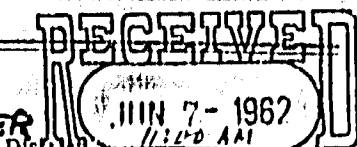


994-3

1. Considered 7-11, 1962
2. Name of Applicant City of Howard
3. Post Office Address _____
4. Amount of water claimed .25
5. Source of water supply ground water
6. Water to be used for municipal
Acres to be irrigated _____
7. Water to be diverted and used in Mineral County
_____ miles _____ of in City
8. Proof of Publication Received ~~2-11-62~~ ✓
 Not Received _____
9. Application Approved ✓
 Subject to _____
 Not Approved _____
 Action deferred _____

10. Remarks:

No. 994.3
 Water Division No. 3 VERMILION RIVER
 (Blanks to be filled by the Engineer for the W. R. C.)



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.)

1. Name of applicant CITY OF HOWARD
 Postoffice address HOWARD, County MINER, State S. D. K.

- I. If a corporation -----
- (a) Name of same -----
- (b) Date and place of incorporation -----
- (c) Amount of capital stock -----
- (d) Amount paid in -----
- (e) Names and addresses of directors -----

(NOTE—A certified copy of articles of incorporation must accompany the application.)

II. Method of accomplishing the work and financial resources of the applicant:

(a) Method of accomplishing work (Whether by contract, employment of others, or by direct labor) -----

(b) Cash on hand, \$ ADEQUATE (c) Treasury stock, \$ -----

(d) Bonds to be issued, \$ ----- (e) Other resources, \$ -----

2. Name of diversion work CITY WELL #4

3. Amount of water claimed 25 cubic feet per second

4. Source of water supply GROUND WATER

5. Location of point of diversion LOT 6, NW 1/4 SE 1/4, SECTION 3, T106N R56W

----- on ----- bank MINER County.

6. Annual period or periods during which water is to be used CONTINUOUSLY

7. To be used for:

I. Irrigation or domestic use: Gravity, overhead sprinkling or combination system? -----

(a) Number of acres to be irrigated ----- acres.

(b) Legal subdivisions to be irrigated -----

(NOTE—A list of lands to be irrigated, giving each subdivision and fraction with acreage thereof, should be written here, or may be appended as a part of this application. Same must also be shown on accompanying map.)

(c) Statement as to domestic use (giving location, etc.) -----

MUNICIPAL USE

II. Stockwatering, milling, power, fish culture, fire protection and public recreation:

(a) Nature of use -----

Name any of the above uses claimed

(b) Amount of power to be generated ----- horse power.

Amount claimed for engine cooling -----

(c) Location of plant -----

(d) Method of developing power -----

(e) Point where water will be returned to stream -----

MAP NO. 439-3

8. Estimated cost of work:

(a) Head Gates, \$

(c) Fluming, \$

(e) Other structures

(d) Canal-earth, \$

(b) Pumping plant, \$

Rock, \$

Total, \$

9. Description of diversion works:

I. Nature of works: (Reservoir, dam, ditch, flume, pumping plant, etc.)

II. Dimensions of works.

(a) Dam: Height feet; length at bottom feet; length at top feet; thickness at bottom feet; thickness at top feet; slope at front water face; slope at back face material used in construction

(b) Reservoir: Capacity when filled acre feet. Surface area at highwater mark acres.

DEPTH AT OUTLET-Feet	SURFACE AREA AT EACH DEPTH AT OUTLET--ACRES	FEET	ACRE-Feet CAPACITY

(c) Head gate: Width feet; height feet;

Material

(d) Canal: Total length miles.

LOCATION BELOW HEADGATE	DEPTH	BOTTOM WIDTH	WIDTH AT WATER-LINE	GRADE PER MILE
At Mile	feet	feet	feet	feet
At Mile	feet	feet	feet	feet
At Mile	feet	feet	feet	feet
At Mile	feet	feet	feet	feet
At Mile	feet	feet	feet	feet
At Mile	feet	feet	feet	feet

(Give dimensions where reductions in size are made.)

10. Time required for completion of work years.

11. Time required for complete application of water to the proposed beneficial use years.

12. Choice of newspaper for publication of notice of intention to appropriate

MINER COUNTY PIONEER HOWARD, S.D.

STATE OF SOUTH DAKOTA

County of MINER

I, E. M. TRIPP, Mayor of HOWARD CITY

being first duly sworn on my oath depose and say: That my relation to the above described undertaking is that of owner, that I have read the above foregoing statement, examined the map accompanying the same, and that I know of my own personal knowledge that the matters therein stated and shown are true.

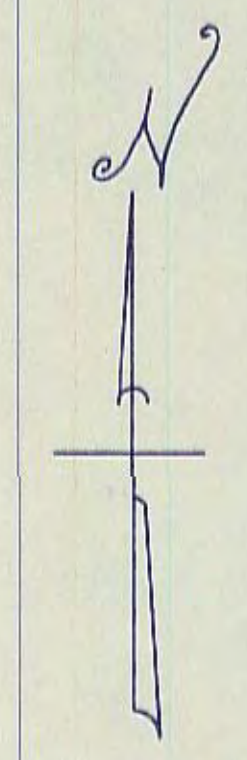
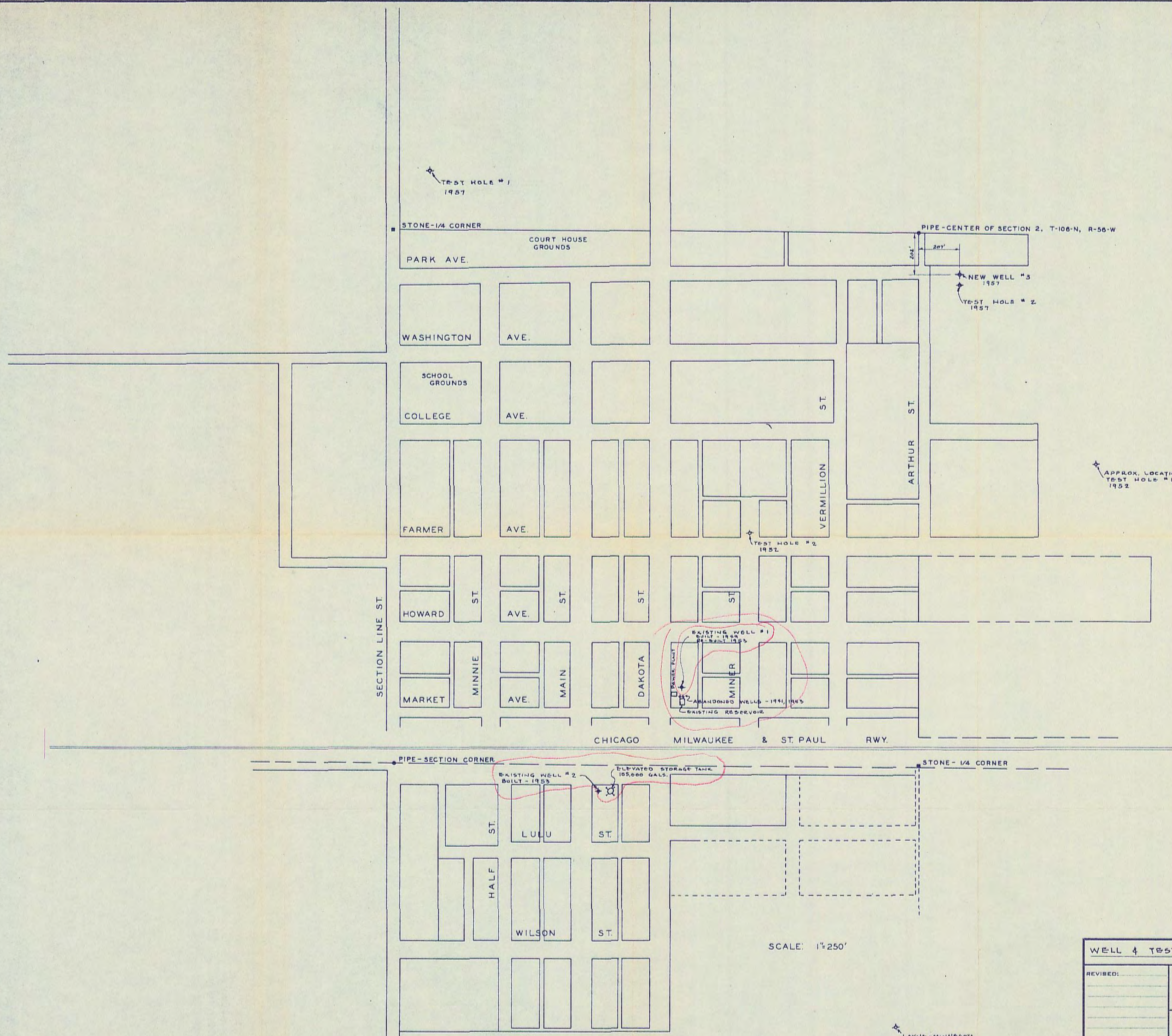
Signed

Subscribed and sworn to before me this 31st day of MAY 1932

Notary Public (for other qualified person.)

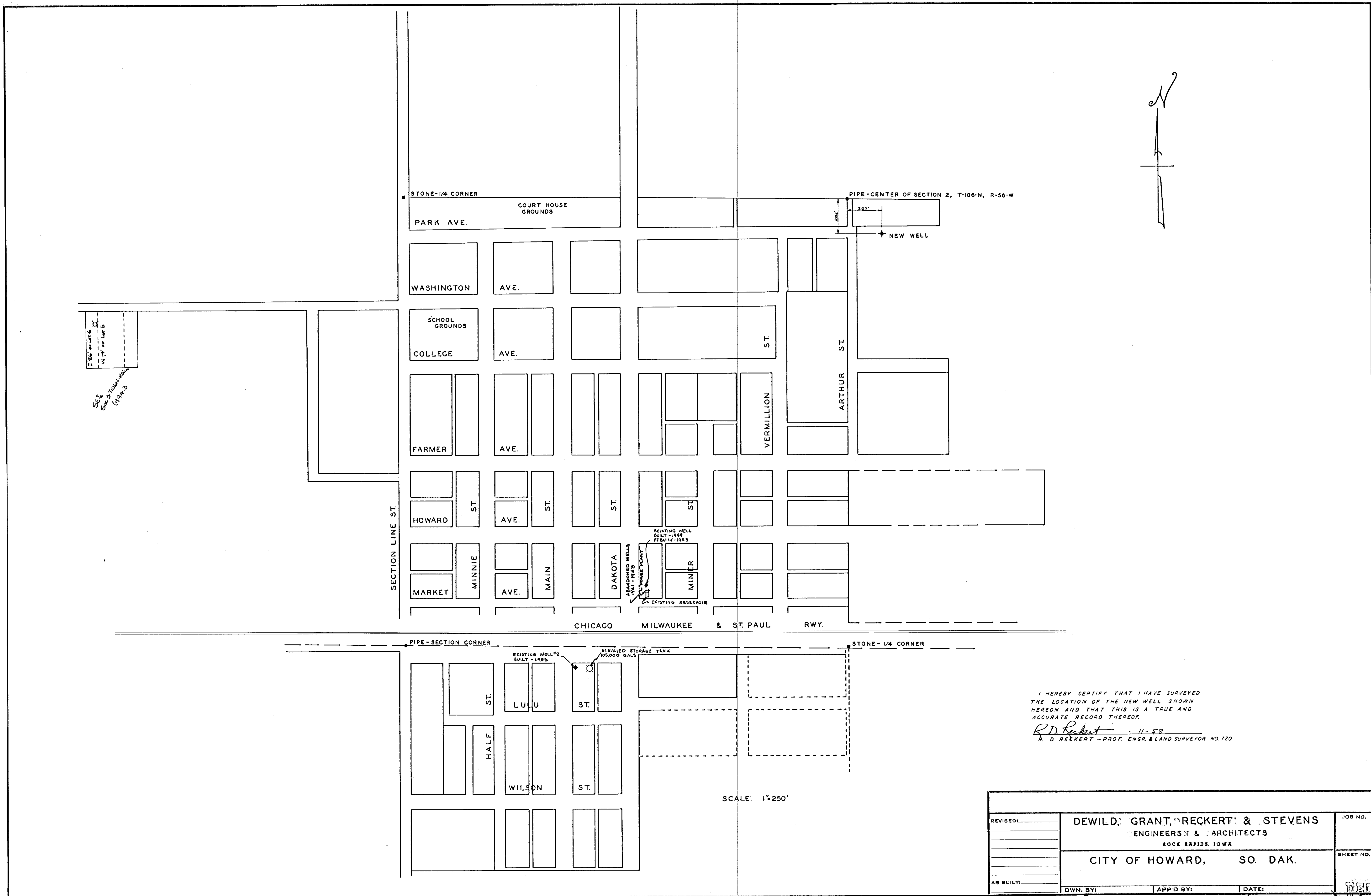
MINER COUNTY, S. DAK.
MY COMM. EXPIRES 3/23/69
(SEAL)

*Each diversion must have a headgate or measuring device.

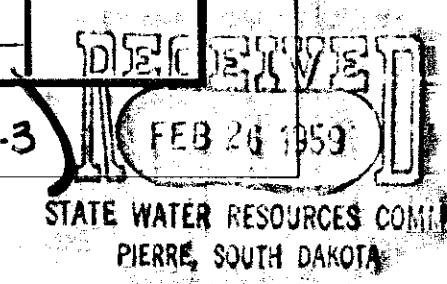


WELL & TEST HOLE LOCATION PLAN			
REVISED:	DEWILD, GRANT, RECKERT & STEVENS ENGINEERS & ARCHITECTS ROCK RAPIDS, IOWA		JOB NO.
AS BUILT:	CITY OF HOWARD, SO. DAK.		SHEET NO.
DWN. BY:	APP'D BY:	DATE: 1-59	

7760# 439 (W/R 994-3)



Map No. 439-3 (Appl's No's 576-3, 577-3, 578-3 & 994.3)



Remarks by State Water Resources Commission:

STATE OF SOUTH DAKOTA
County of HUGHES } ss.

Pierre, South Dakota,

SEPTEMBER 21, 1962

This is to certify that the foregoing application was received by the Commission at 11:00 o'clock
a.m. upon the 7TH day of JUNE, 1962

State Water Resources Commission

By:

Burton Jones
for Chief Engineer, Executive Officer

Number of permit 994-3

Date of first receipt of application JUNE 7, 1962

Date of return to applicant for correction, amendments or changes required as follows: —, 19—

Date of receipt of corrected application —, 19—

Date from which applicant may claim right JUNE 7, 1962

Approved SEPTEMBER 19, 1962, Recorded in Book 7 Page 176

This is to certify that we have examined the foregoing application for a permit to appropriate water of the State of South Dakota, and we hereby grant the same as stated herein, subject, however, to the following limitations and conditions:

1st. The equivalent of at least one-fifth of the work above specified is to be completed on or before

MARCH 19, 1963

2nd. The whole of said work is to be completed on or before SEPTEMBER 19, 1963

3rd. The limit of time for proof of beneficial use of water appropriated in accordance herewith is

SEPTEMBER 19, 1963

4th. The water appropriated shall be used for the purpose of MUNICIPAL USE

5th. 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.

6th. The amount of the appropriation herein granted shall not exceed 25 cubic feet per second; neither shall it exceed the capacity of the above described system of diversion works, nor the least amount of water that experience may hereafter indicate as necessary for the production of crops in the exercise of the best husbandry, and further, said appropriation must be limited to not more than one-seventieth (1/70) of one cubic foot of water per second of time for each acre of land to which water is actually

USED FOR MUNICIPAL PURPOSES.

and beneficially applied for irrigation on or before SEPTEMBER 19, 1963; said water to be used during the following described annual period:

CONTINUOUSLY

Witness my hand this 21ST day of SEPTEMBER, 1962

State Water Resources Commission

By:

John B. Jones
Chief Engineer, Executive Officer

Certificate of Construction issued

April 14, 1964

Water License issued

April 14, 1964

Remarks by the Applicant:

THIS WELL IS LOCATED ON THE EAST 26 FT. OF LOT 6, AND THE WEST 74 FT. OF LOT 5, ALL IN LOT 34 OF SE $\frac{1}{4}$ OF SECTION 3 - 106 - 56 IN MINER COUNTY, SOUTH DAKOTA, WHICH PROPERTY IS OUTSIDE THE CITY LIMITS OF HOWARD, BUT IS OWNED BY THE CITY.

THE WELL WAS COMPLETED IN SEPTEMBER, 1961.

Form 2A — Wells (Supplement to Form 2)

9. (Continued)

III. Well Specifications

(a) Hole and casing

Size of drill hole or excavation 14", Depth 490'

Type of casing STEEL
(wood, concrete, steel, etc.)

Size of casing 10", Thickness of casing 0.365"

Length of casing 490' If collection gallery, length, size and depth of gallery

(b) Screens

Type of perforated screen NONE

Size of perforated screen NONE
(diameter) (length)

Thickness of gravel pack NONE, length of gravel pack NONE

(c) Water Bearing Materials

Distance to water 140 ft Character of water bearing materials ROCK
OR QUARTZITE

Thickness of water bearing material UNKNOWN-TOTAL DEPTH OF WELL 575'

(d) Pump and Motor

Type of pump TURBINE
(centrifugal, propeller, mixed flow, etc.)

Name of pump LAYNE, size 8"

Kind of motor ELECTRIC
(gasoline, electric, diesel, etc.)

Horsepower 20, Name of Motor LAYNE

(e) Complete well

Capacity 110 GAL PER MIN at drawdown of 20 FT. Estimated cost 10,458.55

(f) Owner of land upon which well is located HOWARD CITY
Name

HOWARD, SOUTH DAKOTA

Address

(g) Distance to nearest existing wells

On same owner's property 200 rods. On property owned by others 300 rods

SCALE 1" = 100'

TOTAL DEPTH
575'

HOWARD CITY
WELL

GROUND SURFACE

CEMENT 200 seals →

WATER HEAD 140'
& 10" CASEING

ROCK SURFACE

9 3/4" HOLE
TO 505' in Rock. →

2 3/4" HOLE
TO 595' TO
ROCK

By J. M. S. PER
WONGCHAY, S. DAN

STATE OF SOUTH DAKOTA

WATER LICENSE No. 994-3

WHEREAS, On the 7th day of June A. D. 1962
the City of Howard

XX County of Miner and State of
South Dakota duly made application (No. 994-3) to us for a permit to use .25
cubic feet per second of the waters of ground water
County of Miner, State of South Dakota, for municipal
purposes; and

WHEREAS, On the 21st day of September A. D. 1962
Permit No. 994-3 was issued to said applicant for the diversion of said water, and providing for the
completion of the works of diversion therein described on or before the 19th day of
September 63 A. D. 1963 and for the application to beneficial use of said
water on or before the 19th day of September 63 A. D. 1963
and,

WHEREAS, On the 17th day of March A. D. 1964
the holder of said permit duly made proof of the completion of adequate works for the diversion of
cubic feet per second of said waters, as evidenced by our Certificate No. 994-3
April 14, 1964 confirming the completion of works of sufficient capacity for
diverting and conveying to the place of intended use .25 cubic feet per second of water, with date of
priority of June 7, 1962 and, and,

WHEREAS, On the 17th day of March A. D. 1964
proof was duly made of the application to beneficial use of .25 cubic feet per second of said water;
to be used for municipal purposes in the City of Howard.

NOW, THEREFORE, By the virtue of the authority vested in us by the laws of the State of South Dakota,
We hereby grant and confirm to the City of Howard

~~XX~~ the holder and owner of said permit No. 994-3

a water right, dating from June 7, 1962 to the use of .25

cubic feet per second of the waters of ground water

In the County of Miner and State of South Dakota, or so much thereof as may be

necessary for the purposes hereinafter mentioned, to be diverted at a point in Lot 6, NW 1/4 Sec 1,

Section 3, T106N, R56W

and conducted ~~through the city water distribution system~~

for the purpose of municipal use

subject, however, to the laws of the State of South Dakota applicable to a license for the use of the waters of the State, and subject, also to the local or community customs, rules and regulations which have been or may be adopted from time to time by a majority of the users from a common source of supply, canal or lateral from which such water may be taken when such rules and regulations have for their object the economical use of such water.

WITNESS, My hand and seal of our office at Pierre, South Dakota,
this 14th day of April A. D. Nineteen
Hundred and Sixty-Four

State Water Resources Commission

By:

J. W. GRIMES
Chief Engineer, Executive Officer

STATE OF SOUTH DAKOTA

Water License No. _____

To _____

Source of Supply _____

County _____

Am't _____ c. f. s.

Point of Diversion _____

Place of Use _____

Purpose _____

Date of Priority _____

Recorded _____

In Book _____ of _____ Page _____

Permit No. 994-3

Water Division No. 3 Vermillion River Water District

Certificate of Completion of Works

TO ALL WHOM IT MAY CONCERN:

This is to Certify, That the City of Howard

xx _____, County of Miner, and State of South Dakota, the holder of Permit No. 994-3, Issued upon Application No. 994-3, bearing date of priority of June 7, 1962, authorizing the diversion of .25 cu. ft. per second of the waters of ground water

County of Miner, State of South Dakota, at a point in Lot 6, NW $\frac{1}{4}$ SE $\frac{1}{4}$ Section 3, T106N, R56W

_____ for municipal purposes, has ⁸ fully 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 .25 cu. ft. per second of water; and that the ~~lands proposed to be irrigated by the use of said water are described as follows,~~ for municipal uses in the city of Howard. to-wit: _____

Witness my hand this 14th day of April A. D. 1964

State Water Resources Commission

By: J. W. GRIMES
Chief Engineer, Executive Officer

PROOF OF PUBLICATION

STATE OF SOUTH DAKOTA }
County Miner } ss.

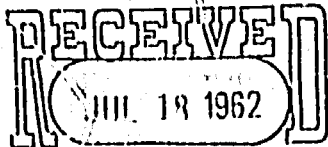
Ed H. Dawson being duly sworn, deposes and says the annexed printed copy of Notice of Intention to appropriate Water was taken from the Miner County Pioneer newspaper which during the whole time of publication of said notice herein after stated, has been and is printed and published in the City of Howard County of Miner and State of South Dakota; that the said notice was published in said newspaper on the following dates:

June 15, 1962
June 22, 1962
June 29, 1962
July 6, 1962

In each and every issue of the full number thereof, the first publication being made on the 15 day of June 1962 and the last publication on the 6th day of July 1962, upon which days or times of publication aforesaid the newspaper was regularly published, and that during the whole time of said publication he was the printer and publisher of the said newspaper.

Ed H. Dawson

Subscribed and sworn to before me this 17th day of July A. D. 1962



STATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA

Notary Public Miner County, S. D.

KEVIN C. COLLIER, Notary Public
Miner County, South Dakota
My Commission Expires Jan. 24, 1965

NOTICE OF INTENTION
TO APPROPRIATE WATER

Appropriation of Water
Office of State Water Resources Commission, Pierre, South Dakota, June 7, 1962.
Notice is hereby given that the City of Howard, S. Dak., has made application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use 25 cubic feet of water per second of time from ground water through the City Well No. 4, the point of diversion of which is to be located in the NW 1/4 of the SE 1/4 of Section 3, Twp. 106N Range 50W. Said water to be used for the purpose of providing municipal supplies for the City of Howard.

This application will be taken up by the State Water Resources Commission at their office at Pierre for consideration upon the 11th day of July, 1962, at 2 P. M. All interested persons may appear and be heard.

Appropriate action will be taken by the Water Resources Commission after suitable time has elapsed for the consideration of any or all information presented.

State Water Resources Commission.

By: Burton F. Jones,
Water Right Specialist.
(June 15-22-29 July 6)

on or before June 15, 1962
(First Publication before June 15, 1962)

APPROPRIATION OF WATER

Office of State Water Resources Commission,

Pierre, S. Dak., June 7, 1962

Notice is hereby given that the City of Howard

XXXXXX S. Dak., has made an application in accordance with the provisions of the water laws of South Dakota for a permit to appropriate for beneficial use .25 cubic feet of water per second of time from ~~the~~ Ground water through the City Well #4, the point of diversion of which is to be located ~~at the~~

XXXXXXXXXX in the NW 1/4 of the SE 1/4 of Section 3 Twp. 106N Range 56W. Said water to be used for the purpose of providing XXXXXXXXXXXX

XXXXXX:

municipal supplies for the City of Howard

XXXXX XXXXXXX

This application will be taken up by the State Water Resources Commission at their office at Pierre for consideration upon the 11th day of July, 1962, at 2 P. M. All interested persons may appear and be heard.

Appropriate action will be taken by the Water Resources Commission after suitable time has elapsed for the consideration of any or all information presented.

State Water Resources Commission

By:

BURTON F. JONES
Water Right Specialist

CC: S. I. Davidson, Sr.,
Publisher
Minor County Pioneer
Howard, South Dakota

City of Howard Water Report

**DeWild, Grant, Reckert & Stevens
Engineers & Architects
Rock Rapids, Iowa**



Review of Water Supplies
City of Howard, South Dakota
1938-1958

January, 1959

This report is for the purpose of reviewing and summarizing information and data obtained during a period of construction of new well facilities in the summer of 1957.

Prior to that time it had become obvious, because of municipal demands upon the water system, that the volume of water supply then available was not adequate to provide unlimited supplies of water for domestic purposes and was further very inadequate for fire protection. Water quality from the existing aquifer was quite poor also.

At that time the City was dependent upon two wells for their entire water supply. These wells are identified and described below:

Well No.1 - Located about 75' northeast of municipal power plant.

8" casing - 0' to 210' depth

6" casing - 210' to 410' depth - bottom of well

The casing is of steel; no screen is provided at the bottom of the well. Static water level was 148' below surface in 1957.

Past records indicate that the water bearing material from which the water is taken occur from 390' to 410' below the surface.

A pumping test conducted in April, 1957, indicated a drawdown of 8 ft. while pumping at a rate of 72 gallons per minute which indicates a specific yield of 9 gallons per minute per foot of drawdown.

The pumping unit installed in the well consists of a Fairbanks-Morse, Figure 6930-R water lubricated deep well turbine with unit-type head and above ground discharge. The pump is a 31 stage - 6 inch, Figure 6930-R open impeller pump with 180 ft. of 5" steel discharge pipe and a 10' length of 5" steel suction pipe with a galvanized strainer. The pumping unit has a 15 horsepower Fairbanks-Morse electric motor, Type QS2V, 3 phase, 60 cycle, 220 volts, and rotational speed of 1750 r.p.m.

From information received in the City Auditor's office this well was originally constructed to a depth of about 230 ft. The original work on this well was done by A.F. Kuborn of Woonsocket, with Lloyd M. Hinker as driller, in the spring and summer of 1949. The log of this well is as follows:

- 10'-20' - fill and clay
- 20'-30' - clay and sand
- 30'-40' - oversize gravel and sand
- 40'-60' - blue clay
- 60'-70' - sand-rock and blue clay
- 70'-80' - blue clay and rock
- 80'-110' - blue clay
- 110'-120' - blue clay, oversize
- 120'-130' - blue clay, quick sand, rock
- 130'-140' - blue clay, oversize
- 140'-160' - coarse gravel-sand

160'-190' - Blue clay-oversize-rock
 190'-200' - 190'-rock, cored 8 inch blue clay
 200'-220' - Blue clay
 220'-230' - Sand

(Drillers Note: At 220' we hit a formation of sand which by the time we had drilled to a depth of 225' had taken all the mud (drilling mud). This appeared to be a good strong water table).

Apparently an 8" cased well was developed out at this level and used until about 1953 when the well failed structurally at the bottom (this is presumed). In June of 1953 this well was reamed out and drilled to a depth of 400 ft. by the same well driller as before. We have been unable to obtain a log of this final drilling among the City records but a sample of the water was submitted to the State Chemical Laboratory in Vermillion in July, 1953, with the following reported results:

	Parts per Million	Grains per Gallon
Total solids	2173	127
Chloride (Cl)	124	7
Sulfate (SO ₄)	1117	65
Calcium (Ca)	197	12
Silica (Si O ₂)	24	1
Magnesium (Mg)	50	3
Alkalinity		
Phenolphthalein	9	-
Methyl Orange	204	12
Total hardness (as Ca CO ₃)	697	41
Fluorine (F)	3.2	-
Iron (Fe)	None	
Manganese (Mn)	None	

Well No. 2 - Located in addition to Municipal Storage Building just west of elevated storage tank.

This well was constructed by Paulsen Drilling Co. in about 1953.

10" casing - 0' to 380' depth
 8" casing - 380' to 400' depth (Sioux quartzite at 400' depth)
 8" open hole - 400' to 435' depth in Sioux quartzite.

The casing is of steel. The static water level was about 150 ft. below the surface in 1957.

The pumping unit installed in the well consists of a Lyne Turbine Pump No. 28795, with a U.S. Motor, Frame 364 P, Type CFU, Serial No. 2353998, 20 horsepower, 3 phase, 60 cycle, 1800 revolutions per minute.

The pump setting is not known for certain but is believed to be about 250 ft. below the surface.

The well driller has contended that the water bearing material is fissured Sioux quartzite. The attempted pumping tests indicated massive sand clogging which must come from a sandstone formation located from about 360 ft. to 400 ft. below the surface.

From all indications it is quite apparent that the true water bearing material is sandstone located just above the quartzite and that the water (and sand) enters the well by flowing downward from the sandstone into the open hole in the quartzite.

No water sample analyses were available at the time of writing this report but presumably the water quality in this well is about the same as that from Well No. 1.

Early Well Data.

One of the purposes of this written report is to summarize and tabulate information on hand regarding previous well exploration and construction. The information available is rather incomplete but does indicate conditions and investigations made back to 1938.

Water Report, 1938.

A report from the South Dakota State Board of Health, dated July 9, 1938, indicates that water supply problems were existent at that time. This report is reproduced below:

"On June 16 the writer made a sanitary survey of your water supply system for the purpose of assisting you in determining possible defects which might impair the safety of the supply. A report of the survey follows.

SOURCE AND DESCRIPTION OF SUPPLY:

Water is obtained from two drilled wells which are practically identical in construction and which are both located in the city pump house. These wells are 6" in diameter, 40-4' deep, have wrought iron casings, and the water level is at 135'. Water is delivered with plunger type pumps having a capacity of 63 g.p.m. The wells and pumps are enclosed in a concrete floored building roughly 60 x 50'. The pumps discharge into two interconnected surface reservoirs having combined capacities of 35,000 gallons. Water is boosted from the surface reservoir to the distribution system and elevated tank by a 50 g.p.m. triplex pump or a 350 g.p.m. centrifugal pump. These pumps are located in the same building that houses the wells. The elevated tank has a capacity of 106,000 gallons and is 135' high.

INSANITARY FEATURES:

- (1) There is no adequate drain for the pump room/floor which results in waste water standing on the floor and contributes to a general unsightly condition.
- (2) The surface reservoirs have wooden man holes opening into them which are not water and dust proof. Water and dust might carry pollution into the system.
- (3) The overflow to the surface reservoir consists of a 4" pipe extending from the reservoir to the surface of the ground. The elevation of this pipe is such that a hard rain which would cause water to stand on the ground will undoubtedly carry pollution into the system.
- (4) At the time of this survey samples of water were submitted to the State Health Laboratory at Vermillion who report this water to be "Unsafe". Copies of the analyses are enclosed.

() A dental survey made this spring by a representative of the Board of Health and the United States Public Health Service showed that approximately one out of five school children who had used your city water continuously were affected with dental fluorosis, commonly called mottled enamel. As you know, this malady is characterized by a white chalky type tooth frequently accompanied by brown stains and is caused by small amounts of fluorides in the domestic water supply. Chemical analyses sent to the State Chemist on May 24 are enclosed. They show a fluoride content of 1.6 ppm, which is in excess of the allowable amount.

RECOMMENDATIONS:

(1) A suitable drain to the pump house should be installed to carry waste water from the building.

(2) The man hole opening to the surface reservoir should be replaced with concrete structures which are impervious to water. The opening into the reservoir should be bed up at least 6" above the top of the man hole and a water-tight over-lapping cover should be installed. We are enclosing cuts of approved man hole covers. If it is desirable to vent these reservoirs the vents should consist of a vertical pipe terminating in a return bend looking down and screened with a fine mesh bronze screen. We are enclosing cuts of approved reservoir breathers.

(3) The overflow to the surface reservoir should be abandoned and permanently plugged with an adequate concrete seal. If it is felt that an overflow is necessary it should leave the reservoir at a point at least 12" higher than the highway grade, extend horizontally through the reservoir embankment and terminate in an elbow looking down. The bottom of this elbow should also be screened with bronze screening.

(4) Orders should be issued that this water is unsafe for domestic use and that the water should be boiled until satisfactory bacteriological analyses have been obtained. Before submitting further samples to the Laboratory the supply should be sterilized as follows: Take two 12 ounce cans of chlorinated lime, make into a thin paste and dilute to 30 gallons. Half of this solution should be poured into each of the wells through the annular opening between the casing and drop pipe and allowed to stand for two hours before pumping. At the same time a second solution should be made up of 12 cans of chlorinated lime and 30 gallons of water and thoroughly mixed with the water in the surface reservoir. This should be allowed to stand for two hours, then the pumps should be started and empty the surface reservoir into the elevated tank. It would be best to perform this operation at night so that the water consumption would be at a minimum. Continue pumping until the elevated tank is overflowed and then flush the distribution system until the chlorine taste disappears. In flushing the distribution system, open the hydrant closest the elevated tank until the chlorine taste appears, then close hydrant and proceed to the next hydrant on the line, etc. After it is certain that all chlorine has been removed from the system bacteriological samples should be submitted to the State Health Laboratory at Vermillion for further analyses.

(5) So far as we know there is no satisfactory method of removing fluorides from water, therefore the only solution to eliminate mottled enamel seems to be the location of a new water supply which is free from fluorides. Until such a supply can be found the water customers should be advised of the danger of using this water for either drinking or cooking by children less than eight years of age. This information could be stamped on the water bills and would protect the city against damage suits which might be charged to negligence.

CONCLUSION:

From a chemical standpoint this water leaves much to be desired. Aside from its high fluoride content, which we have discussed, excessive amounts of iron and manganese are found which will stain laundry, toilet fixtures, etc. Hardness is high and necessitates excessive amounts of soap. Sulphates are also high which contributes to the hardness and gives the water its characteristic artesian taste sometimes objectionable to the uninitiated.

Bacteriological analysis of this water indicates pollution entering the system and the foregoing recommendations outlined should be carried out at once.

The Division of Sanitary Engineering wishes to cooperate with you in this matter, and would like you to feel free to called upon it at any time."

Well Construction, 1941.

In April 1941, a contract was awarded to A.F. Kuborn of Woonsocket, South Dakota, to construct a well of 400 ft. depth in one of the City buildings just east of the present power plant. The size of the well is not known at this time but was probably 12", 10" and 8" casing size, stepping down as the depth increased. The specifications called for a 4½" diameter screen of unknown length. The "screen shall be sand packed with clean, graded sand, 'buckwheat' size, 1/16 to 1/8 inch". The intent was to develop a well of 150 gallon per minute capacity. A water analysis on the water from this well by the State Chemical Laboratory at Vermillion, dated April 3, 1942, indicated the following:

	Parts per Million	Grains per Gallon
Total solids	1395	81.3
Silica	7	0.4
Sulphate (SO ₄)	753	43.9
Chloride (Cl)	23	1.3
Calcium (Ca)	148	8.6
Magnesium (Mg)	44	2.6
Alkalinity as Ca CO ₃		
Phenolphthalein	None	-
Methyl Orange	252	-
Hardness as Ca CO ₃	551	14.7
Iron	None	32.1
Manganese	None	-
Fluoride	1.2	-

It can be seen from this analysis that the water quality from this well is better than that found in Well No. 1 reported above.

Apparently this well failed in a fairly short period of time as determined by the subsequent work performed in 1943.

Water Exploration and Well Construction, 1943.

In July, 1943, the City entered into contract with Layne-Minnesota Co. for the purpose of drilling test holes to locate the best source of supply for a new well.

On August 12, 1943, Layne-Minnesota Co. submitted their report, applicable portions of which are included below.

"We are pleased to submit herewith our report on test drilling operations performed by the Layne-Western Co. of Minnesota, under contract with the city of Howard, South Dakota, dated July 12, 1943.

In undertaking the project we assumed that a well of approximately 100 gallons per minute yield would provide the city with an adequate water supply, and therefore confined our efforts to the search for water bearing strata of at least this potential yield.

The well installed by the city in 1941 showed a more acceptable water quality than the other city wells, but as there was no possibility of determining the level from which this water was obtained, it seemed advisable to drill the first test well near the site of this well. The log of test well no. 1, is as follows:

0 ----- 2 ft. - fill
 2 ----- 5 ft. - top soil
 5 -----28 ft. - yellow clay showing sand
 28 -----33 ft. - fairly coarse sand
 33 -----53 ft. - hard blue clay showing sand
 53 -----74 ft. - hard and soft streaks of sand & clay
 74 -----154 ft. - soft blue clay showing of sand and boulders
 154 -----158 ft. - hard blue clay, boulders and sand
 158 -----160 ft. - gravel and boulders
 160 -----165 ft. - boulders, sand and clay
 165 -----182 ft. - blue clay and boulders
 182 -----205 ft. - fine sand and boulders
 205 -----220 ft. - coarse hard gravel
 220 -----347 ft. - very hard blue clay, streaks of sandstone
 347 -----360 ft. - sand stone
 360 -----409 ft. - blue shale showing sand and gravel
 409 -----410 ft. - red rock (6" core recovered)

The best water bearing formation appeared to be at a depth of 182 to 220 feet. This strata showed possibility of developing over 100 gallons per minute, and therefore was pumped at 4 gallons per minute and water samples obtained.

Water by trial analysis was somewhat softer than city wells and approximately same quality as that found in the abandoned city well.

A second test well drilled N.E. of city limits showed two water bearing formations at shallow depths. The log of test well no. 2 is as follows:

0 - 3 ft. - top soil
 3 - 10 ft. - dirty yellow gravel
 10 - 12 ft. - clear coarse yellow gravel
 12 - 15 ft. - coarse gray sand and gravel
 15 - 27 ft. - blue clay
 27 - 29 ft. - gray sand

A temporary screen was installed at a depth of 15 ft., and water sample obtained. The water showed the same hardness as other shallow wells in the vicinity of the city and was much harder than the 182 to 200 ft. strata found in well no. 1.

It is therefore recommended that a Layne Gravel Wall Well be installed at the site of test well no. 1, with screen setting at the 182 to 220 ft. level. The well should be of the cemented casing type to seal out undesirable upper waters and to preserve the casing. Twenty feet of 6" I.D. Layne shutter screen will give sample screen opening to well over the required yield and should be set at the best parts of the formation to be developed. The water bearing strata should be mechanically or hydraulically under-reamed or both, to a minimum diameter of 38 inches to insure stability in the well and prevent unnecessary sand pumping.

Gravel should be placed around screen while circulation is maintained around screen to assure complete filling of under-reamed hole with the proper size gravel to control the native formation.

Indications are that the size gravel should be not less than 8 mesh nor more than 4 mesh, but this may be modified as further tests are run on samples from the larger hole.

We are confident that a well installed in the above manner will provide the city with an adequate and satisfactory water supply and are willing to undertake the installation under such a guarantee. We can however, give no assurance to the city that a well installed in a manner other than outlined would give any greater degree of satisfaction than the last well installed in 1941.

It is also our opinion that the pump which the city owns may, due to higher pumping level, give more water than before, but as pumping conditions cannot be accurately determined until after the well is tested. At that time, the city can modify the present pump to correspond to well conditions.

During the time that this test drilling work was proceeding two water samples were submitted to the State Chemical Laboratory which show greatly differing results.

One sample was submitted on July 30, 1943, designated only as Test Well No. 1, with a request that the State Department of Health comment on its adequacy for human consumption. The results of the analysis follows:

	Parts per Million	Grains per Gallon
Total solids	2040	119
Alkalinity		
Phenolphthalein	None	-
Methyl Orange	316	18.4
Silica	34	2.0
Calcium	197	11.5
Magnesium	48	2.8
Hardness as Ca CO ₃	691	40.4
Chloride	44	2.6
Sulfate	1060	61.9
Manganese	1.0	-
Iron	0.2	-
Fluoride	1.0	-

This analysis was accompanied by a letter dated August 14, 1943, from Mr. Glen J. Hopkins, Director, Division of Sanitary Engineering of the State Department of Health, which is included in its entirety, below.

"This will acknowledge receipt of your letter of August 13 with which you enclosed a chemical analysis of your test well and in which you request our opinion regarding the adaptability of this water for human consumption.

The total solids, the sulfate content and the manganese and iron content of the water exceed limits established as desirable for domestic water supplies. The fluoride content further approaches the maximum limits established for domestic water supplies.

Accepted standards established a maximum total solids content of 500 ppm as desirable waters cannot be obtained. The total solids content of your test well is given as 2040 ppm.

The sulfate content as indicated by the analysis is 1060 ppm. Standards established as desirable limit sulfate content to 250 ppm. It is believed that the sulfate content indicated in your water is sufficiently high to be cathartic in nature and objectionable from this standpoint.

The total of iron and manganese evidenced in your water is 1.3 ppm whereas a limit of 0.3 is established for desirable waters.

The fluorine content of 1 ppm should be substantiated by further analysis in as much as the single sample indicated 1 ppm the maximum established for safe water supplies. This amount is inductive to mottling of enamel of teeth, especially in children.

The water is not adaptable for treatment by conventional methods to render it more satisfactory for domestic purposes. The supply compares favorably with that used by the cities of Emery and Alexandria and you are referred to these cities for comments on their water supply.

The supply further evidences objectionable chemical content to a less degree than the supply used by your neighboring city of Winfred. You are invited to investigate the desirability of the Winfred supply for your purposes.

The chemical analysis of the test well compares favorably with that from the existing 400 foot Howard well. Total solids and sulfates are practically the same as evidenced in the present water supply. Fluorine content is somewhat lower and manganese is comparable.

The water is not believed to be detrimental to public health. It will, however, probably be unsatisfactory as to palatability and of a pronounced cathartic nature. In the absence of a more satisfactory supply the State Board of Health would not want to condemn the usage of this water. We feel that the City itself should determine the desirability of using the supply".

On August 23, 1943, a sample of water from "New Well" was submitted for analysis. The "new well" must mean a test well drilled by Layne-Minnesota, although no definite information is available indicating that, nor is there any information regarding the depth from which the sample was taken, although we presume it must have been from 182 ft. to 200 ft. depth from Layne-Minnesota Test Well No. 1 covered in their report.

	<u>Parts per Million</u>	<u>Grains per Gallon</u>
Total solids	1072	62.7
Alkalinity		
Phenolphthalein	6	0.4
Methyl Orange	45	2.6
Silica	5	0.3
Calcium	45	2.6
Magnesium	36	2.1
Hardness as Ca CO ₃	261	15.3
Chloride	25	1.5
Sulfate	680	39.8
Manganese	None	-
Iron	7.2	-
Fluoride	1.0	-

This sample indicates by far the best quality of water run across in the work done on this report. Subsequent to the test work and report done by Layne-Minnesota, the City entered into contract with Layne-Minnesota on September 17, 1943, for the construction of a 38 inch diameter gravel-packed well to a depth of about 205 feet. The bottom 20 ft. consisted of a silicon manganese bronze well screen. The well was to pump 100 gallons per minute. A water sample designated as "water from new well at City of Howard," was submitted for analysis on May 6, 1944, the results being as follows.

	Parts per Million	Grains per Gallon
Total solids	1942	113.6
Alkalinity		
Phenolphthalein	12	0.7
Methyl Orange	322	18.8
Silica	31	1.8
Calcium	191	11.2
Magnesium	43.5	2.5
Hardness as Ca CO ₃	657	38.4
Sulfate	611	35.7
Chloride	18.0	1.1
Iron	3.0	-
Manganese	1.2	-
Fluoride	0.7	-
Free carbondioxide (CO ₂)	320	-
Half-bound carbondioxide (44% of alkalinity)	131	-
Non-carbonate hardness	323	-

Ref. Manual of Water Quality and Treatment (1940), page 209.

For commercial softening this water requires 4.8 lbs. lime (CaO) and 0.40 lbs. soda ash (Na₂ CO₃) per 1000 gallons of raw water.

It is not possible to explain the change in analysis from this water sample as compared with that listed as coming from Layne-Minnesota Test Well No. 1. It is known that water quality will change upon hard pumping.

This well was constructed adjacent to the 1941 Kuborn Well in the municipal building just east of the Power Plant. Difficulties were encountered some time in the 1940's with the Layne-Minnesota production falling off from sand plugging. An attempt was made to rejuvenate this well but as happens occasionally in this kind of work the well completely plugged at the bottom and further attempts to restore it failed.

Following this failure existing Well No. 1 was constructed.

Exploratory Work Prior to 1957.

Apparently there has never been a period in the twenty years prior to 1957 when the City water supply has not been a problem and source of difficulty.

In 1951, following the construction of existing Well No. 1 (built in 1949) and when difficulties were developing over this well, two test holes were dug by Layne-Minnesota Co. Test Hole No. 1 was located near the present Shimmerda property in the area of the abandoned gravel pits south of the City. Test Hole No. 2 was located adjacent to the golf course on the east side of the branch of the Vermillion River. Their report, dated October 29, 1951, is included below.

"The following is a report covering the field and laboratory findings during our recent test drilling program. Logs of the two holes are as follows:

Test Hole #1

0 - 6' Topsoil
 6 - 8 Sand
 8 - 11 Yellow Clay
 11 - 12 Blue Clay
 12 - 16 Sand & Gravel
 16 - 29 Blue Clay
 29 - 31 Sand
 31 - 42 Blue Clay

Test Hole #2

0 - 3' Topsoil
 3 - 15 Yellow Clay
 15 - 64 Fine sand
 64 - 72 Blue Clay

A sieve test was run on the sand samples obtained from test hole #2 with the following results:

<u>U.S. No.</u>	<u>Opening</u>	<u>Percent Retained</u>
12	0.063	2.7
16	0.046	4.1
20	0.033	13.7
30	0.023	24.6
40	0.016	21.9
50	0.0116	16.6
70	0.008	9.6
100	0.006	4.1
200	0.003	2.7

Flow tests run on the sand samples from test hole #2 indicate that the formation should yield a minimum of 40 gallons per minute and a possible maximum of 95. However, since test hole #1 shows no formation, there is not sufficient data on the area of the water-bearing structure to make any definite prediction or guarantee. In order to arrive at any absolute conclusions, at least two more test holes should be drilled, so that the area and extent of this formation can be plotted.

However, if the sand is extensive enough to support the continuous pumping which a municipal supply must undergo, there are several definite recommendations which we would make on the well construction.

The well log indicates, and the sieve test shows, that this water bearing sand is very fine. Therefore, the well must be designed to control this sand and prevent its moving with the water. For this purpose, we would recommend the installation of a Layne Gravel-Wall well with a minimum diameter of 42". The gravel should be selected filter gravel sized so as to prevent sand movement toward the screen. The large diameter is necessary for two reasons. First, to get the maximum amount of water with the minimum drawdown (since in a shallow well drawdown is necessarily limited). Second, to reduce the entrance velocity of the water coming from the fine sand.

The screen itself should be of a non-corrosive metal such as Everdur, Stainless steel, or Monel, with large slot openings. If a 12" or 16" diameter is used, 5' will be a sufficient length.

Such a well, if further testing proves favorable, would give a lifetime of service.

A water sample was pumped, but the jar was cracked on arrival at the laboratory, probably due to freezing. But the water is undoubtedly much like that obtained from other shallow wells on the east side of Town".

No information is available on the quality of water taken from Test Hole No. 2.

In August 1952, two additional test holes were drilled. Records available do not indicate who the driller was. Notations are given as they appear on the logs.

Test Hole #1 - At Golf Course

2' - 15' - Gravel
15' - 26' - Blue Clay
26' - 30' - Gravel
30' - 32' - Blue Mud
32' - 34' - Gravel
34' - 41' - Blue Mud
41' - 44' - Gravel

Rest of hole no good.

Test Hole #2 - Farmer Aven. and Miner St.

2' - 14' - Clay and Gravel
14' - 21' - Gravel and Blue Clay
21' - 25' - Blue Clay
25' - 28½' - Gravel with some blue clay
28½' - 30' - Blue Clay
30' - 31½' - Clean Gravel
31½' - 33' - Blue Clay
33' - 36' - Gravel
36' - 39' - Blue Clay
39' - 41' - Gravel
41' - 44½' - Fine sand
44½' - 57' - Gravel and Blue Clay
57' - 59' - Fine Sand
59' - 63' - Blue Clay
63' - 67' - Gravel and boulders
67' - 68' - Rocks and Blue Clay
End of hole.

Exploratory Work and New Well - 1957, Existing Well No. 3.

Lack of an adequate water supply in the City continued and in the spring of 1957 this firm was retained by the City for the purpose of studying the situation and making recommendations which would help alleviate the previous water shortages.

In April of 1957, a brief report was filed covering studies made on the only two producing wells and recommending additional test drilling for the purpose of constructing a new well.

The seriousness of the situation was easily apparent when the following conditions were observed.

Design population - 1500

Design usage (domestic usage only) - 1500 x 100 gals/person/day - 150,000 g.p.d.
or 105 g.p.m.

Fire demand (according to Fire Underwriters Formula)

1250 gallons per minute for 5 hours plus 1/2 normal domestic demand

$1250 \times 60 \times 5 + 5/24 \times 150,000 \times 0.5 = 390,000 \text{ gals.}$

Elevated tank - 105,000 gallons.

Wells must then supply 390,000-105,000 - 285,000 gallons in 5 hours or 950 gallons per minute. This could also come from a combination of underground reservoir storage and wells if pumps and piping are properly arranged.

Well No. 1 will produce about 85 g.p.m. with the existing pump installed. Well No. 2 will produce about 25 g.p.m. (on a continuous basis).

It is easily seen then that Wells No. 1 and 2 will barely take care of the domestic demand with no safety margin for fire protection.

The report filed in April, 1957, is reproduced herein.

Introduction.

The City of Howard now has two pumping wells which are supplying the water required by those who use the municipal supply. Within the last six months or so it began to appear that the south well was not doing as well as it had been. It then became quite evident that something should be done to assure an adequate supply of water for the future. The question then arose as to what would be the best way of meeting this problem. The Council was then advised by the engineering firm, DeWild & Grant, assisted by the Frederickson Well Co., specialist in ground water surveys, that it would be well to learn all that could be determined about the existing wells and the formations in which these wells are located before anything else was done. It is for this reason that a pumping test was conducted on the existing wells on April 11-12, 1957.

Conclusions and General Observations.

The existing wells are located in a formation which is capable of producing all the water that is needed for the City of Howard. The real problem is one of proper well construction so that the water can be obtained from this formation.

A short test was run on the south well. It was evident immediately that this well was not satisfactory for continuous operation to supply any large amount of water. The meter which had been cleaned just prior to the test stopped almost immediately, apparently because of sand being pumped. We therefore had no good way of telling how much water was being pumped. It is quite certain the pumping rate did not reach 100 gallons per minute and perhaps it was considerably lower than that. Pumping at that rate the water level in the well dropped about 100 feet to the bottom of the pump suction in a very few minutes. It is evident that this well will not continue to be satisfactory for a continuous supply. It is apparent that its main use will be that of a standby well to help carry the City over any emergencies that may develop.

A pumping test was then conducted on the well just northeast of the power plant. This test was conducted for some 18 hours. This test showed that the well is in a formation which is capable of producing substantial amounts of water. This well should probably continue to be used at its present rate rather than putting a larger pump in this existing well. However this test does show that this formation is capable of producing 250 gallons per minute from a properly constructed well.

Formations of the type that appear to exist in the vicinity of this well will transmit water in such a way that wells in the vicinity of the pumping well will be affected. The capacity of a second pumping well located at various distances from another pumping well will be diminished from its normal capacity by the percentages shown in the following table.

1000'	- - - -	44%
2000'	- - - -	36%
3000'	- - - -	31%
4000'	- - - -	28%
5000'	- - - -	25%

This means that if two wells were located two thousand feet apart the second well could only pump 64 per cent as much water as it would if it were by itself. This indicates that it is advisable to space the wells as far apart as possible consistent with other design problems such as pumping and piping.

It is very evident that the City of Howard is going to need a new well in the near future. It appears that the formation that is supplying the present water for Howard extends at least a mile in every direction from the well. However, no one can actually be sure of this. Therefore it is desirable to drill a test hole or holes in the locations that are to be considered for future wells. The test hole is also desirable to obtain exact information on the formation. One of the problems encountered by the City of Howard in the past has been that of pumping sand. A properly designed well should not pump sand. However the only way to obtain information to properly design a well is to actually get samples of the formation in which the well is to be located. If good accurate samples are obtained it is possible to build wells that will not pump sand.

In the past Howard has had some wells in a shallower formation. These wells apparently also produced substantial amounts of water. It would perhaps be well to study this shallower formation as well as the deeper ones in which the present wells are located. The shallower formation would probably produce a better quality water. If this water could be obtained in sufficient quantities it would be advisable to build a well in that formation. This will save on pumping costs as well as giving more desirable water to the public.

We would suggest that at least one, and perhaps two, test holes be drilled and the formations checked by means of electric log. The visual samples obtained combined with the electric log information should be sufficient to determine the design characteristics that would be incorporated in a producing well. These data would also be invaluable from the standpoint of determining whether the shallower formation looks promising we will recommend that one of the test holes be screened, cased, and developed out and a non-equilibrium pumping test run to determine its productive capacity as a permanent well."

Two test holes were drilled from May 1, 1957, to May 15, 1957, by Frederickson Well Co., Hutchinson, Minnesota.

Test Hole No. 1 was located at the south end of the athletic field. Test Hole No. 2 was located in the northwest corner of the golf course.

The test logs are shown below and electric logs of these are reproduced on the following pages.

Jim Gordon has electric logs filed in his office

City of Howard, South Dakota

Test Hole #1 on Athletic Field

Kind of Formation	Color of Formation	Stated at What Depth	Ended at What Depth	Total Thickness of Formation
Top soil	Black	0'	2'	2'
Clay	Brown	2'	70'	68'
Sand coarse	Colored	70'	85'	15'
Clay	Blue	85'	152'	67'
Sand	Colored	152'	154'	2'
Clay	Blue	154'	158'	4'
Sand	Yellow	158'	161'	3'
Sand, dirty	Colored	161'	175'	14'
Clay	Blue	175'	200'	25'
Shale	Black	200'	244'	44'
Soft shale	Gray	244'	252'	8'
Shale hard	Gray	252'	478'	226'
Sand	Gray	478'	480'	2'
Shale lensed with sand	Gray & Black	480'	500'	20'
Sioux quartzite			500'	

Drilled by: Frederickson's, Inc.
Hutchinson, Minnesota
May 9, 1957

Engineers: DeWild & Grant
Rock Rapids, Iowa

City of Howard, South Dakota

Test Hole #2 on Golf Course

Kind of Formation	Color of Formation	Started at What Depth	Ended at What Depth	Total Thickness of Formation
Top soil	Black	0'	3'	3'
Coarse sand	Brown	3'	18'	15'
Sandy clay	Blue	18'	170'	152'
Dirty sand	Colored	170'	175'	5'
Sand	Colored	175'	182'	7'
Clay	Blue	182'	184'	2'
Silty coarse sand	Colored	184'	198'	14'
Shale	Black	198'	226'	28'
Clay, sandy	Blue	226'	274'	48'
Shale				
	Gray	274'	344'	70'
Shale, hard	Gray	344'	380'	36'
Shale				
	Gray & Black	380'	405'	25'
Sioux Quartzite	Red	405'		

Drilled by: Frederickson's, Inc.
Hutchinson, Minnesota
May 15, 1957

Engineers: DeWild & Gant
Rock Rapids, Iowa

Following this test drilling work a contract was entered into by the City and Frederickson's, Inc. for the purpose of constructing a new well in the vicinity of Test Hole No. 2.

In view of the favorable water quality samples observed in the water bearing formation located about 200 ft. below the surface (from previous work done in 1941) and based upon the electric log of Test Hole No. 2 the new well was constructed to a total depth of 196 ft. below the surface. The well consists of the following:

10" steel casing - 176 ft. Schedule 40
10" screen - 20 ft. nominal

The screen is a #13 slot Everdur screen with an 8" x 10" slip packer. Total screen and leader is 26 ft. long.

The static water level was 113 ft. below the surface. The pump is a 10 horsepower Berkeley submersible unit, 3 phase, 60 cycle, model 3P 102631, serial C230, 3450 r.p.m. The top of the well is finished off with a Merrill Well-King pitless unit, 12" with adaptor for 10" casing.

Pumping conducted on the well after completion indicated that it would be capable of producing about 75 gallons per minute on a continuous basis.

After about a year of continuous operation it was found necessary to reduce the production of this well to about 40 gallons per minute because of apparent air pumping. The reason has not been determined.

During the summer of 1958 a number of complaints were made by property owners regarding the quality of the water from this well. The contention was that this water was of much poorer quality, taste and odor-wise than the water from either well No. 1 or No. 2.

A water sample analysis of water taken from this well does not substantiate this although it is possible that the dissolved gas content, not shown by the analysis, may be higher. A copy of the analysis is reproduced below.

Well No. 3

Sample analyzed and report on July 16, 1958

	<u>Parts per Million</u>	<u>Grains per Gallon</u>
Total solids	2007	
Total iron, Fe	0.45	
Alkalinity-P	0	
pH	7.50	
Potassium, K	22.09	
Sodium, Na	372.6	
Calcium, Ca	180.2	
Magnesium, Mg	40.1	
Manganese, Mn	1.04	
Nitrate	0	
Fluoride, F	0.72	
Chloride, Cl	21.0	
Sulfate, SO ₄	1042.2	
Bicarbonate, HCO ₃	403.8	
Calculated hardness as Ca CO ₃	617.7	36.2

This water, while not good by U.S. Public Health Standards, compares favorably with that from the other two producing wells.

Conclusions and Recommendations.

The review of information presented in this report indicates that the City of Howard has experienced considerable difficulty in obtaining a desirable water supply both in quality and quantity over the past 20 years. The job of obtaining adequate, dependable, and good quality water supplies is a difficult problem in this area.

Two general aquifers have been developed and tapped for water supply. The upper aquifer is located about 200 ft. below the surface, the lower aquifer existing just above the Sioux quartzite at a depth of about 400 ft.

The lower aquifer appears to present the best source of water in volume, while sample analyses available seem to indicate that the upper aquifer has the better quality of water (although this is questionable also).

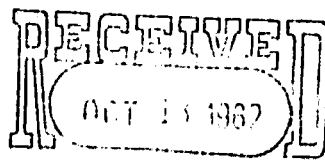
Failures of wells constructed in the lower aquifer have all been structural and should be capable of remedy through proper well construction.

We earnestly recommend that the City Council based upon material summarized in this report, proceed with the following steps at the very earliest opportunity in order to provide the necessary supply of water of desirable quality necessary for the City of Howard.

1. Investigate and develop additional well supplies from the existing aquifers capable of producing a total water supply of 500 gallons per minute. Also investigate the possibility of shallow wells adjacent to the branch of the Vermillion River again.
2. Increase underground storage reservoir to a total of 135,000 gallon capacity.
3. Install feeder piping from wells to underground reservoir, high service pumps, and control system for operation of wells.
4. Investigate economics of water treatment covering the following items.
 - a. Gas removal
 - b. Iron and manganese removal
 - c. Water softening
 - d. Gas chlorination

Of these items, Items a, b, and d are virtually necessities in order to make the water reasonably usable and palatable for domestic consumption.

5. Investigate the water distribution system for fire protection adequacy, especially in the business district.

Permit No. 994-3Water Division No. 3 Vermillion River DistrictSTATE WATER RESOURCES COMM.
PIERRE, SOUTH DAKOTA**Notice of Application of Water to Beneficial Use**

(This blank must be filled out by holder of permit and forwarded to the State Water Resources Commission at least sixty days before the time set for application of water.)

(P. O.) HOWARD, SOUTH DAKOTA(Date) OCTOBER 12, 1962

TO THE STATE WATER RESOURCES COMMISSION OF SOUTH DAKOTA, PIERRE:

DEAR SIR: Notice is hereby given that on the _____ day of _____
 19____, at _____ County of _____ State of South Dakota,
 before _____ (Examining Engineer or Officer) proof will be submitted of the application to beneficial use
 of .25 cubic feet per second of the waters of City Hall #4
 _____ in accordance with the terms and conditions of Permit No. 994-3
 heretofore issued by the Water Resources Commission of South Dakota.

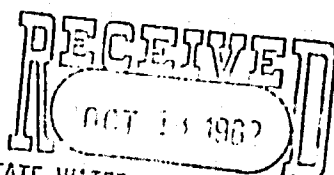
1. The name and postoffice address of the person or corporation holding said permit are _____
CITY OF HOWARD HOWARD, S. DAK.
2. The use to which said water has been applied is _____ MUNICIPAL
3. The amount applied to beneficial use is _____ ALL
4. The place where said water is used is (If for irrigation, give full and accurate description of the lands irrigated) City of Howard
5. The name of the canal or ditch or other works by which said water is conducted to such place of use is _____
6. The right to take the water from such works is based upon permit No. 994-3
7. The source of supply from which such water is diverted is ground water
8. The date of priority which said user is prepared to establish is _____

(Sign)

E. M. L. J. Meyer

Permit No. 994-3Water Division No. 3

Water District



STATE WATER RESOURCES COM. PIERRE, SOUTH DAKOTA

NOTICE OF COMPLETION OF WORKS

This blank must be filled out by the holder of permit and forwarded to the Executive Officer at least 60 days before the time set for completion of works

(P. O.) HOWARD, SOUTH DAKOTA(Date) OCTOBER 12, 1962

TO THE STATE WATER RESOURCES COMMISSION
OF SOUTH DAKOTA, PIERRE:

DEAR SIR: Notice is hereby given of the completion of the works for the diversion of CITY WELL #4.25 cu. ft. per second of the waters of the state from

through the

for MUNICIPAL purposes

In accordance with the terms and conditions of a certain permit heretofore issued by the Water Resources Commission of the State of South Dakota.

1. The name of the person or corporation holding said permit is

CITY OF HOWARD2. The postoffice address of such person or the place of business of such corporation is HOWARDCounty of MINER State of SOUTH DAKOTA3. The number of such permit is 994-3 and the date set for the completion of such work isSEPTEMBER, 19614. Said water to be used for MUNICIPAL purposes.

5. Said works of diversion will be fully completed on the date set for such completion, and the amount of water which said works are capable of conducting to the place of intended use, in accordance with the plans accompanying the application for such permit, is .25 cubic feet per second.

6. The amount of land for which said water is available is _____ acres,
particularly described as follows: _____

I hereby certify that the facts set forth in the above notice are true.

CITY OF HOWARD

(Signature of Owners)

E. M. Topp, Mayor

Permit No. 994-3
 Water Division No. 3 Vermillion Water District
Rider

Certificate of Examination of Works

Report of Examining Engineer

To the State Water Resources Commission, Pierre, South Dakota:

Dear Sirs: I hereby certify that in accordance with your letter of authorization dated _____

I have this day made a thorough examination of the diversion works constructed by the
City of Howard, et
Miner County, South Dakota, holder of Permit No. 994-3, issued
 upon Application No. 994-3, bearing date of priority of June 7, 1962, authorizing the
 diversion of 2.5 cu. ft. per second of the waters of ground water for municipal
 purposes. I have to report on the condition of the same as follows:

The diversion works comprise: 575' deep well w/ Layne-
Bowler 4" pump #28759, powered w/ 20 HP
U.S. Electric Motor, Type CFU

and the system is in the following condition: Excellent

The point of diversion is located Lot 6, NW¹SE⁴, Section 3, T106N,
R56W

The works are capable of diverting and conveying to the place of use 2.5 cu. ft. per second of water,
 which is to be used for municipal purposes

The legal sub-divisions to be irrigated are: _____

_____ comprising a total of _____ acres of land.

The domestic use intended comprises _____

The utilization for power, mining, or other beneficial uses comprises: _____

Witness my hand, this 17th day of March, 1962

—SEAL—

Dwight J. Jones
 Examining Engineer
 officer