

STATE OF SOUTH DAKOTA
William J. Janklow, Governor

DEPARTMENT OF WATER AND NATURAL RESOURCES
John J. Smith, Secretary

GEOLOGICAL SURVEY
Merlin J. Tipton, State Geologist

Open-File Report No. 38-UR

GREGORY PETROLEUM LEAK

by

Derric L. Iles

Science Center
University of South Dakota
Vermillion, South Dakota

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INTRODUCTION

At the request of the City of Gregory in 1984, the South Dakota Geological Survey investigated the hydrogeology of an area within the City limits where gasoline contamination was a problem. Liquid gasoline had been found in the sanitary sewer system and gasoline vapors were present in the basement of an office building. The Geological Survey drilled 16 test holes and installed observation wells in five of them. Also, water levels were measured on two occasions and the relative elevations of the wells were surveyed.

GEOLOGY

The City of Gregory is underlain by the Tertiary age Valentine Formation (Stevenson, 1958). Stevenson described it as a greenish-tan, fine-grained, partly clayey and tuffaceous, arkosic sand with local white, dense, sandy, limestone concretions and interbedded green clay. He also stated that it contained a basal conglomerate and an impure discontinuous ash. In the area of the gasoline contamination, the Valentine Formation was found to be very clayey and silty.

BACKGROUND

The Geological Survey was contacted by Deputy State Fire Marshall Pat Harrington on January 4, 1984. He reported observing gasoline floating in the sanitary sewer in the manhole at 5th and Main Streets and detecting gasoline fumes in the basement of a building at 405 Main Street (across the street from a Mobil Service Station).

The author of this report, representing the Geological Survey, went to Gregory on January 5, 1984, to assess the situation. As a result of that visit and subsequent visits, the following sequence of events was compiled. These events preceded the Geological Survey's involvement. All information was gathered by and all reports were made directly to the author unless otherwise noted.

1. The Mobil Station, on the corner of 4th and Main Streets, had been closed for some years prior to March, 1983, according to Al Cerney (Gregory City Manager).
2. The owner of the Mobil Station (Bill Janas) used one or both of the buried gasoline tanks for his own purposes while the Station was closed, according to Dianne Rajewich (present operator of the Mobil Station).
3. Bill Janas leased the Station to Diane Rajewich who opened it for business in March, 1983.

4. Bill Janas said he replaced both of the buried gasoline tanks prior to opening the Station in March, 1983.
5. After some time (length of time was not made known to the Geological Survey), Diane Rajewich said she noticed a loss of gasoline. On January 5, 1984, she reported to the author that the loss was approximately 300 gallons. She subsequently checked her records and determined that a total of 442 gallons of gasoline (253 gallons of regular and 189 gallons of unleaded) had been lost since she began operating the station in March, 1983 (information obtained during a phone conversation with Al Cerney on March 19, 1984).
6. Diane Rajewich said that Bill Janas replaced the line between the pump and the buried tank containing leaded gasoline after she reported the loss of gasoline. Bill Janas said that he could see seeps of gasoline coming out of the line when it was replaced.
7. According to Al Cerney, gasoline fumes in the basement of a building at 405 Main Street were first reported sometime near November 25, 1983.
8. Diane Rajewich stated that Bill Janas replaced the line between the tank containing unleaded gasoline and the pump in December, 1983, after reports of gasoline fumes in the building at 405 Main Street.

OBSERVATION-WELL CONSTRUCTION

All holes were drilled using the flight auger method (4-inch diameter) and holes in which casings were installed were drilled to a depth of 18 feet. The casing in each of the five observation wells consists of one 20-foot length of 2-inch diameter, 160 psi PVC with a slip cap glued to the bottom. Vertical, overlapping slots were cut in the lower 15 feet of the casing using a circular saw. Each observation well was gravel packed from the bottom of the hole to within 2.5 or 3 feet of the land surface with crushed quartzite to cover the slots in the casing. The remaining 2.5 or 3 feet of annular space between the casing and hole wall were filled with powdered bentonite to provide a seal at the top of the observation well. Locations of test holes and observation wells are shown in figure 1 and logs are presented in the appendix.

WATER LEVELS

The ground-water gradient is such that gasoline in the ground could migrate eastward from the Mobil Station to the sanitary sewer (fig. 2). Because the water level in the sewer is lower than water table in the sediments to both the east and west, gasoline migrating eastward from the Mobil Station would not move

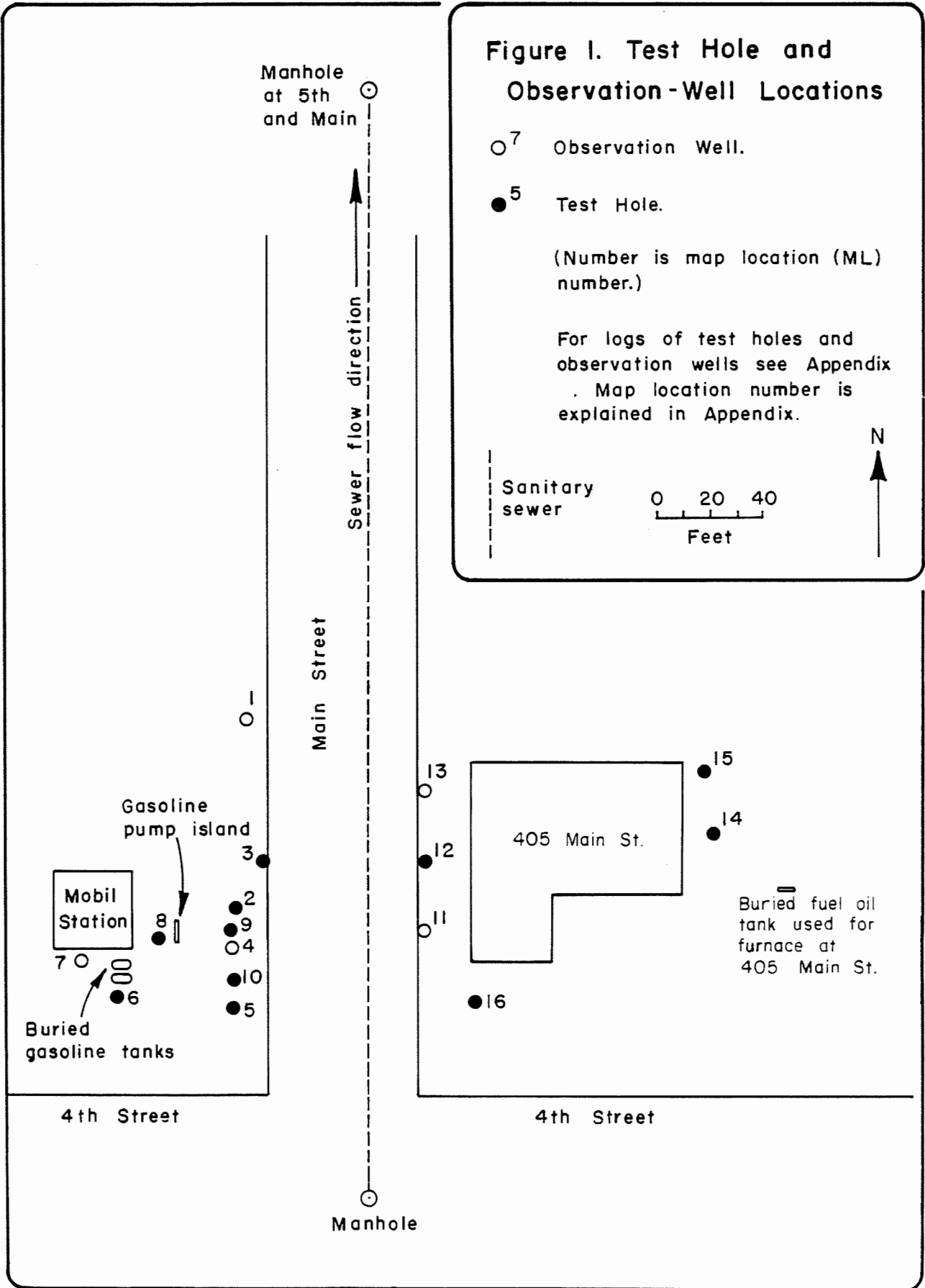


Figure 2. Water-Level Elevations: Jan. 25, 1984

87.50 X An arbitrary point along the sewer for which a water level was calculated. An even gradient is assumed between 4th and 5th streets. Number is in feet.

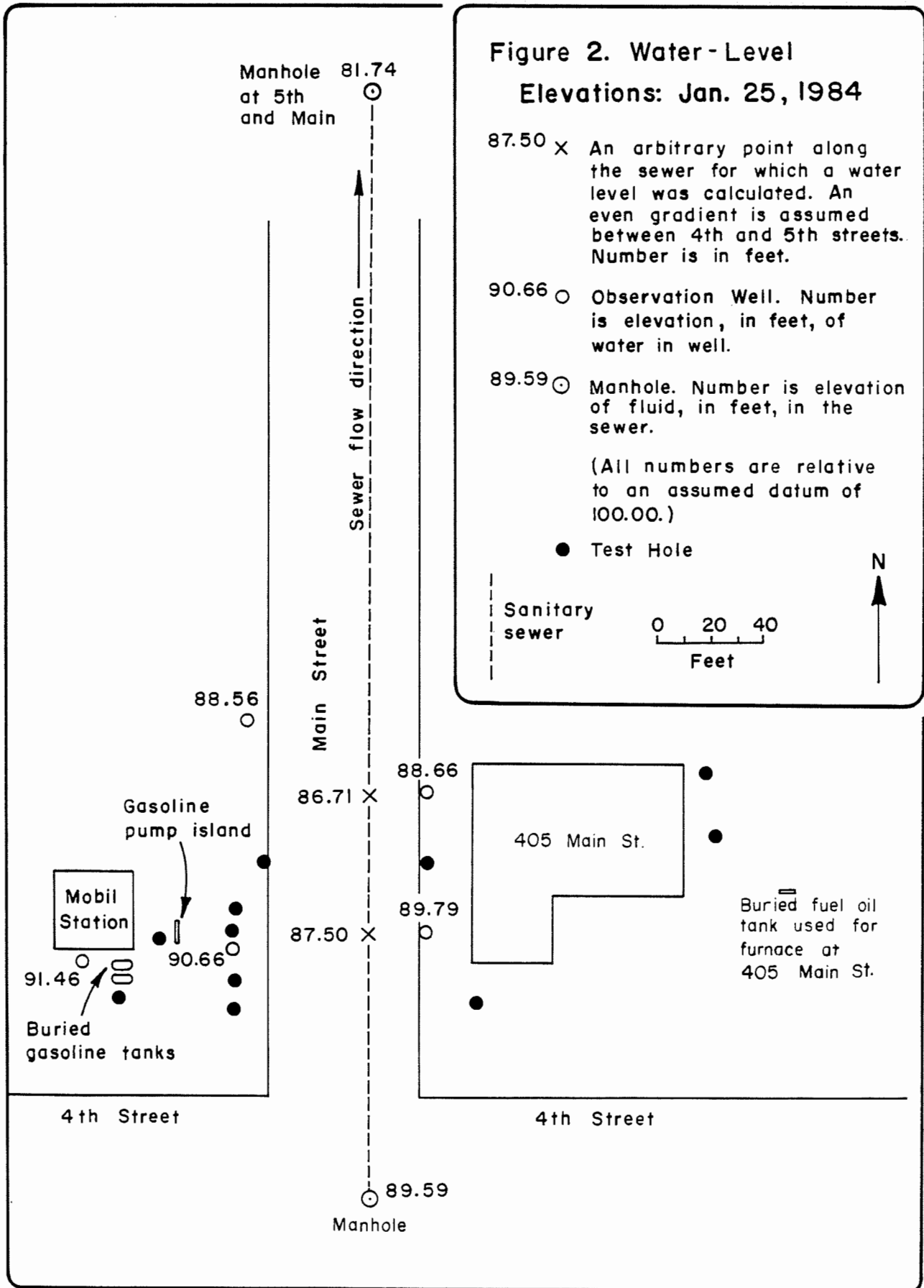
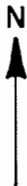
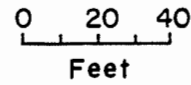
90.66 O Observation Well. Number is elevation, in feet, of water in well.

89.59 O Manhole. Number is elevation of fluid, in feet, in the sewer.

(All numbers are relative to an assumed datum of 100.00.)

● Test Hole

Sanitary sewer



eastward beyond the sewer (under observed water-level conditions). It is assumed that the water level in the sewer is reflective of the ground-water level around the sewer. Water-level measurements and relative elevations of observation wells and two manholes are listed in table 1.

CONTAMINATION

A phenomenon noted during the drilling was that the odor of gasoline was associated with an uncharacteristic color of drill cuttings. The normal color of the cuttings should have been a variation of brown but where a gasoline odor was present, the cuttings were a variation of gray. This discoloration and the odor of gasoline were used as the criteria for determining the presence of contamination (fig. 3).

All holes drilled on the west side of Main Street except one at map location (ML) 1 (fig. 1) showed the ground to be contaminated to some degree with a petroleum product; whereas, none of the holes drilled on the east side of Main Street appeared to be contaminated (fig. 3). During drilling of the hole at ML 4 (fig. 1), sediment was encountered which had a strong gasoline odor and appeared to be wet with gasoline. An observation well was installed in this hole and a dark-brown layer of fluid accumulated on top of the water in the well. This dark-brown fluid was subsequently analyzed by the State Chemist. He indicated that the sample appeared to be Mobil leaded gasoline.

Gasoline was also observed in the sanitary sewer in the manhole at 5th and Main Streets on January 4, 1984, by Pat Harrington (Deputy State Fire Marshall). In addition, Mr. Harrington detected a gasoline odor in the basement of a building at 405 Main Street. A fan was placed over the manhole at 5th and Main Streets to help remove the gasoline fumes from the sewer. A noticeable decrease in the concentration of gasoline fumes in the building at 405 Main Street coincided with the use of the vent fan over the manhole.

When the Geological Survey began field work on January 9, 1984, the amount of gasoline in the sewer was less than that observed on January 4, 1984. Although there were still gasoline fumes in the sewer, the observed concentration of liquid gasoline in the sewer was not sufficient to allow a sample to be collected for identification of the gasoline. However, it is thought that the gasoline in the sewer is the same as that found in observation well at ML 4 (fig. 1). This conclusion is based on hydrogeologic conditions present in the area and the absence of gasoline in liquid or vapor form in the manhole at 4th and Main Streets while it was detected in the manhole at 5th and Main Streets.

The amount of contamination observed while drilling the test holes indicates that much more than the reported 442 gallons of gasoline has been lost in the past. A publication by the

TABLE 1

Surveying and water-level measurements

Well map location number *	Relative elevation of casing top (ft)**	Depth to water from casing top (ft)	
		1-11-84	1-25-84
1	100.35	18.65	11.79
4	101.78	10.66	11.12
7	102.59	15.60***	11.13
11	100.00	14.14	10.21
13	99.13	10.05	10.47

* * * * *

Location of manhole	Relative elevation of manhole rim (ft)	Depth to water from manhole rim (ft)
		1-25-84
4th and Main Streets	99.99	10.40
5th and Main Streets	93.14	11.40

* For location, see figure 1. For description of map location (ML) number, see appendix.

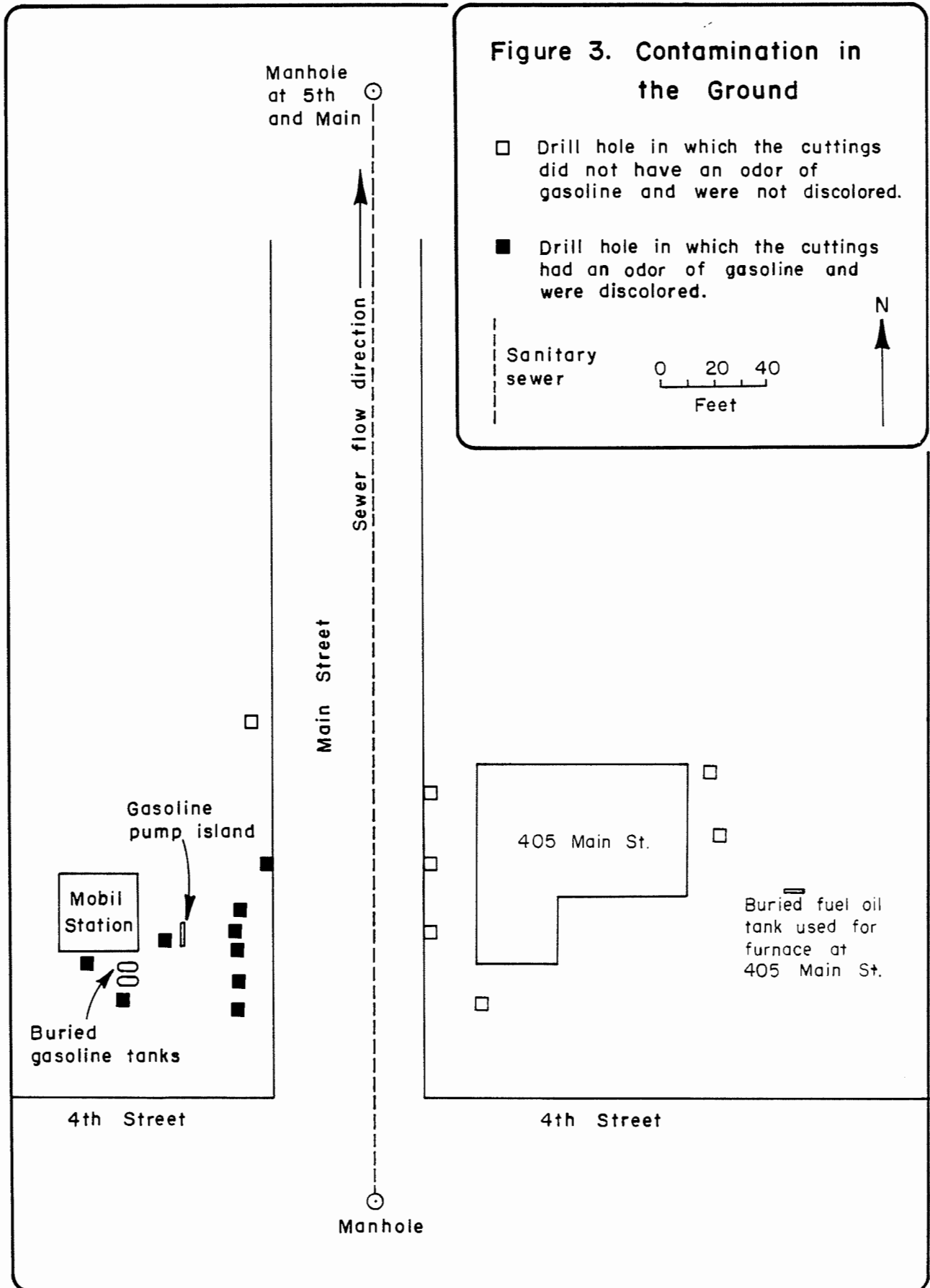
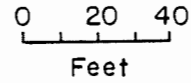
** All elevations are relative to an assumed datum of 100.00

*** Measurement taken the day after the hole was drilled but before any casing was installed and is relative to ground surface and not casing top.

Figure 3. Contamination in the Ground

- Drill hole in which the cuttings did not have an odor of gasoline and were not discolored.
- Drill hole in which the cuttings had an odor of gasoline and were discolored.

Sanitary sewer



American Petroleum Institute (1972) presents a method for calculating the volume of sediment required to immobilize a given quantity of gasoline. Using the methodology presented therein and assuming a contaminated thickness of 5 feet within the area of the triangular-shaped area shown on figure 4, the amount of gasoline required to contaminate a volume of this size is 3,245 gallons. If assumptions are correct, this amount is a minimum because the triangle on figure 4 does not encompass all contaminated ground. Also, the sewer has probably been intercepting and carrying away gasoline as it reached the sewer which prevented gasoline from contaminating more ground to the east of the sewer.

CONCLUSIONS

The gasoline fume problem in the building at 405 Main Street is the result of gasoline in the sanitary sewer. The source of gasoline in the sewer is believed to be from a gasoline leak at the Mobil Station located at the intersection of 4th and Main Streets. Gasoline fumes apparently enter the building through leaks in the plumbing within or under the building. Three items which support this interpretation are:

1. No gasoline was detected in the drill holes on the east side of Main Street;
2. The ground-water gradient would allow movement of gasoline from the vicinity of Mobil's buried tanks toward the sanitary sewer; and
3. A vent fan placed over the manhole at 5th and Main Streets caused a reduction in the concentration of fumes in the building at 405 Main Street.

The reported loss of gasoline in the amount of 442 gallons is not enough to account for the extent of contamination observed during the course of this investigation. It is suspected that gasoline was leaking from buried tank(s) and/or lines(s) at the Mobil Station prior to March, 1983. The duration and magnitude of the leak was not made known to the writer.

REFERENCES


- American Petroleum Institute, 1972, The migration of petroleum products in soil and ground water, principles and countermeasures: Committee on Environmental Affairs, Washington, D.C., publication no. 4149.
- Stevenson, R. E., 1958, Geology of the Gregory quadrangle, South Dakota: South Dakota Geol. Survey, Geol. Quad., map and text.

Figure 4. Thickness of Contaminated Sediment

○⁷ Observation Well.

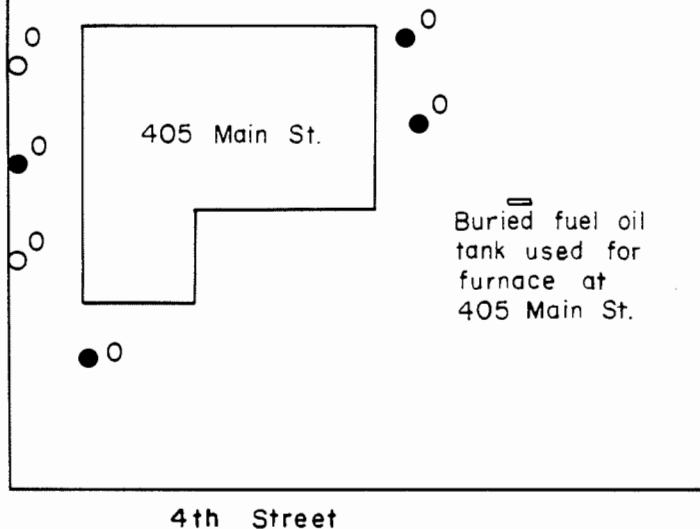
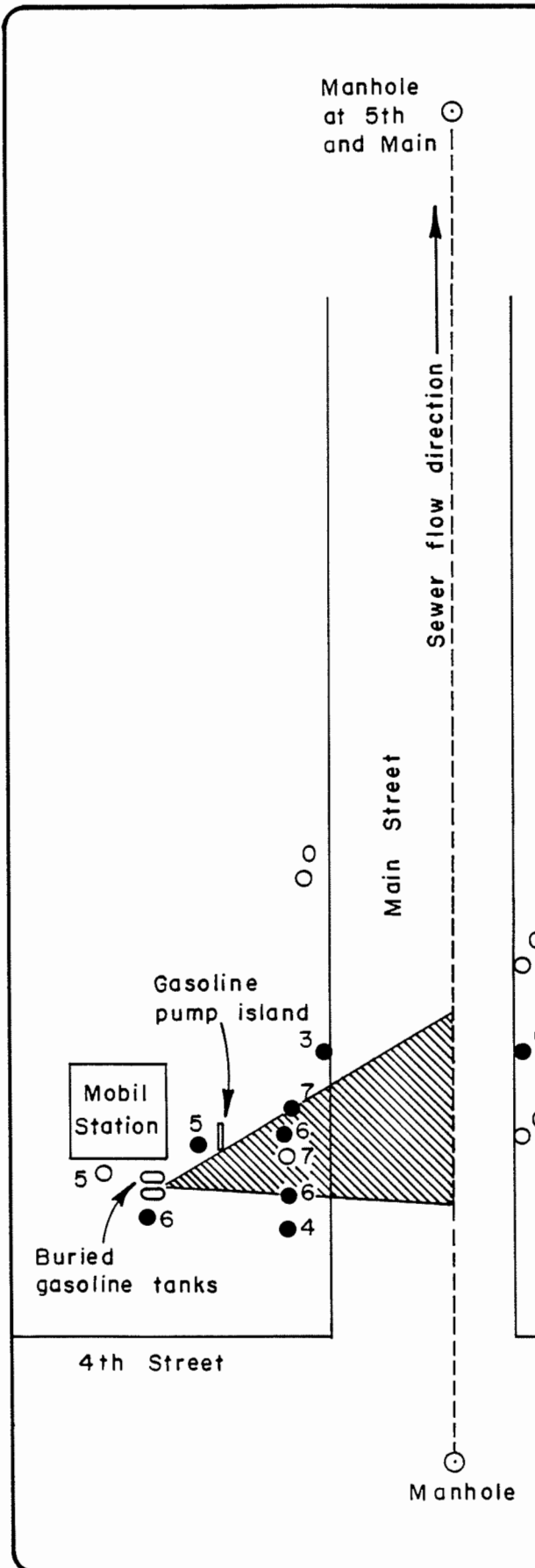
●⁴ Test Hole.

(Number refers to thickness, in feet, of contaminated sediment observed during drilling. Thickness corresponds to gray colored sediment described in Appendix.)

 Area for which the volume of gasoline lost was calculated. (See text for explanation.)

Sanitary sewer

0 20 40
Feet



APPENDIX

Logs of test holes and observation wells

MAP LOCATION (ML)

A number which is arbitrarily assigned to the log according to the order in which it is listed (see LEGAL LOCATION and LOCATION). This number corresponds to the numbers shown on figure 1.

LEGAL LOCATION and LOCATION

The logs are listed by smallest township number, then the smallest range number, the smallest section number, and then by quarter section: NE = A; NW = B; SW = C; SE = D.

LATITUDE and LONGITUDE

The format is DD.MMSS where D is degrees, M is minutes, and S is seconds.

DRILLING COMPANY

SDGS is an abbreviation for South Dakota Geological Survey.

TOTAL DRILL-HOLE DEPTH and SCREEN LENGTH

The numbers are presented in feet.

SCREEN TYPE and CASING TYPE

PVC - polyvinylchloride; HM. - home made.

CASING-TOP ELEVATION and GROUND-SURFACE ELEVATION

The numbers are presented in feet above mean sea level. The (T) following the number means that the elevation was estimated from a 7-1/2 minute series topographic map.

CASING DIAMETER

The numbers are presented in inches.

DATE DRILLED: 01-09-1984 DRILLING METHOD: AUGER
GROUND SURFACE ELEVATION: 2174.00 T
TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-12
USGS HYDROLOGICAL UNIT CODE: 10140101
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0 - 2 CLAY, DARK-BROWN, SILTY, SANDY, PEBBLY;
MOIST
2 - 9 CLAY, GRAY, VERY SILTY, SANDY; MOIST,
GASOLINE ODOR (VALENTINE FORMATION)
9 - 18 CLAY, LIGHT-BROWN, VERY SILTY; MOIST
(VALENTINE FORMATION)

* * * *

COUNTY: GREGORY LOCATION: 097N-73W-12CCAA 2
MAP LOCATION: 3
LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
LATITUDE: 43.1348 LONGITUDE: 99.2550
LAND OWNER:
PROJECT: GREGORY PETROLEUM LEAK
DRILLING COMPANY: SDGS
DRILLER: D. TOMHAVE DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 01-09-1984 DRILLING METHOD: AUGER
GROUND SURFACE ELEVATION: 2173.00 T
TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-13
USGS HYDROLOGICAL UNIT CODE: 10140101
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0 - 1 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
1 - 5 CLAY, LIGHT-BROWN, SILTY; MOIST
(VALENTINE FORMATION)
5 - 8 CLAY, DARK-GRAY, VERY SILTY, SANDY; MOIST
TO VERY MOIST, GASOLINE ODOR (VALENTINE
FORMATION)
8 - 18 CLAY, LIGHT-BROWN, SILTY, MOIST
(VALENTINE FORMATION)

LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE
 GEOLOGIST: D. ILES
 DATE DRILLED: 01-10-1984
 GROUND SURFACE ELEVATION: 2175.00 T
 TOTAL DRILL HOLE DEPTH: 18
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA:
 SAMPLES:

DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: AUGER
 TEST HOLE NUMBER: A1-84-15
 SINGLE POINT RESISTIVITY:
 EXTRA:

0 -	3	CLAY, BROWN, SILTY, PEBBLY; MOIST
3 -	7	CLAY, LIGHT-GRAY, VERY SILTY; MOIST, GASOLINE ODOR (VALENTINE FORMATION)
7 -	18	CLAY, LIGHT-BROWN, SILTY; MOIST (VALENTINE FORMATION)

* * * *

COUNTY: GREGORY
 MAP LOCATION: 6
 LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
 LATITUDE: 43.1348
 LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE
 GEOLOGIST: D. ILES
 DATE DRILLED: 01-10-1984
 GROUND SURFACE ELEVATION: 2176.00 T
 TOTAL DRILL HOLE DEPTH: 13
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA:
 SAMPLES:

LOCATION: 097N-73W-12CCAA 5
 LONGITUDE: 99.2550
 DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: AUGER
 TEST HOLE NUMBER: A1-84-16
 SINGLE POINT RESISTIVITY:
 EXTRA:

0 -	1	CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
1 -	7	CLAY, GRAYISH-BROWN, SILTY; MOIST, GASOLINE ODOR
7 -	13	CLAY, LIGHT-BROWN, SILTY; MOIST, HIT SOMETHING REDDISH-BROWN AND HARD, ABANDONED HOLE

LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
 LATITUDE: 43.1348 LONGITUDE: 99.2550
 LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 01-10-1984 DRILLING METHOD: AUGER
 GROUND SURFACE ELEVATION: 2175.00 T
 TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-18
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0 - 2 SAND; BACK-FILL MATERIAL
 2 - 7 CLAY, GRAY, SILTY; MOIST, GASOLINE
 ODOR (VALENTINE FORMATION)
 7 - 18 CLAY, LIGHT-BROWN, SILTY; MOIST
 (VALENTINE FORMATION)

* * * *

COUNTY: GREGORY LOCATION: 097N-73W-12CCAA 8
 MAP LOCATION: 9
 LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
 LATITUDE: 43.1348 LONGITUDE: 99.2550
 LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 01-10-1984 DRILLING METHOD: AUGER
 GROUND SURFACE ELEVATION: 2175.00 T
 TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-19
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0 - 2 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
 2 - 8 CLAY, DARK-GRAY, SILTY; MOIST,
 GASOLINE ODOR (VALENTINE FORMATION)
 8 - 18 CLAY, LIGHT-BROWN, SILTY; MOIST

SCREEN TYPE: PVC, HM. SCREEN LENGTH: 15.0
 CASING TYPE: PVC CASING DIAMETER: 2.0
 CASING TOP ELEVATION:
 CASING STICK-UP: 2.00 TOTAL CASING AND SCREEN: 20.0
 WELL MAINTENANCE DATE:
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

THE WELL SCREEN CONSISTS OF VERTICAL OVERLAPPING
 SLOTS CUT IN THE 160 PSI CASING WITH A CIRCULAR
 SAW. THE WELL BOTTOM IS CAPPED WITH A SLIP CAP
 (GLUED ON). THE WELL WAS GRAVEL PACKED WITH
 QUARTZITE CHIPS AND SEALED AT THE TOP WITH
 BENTONITE.

0 - 2 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
 2 - 18 CLAY, BROWN, SILTY; MOIST (VALENTINE
 FORMATION)

* * * *

COUNTY: GREGORY LOCATION: 097N-73W-12CCA11
 MAP LOCATION: 12
 LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
 LATITUDE: 43.1348 LONGITUDE: 99.2549
 LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE DRILLER'S LOG:
 GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
 DATE DRILLED: 01-10-1984 DRILLING METHOD: AUGER
 GROUND SURFACE ELEVATION: 2173.00 T
 TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-22
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
 NATURAL GAMMA: EXTRA:
 SAMPLES:

0 - 2 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
 2 - 18 CLAY, BROWN, SILTY; MOIST (VALENTINE
 FORMATION)

DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE
 GEOLOGIST: D. ILES
 DATE DRILLED: 01-10-1984
 GROUND SURFACE ELEVATION: 2171.00 T
 TOTAL DRILL HOLE DEPTH: 18
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA:
 SAMPLES:

DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: AUGER
 TEST HOLE NUMBER: A1-84-25
 SINGLE POINT RESISTIVITY:
 EXTRA:

0 - 2 CLAY, BLACK, SILTY
 2 - 18 CLAY, LIGHT-OLIVE-YELLOW-BROWN, SILTY;
 MOIST (VALENTINE FORMATION)

* * * *

COUNTY: GREGORY
 MAP LOCATION: 15
 LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
 LATITUDE: 43.1349
 LAND OWNER:
 PROJECT: GREGORY PETROLEUM LEAK
 DRILLING COMPANY: SDGS
 DRILLER: D. TOMHAVE
 GEOLOGIST: D. ILES
 DATE DRILLED: 01-10-1984
 GROUND SURFACE ELEVATION: 2171.00 T
 TOTAL DRILL HOLE DEPTH: 18
 USGS HYDROLOGICAL UNIT CODE: 10140101
 ELECTRIC LOG INFORMATION:
 SPONTANEOUS POTENTIAL:
 NATURAL GAMMA:
 SAMPLES:

LOCATION: 097N-73W-12CCA14
 LONGITUDE: 99.2548
 DRILLER'S LOG:
 GEOLOGIST'S LOG: X
 DRILLING METHOD: AUGER
 TEST HOLE NUMBER: A1-84-26
 SINGLE POINT RESISTIVITY:
 EXTRA:

0 - 4 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
 4 - 18 CLAY, LIGHT-BROWN, SILTY; MOIST
 (VALENTINE FORMATION)

* * * *

COUNTY: GREGORY
 MAP LOCATION: 16

LOCATION: 097N-73W-12CCA15

LEGAL LOCATION: NE NE SW SW SEC. 12, T. 097 N., R. 73 W.
LATITUDE: 43.1348 LONGITUDE: 99.2549
LAND OWNER:
PROJECT: GREGORY PETROLEUM LEAK
DRILLING COMPANY: SDGS
DRILLER: D. TOMHAVE DRILLER'S LOG:
GEOLOGIST: D. ILES GEOLOGIST'S LOG: X
DATE DRILLED: 01-10-1984 DRILLING METHOD: AUGER
GROUND SURFACE ELEVATION: 2173.00 T
TOTAL DRILL HOLE DEPTH: 18 TEST HOLE NUMBER: A1-84-27
USGS HYDROLOGICAL UNIT CODE: 10140101
ELECTRIC LOG INFORMATION:
SPONTANEOUS POTENTIAL: SINGLE POINT RESISTIVITY:
NATURAL GAMMA: EXTRA:
SAMPLES:

0 - 4 CLAY, DARK-BROWN, SILTY, PEBBLY; MOIST
4 - 18 CLAY, LIGHT-BROWN, SILTY; MOIST
(VALENTINE FORMATION)

* * * *