentrations with similar data compiled in past years, long-term trends of changes in water quality can be determined without considering the minor variations that might occur seasonally or within the laboratory as a result of laboratory techniques. Some wells did not have a total of 12 samples collected during the year as noted above. It is felt, however, that sufficient analyses were available to make comparisons valid with the exception of Well 3 as explained later.

Comparing the mean concentrations in Table 1 for 1978 with similar data for the previous years, the following summaries for each well seem pertinent:

Well 1 - Well 1 is considered to be one of the most strategically located wells in the water monitoring program because it is in the probable downstream direction for groundwater flow from the cooling pond and the blowdown pond. As groundwater moves toward the Whetstone River, quality changes if they occur should be monitored first at this well.

In 1978, an unusual change in quality occurred during the early part of the year. Chlorides and nitrates both increased substantially during the first five months to maximum concentrations in May. The maximum nitrates (51 mg/l) and chlorides (124 mg/l) concentrations could be from percolation through old animal wastes deposits in the vicinity of the well. Chlorides, however, have never been more than 6 mg/l at this well in the past, and the mean concentration in 1978 was 31 mg/l. The generally recommended maximum level of chlorides for drinking water is 250 mg/l, although high chlorides is not considered a health factor. One previous sample in 1975 had a nitrates concentration of 44 mg/l while other samples in previous years had nitrates of less than 1 mg/l at this well. Most other concentrations were within the ranges established by past data although a maximum sulfates concentration also occurred in 1978. The mean total hardness concentration (1290 mg/l) was the highest recorded at this well since the monitoring program began.

TABLE 1 - Mean Concentrations of Chemical Constituents
for Samples from Nine Wells
Big Stone Plant Area
January-December 1978

Determination*	Well Number 1	2**	3***	4	5	6	7**	8	9
pH - units (median)	7.0	6.8	7.6	6.9	7.1	7.3	7.2	7.0	7.2
Conductivity - µmhos/cm-25°C	1898	2895	787	2491	1580	1290	1279	1394	1397
Total Hardness	1290	2087	430	1669	953	766	727	821	761
Calcium Hardness	798	1475	195	1148	589	452	388	534	438
Sodium	19	28	41	22	21	19	22	19	42
Total Alkalinity	394	486	228	485	462	463	337	441	290
Chlorides	31	45	3.3	47	5.5	2.8	2.5	2.4	27
Sulfates	777	1404	213	1096	537	348	403	438	528
Total Phosphorus	0.05	0.17	0.03	0.04	0.04	0.12	0.09	0.02	0.03
Nitrate Nitrogen	14	0.27	0.02	0.68	6.74	0.01	0.01	0.01	0.15
Ammonia Nitrogen	0.24	1.40	3.26	0.78	0.46	0.57	1.10	1.20	0.98
Kjeldahl Nitrogen	0.45	2.32	3.45	0.65	0.55	0.61	1.27	0.98	1.14
Total Residue	1773	2898	522	2384	1398	1027	1049	1150	1137

*Results expressed as mg/l except as noted.
**Mean concentration based on less than 12 samples.
***Single sample during 1978 collected on January 24.

Well 2 - Well 2 is also strategically located directly south of the cooling pond. However, because it has an old two-foot diameter wooden curbing, problems have occurred periodically because of curbing failure and subsequent caving of the well. For this reason and because of freezing problems, samples have been missed annually since 1974. The air line has also been plugged on occasion so that water levels could not be measured. In 1978, samples and air line readings could not be taken after May when a severe curbing failure occurred.

Well 2 is one of the wells with the poorest water quality in the monitoring program. After the cooling pond was filled in 1972, a general trend of increased chemical concentrations was noted from 1973 through 1975. This quality change was a matter of concern even though cooling pond quality at that time was better than well water quality. To simulate the situation represented by 1972-73 data when the well was used for sanitary purposes serving trailers during plant construction, more frequent pumping was accomplished in 1976 and substantially improved chemical quality resulted. With increased pumping, however, the wooden curbing failed and regular pumping was stopped. The following year, 1977, mean chemical concentrations again increased, although maximum concentrations occurred for only a few constituents. These quality changes revealed that pumping frequency was probably the major factor in the past quality changes.

In 1978, with only five monthly samples, mean concentrations in most cases were lower than several previous annual mean values. Only alkalinity of the common chemical constituents showed a significant increase with new maximum values. Nitrates concentrations were very low (<1.0 mg/l) compared to maximum concentrations from 25 to 51 mg/l from 1973 through 1976. Because of the poor water quality at Well 2 and as a result of the curbing failure, a decision has been made to eliminate Well 2 from the present monitoring program.

Well 3 - The lamp burned out in the pump pit, and the pump froze prior to February 1978. A new pump was installed by April, but other difficulties with the well and pump have prevented the collection of samples at Well 3 since January 24, 1978. Water levels, however, have been recorded regularly in 1978. The single January sample revealed nothing unusual with respect to chemical quality. The water at this well is of substantially better quality than from most wells of the area but seems to exhibit considerable variation in both quality and water level from season to season. There appears to be some evidence that water from the small pond northwest of the plant or water from that general area serves to recharge this well. Because of the comparatively good quality of water from the well and its location immediately southwest of the plant, this well and pump should be repaired and again included in the monitoring program if at all possible.

Well 4 - Most of the mean concentrations of constituents for this well in 1978 were very similar to 1977 values as well as 1972 mean values collected before the cooling pond was filled. Alkalinity values were higher than in the past with a new maximum value recorded. Nitrates were the lowest of any year of the monitoring program with a maximum and mean concentration of 4 mg/l and 0.7 mg/l respectively. An unusually high pH (7.9) was recorded for a single sample, although other pH values were normal. With the above exceptions, the other analyses fell within the range established by past monitoring data.

Well 5 - During 1978, mean concentrations of nearly all constituents fell within the range of past mean values for this well. Also there were no individual determinations that had concentrations that exceeded the range established by past results. In the summer of 1977, low water levels forced the owner of this farmstead north of the plant to dig a deeper well adjacent to the old well although the air line remains in the old well. There seems to be no evidence that water quality differs between the two wells or that any detrimental quality changes have occurred at this well since the monitoring program began. Lower nitrate concentrations have been measured in the last few years after unacceptably high concentrations in 1972 and 1973. An unsatisfactory bacteriological sample was collected in November 1978, but the recheck sample for December proved satisfactory. In the early 1970's, unsatisfactory bacteriological samples were not uncommon at this well. A single unusually low water level which could have been caused by heavy pumping was recorded in August; however, water quality was normal.

Well 6 - Water quality at this well has been quite uniform throughout the water monitoring program. Although nearly every analytical determination made for this well in 1978 fell within the range established by past analyses, numerous near minimum values occurred. Overall, it appears that the water quality was slightly improved in that minimum mean values for the monitoring program for conductivity, calcium hardness, sulfates and total residue were recorded for 1978.

Well 7 - Samples from Well 7, located at the church camp, showed extreme variability during 1978. During the previous year (1977), the mean concentrations of many constituents were the lowest recorded in the water monitoring program. Comparatively low concentrations of many constituents continued through March when a new minimum hardness was recorded. In April the pump was disconnected from the power supply so a sample could not be collected. The May and June samples, however, showed marked increases in concentrations with maximum values for the monitoring program being recorded for total hardness, sulfates and

total residue in May. In July, when the camp was in session, concentrations were higher than normal but somewhat lower than those recorded in May. At the end of the year, high concentrations were again recorded. This is far more variation in chemical quality than has been experienced in past years. Overall, however, some mean values were in the lower range of mean values recorded for the monitoring program.

The church camp has a large pressure tank that makes collection of representative samples difficult. The sampling procedure, as in the past however, is to run water until the pump has operated for some time to collect a sample of pumped water before it enters the storage tank. Consequently, the variability of the water quality at this well might be related to sampling difficulty. However, the rapid change in quality after the spring thaw combined with the key location of this well between the land disposal area for irrigation of blowdown water and Big Stone Lake also suggests a possibility of a water quality change due to the irrigation practices. It is unfortunate that water levels could not be measured at Well 7 because this information would have been helpful in interpreting the above quality data.

Well 8 - This well is also located between the irrigated land disposal area and Big Stone Lake, and there were only a few analyses at this well that did not fall within the range of past data. Overall, there appears to have been no quality change or unusual variability at this well in 1978. In many respects, the quality in 1978 was very similar to that recorded in 1972 before the plant was in operation in that mean concentrations of total hardness, alkalinity, sulfates and nitrates were almost identical. Although the owner had collected a bacteriological sample in October that was reported as unsatisfactory, he was informed that the bacteriological samples collected in the monitoring program in 1978 were all satisfactory for drinking purposes.

Well 9 - This sampling station represents the Big Stone City water supply rather than the water quality of a single well since two wells are now located at about the same location near Big Stone Lake. There has been a trend toward increased mineralization at Well 9 since about 1973 until water quality at this well is quite comparable to the quality of other wells in the area (Wells 7 and 8). For example, mean concentrations of total hardness, calcium hardness, sulfates and total residue have all increased for each of the past four years and now are from 23 to 42 per cent higher than 1972 levels. In the early years of the monitoring program, water quality at this well seemed to be related to the quality of water in nearby Big Stone Lake; and if this relationship continues to exist, water quality should have improved or will improve in the future with the improvements of Big Stone Lake quality.

> The trend toward increased mineralization may be the result of factors other than those related directly to the power plant operations. For example, increased city pumpage would be expected to draw a greater portion of the Big Stone City water from groundwater as it moves underground toward the lake rather than from inflow from the nearby lake. Since groundwater is usually more mineralized than the lake water, increased concentrations would result. The relative location of Well 9, however, with respect to the land disposal area for blowdown water and the variability of water quality for similarly-located Well 7 suggest a continued watch of water quality data at this well in the future.

In summary, water quality at Well 1 appears to have shown a change in some concentrations that could possibly be related to the blowdown pond although other causes also seem plausible. Wells 4, 5 and 6 located at farmsteads west and north of the plant site have not revealed any changes that might be attributed to the cooling pond. Wells 7 and 9 located between the land disposal area for blowdown water and Big Stone Lake have shown water quality changes and variability that suggest continued surveillance.

Trace Metals

During the period 1973 through 1975, the well samples were analysed for certain trace metals that were included in the drinking water standards with some additions that were present in the coal ash. These analyses were made to collect background data on the private wells that were used for drinking water as well as other wells in the monitoring program. For the most part, the analyses were performed at the State Chemical Laboratory in Vermillion, South Dakota, although selenium concentrations were determined at Station Biochemistry Laboratories at South Dakota State University and silver and barium concentrations were determined by Dr. James J. Worman, Associate Professor of Chemistry, South Dakota State University.

In 1975 it was recognized that relatively little information was being obtained as to the actual concentration of these metals in the well samples because most results were reported as below the detectable limit for the particular determination used by the specific laboratory. Consequently, it was recommended that these analyses be dropped for economy purposes even though new EPA Primary Drinking Water Regulations were being issued that included maximum allowable concentrations of many of these metals. It was understood that when a state laboratory obtained the sophisticated analytical equipment and testing procedures to make determinations at concentrations below the maximum allowable limits set by EPA, the trace metals determinations might be resumed. A detailed summary of previous trace metals results and the rationale for discontinuing these analyses is included in the 1975 monitoring report (pages 7-12).

For the 1978 monitoring program, it was recommended that one set of samples be collected for trace metals from the wells and plant water supply and analysed for those trace metals included in the EPA Primary Drinking Water Regulations. The South Dakota State Department of Health Laboratory had developed the analytical capabilities necessary to reach the very low limits specified in the standards and was certified by EPA. The samples were collected on August 22, 1978, using sampling and preservation methods established by that laboratory. The results of these analyses are presented in Table 2. Samples could not be collected from Wells 2 and 3. It will be noted that most of the concentrations are reported in micrograms per liter which is about equivalent to parts per billion.

TABLE 2

Drinking Water Supply Chemical Analysis Data
Big Stone Power Plant Area
August 22, 1978

Determination	Maximum Allowable Contaminant Level*	Concentration - units comparable to maximum contaminant level									
		Plant Supply	Well 1	Well 2	Well 3	Well 4	Well 5	Well 6	Well 7	Well 8	Well 9
Fluoride	2.4 mg/l	0.10	0.24			0.22	0.23	0.26	0.22	0.26	0.76
Nitrate as N	10 mg/l	0.1	5.5	N O S A M P L E	N O S A M P L E	1.4	1.3	< 0.1	< 0.1	< 0.1	0.6
Arsenic	50 µg/l	<1.0	<1.0			<1.0	1.0	157** (25)	5.?	< 1.0	< 1.0
Barium	1000 µg/l	< 20	32			45	36	20	36	34	56
Cadmium	10 µg/l	1.2	8			14** (19)	7.0	4.5	9.7	5.5	3.5
Chromium	50 µg/l	< 10	< 10			< 10	<10	< 10	11	< 10	< 10
Lead	50 µg/l	4.4	3.1			5.4	2.1	2.8	140** (4.3)	2.4	1.2
Mercury	2 µg/l	< 0.20	0.51			< 0.20	< 0.20	0.29	0.53	0.20	< 0.20
Selenium	10 µg/l	< 1.0	<1.0			< 1.0	< 1.0	< 1.0	<1.0	1.0	< 1.0
Silver	50 µg/l	2.6	22			12	10	8.0	11	17	6.5

*Except for Nitrate and Fluoride (both in mg/l), the numbers denote the maximum contaminant levels in micrograms/l (µg/l) as set forth by the Federal Drinking Water Standards.

**Measured concentration exceeds maximum allowable contaminant level. Recheck samples collected on October 25, 1978, had concentrations in parentheses.

From Table 2, it can be noted that the plant water supply had concentrations substantially below the maximum allowable contaminant level listed in the drinking water standards. Only three wells (Wells 4, 6 and 7) had individual concentrations that exceeded one of the standards. These three wells were resampled on October 25, 1978, for recheck analyses, and only Well 4 exceeded the maximum cadmium concentration on the recheck determinations.

For the most part, the reported trace metals results were substantially below the maximum allowable concentration suggesting that trace metals concentrations in the area are not a problem at present. The single exception is the cadmium concentration which is only slightly below the limit for all wells except Well 4 which exceeded the limit. The nitrates levels at these sampling times were well below the maximum contaminant level; however, this determination has been performed routinely in the past and several wells, particularly Wells 2, 4 and 5, have exceeded this limit nearly every year.

Groundwater Elevations

Groundwater levels in the Big Stone Plant area are monitored by two methods. Five well points were installed in 1972 in gravel-packed holes to depths of about 25 feet along the county road north of the cooling pond (See Figure 1.). These well points were installed to monitor water levels in the saturated soil for the purpose of detecting possible leakage from the cooling pond. Throughout 1978 measurements were made at the well points at about monthly intervals when the samples were collected. Initially, six farmstead wells (Wells 1, 2, 3, 4, 5 and 7) were fitted with air lines to determine water levels on a monthly basis when samples were collected. During 1977, the air line at Well 7 was broken during well repairs and has not been replaced to date. In 1978, the air line

at Well 2 became plugged after curbing failure and was removed. The recorded water levels for 1978 are included in the Appendix.

During the past several years of monitoring experience, it has been shown that the water levels in the well points north of the cooling pond respond closely to precipitation patterns. Maximum water levels are recorded after periods of high precipitation, especially when water is standing in the ditch next to the well points. Maximum levels have usually occurred in the spring or early summer. Similarly, minimum water levels are observed after extended dry periods and transpiration uses of plants have reduced soil moisture to minimal levels. These conditions usually prevail in the late summer and fall when minimal groundwater levels are usually recorded. The response of the water levels at the well points for an unusually wet year (1977) was compared with that of an extremely dry year (1976) in the 1977 water monitoring report.

During 1978, the precipitation total for the Big Stone Plant area was about normal for the year although there were several aspects of the precipitation and water-level relationships that should be pointed out. Table 3 is a summary of the monthly precipitation at Milbank, South Dakota, from 1972 through 1978 during which the water monitoring program has been operative. From this table, it can be observed that although annual precipitation was near normal, at about 21 inches, the spring and summer growing period from April through September accounted for more than 19 inches of this total. During four months (April, May, July and August) of these six months, rainfall was above normal; and April of 1978 recorded the highest April precipitation since the monitoring program began. By contrast, the monthly precipitation in March and December were the minimum totals for those months during the monitoring program.

TABLE 3 - Monthly Precipitation - Inches
Milbank, South Dakota, 1972-1978

	Mean[1].	1972	1973	1974	1975	1976	1977	1978
January	0.71	0.29	0.10	Trace*	1.69**	0.98	0.37	0.11
February	0.73	0.12*	0.20	0.50	0.19	0.27	1.11**	0.35
March	1.28	1.27	1.59	0.34	1.34	1.28	6.04**	0.16*
April	2.27	2.91	1.10	2.79	2.63	0.67*	3.62	3.77**
May	2.94	5.86**	5.25	2.21	1.16	0.16*	2.42	3.77
June	4.13	1.42	0.46	1.95	3.15**	0.45*	2.99	2.75
July	2.63	5.83**	1.43	1.72	0.25*	0.52	2.51	4.06
August	2.78	1.37	1.40	3.30	2.11	0.79*	4.07**	3.21
September	1.91	0.08*	1.38	0.80	1.82	1.45	3.47**	1.85
October	1.51	1.55	1.55	0.74	1.43	0.17*	3.40**	0.20
November	0.95	1.55	1.00	1.73	0.74	0.00*	3.58**	0.77
December	0.65	0.83	0.42	0.07	0.28	0.26	0.93**	0.06*
Total	22.49	23.08	15.88	16.15	16.79	7.00	34.51	21.06

[1]. Mean precipitation based on 70-71 years of records at the Milbank station.
* Minimum monthly precipitation for years indicated.
** Maximum monthly precipitation for years of monitoring program.

Source: "Climatological Data", United States Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Data Service.

Figure 2 shows the water levels at the well points as recorded during 1978. From this figure, it can be noted that water levels remained comparatively uniform during the summer months when in the past the levels have dropped throughout the summer. This uniformity of water levels in summer would be due to the effect of the higher-than-normal summer precipitation maintaining the water levels in spite of high transpiration requirements of the growing plants. In the fall when precipitation was below normal, the water levels remained nearly constant.

From Figure 2, it will also be noted that the water in well points B and E was frozen during January and February. This is the first time that ice has been noted in the well points during the monitoring program. The unusually high water level that was observed at all well points in December of 1977 was probably frozen during the following cold weather at these two well points. Frost penetration into the high groundwater of the saturated soil might have also been a contributing factor to the unusually low water level in well point D during February. Water level in well point D has been shown in the past to be influenced to some degree by the cooling pond. It may be that the sand lens in which well point D is located is fed by seepage water or groundwater which was subject to frost penetration.

To compare the variation in water level and the maximum and minimum water levels in the well points with data from previous years, Table 4 was prepared. It will be noted from Table 4 that the maximum water level recorded at each of the well points in 1978 was also the maximum recorded during the entire monitoring period. Also, these 1978 maximum levels were recorded in the spring as usually occurs. Similarly, the minimum values occurred at the well points in the fall as usual except for well point D which was possibly influenced by

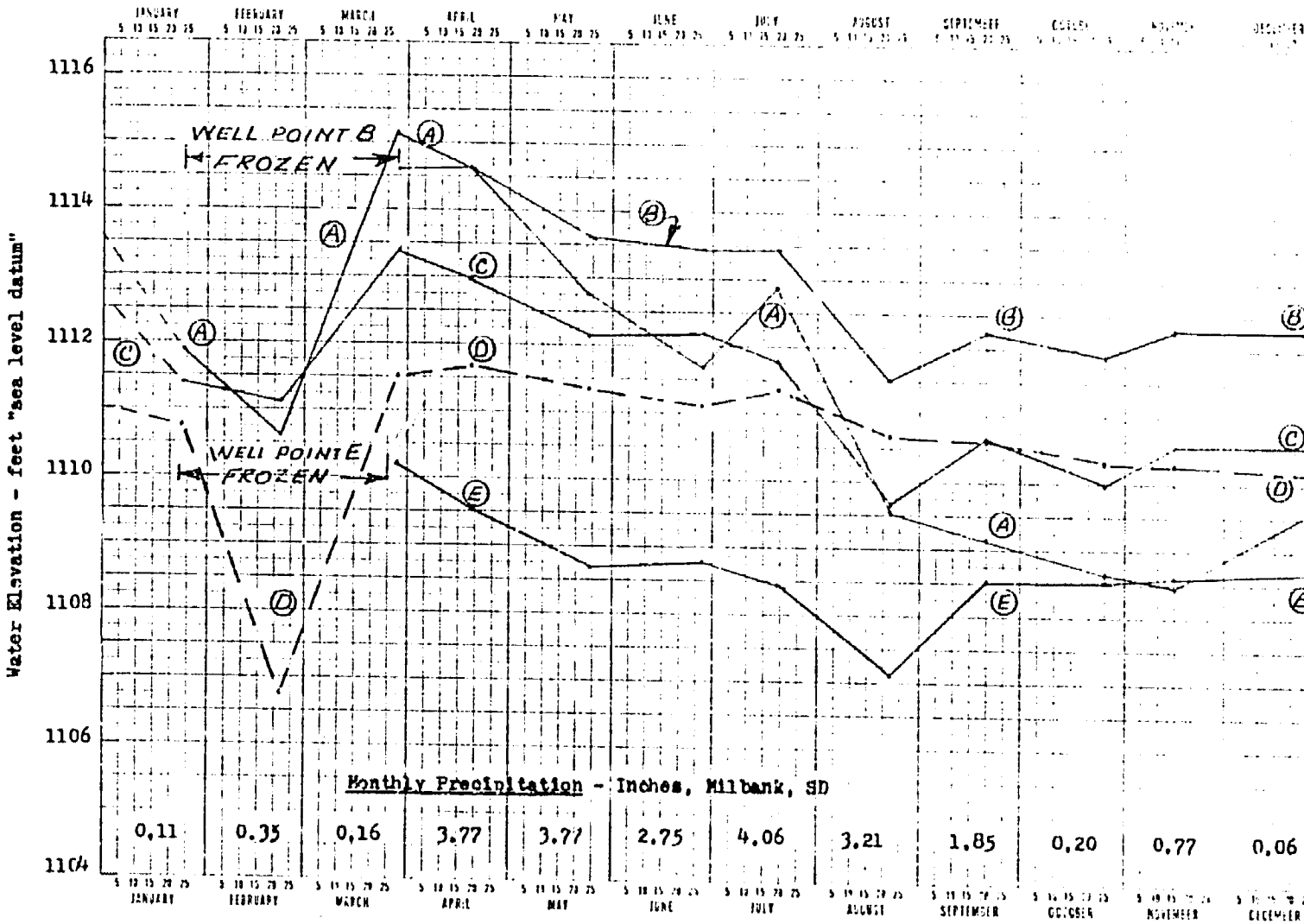


Figure 2 - Water levels in well points along county road north of cooling pond - 1978

TABLE 4
Maximum and Minimum
Water Levels in Five Well Points
North of Cooling Pond, 1972-1977
Big Stone Plant Area
Big Stone City, South Dakota

Well Point	Year	Number of Readings	Maximum Water Level	Minimum Water Level	Difference - feet
A	1972	15	1115.03 June	1108.42 Dec.	6.61
	1973	50	1113.63 Mar.	1106.63 Oct.	7.00
	1974	29	1112.97 Mar.	1106.11 Oct.	6.86
	1975	12	1114.46 Apr.	1105.96 Oct.	8.50
	1976	12	1113.96 Feb.	1102.88 Dec.	11.08
	1977	11	1114.55 Dec.	1102.46 Jan.	12.09
	1978	12	1115.13 Mar.	1108.46 Nov.	6.67
B	1972	15	1114.25 June	1109.29 Dec.	4.96
	1973	50	1114.21 May	1109.37 Sep.	4.84
	1974	29	1113.54 May	1109.18 Jul.	4.36
	1975	12	1114.54 Apr.	1109.46 Sep.	5.08
	1976	12	1114.79 Feb.	1107.04 Sep.	7.75
	1977	11	1113.96 Mar.	1107.96 Jan.	6.00
	1978	10	1114.62 Mar.	1111.54 Aug.	3.08
C	1972	15	1112.97 June	1108.36 Oct.	4.61
	1973	50	1112.49 Mar.	1107.57 Sep.	4.92
	1974	29	1112.07 May	1107.51 July	4.56
	1975	12	1112.82 Apr.	1107.74 Sep.	5.08
	1976	12	1112.74 Feb.	1105.65 Sep.	7.09
	1977	12	1113.40 Dec.	1106.07 Jan.	7.33
	1978	12	1113.40 Mar.	1109.82 Aug.	3.58
D	1972	15	1110.15 June	1105.32 Dec.	4.83
	1973	50	1110.53 May	1105.32 Jan.	5.21
	1974	29	1110.36 May	1109.02 Feb.	1.34
	1975	12	1111.36 Apr.	1108.61 Sep.	2.75
	1976	12	1110.86 Mar.	1006.52 Sep.	4.34
	1977	12	1111.19 Dec.	1108.02 Jan.	3.17
	1978	12	1111.69 Apr.	1106.77 Feb.	4.92
E	1972	15	1108.32 June	1103.44 Dec.	4.88
	1973	50	1109.77 May	1103.36 Jan.	6.41
	1974	29	1109.19 May	1106.28 Jan.	2.91
	1975	12	1109.86 Apr.	1105.52 Sep.	4.34
	1976	12	1109.94 Feb.	1103.02 Sep.	6.92
	1977	12	1109.52 Dec.	1105.77 Jan.	3.75
	1978	10	1110.23 Mar.	1107.11 Aug.	3.12

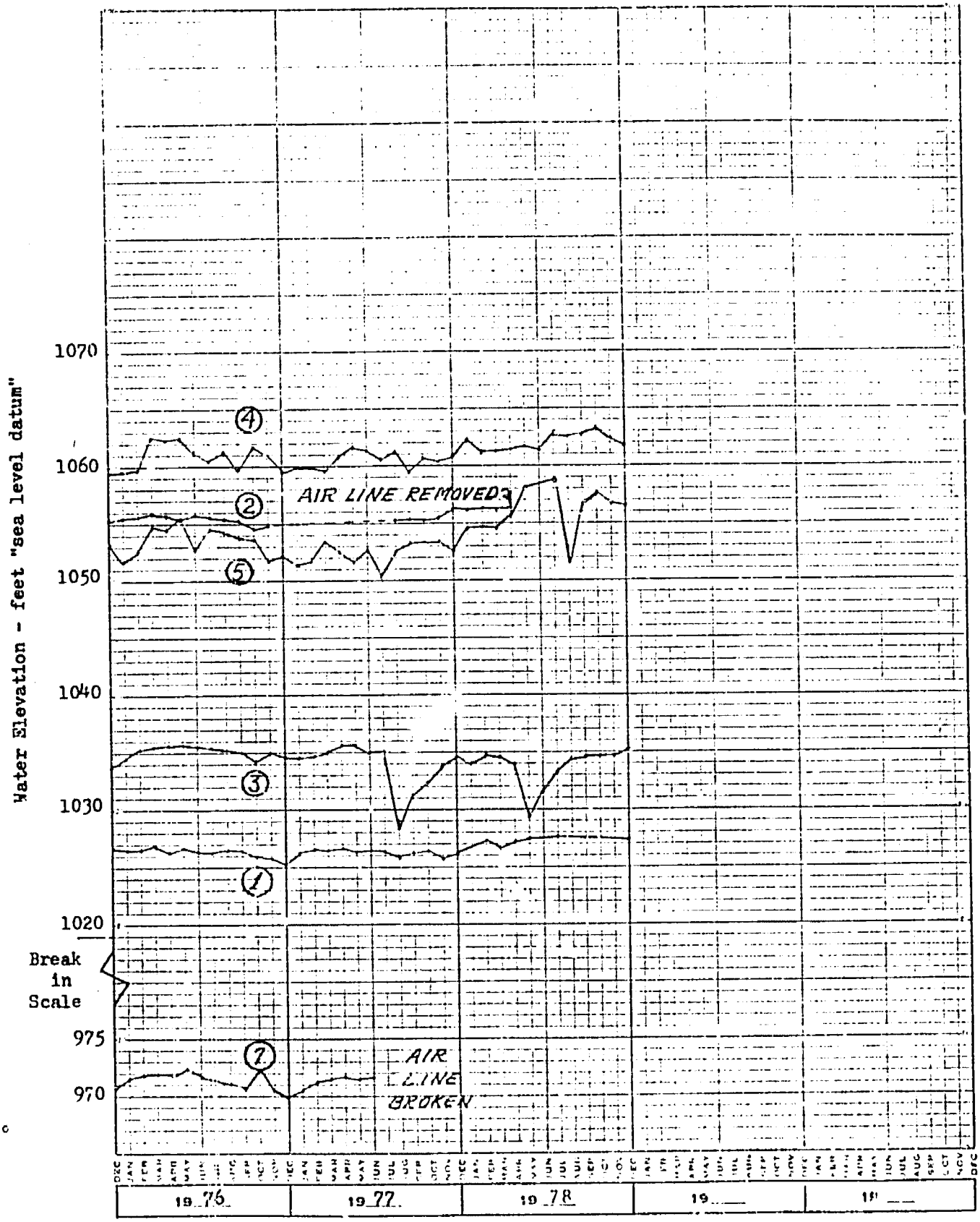
frost penetration as previously explained. These minimum values were also substantially higher than past minimum values. The annual variation in 1978 as indicated by the difference between maximum and minimum water levels was comparatively low considering past monitoring records.

In summary, the well point information for 1978 revealed an overall high water table in the saturated soil even though annual rainfall was near normal. The high rainfall in the summer months prevented the usual pronounced drop in the water level that usually occurs in the summer and, consequently, comparatively uniform water levels prevailed throughout the year. Water level in well point D which is believed to be influenced slightly by pond seepage varied only slightly except for a marked drop in February, possibly due to frost penetration.

Figure 3 shows the water levels recorded at the sampling wells during the past three years. As mentioned previously, the air line in Well 2, located south of the pond, was removed in 1978 because the curbing of that well failed and the line became plugged. This was also the case in early 1977. A complete review of the water levels for Well 2 reveals that since the pond was filled in late 1972, the water levels have remained unusually constant with a total observed variation of only about two feet. This period included both the most severe drought year (1976) and a near record precipitation year (1977). Consequently, the inability to measure water levels at this well does not appear to be important at this time.

At Well 1, located southeast of the pond and directly south of the blow-down pond, the water level was slightly higher than in 1977 and most previous years. The water level at this well has also been quite uniform since the pond was filled, varying less than three feet during the past six years.

Figure 3 -
Groundwater Levels Recorded at Six Wells
Big Stone Plant Area



At Well 3, the water level has been observed to fluctuate substantially during a single year and 1978 was no exception. During 1977 and 1976, rather sharp drops in water level were noted during the summer periods. These sharp fluctuations in water level would be indicative of well pumping influence. Water level fluctuations of more than five feet were, however, also noted at Well 3 during 1973 and 1975 with comparatively uniform water levels in 1974 and 1976, comparatively dry years. Consequently, the hydrologic influences on Well 3 are still not understood. Samples could not be collected from this well since January because of pump failure.

The water level in Well 4 during 1978 was also somewhat higher than in 1977, but in the past (1972-1974) the water has been more than three feet higher than 1978. Similarly the water level at Well 5 was substantially higher in 1978 than during the past several years but did not approach the high water levels (above 1061 feet) recorded in 1972 and 1973.

The air line at Well 7 was broken during well repairs in July 1977 and depth readings have not been possible since that time. Although water level variations in this well were only about three feet total prior to 1977, that well was located so as to best measure the long-term influence of the application of blowdown water to the field directly southwest of the well. Water level data at this well may have been very helpful in interpreting recent water quality data from Well 7.

In summary, the water level data at the well points have demonstrated that climatic factors are the primary influence on water levels in the adjacent agricultural land and that the cooling pond has not been an important factor. The water levels that have been measured in the sampling wells have also been influenced by climatic factors, but water levels in these deeper aquifers do not respond as quickly to precipitation changes.

Cooling Pond

The potential influence of the cooling pond on the surrounding groundwater has been one of the major factors of the water monitoring program. To evaluate this influence, several wells in the vicinity of the plant have been monitored for changes in both water level and water quality. The data collected from these wells have documented that the cooling pond has not had any appreciable effect on the surrounding groundwater through 1978.

In recent years, however, the chemical quality data for the cooling pond has been useful in planning for blowdown from the pond and replenishment of water from Big Stone Lake. The cooling pond was sampled on a quarterly basis during 1973 and 1974 before the plant was in operation. During these years, the water quality in the cooling pond was substantially better than the water quality of the wells in the surrounding area, and comparatively little change in pond water quality throughout the year was noted. In 1975, monthly samples were collected to provide base data to compare with similar data after the plant was in operation.

In 1976 with the plant in operation, it was noted that concentrations of virtually all parameters increased rapidly throughout the year. In 1977, with substantial withdrawals of water from the cooling pond to the blowdown pond and replacement with water from Big Stone Lake, it was possible to accomplish some reduced concentrations in the cooling pond in the spring and fall. Nevertheless, maximum concentrations of many constituents occurred in the cooling pond in February and September of 1977 prior to the additions of water.

Table 5 contains the results of the analyses of samples collected from the cooling pond in 1978. Although the concentrations varied considerably throughout the year, most concentrations were maintained at substantially

COOLING POND (At plant intake structure) TABLE 5 Station: CP - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	11.2	8.7	16	11.7	25.0	28.5	30	26.5	14.2	15.5	10.0	4.6
pH - units	7.7	8.0	6.7	8.1	8.3	7.3	8.1	7.9	8.3	8.4	7.8	8.3
Conductivity - micromhos/cm-25°C	2203	2720	2620	2287	2450	2370	2555	2845	2460	2755	2726	2405
Total Hardness	1095	1135	1181	1016	922	1028	1025	1130	1180	1237	1302	1287
Calcium Hardness	650	545	660	510	502	526	500	530	545	552	589	565
Sodium	190	155	210	165	153	133	144	203	205	248	244	239
Total Alkalinity	136	138	124	135	142	129	135	134	133	130	132	138
Chlorides	53	55	57	50	52	52	52	59	58	55	49	55
Sulfates	1200	1150	1350	940	980	1200	1120	1310	1340	1410	1610	1530
Total Phosphorus	0.04	0.04	0.05	0.11	0.03	0.03	0.03	0.06	0.04	0.05	0.05	0.03
Nitrate Nitrogen	0.08	0.07	0.02	0.06	0.02	0	0.01	0.03	0	0.05	0.01	0.01
Ammonia Nitrogen	0.14	0.10	0.10	0.18	0.22	0.10	0.12	0.11	0.10	0.13	0.09	0.06
Kjeldahl Nitrogen	1.50	1.45	1.55	1.55	1.45	1.8	1.6	1.4	1.2	1.6	2.2	2.0
Total Residue	2218	2265	2319	2049	1976	2167	2225	2435	2475	2591	2708	2684
Total Suspended Matter	6	8	32	65	19	17	15	30	30	21	14	17
Dissolved Oxygen	11.6	11.4	8.7	8.8	8.6	7.4	7.0	7.3	8.3	7.5	9.6	11.7
Biochemical Oxygen Demand	5.5	3.4	2.2	6.0	5.8	3.3	3.0	5.3	2.5	4.0	2.2	4.4
Turbidity	5.6	3.3	8.3	12	6.2	4.8	4.6	6.5	6.4	4.4	5.0	6.9
Coliform Group - MPN/100 ml	< 5	55	< 5		old	4300	450	650	1200	25	5	10
Fecal Coliforms - MPN/100 ml	< 3	33	3		old	2	27	130	< 3	< 3	< 3	< 3

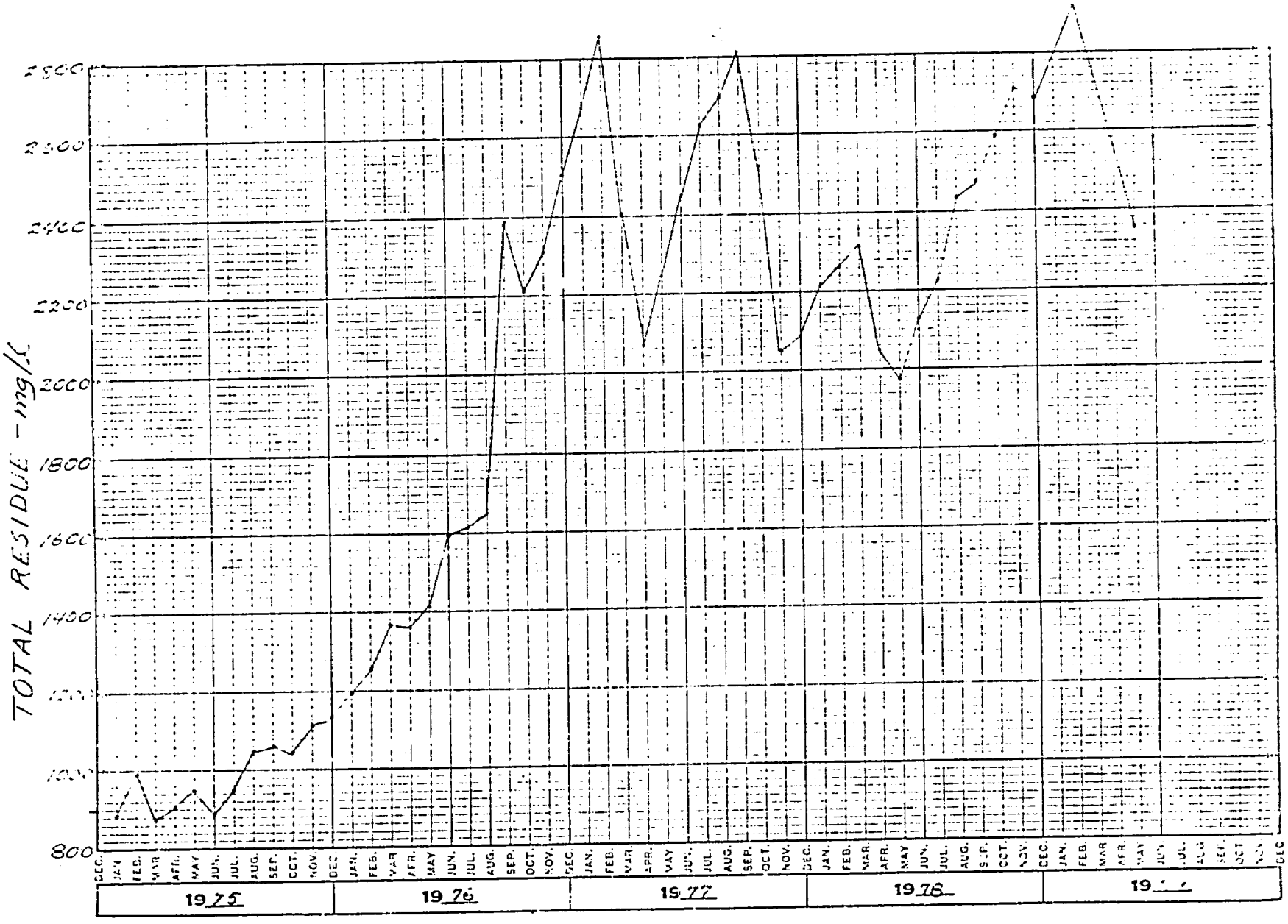
*Results expressed as mg/l except as noted.

lower levels than during 1977. With the exception of sodium, the maximum concentration of all constituents was lower in 1978 than in 1977. Virtually all determinations had slightly lower mean concentrations in 1978 compared to 1977. There was, however, a general trend of increasing concentrations of many of the dissolved constituents in the second half of the year, and somewhat higher concentrations of most constituents were noted at the end of the year.

There was a substantial increase in total suspended matter and turbidity in April when the maximum concentrations of these constituents were recorded. During April, over one-half of the total water purped from Big Stone Lake in 1978 was added to the cooling pond. Also, it was during April that suspended solids were unusually high in Big Stone Lake, apparently from previous inflow from the Whetstone River. Nevertheless, the concentrations of dissolved chemical constituents such as calcium, sodium, sulfates and total residue were substantially reduced after the April and May additions of water to the cooling pond. Natural coagulation and sedimentation seems to have removed much of the suspended solids by May.

Total residue concentrations have been used in past reports to demonstrate the overall trends in concentrations of dissolved constituents or salinity in the cooling pond. For this determination, a specific volume of water is evaporated to dryness and the remaining salts weighed and reported as total residue concentration. Consequently, the total residue concentration reflects the combined effects or salinity of all the individual ions. Figure 4 shows the total residue concentration in the cooling pond since monthly samples were collected.

Figure 4 - Total Residue of Cooling Pond Water



It can be seen from Figure 4 that in 1978 the total residue concentration was generally at lower levels than in 1977. Past periods of sharp increases of total residue in the cooling pond (November 1976-February 1977 and April 1977 to July 1977) demonstrate that total residue in the cooling pond can be expected to increase at a rate of about 185 mg/l per month as a result of evaporation losses. In 1978, with some water pumped from Big Stone Lake to the cooling pond in May, June, July, October and November, the average rate of increase was only 120 mg/l per month. Nevertheless, the December 1978 sample revealed a higher concentration of total residue than the previous two December samples, and further increases occurred to February 1979 when a high of 2919 mg/l was measured.

During the fall of 1977, removal of large quantities of blowdown (about 910 acre-feet) from the cooling pond combined with pumpage (about 460 acre-feet) from Big Stone Lake substantially reduced the total residue concentrations and pond salinity in general. At the end of 1977, the salinity was at comparatively low levels. In the spring (April-July) of 1978, a total of 2500 acre-feet of water was also pumped to the pond. Two-thirds of that pumpage occurred in April after an estimated blowdown of about 900 feet and substantial reductions were again noted (See Figure 4). Pumpage of an additional 615 acre-feet in the fall of 1978 without a previous blowdown from the cooling pond did not, however, reduce the residue and salinity of the pond. Thus, the importance of removing large quantities of blowdown from the cooling pond prior to pumpage from Big Stone Lake was evident.

The land-disposal system presently used at the plant to control salinity in the cooling pond includes a number of factors that require considerable

coordination. Pumpage from Big Stone Lake should be accomplished when the lake quality is best, but it should also be preceded by blowdown from the pond. However, storage capacity in the blowdown pond and the availability of water from the lake are limiting factors. The irrigation of blowdown water to the land must be accomplished when the soil is not frozen and within other climatic constraints that influence infiltration capacity.

Cropping practices also present a time constraint to the operation of the irrigation system and also influence the quality of water that may be applied. The transfer of huge quantities of water from the lake to the cooling pond, from the pond to the blowdown pond and through the irrigation system also requires long time periods. Because of the many factors involved, it is unlikely that an established routine for operation of the land-disposal system to maximize salinity control for the cooling pond will ever be possible. Certainly, there has not been sufficient experience with the present land-disposal system to evaluate its influence on the quality of the groundwater underlying that area. Nevertheless, it would appear to be desirable to operate the available land-disposal system so as to maximize salinity control in the cooling pond as much as practical. The water monitoring program in the future will serve primarily to document groundwater quality changes, if any, that occur.

Samples from the blowdown pond were not collected during 1978 although they are being collected in 1979. This information is helpful because certain ions such as sodium can deflocculate the soil and further reduce its ability to accept water. Excessive salinity, usually measured with the specific conductance determination, also retards plant growth. Consequently, future quality information for the blowdown pond will be helpful in estimating the ability of the soil to accept saline water and still grow crops.

It is our understanding that a brine concentrator will be installed to control the salinity of the water in the cooling pond in the future. Because we have not been informed on the nature of the unit and how it may influence the existing land-application system, the overall influence of the operation of the brine concentrator on the water monitoring program cannot be anticipated at this time.

Surface Water Quality

The Big Stone Plant is not expected to influence the surface water quality in the plant area except in a highly unusual runoff situation. Nevertheless, sampling stations have been established to document the surface water quality and observe natural quality variations on Big Stone Lake, the Minnesota River, and the Whetstone River. The two stations on the Whetstone River were established at bridges upstream and downstream from points where surface drainage from the plant site would enter the river. The results of analyses of the monthly samples collected at these stations are appended to this report.

Table 6 includes the mean concentration and range of concentrations of constituents obtained in 1978 for the surface water stations. As in past years, wide variations in quality were noted at all sampling stations with the variation due primarily to seasonal climatic conditions. Overall, however, the mean values in 1978 suggest a slightly improved quality compared to 1977. The samples collected on March 28, 1978, are particularly noteworthy as they represent a pronounced snowmelt runoff condition.

The mean concentrations of chemical constituents for the two stations on the Whetstone River do not compare as closely in 1978 as has been the case for previous years. This variation in mean values between the two stations may be

TABLE 6 - Mean and Range of Concentrations of Chemical Constituents for Samples from Four Surface Sampling Stations
Big Stone Plant Area - January-December 1978

Determination*	Big Stone Lake		Minnesota River		W-1 Whetstone River		W-2	
	Mean	Range	Mean	Range	Mean	Range	Mean**	Range
Temperature - °C		1.5-26.5		0-26		0-25.2		0.5-24.2
pH - units		7.3-8.8		6.7-8.5		7.3-8.2		7.1-8.2
Conductivity - µmhos/cm-25°C	1072	320-1835	999	375-1470	1113	380-1490	1066	360-1443
Total Hardness	495	119-850	514	162-730	539	198-715	495	151-666
Calcium Hardness	278	91-520	310	111-505	338	140-500	313	106-388
Sodium	51	10-88	48	12-74	46	11-88	42	9.8-89
Total Alkalinity	175	90-243	243	116-367	289	107-368	273	113-372
Chlorides	17.9	7.1-34	18.4	5.7-46	24.7	6.1-57	21.3	5.0-65
Sulfates	409	84-800	346	104-438	317	120-454	291	90-385
Total Phosphorus	0.18	0.05-0.47	0.30	0.09-0.74	0.30	0.11-0.62	0.25	0.09-0.57
Nitrate Nitrogen	0.25	0.02-1.12	0.35	0.01-1.05	0.34	0.01-1.03	0.26	0.02-1.06
Ammonia Nitrogen	0.40	0.09-1.51	0.53	0.12-1.33	0.52	0.10-1.60	0.36	0.07-1.23
Kjeldahl Nitrogen	1.59	0.95-2.60	1.35	0.40-2.15	1.18	0.40-2.20	1.2	0.5-2.40
Total Residue	896	268-1453	897	632-1158	879	517-1140	815	466-1099
Total Suspended Matter	38	9-173	72	3-350	36	6-250	37	8-225
Dissolved Oxygen	9.6	7.5-11.8	8.8	5.9-13.3	8.8	5.8-13.1	8.4	5.3-13.2
Biochemical Oxygen Demand	5.1	2.4-10.3	5.7	3.1-11.3	4.8	2.6-13.1	3.5	1.7-6.1
Turbidity	11.6	2.5-43	14.1	5.1-43	11.8	4.6-55	11.9	4.6-50
Coliform Group - MPN/100 ml		< 5-1400		75-4600		100-28000		100-3300
Fecal Coliforms - MPN/100 ml		< 3-20		3-400		13-3800		40-330

*Results expressed as mg/l except as noted. **Mean values for W-2 represent 10 samples.

the result of a different number of samples because samples could not be collected at station W-2 during January and February when the river was apparently frozen to the ground. Field sheets indicated about three feet of ice at two locations. It can be noted that the general range of concentrations for the year was quite comparable in many instances between the two stations.

The March 28, 1978, samples represented a high-flow condition resulting from snowmelt runoff. Minimum values were recorded for conductivity, total and calcium hardness, sodium and sulfates at the Whetstone River for the entire monitoring program since 1972. The suspended solids concentrations in March were also the maximum recorded since monthly sampling was started and would be typical of a high-flow surface runoff condition. Photographs of the Whetstone and Minnesota River sampling stations are included in Figure 5 to reveal the river conditions at the time the March samples were collected.

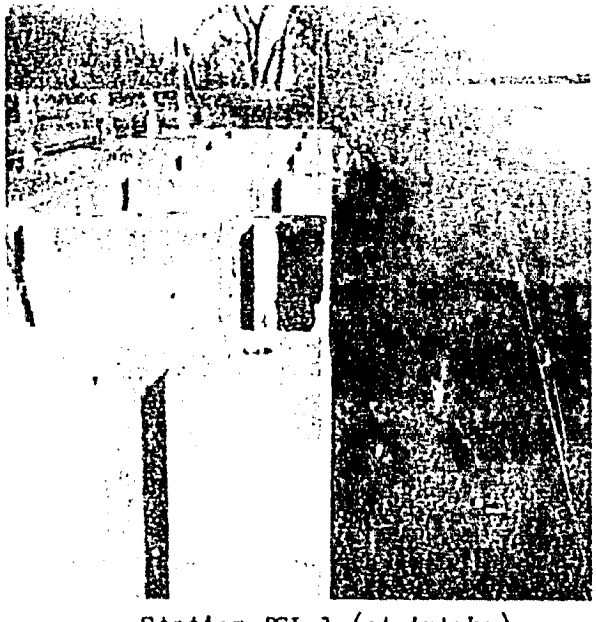
Although the March 28, 1978, samples represented a high-flow condition due to snowmelt runoff and the chemical quality was exceptionally good at this time, it should be recognized that the more extreme values for the various constituents have probably not been observed for the Whetstone River stations. For example, while planning the monitoring program in 1971, samples were collected from the Whetstone River that represented the runoff occurring after several inches of rainfall had occurred in the area. Selected results taken from the October 20, 1971, "Progress Report for a Water Quality Monitoring Program for the Big Stone Lake Power Plant" are included in the following table.



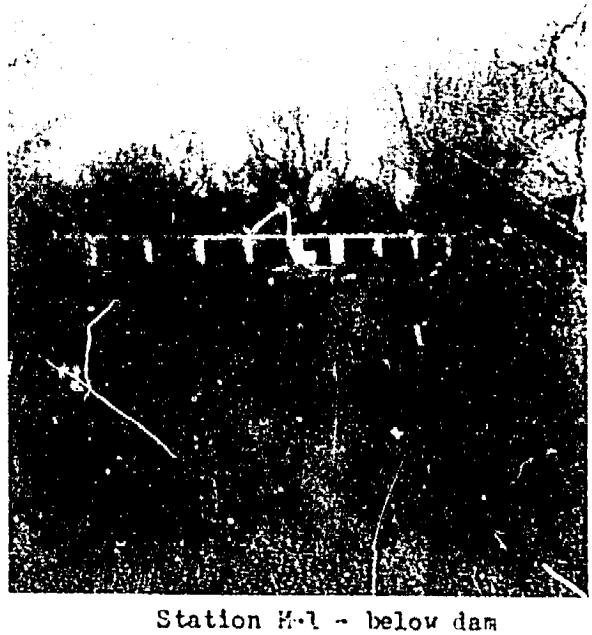
Station W-1 (upstream)



Station W-2 (upstream)



Station BSL-1 (at intake)



Station M-1 - below dam

Figure 5 - Photographs of Whetstone and Minnesota Rivers and Big Stone Lake Sampling Stations Taken March 28, 1978

TABLE 7 - Results of Analyses of Selected Determinations for the Whetstone River for Known Surface Runoff Conditions

Determination (mg/l except as noted)		Rainfall Runoff June 20, 1971	Snowmelt Runoff March 28, 1978
Conductivity (µmhos/cm@25°C)	W-2	341	360
	W-1	355	380
Suspended Residue	W-2	622	225
	W-1	806	250
Total Hardness	W-2	180	151
	W-1	180	198
Calcium Hardness	W-2	100	106
	W-1	120	140

From these results (Table 7), it will be noted that low conductivity which is indicative of low dissolved solids concentrations occurred from both runoff conditions. With surface runoff conditions, total and calcium hardness and conductivity, which are representative of dissolved chemical quality, occurred at values only about one-third as high as the mean annual values of 1978 (See Table 6). By contrast, the suspended solids concentrations that occurred after rainfall runoff in June 1971 were about three times higher than those of snowmelt runoff conditions in 1978 which represent the maximum values observed by monthly sampling since November 1971. From these comparisons, it should be obvious that routine monthly samples for the Whetstone River are unlikely to detect the extremes of water quality but the past monthly data covering about seven years should well define the usual surface water quality.

In 1978 the overall chemical quality of water in Big Stone Lake was greatly improved over recent years. For example, the mean concentrations in 1978 of the major chemical constituents such as those causing hardness and

dissolved ions such as chlorides and sulfates were only about 75 to 80 per cent as high as in 1977. Also, mean values for total residue and conductivity in 1978 were about 78 per cent of 1977 values. Overall, the 1978 mean values for such constituents as conductivity, total hardness, sulfates and total residue were the lowest since 1973 demonstrating the importance of above-average precipitation and resulting surface runoff maintaining better chemical quality of the lake water.

As in past years, the maximum values for many chemical constituents occurred in the February samples when the freeze-out effect of thick ice cover concentrates the dissolved constituents in the underlying water. By contrast, the minimum values were recorded for the March sample when much of the ice cover was melted and surface runoff had entered the lake. It should be emphasized that the March sample is probably not fully representative of lake water quality as a whole because the partially melted ice cover prevented adequate mixing by wind action of the surface runoff with the overall lake contents (See Figure 5). Nevertheless, the late summer and fall samples revealed a much improved water quality for Big Stone Lake for 1978.

The April samples from Big Stone Lake and the Minnesota River revealed unusually high suspended solids concentrations while these high concentrations were not shown in Whetstone River samples. Field notes recorded that the Whetstone River was "gently flowing within its banks" and had "low turbidity." By comparison, for the Minnesota River, the field sheets included "very high flow" and "high turbidity." Similarly, Big Stone Lake comments for April included "high waves on lake," "high turbidity" and "much floating debris." It appears that during the high spring flows of the Whetstone River preceding the April sample, sufficient overflow into

Big Stone Lake may have occurred to fill the south end of the lake with turbid water, high in suspended matter. When the Whetstone River flow receded, outflow from Big Stone Lake accounted for the major portion of the Minnesota River flow.

The quality of the Minnesota River samples recorded for 1978 in most instances most closely resembles that of the Whetstone River; however, at times the overflow of Big Stone Lake influences the Minnesota River quality. For example, similar to the Whetstone River the Minnesota River sample on March 28, 1978, revealed minimum values for conductivity, total and calcium hardness, sodium and sulfates recorded for the entire monitoring program since 1972. Also similar to the Big Stone Lake quality, the annual mean concentrations for conductivity, total hardness, chlorides and total residue were the lowest since 1973.

On specific months such as May and June 1978, the Minnesota River samples reflect a mixture of the quality recorded for the Whetstone River and Big Stone Lake. On other months, the quality recorded for the Minnesota River is nearly identical to that of the Whetstone River as in November 1978. In the past, the annual data for Minnesota River has revealed a slightly wider range of values than either the Whetstone River or Big Stone Lake alone. Situations of this type make comparison from year to year of quality data for the Minnesota River extremely difficult and somewhat meaningless as the results are entirely dependent upon the hydrologic conditions that prevail at sampling time. For these reasons, it is recommended that the Minnesota River sampling station be dropped from the Big Stone Plant water monitoring program.

Recommendations for Continued Monitoring

The purpose of a water monitoring program as followed by the companies for the Big Stone Plant is to determine if changes in water quality or groundwater conditions occur as a result of plant operation and to determine the significance of these changes to provide information for corrective action if necessary. The program was initiated and has been conducted primarily to minimize the possibility of the power plant being held responsible for alleged degradation of local waters when in fact no actual changes in water quality have occurred or when other sources may be the cause of quality changes.

A water monitoring program related to disposal of wastewaters by land application has, in general, several overall functions:

1. To obtain base-line data before changes occur;
2. Documentation of conditions to prove that requirements are met;
3. Confirmation of the adequacy of the design;
4. Act as a source of data for future design; and
5. Forms a basis for certain management decisions.

To enable the monitoring system at the Big Stone Plant to be most effective, sampling sites established to obtain background water quality and water levels have been maintained almost intact for the post operational monitoring program that has continued. There are, however, certain changes in water monitoring that appear warranted at this time for reasons of economy and practicality.

On January 23, 1979, a meeting was held at the Big Stone Plant to discuss continuation of the monitoring program. Possible changes that might be warranted were discussed even though the annual evaluation of 1978 data had not been completed. As a result of this discussion and the subsequent data

evaluation, the following changes are proposed for the water monitoring program for 1979:

1. Reduce the frequency of sampling to quarterly from annually for both the well and surface water sampling stations. Quarterly samples are expected to provide sufficient data to compute adequate mean values to compare with past background and operational data. Quarterly samples could be either a January, April, July and October sequence or a February, May, August and November sequence to provide for seasonal variation. Analytical quality control would be obtained from duplicate analyses in most cases. This change recognizes a trade-off of more frequent cooling pond and Big Stone Lake analyses for economy purposes.

2. Eliminate the sampling points at Well 2 and at M-1 on the Minnesota River. Well 2, although in an excellent location for monitoring the groundwater, has experienced a curbing failure and would need a complete repair. The normally poor water quality at the well would also make detection of adverse quality changes difficult. The water quality data at station M-1 on the Minnesota River has been difficult to interpret since it is a mixture of Whetstone River and Big Stone Lake water and subject to extreme variations depending upon the predominant source of flow. Monitoring of both the Big Stone Lake and the Whetstone River sources individually as in the past is recommended.

3. Eliminate water level measurements at the 5 well points north of the pond. Sufficient water level information has been collected at these points to serve the original purpose of determining if there

was any influence of the pond on the adjacent land. The existing data demonstrates that the weather conditions, and not the cooling pond, are the major influencing factors regarding water level in the adjacent agricultural lands.

4. Add the blowdown pond as a surface sampling station during the spring and summer. This data is desirable to record the quality of water applied to the land so as to evaluate the impact of irrigation on the soil and the underlying groundwater.

5. Continue to report analytical data quarterly but data evaluation and interpretations would be confined to an annual basis reported in an annual report. It is anticipated that if a cursory inspection of quarterly data reveals an unusual quality this situation would be reported with the data.

Additional changes such as complete elimination of the Big Stone City water supply as a sampling station and sampling of Wells 4, 5 and 6 only on an annual basis were considered. These stations were initially included to provide information on groundwater quality of the area and to protect the companies from unwarranted criticism by the public and regulatory agencies. These reasons are still very valid especially since the Big Stone City water supply wells are the most important of all wells in the area. Also single samples do not sufficiently describe water quality on an annual basis even from a groundwater source. Consequently, the above changes were rejected.

With the recommended changes, the water monitoring program will still contain all of the original, essential features and the overall integrity of the essential data is preserved. Quarterly data collection will

substantially reduce costs but still adequately document future conditions for comparison with the original base-line data and demonstrate the adequacy of the Big Stone Plant system to prevent environmental degradation. Long-term continuity of data at specific sites is of prime importance for a water monitoring program.

APPENDIX

BIG STONE LAKE (at lake intake to pumping station)

Station: BSL - 1

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	2.3	2.6	2.5	3.0	21.0	24.1	26.5	21.9	16.3	8.9	2.0	1.5
pH - units	7.5	7.8	7.3	7.9	8.1	8.4	7.9	8.6	8.6	8.8	8.3	8.2
Conductivity - µmhos/cm-25°C	1322	1835	320	973	1000	1082	1082	1082	1017	1012	982	1162
Total Hardness	810	850	119	449	454	476	445	443	451	461	470	506
Calcium Hardness	520	465	91	350	268	260	233	221	218	220	238	253
Sodium	87	88	10	41	51	40	44	48	47	45	51	58
Total Alkalinity	243	238	90	140	162	169	164	153	157	178	177	216
Chlorides	33	34	7.1	18	18	10	21	20	16	13	7.3	18
Sulfates	580	800	84	376	396	424	354	342	354	394	372	428
Total Phosphorus	0.13	0.21	0.47	0.17	0.05	0.1	0.12	0.17	0.16	0.21	0.14	0.19
Nitrate Nitrogen	0.33	0.28	1.12	0.56	0.08	0.04	0.02	0.07	0.02	0.12	0.12	0.19
Ammonia Nitrogen	0.37	0.34	1.51	0.09	0.30	0.10	0.25	0.36	0.28	0.18	0.42	0.57
Kjeldahl Nitrogen	1.35	1.50	2.60	1.40	0.95	1.2	1.3	1.8	1.1	1.4	2.1	2.4
Total Residue	1356	1453	268	871	833	888	800	912	830	880	753	905
Total Suspended Matter	9	33	37	173	14	19	22	42	23	57	12	10
Dissolved Oxygen	10.7	10.4	8.7	11.7	7.5	8.4	9.1	8.1	7.7	10.4	11.8	11.0
Biochemical Oxygen Demand	5.5	4.0	5.0	7.5	3.0	2.4	6.0	10.3	4.9	7.0	2.6	3.5
Turbidity	2.5	6.5	5.7	43	5.0	10.5	8.4	14.3	12.6	23.0	4.4	3.1
Coliform Group - MPN/100 ml	< 5	300	550		old	1400	200	50	55	25	< 5	5
Fecal Coliforms - MPN/100 ml	< 3	< 3	< 3		old	20	7	3	3	< 3	< 3	< 3

*Results expressed as mg/l except as noted.

MINNESOTA RIVER (At lake outlet control structure)

Station: M - 1

Determination*	Sampling Dates - 1978											
	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	0	0	3.0	3.1	21.4	24.9	26	22.3	16.8	11.1	1.2	1.0
pH - units	7.4	6.7	7.7	7.8	8.0	8.4	8.4	8.3	8.5	8.4	8.1	7.9
Conductivity - µmhos/cm-25°C	1300	1470	375	986	1110	1004	1072	1152	1017	1039	1092	1373
Total Hardness	730	705	162	426	502	472	446	500	459	487	566	718
Calcium Hardness	505	445	111	325	306	288	260	299	227	265	311	382
Sodium	72	64	12	43	47	37	44	41	48	44	51	74
Total Alkalinity	367	349	116	136	210	223	171	284	184	203	303	367
Chlorides	45	46	5.7	18	7.6	8.4	10	28	12	16	11	13
Sulfates	420	330	104	386	360	422	362	302	340	386	300	438
Total Phosphorus	0.32	0.40	0.74	0.58	0.11	0.24	0.17	0.25	0.22	0.18	0.09	0.26
Nitrate Nitrogen	0.95	0.67	1.05	0.57	0.08	0.03	0.18	0.14	0.01	0.09	0.06	0.42
Ammonia Nitrogen	1.13	1.33	0.95	0.33	0.31	0.12	0.21	0.18	0.42	0.43	0.12	0.78
Kjeldahl Nitrogen	1.35	1.55	2.15	1.70	0.90	1.4	1.5	0.4	1.3	1.6	0.9	1.5
Total Residue	1158	1072	632	1007	835	819	800	887	534	830	828	1061
Total Suspended Matter	8	3	350	312	30	39	17	31	29	19	13	9
Dissolved Oxygen	9.6	10	9.9	11.5	6.0	6.1	8.0	5.9	7.8	7.5	13.3	9.8
Biochemical Oxygen Demand	8.2	4.0	6.8	4.8	4.3	4.7	7.8	5.6	11.3	4.6	3.1	3.5
Turbidity	5.1	5.2	40	43	9.0	11.4	6.8	8.8	13.1	11.0	9.4	6.4
Coliform Group - MPN/100 ml	75	1100	4300		old	4600	500	130	330	150	1300	1800
Fecal Coliforms - MPN/100 ml	10	10	50		old	400	20	23	110	43	3	30

*Results expressed as mg/l except as noted.

Station: W - 1

WHETSTONE RIVER (U.S. Hwy. 12 - west of Big Stone City)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	0.5	0	4.0	4.8	21.2	23.1	25.2	21.2	14.3	8.2	1.0	1.0
pH - units	7.5	7.7	7.3	8.0	8.1	8.2	8.2	8.1	8.0	8.1	8.0	7.9
Conductivity - µmhos/cm-25°C	1285	1490	380	940	1170	1047	1258	1142	1017	1117	1097	1413
Total Hardness	715	700	198	467	686	508	486	509	452	539	559	655
Calcium Hardness	500	450	140	319	370	364	322	301	280	325	323	367
Sodium	73	66	11	29	44	36	33	41	40	45	51	88
Total Alkalinity	368	345	107	240	291	262	320	298	259	301	307	366
Chlorides	45	45	6.1	13	9.6	10	20	28	28	28	6.4	57
Sulfates	375	336	120	396	454	329	284	269	260	300	309	375
Total Phosphorus	0.38	0.54	0.62	0.32	0.14	0.20	0.25	0.26	0.21	0.11	0.11	0.41
Nitrate Nitrogen	0.97	0.69	1.03	0.60	0.07	0.05	0.03	0.06	0.02	0.01	0.09	0.48
Ammonia Nitrogen	1.16	1.60	1.02	0.27	0.16	0.10	0.17	0.27	0.16	0.18	0.14	1.05
Kjeldahl Nitrogen	1.45	1.60	2.20	0.90	0.80	1.2	1.1	0.7	0.4	0.8	1.25	1.75
Total Residue	1140	1052	517	726	907	916	866	917	765	843	837	1064
Total Suspended Matter	7	6	250	36	15	14	22	36	18	9	13	9
Dissolved Oxygen	9.6	9.6	10.0	10.2	7.2	6.1	5.8	6.3	8.4	9.1	13.1	10.3
Biochemical Oxygen Demand	3.7	2.7	6.1	13.1	4.1	3.9	3.5	5.1	3.5	5.1	3.9	2.6
Turbidity	7.3	8.8	55	11	6.4	7.5	12	11.7	7.1	4.6	5.8	4.8
Coliform Group - MPN/100 ml	200	2400	1400		old	20000	10000	28000	1500	100	1200	120
Fecal Coliforms - MPN/100 ml	13	80	20		old	3800	180	70	160	10	37	90

*Results expressed as mg/l except as noted.

WHETSTONE RIVER (On county road 1½ miles south of plant site) Station: W - 2

Determination*	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
			Sampling Dates - 1978									
Temperature - °C			3.0	4.1	19.8	22.5	24.2	21.8	15	8.2	1.0	0.5
pH - units			7.1	8.0	8.0	8.2	8.0	7.9	8.0	8.2	8.1	7.9
Conductivity - µmhos/cm-25°C	NO SAMPLE	NO SAMPLE	360	944	1160	1157	1243	1142	1027	1097	1087	1443
Total Hardness			151	490	548	518	518	507	460	531	557	666
Calcium Hardness			106	360	368	330	322	309	283	328	331	388
Sodium			9.8	25	44	37	37	38	43	46	51	89
Total Alkalinity			113	236	285	264	312	295	257	297	299	372
Chlorides			5.8	13	5.0	12	23	25	30	27	7.1	55
Sulfates			90	286	364	338	282	276	252	294	318	385
Total Phosphorus			0.57	0.18	0.11	0.21	0.24	0.24	0.21	0.09	0.11	0.51
Nitrate Nitrogen			1.06	0.74	0.07	0.05	0.09	0.04	0.03	0.02	0.10	0.41
Ammonia Nitrogen			1.00	0.31	0.19	0.08	0.10	0.27	0.21	0.11	0.07	1.23
Kjeldahl Nitrogen			2.10	1.05	1.35	1.1	1.1	0.7	0.5	0.7	0.9	2.4
Total Residue			466	693	878	887	838	883	756	827	820	1099
Total Suspended Matter			225	33	11	28	22	13	15	8	10	10
Dissolved Oxygen			9.8	10.5	6.72	5.7	5.3	6.5	7.3	9.3	13.2	9.8
Biochemical Oxygen Demand			6.1	1.8	1.7	2.1	4.6	4.4	2.6	3.1	4.0	4.2
Turbidity			50	15	5.3	8.9	6.2	12.0	5.8	4.8	6.1	4.6
Coliform Group - MPN/100 ml			3300		old	1700	1300	600	2200	100	750	710
Fecal Coliforms - MPN/100 ml			67		old	320	110	60	330	40	130	120

*Results expressed as mg/l except as noted.

DERALD HAY FARM (SW ¼, Sec. 7)(Southeast of cooling pond on plant site) Station: Well - 1

Determination*	Sampling Dates - 1978											
	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	10.0	9.0	9.5	8.9	11.1	10.4	11.0	9.9	9.7	9.0	9.0	9.7
pH - units	7.0	7.0	7.0	7.0	7.3	7.0	6.9	6.9	7.0	6.9	6.9	7.1
Conductivity - µmhos/cm-25°C	1768	2150	1950	1836	2080	1563	1964	1994	1854	1914	1904	1804
Total Hardness	1250	1610	1188	1184	1536	1168	1190	1249	1245	1270	1310	1277
Calcium Hardness	950	715	679	685	778	886	796	818	845	854	857	714
Sodium	20	22	20	23	23	13	15	17	17	17	19	24
Total Alkalinity	398	386	360	350	373	414	425	418	407	411	401	386
Chlorides	21.8	30	44	73	124	14	6.7	20	7.0	3.5	4.2	27
Sulfates	740	665	735	650	645	775	790	845	830	955	890	805
Total Phosphorus	0.02			0.02			0.14			0.03		
Nitrate Nitrogen	9.80	15.6	24	37	51	2.8	1.3	7.9	1.38	0.54	0.43	16.8
Ammonia Nitrogen	0.16			0.09			0.34			0.36		
Kjeldahl Nitrogen	0.43			0.45			0.40			0.50		
Total Residue	1670	1733	1695	1621	1927	1815	1772	1820	1824	1807	1814	1783
Coliform Group - MPN/100 ml								<1				
Iron										1.0		

*Results expressed as mg/l except as noted.

Station: Well - 2

TRAILER SITE (SE ¼, Sec. 12)(South of cooling pond)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	8.8	8.0	9.0	8.6	13							
pH - units	6.8	6.7	6.7	6.8	7.0							
Conductivity - µmhos/cm-25°C	2633	3240	2935	2885	2780	NO	NO	NO	NO	NO	NO	NO
Total Hardness	2105	2195	2119	2022	1992							
Calcium Hardness	1530	1485	1495	1491	1374	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE	SAMPLE
Sodium	25	29	29	30	28							
Total Alkalinity	490	465	467	467	541							
Chlorides	45	45	45	44	44							
Sulfates	1310	1280	1580	1510	1340							
Total Phosphorus	0.20			0.14								
Nitrate Nitrogen	0.27	0.44	0.29	0.29	0.07							
Ammonia Nitrogen	1.30			1.50								
Kjeldahl Nitrogen	3.10			1.55								
Total Residue	2861	2929	2891	2934	2876							
Coliform Group - MPN/100 ml												
Iron												

*Results expressed as mg/l except as noted.

FARM AT RAILROAD OVERPASS (NW ¼, Sec. 13)(Southwest of cooling pond)

Station: Well - 3

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	8.0											
pH - units	7.6											
Conductivity - µmhos/cm-25°C	787	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE	NO SAMPLE
Total Hardness	430											
Calcium Hardness	195											
Sodium	41											
Total Alkalinity	228											
Chlorides	3.3											
Sulfates	213											
Total Phosphorus	.03											
Nitrate Nitrogen	.02											
Ammonia Nitrogen	3.26											
Kjeldahl Nitrogen	3.45											
Total Residue	522											
Coliform Group - MPN/100 ml												
Iron												

*Results expressed as mg/l except as noted.

Station: Well - 4

HARRY RUSSMAN FARM (NW ¼, Sec. 11)(West of plant site)

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	5.0	5.5	6.8	6.2	10.4	10.9	15.7	13.6	13.2	10.9	7.5	5.0
pH - units	7.9	6.9	6.9	6.9	6.9	7.0	6.9	6.9	7.0	6.9	6.9	7.0
Conductivity - umhos/cm-25°C	2308	2740	2560	2544	2270	2415	2666	2685	2455	2505	2335	2405
Total Hardness	1700	1735	1705	1692	1654	1658	1628	1630	1641	1670	1665	1656
Calcium Hardness	1205	1205	1187	1280	1118	1152	1110	1101	1111	1129	1082	1096
Sodium	22	22	22	22	22	18	22	22	22	22	23	23
Total Alkalinity	480	478	475	474	517	502	503	500	478	469	468	473
Chlorides	45	46	47	46	48	47	48	50	49	45	44	44
Sulfates	1000	1020	1220	1160	900	1050	1000	1120	1100	1290	1200	1090
Total Phosphorus	0.04			0.06			0.02			0.04		
Nitrate Nitrogen	0	0.01	0	0	0.03	0.12	0.04	0.4	0.4	2.6	2.9	4.0
Ammonia Nitrogen	0.93	0.92		0.55			0.43			1.07		
Kjeldahl Nitrogen	0.55	0.65		.5			0.43			1.1		
Total Residue	2295	2390	2346	2366	2322	2531	2413	2388	2443	2421	2356	2342
Coliform Group - MPN/100 ml			5.1		old			2.2			< 2.2	
Iron										7.0		

*Results expressed as mg/l except as noted.

ED LUNDBORG FARM (NW ¼, Sec. 1)(North of plant site)

Station: Well - 5

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	9.6	8.3	8.0	7.0	10.8	11.5	15.7	12.3	10.6	10.0	7.1	9.0
pH - units	7.0	7.1	7.1	7.1	7.2	7.0	7.1	7.0	7.2	7.1	7.1	7.2
Conductivity - µmhos/cm-25°C	1427	1657	1625	1615	1650	1643	1699	1523	1653	1603	1493	1368
Total Hardness	990	960	985	968	996	936	943	941	886	950	945	936
Calcium Hardness	625	595	741	601	560	576	569	562	613	553	547	527
Sodium	21	20	19	24	23	18	20	21	21	22	22	21
Total Alkalinity	462	448	464	456	475	460	475	472	456	458	455	458
Chlorides	5.2	5.6	5.2	9.7	10	10	5	4.9	5.5	3.0	2.3	0.2
Sulfates	690	500	540	495	470	545	495	580	515	560	540	520
Total Phosphorus	0.04			0.04			0.03			0.03		
Nitrate Nitrogen	1.22	0.84	1.24	6.34	6.74	4.8	1.24	1.24	1.84	0.87	0.25	0.28
Ammonia Nitrogen	0.46			0.36			0.36			0.38		
Kjeldahl Nitrogen	0.55			0.50			0.36			0.5		
Total Residue	1241	1276	1271	1317	1256	1374	1326	1398	1355	1296	1302	1248
Coliform Group - MPN/100 ml			<2.2		old			<1			9.1	<1
Iron										0.9		

*Results expressed as mg/l except as noted.

HERB KAISER FARM (SE ¼, Sec. 1)(Northeast of cooling pond) Station: Well - 6

Determination*	Sampling Dates - 1973 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/25	12/26
Temperature - °C	6.2	7.0	7.2	7.3	9.0	11.3	14.0	13.0	12.1	12.0	12.0	8.3
pH - units	7.1	7.0	7.0	7.0	7.2	7.1	7.1	7.1	7.3	7.1	7.1	7.3
Conductivity - µmhos/cm-25°C	1238	1425	1390	1275	1230	1248	1493	1292	1298	1198	1187	1208
Total Hardness	825	825	800	802	750	746	745	740	787	727	735	713
Calcium Hardness	500	485	553	482	452	458	446	436	382	414	424	392
Sodium	20	19	20	20	18	15	18	20	19	19	21	20
Total Alkalinity	465	470	464	462	452	460	477	475	456	459	459	456
Chlorides	3.3	2.5	3.6	3.5	6.2	4.6	2.5	2.2	2.5	1.4	1.6	0.2
Sulfates	400	396	364	364	324	344	330	352	336	346	326	296
Total Phosphorus	0.08			0.26			0.11			0.03		
Nitrate Nitrogen	0.01	0.02	0.02	0.01	0.01	0	<0.01	0.02	<.01	0.01	0.02	0.01
Ammonia Nitrogen	0.57			0.60			0.56			0.55		
Kjeldahl Nitrogen	0.70			0.65			0.56			0.55		
Total Residue	1013	1028	1044	1038	1050	1133	1063	1123	1015	953	958	909
Coliform Group - MPN/100 ml			<2.2		old			<2.2			<2.2	
Iron										2.0		

*Results expressed as mg/l except as noted.

UNITED METHODIST CAMP (NW ¼, Sec. 8)(Northeast of plant site on Big Stone Lake)

Station: Well - 7

Determination*	Sampling Dates - 1978											
	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	9.2	9.2	9.5		9.4	10.2	11.0	10.6	10.0	9.2	9.0	9.0
pH - units	7.6	7.4	7.5		7.1	7.2	7.0	7.3	7.3	7.1	7.3	7.2
Conductivity - µmhos/cm-25°C	991	1240	975	NO	1580	1308	1463	1042	1408	1418	1137	1503
Total Hardness	625	690	472		966	828	785	493	764	806	644	887
Calcium Hardness	348	350	226	SAMPLE	554	494	491	209	474	400	309	418
Sodium	23	20	22		25	18	21	22	22	24	23	25
Total Alkalinity	374	356	284		444	443	458	276	439	362	323	343
Chlorides	2.6	2.6	3.2		5.2	2.4	1.9	2.4	2.0	2.5	2.0	1.1
Sulfates	235	274	270		630	396	386	326	416	504	396	606
Total Phosphorus	.04						0.07			0.16		
Nitrate Nitrogen	.01	0.01	0.05		0.02	0	0	0.01	<.01	0.01	0.03	0.01
Ammonia Nitrogen	1.10						1.25			0.96		
Kjeldahl Nitrogen	1.25						1.25			1.3		
Total Residue	716	905	714		1498	1168	1160	798	1127	1230	916	1308
Coliform Group - MPN/100 ml			< 2.2		old			<2.2			<2.2	
Iron										7.5		

*Results expressed as mg/l except as noted.

PAUL THIELE FARM (SW ¼, Sec. 8)(East of plant site and cemetery)

Station: Well - 8

Determination*	Sampling Dates - 1978											
	1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	6.1	5.6	5.0	7.0	10.6	14.0	18	15.7	15.9	15.0	11.4	8.9
pH - units	6.8	7.0	6.9	7.0	7.1	7.1	7.0	7.0	7.1	7.1	7.0	7.2
Conductivity - µmhos/cm-25°C	1222	1365	1470	1406	1400	1468	1473	1523	1444	1408	1238	1308
Total Hardness	830	845	841	850	758	832	795	819	807	832	829	810
Calcium Hardness	580	560	561	527	534	524	570	520	512	506	526	484
Sodium	19	19	19	20	18	15	17	19	19	19	21	20
Total Alkalinity	436	434	438	428	470	427	452	452	434	436	447	431
Chlorides	1.9	1.9	3.0	2.9	4.8	2.0	2.4	1.7	2.1	1.2	1.0	3.5
Sulfates	340	456	458	450	432	456	440	456	428	460	456	426
Total Phosphorus	0.02			0.02			0.01			0.02		
Nitrate Nitrogen	0	0.01	0	0	0.02	0	0	0.01	0	0.01	0.01	0.01
Ammonia Nitrogen	1.42	1.67		1.1			0.94			0.86		
Kjeldahl Nitrogen	1.11	1.05		0.9			0.94			0.9		
Total Residue	1088	1122	1122	1129	1141	1254	1181	1219	1164	1131	1167	1082
Coliform Group - MPN/100 ml			< 2.2		old			< 2.2			< 2.2	< 2.2
Iron										4.0		

*Results expressed as mg/l except as noted.

BIG STONE CITY MUNICIPAL WELL (NW ¼, Sec. 8)(Near lake - south of intake) Station: Well - 9

Determination*	Sampling Dates - 1978 1/24	2/22	3/28	4/19	5/24	6/27	7/19	8/22	9/20	10/25	11/15	12/26
Temperature - °C	8.0	7.0	5.2	9.2	18.0	18	19.5	17.3	10.8	15.0	12.7	8.9
pH - units	7.2	7.1	7.2	7.2	7.3	7.3	7.1	7.3	7.7	7.3	7.1	7.0
Conductivity - µmhos/cm-25°C	1201	1485	1455	1229	1440	1523	1308	1553	1488	1338	1323	1423
Total Hardness	680	740	721	780	852	770	706	759	805	629	728	965
Calcium Hardness	395	410	420	430	528	490	369	431	463	345	394	581
Sodium	51	56	55	50	17	30	48	41	31	49	52	20
Total Alkalinity	268	257	279	254	322	285	266	290	332	265	266	403
Chlorides	25	46	38	36	9.8	20	37	20	16	28	26	19
Sulfates	450	575	550	510	532	550	470	564	518	480	550	588
Total Phosphorus	0.03			0.03			0.04			0.03		
Nitrate Nitrogen	0.01	0.09	0.03	0.12	0.06	0.23	0.19	0.43	0.21	0.04	0.32	0.05
Ammonia Nitrogen	1.21			0.77			0.88			1.05		
Kjeldahl Nitrogen	1.45			0.92			1.00			1.2		
Total Residue	1070	1122	1103	1110	1179	1076	1100	1221	1223	1023	1093	1319
Coliform Group - MPN/100 ml			< 2.2		old			< 1			< 2.2	
Iron										1.5		

*Results expressed as mg/l except as noted.

Elevation of the Groundwater*
Big Stone Power Plant Area
Big Stone City, South Dakota

At Sampling Wells:

Date	Well 1	Well 2	Well 3	Well 4	Well 5	Well 7
1978						
January 24		1056.15	1034.00	1062.15	1054.52	
February 22	1027.32	1056.24	1034.84	1061.06	1034.77	
March 28	1026.74	1056.15	1034.67	1061.15	1054.61	
April 19	1027.07	1056.49	1034.00	1061.40	1055.86	
May 24	1027.57		1029.42	1061.73	1058.02	
June 27			1031.50	1061.40		
July 19	1027.65		1033.17	1062.73	1058.77	
August 22			1034.42	1062.56	1051.52	
September 20	1027.65		1034.75	1062.81	1056.77	
October 25			1034.75	1063.15	1057.69	
November 15			1034.82	1062.23	1056.86	
December 26	1027.24		1035.09	1061.90	1056.52	

At Well Points Along County Road North of Pond:

1978	A	B	C	D	E
January 24	1111.88		1111.40	1110.77	
February 22	1110.63		1111.15	1106.77	
March 28	1115.13	1114.62	1113.40	1111.52	1110.23
April 19	1114.63	1114.62	1112.99	1111.69	1109.52
May 24	1112.76	1113.63	1112.15	1111.36	1108.69
June 27	1111.71	1113.46	1112.24	1111.11	1108.77
July 19	1112.88	1113.46	1111.78	1111.36	1108.44
August 22	1109.55	1111.54	1109.82	1110.69	1107.11
September 20	1109.13	1112.24	1110.65	1110.61	1108.52
October 25	1108.63	1111.87	1109.99	1110.32	1108.52
November 15	1108.46	1112.29	1110.57	1110.27	1108.61
December 26	1109.63	1112.29	1110.57	1110.19	1108.69

*All elevations are above "sea level datum."

MEMO

August 2, 1979

TO: Bob Muefeld, Secretary, Water and Natural Resources

FROM: John Hatch, Assistant Director, Water Rights, WMD

SUBJECT: Big Stone Power Plant Report

You have requested that I explain a recent report from the Big Stone Power Plant. The purpose of the report is to provide back ground data on ground water in the event someone has any questions concerning any effects which the Big Stone Power Plant may have on the area around the Power Plant including the ground water. Ground water testing and water level measurements by a private consultant were begun prior to construction of the power plant and have been continued since that time.

No. 1983-3

SOUTH Dakota Department of
Water & Natural Resources

Joe Foss Building Water Rights Division
Pierre, South Dakota 57501 (605) 773-3352

May 6, 1982

Otter Tail Power Company
215 South Cascade
Fergus Falls, Minnesota 56537

Gentlemen:

Enclosed herewith are, Water License No. 1983-3 and Certificate of Construction.

Water License No. 1983-3 is the final water right document completing your process of obtaining a water right.

As long as you use the water beneficially, as stated in the Water License, the State Water Laws provide that you have a continuing right to use the water.

Very truly yours,

JOHN HATCH, Chief Engineer
Water Rights Division

JH:ms

enclosures

NOTE: Applicable portions of Permit No. 1768-3 have been incorporated into this Water License No. 1983-3.

Big Stone Plant
June 7, 1990

DRAFT CHANGES IN OUR SOUTH DAKOTA
WATER APPROPRIATIONS PERMIT

1. The diversion of water from the lake not to exceed 100 cubic feet per second may be made when the surface elevation is at or above project datum elevation 967.

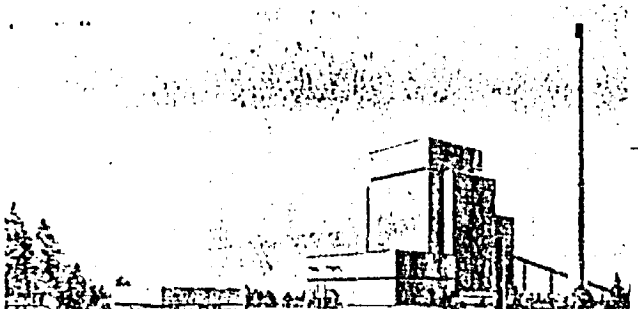
2. Diversion of water from the lake not to exceed 100 cubic feet per second may be made when lake surface levels are between project datum 967 and 965 during the annual period October to May 15 inclusive provided at least 80% of the lake is ice free.

3. Water may not be diverted from the lake when the lake levels are at or below project datum elevation 967 during the annual period May 16 to September inclusive, without permission from the South Dakota Water Resources Commission.

4. This permit includes 9,000 acre feet of off stream storage of water for cooling pond and reserve water supply purposes.



1768-3



BIG STONE PLANT

P. O. BOX 218
BIG STONE CITY, SOUTH DAKOTA 57216
(605) 862-8125

MONTANA-DAKOTA UTILITIES CO.
400 North Fourth Street
Bismarck, North Dakota 58501

OTTER TAIL POWER COMP
215 South Cascade Stree
Fergus Falls, Minnesota 565

NORTHWESTERN PUBLIC SERVICE COMPANY
3rd Street & Dakota Avenue South
Huron, South Dakota 57350

June 13, 1990



Mr. John Hatch
Chief Engineer
Water Rights Division
South Dakota Department
of Water & Natural Resources
Joe Foss Building
523 East Capital
Pierre, SD 57501-3181

Dear Mr. Hatch:

SUBJECT: BIG STONE PLANT WATER APPROPRIATIONS PERMIT
1768-3 & 193-3

Since the drought that was experienced in this area in 1988, Big Stone Plant has been investigating ways to improve our ability to withstand extended water shortages. We have been looking at many alternatives. One of the items being considered is the possibility of amending our Water Appropriations Permits with the States of South Dakota and Minnesota. To that end, we have had discussions with your office and the Minnesota DNR. It appears that there are some minimal changes that can be made to our permit that will benefit both the Big Stone Plant and recreational users of Big Stone Lake. To that end, I am submitting for your consideration the attached proposed amendments to our South Dakota Water Appropriations Permit.

After discussion with the Minnesota DNR, there are some concerns for the fish population in Big Stone Lake that can be eliminated by the proposed amendments. Their main concern was water appropriation when the Lake is ice covered, since pumping during ice cover could deplete oxygen levels and disrupt the fish population. The proposed amendments would allow Big Stone Plant to appropriate water at a rate of 100 cubic feet per second from the time Big Stone Lake was ice free to May 15, as long as the lake was at or above the established levels. This modification would increase the pumping rate, so that pumping could be done with the minimum disruption to the fish population. Also the window to do the pumping was extended by 15 days in order to accommodate pumping after the ice leaves Big Stone Lake. These changes should provide benefit for the Big Stone Plant and benefit for the recreational users of the Lake.

BIG STONE PLANT

P. O. BOX 218
BIG STONE CITY, S.D. 57216

Mr. John Hatch
Chief Engineer
Water Rights Division

The second change that is being proposed is in item 4, which is to amend our permit to allow 9,000 acre feet of off-stream storage of water for the cooling pond and reserve water supply purposes. Our present permit appears to limit our supply storage to 7,000 acre feet. Our ponds have the capacity to hold over 8,000 acre feet when completely full, and we would like to be able to fill the pond completely during times of excessive water in Big Stone Lake. This is another measure that would further enhance our ability to withstand drought conditions.

I request that your Department examine these issues and consider the proposed amendments to pumping restrictions and the permitted storage capacity independently of each other. If you feel that you can support either or both of these proposals, please let me know and we will submit them in a form as a formal request for permit amendment.

I know the information provided in this letter is limited and, if you are in need of more information or have any questions, please feel free to call me at 605-862-8125. We will do whatever we can to help. We very much appreciate all your cooperation and consideration your Department has given us in the past.

Very truly yours,

Mark Rolfes
Plant Manager
Big Stone Plant

MR:rt

cc: Dave Johnson
Terry Graumann

SOUTH DAKOTA Department of
Water & Natural Resources
Joe Foss Building
523 East Capitol
Pierre, South Dakota 57501-3181

August 14, 1990

Mark Rolfes, Plant Manager
Big Stone Plant
PO Box 218
Big Stone City SD 57216

Dear Mr. Rolfes:

I am writing in response to your June 13, 1990 letter to John Hatch, Chief Engineer, regarding proposed amendments to Water Right No. 1983-3. I apologize for the delay in answering your letter; however, we needed to take the time necessary to analyze your water rights and your rested changes.

I have reviewed your proposed qualifications and have the following comments:

1) The diversion of water from the lake not to exceed 100 cfs may be made when the surface elevation is at or above project datum elevation 967.

   No change from the existing water right qualification.

2) Diversion of water from the lake not to exceed 100 cfs may be made when lake surface levels are between project datum 967 and 965 during the annual period October to May 15 inclusive provided at least 80% of the lake is ice free.

   I believe the existing qualifications allow diversions up to 100 cfs provided the 10 cfs daily equivalent volume (19.8 ac-ft) is not exceeded when between datums 965 and 966 and provided the 35 cfs daily equivalent volume (69 ac-ft) or weekly volume (460 ac-ft) is not exceeded when above datum 966 but less than datum 967. Therefore, diversions at 100 cfs could be made for 2.4 hours per day to pump 19.8 acre-feet and 8.3 hours per day to pump 69 acre-feet with the weekly number of hours not exceeding [illegible]

   Pursuant to SDCL 46-5-30.4, a water permit application will be necessary to change your existing water rights to increase the volume of water appropriated and to extend the time period from April to May 15 and/or remove the equivalent volumes specified in the above paragraph.

3) Water may not be diverted from the lake when the lake levels are at or below project datum elevation 967 during the annual period May 16 to September inclusive, without permission from the South Dakota Water Management Board.

The time period during which pumping can occur is being extended by 15 days according to this qualification. Again, a permit application will be necessary to extend the time period during which pumping may occur.

4) This permit includes 9,000 acre-feet of off stream storage of water for cooling pond and reserve water supply purposes.

An application will be necessary to increase the authorized storage by 2,000 acre-feet.

All changes can be included on one application. A report and recommendation will be prepared when the completed application is received, prior to publication for a hearing before the Water Management Board.

Please contact me if you have any questions.

Sincerely,

Ron Duvall
Natural Resources Engineer
605 773-3352

E-8971 Copies 1768-3 ~~E-8851 Copies~~

