UTAH GEOLOGICAL AND MINERAL SURVEY

REPORT OF INVESTIGATION

NO. 215

TECHNICAL REPORTS FOR 1986
SITE INVESTIGATION SECTION

Compiled by
William E. Mulvey

1987

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ILLUSTRATIONS

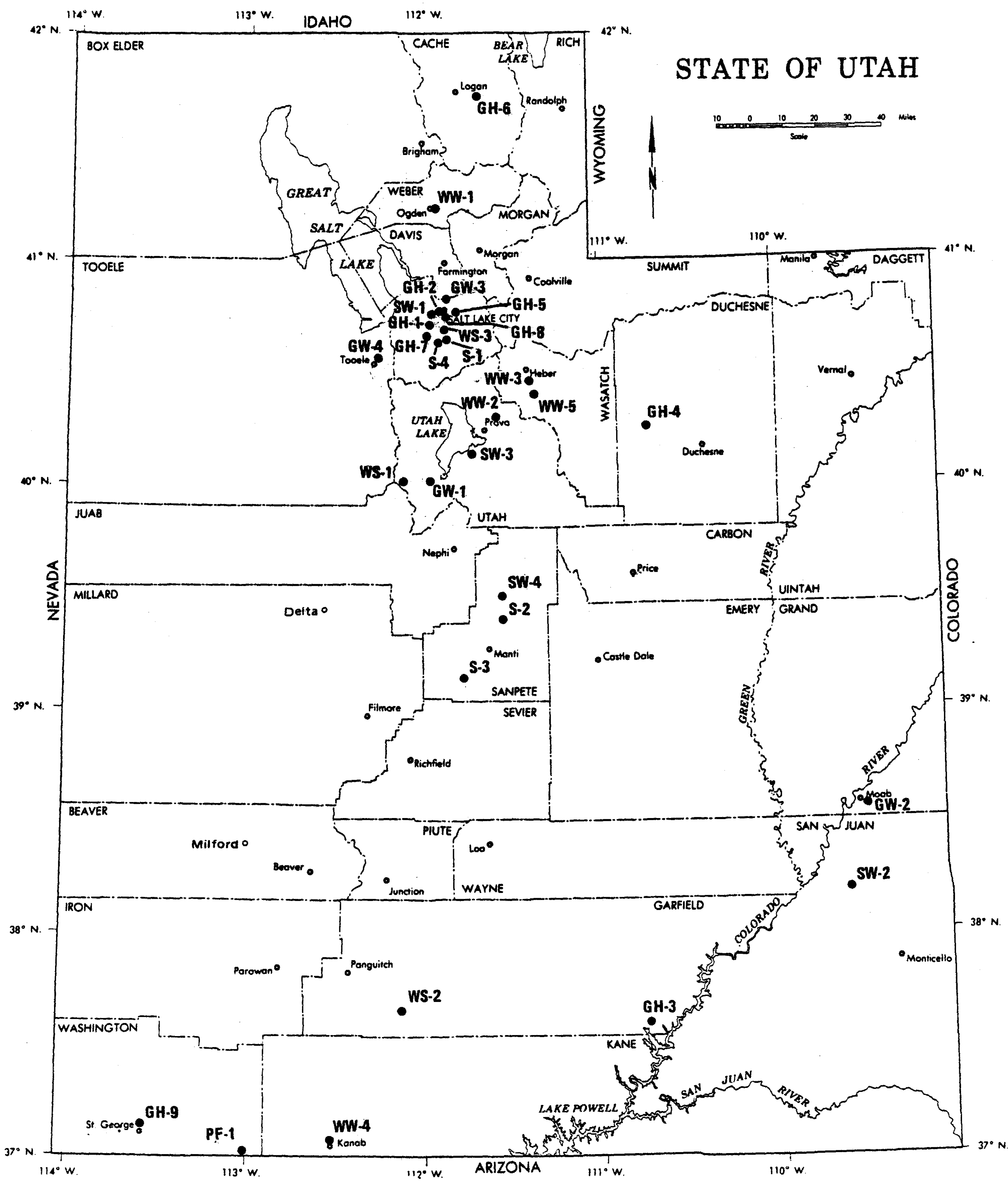


FIGURE 1. Location map.

PREFACE

The Site Investigation Section is part of the Utah Geological and Mineral Survey Applied Geology program. The section is charged with providing assistance to tax-supported entities (cities, towns, counties, state agencies, school districts) on matters where geologic factors are of concern. As a consequence, the Site Investigation Section undertakes a broad spectrum of projects that vary in length and complexity. Emphasis is placed on site evaluations for critical public facilities (police and fire stations, hospitals, water treatment plants and schools). The section also conducts investigations to answer specific geologic or hydrologic questions from state and local governments. Examples include evaluation of protection zones required for culinary springs and investigating slope stability or soil problems in developing areas for county planning departments. Such projects are usually of short duration (a month or less) and are performed at no cost to the requesting agency, although services in kind are usually provided. In addition to these projects, the UGMS reviews and makes comments on technical reports generated for state and local governments by private consultants. At times, however, the Site Investigation Section conducts studies of a longer and more detailed nature. These studies are also designed to meet a specific need, and are generally performed under a cost-sharing program with the public entity requesting the study.

Information dissemination is a major goal of the UGMS. Site Investigation Section studies considered of general interest to the public are published in one of several UGMS formats (Report of Investigation, Special Studies, Bulletin) that allow for wide distribution and long-term availability. They are included on the UGMS publications list. Special Studies and Bulletins can be purchased from the UGMS and are placed in libraries throughout the state. Reports of Investigation can be obtained for the cost of reproduction at the UGMS publications sales desk. However, most Site Investigation Section special-purpose projects address specific problems of interest to a limited audience. The results of these studies are commonly presented in a technical report or letter and are distributed on a need-to-know basis. Copies of the reports are maintained in the Site Investigation Section files.

The purpose of this Report of Investigation is to present in a single document the 28 special purpose technical reports and letters prepared by the Site Investigation Section in 1986 (fig. 1) which received only limited distribution. The reports are grouped by topic, and the author(s) and requesting agency are indicated. Minor editing has been performed for clarity and conformity, but no attempt has been made to upgrade the original graphics, most of which were produced using a copying machine. This report represents the fourth of an annual compilation of such studies, and is intended to make the results of all Site Investigation Section projects more easily available to the public.

William E. Mulvey
April 3, 1987

PUBLIC FACILITIES

Project: Geologic site investigation for a proposed fire station, Hildale, Washington County, Utah			Requesting Agency: City of Hildale
By: William F. Case	Date: 9-22-86	County: Washington	Job No.: 86-019 / PF-1
USGS Quadrangle: Hildale (32)			

PURPOSE AND SCOPE

Mr. David K. Zitting, mayor of Hildale, requested that the Utah Geological and Mineral Survey make a site investigation of a proposed fire station site. The two story, slab-on-grade building will be located directly east of the Hildale town hall (attachment 1). The scope of the work included a literature search, field reconnaissance, and logging of a 9 foot deep exploration pit. The field reconnaissance was conducted on July 23, 1986 in the company of Mayor Zitting.

SOILS AND GENERAL GEOLOGY

The site is located in section 34, T. 43 S., R. 6 W., SLBM, on a flood plain at the confluence of Short Creek and an unnamed tributary in the Vermilion Cliffs region of Washington County, Utah (attachment 1). According to the Soil Survey of Washington County (Mortensen and others, 1977), Redbank fine sandy loam is the soil type at the site. The Redbank is a slightly alkaline, alluvial soil with moderate permeability and slight erosion hazard. The topography consists of the several hundred feet high Vermilion cliffs which underlie sandstone mesas that are dissected by narrow valleys choked with rock-fall talus, sand dunes, and stream alluvium. The nearly horizontal sandstone layers exposed in the cliff face consist of the Springdale Sandstone Member of the Triassic Moenave Formation overlain by the Jurassic Kayenta Formation and, at cliff top, the Jurassic Navajo Sandstone (Pillmore, 1956). The Springdale Member is pale red to brownish-red, fine- to very fine-grained sandstone (Wilson, 1958). The Kayenta Formation consists of grayish-white to moderate reddish-orange sandstone with low-angle cross-bedding in contrast to the high-angle cross-bedding of the overlying white to grayish-orange Navajo Sandstone (Wilson, 1958).

HAZARD EVALUATION AND SITE RECONNAISSANCE

The only engineering limitations of the Redbank soil series according to Mortensen and others (1977), is a moderate potential for frost action which may affect buildings and roadways; they also note that the soil has low shrink/swell potential. No collapsible soil features were noted in the test pit from the surface to a depth of 9 feet (attachment 2), on the surface of the site, or within several nearby city blocks. Hildale town hall, directly west of the fire station site, has existed for several years; no structural distress due to foundation conditions was noted during an inspection of the building foundation and basement. No ground water was encountered in the test pit. The water table is probably several tens of feet beneath the ground surface. The rock fall hazard is minimal because the site is at least 1/4 mile from the nearest cliff face. The nearest active fault is the Hurricane fault, approximately 15 miles to the west of the site. The Seismic Safety Advisory Council for the State of Utah has recommended that construction of facilities in the study area conform to requirements for seismic zone UBC-2 (Ward, 1979). The Department of Housing and Urban Development flood hazard boundary map (attachment 3) for the town of Hildale shows no flooding hazard from Short Creek or the unnamed tributary to the west within a few hundred feet of the site. Mayor Zitting mentioned that within the last few years two 100-year floods have occurred in Short Creek valley; the fire station site was not affected.

CONCLUSIONS AND RECOMMENDATIONS

There appear to be no geologic hazards that would adversely effect the proposed fire station site. The site should be suitable assuming the construction conforms to standards for seismic zone UBC-2 and high quality materials are used.

CITED REFERENCES

Mortensen, V. L., and others, 1977, Soil survey of Washington County area, Utah: U.S. Department of Agriculture Soil Conservation Service in cooperation with Utah Agricultural Experiment Station, 140 p.

Pillmore, C. L., 1956, Photogeologic map of the Springdale SW Quadrangle, Kane and Washington Counties, Utah, Mohave County, Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-132, scale 1:24,000.

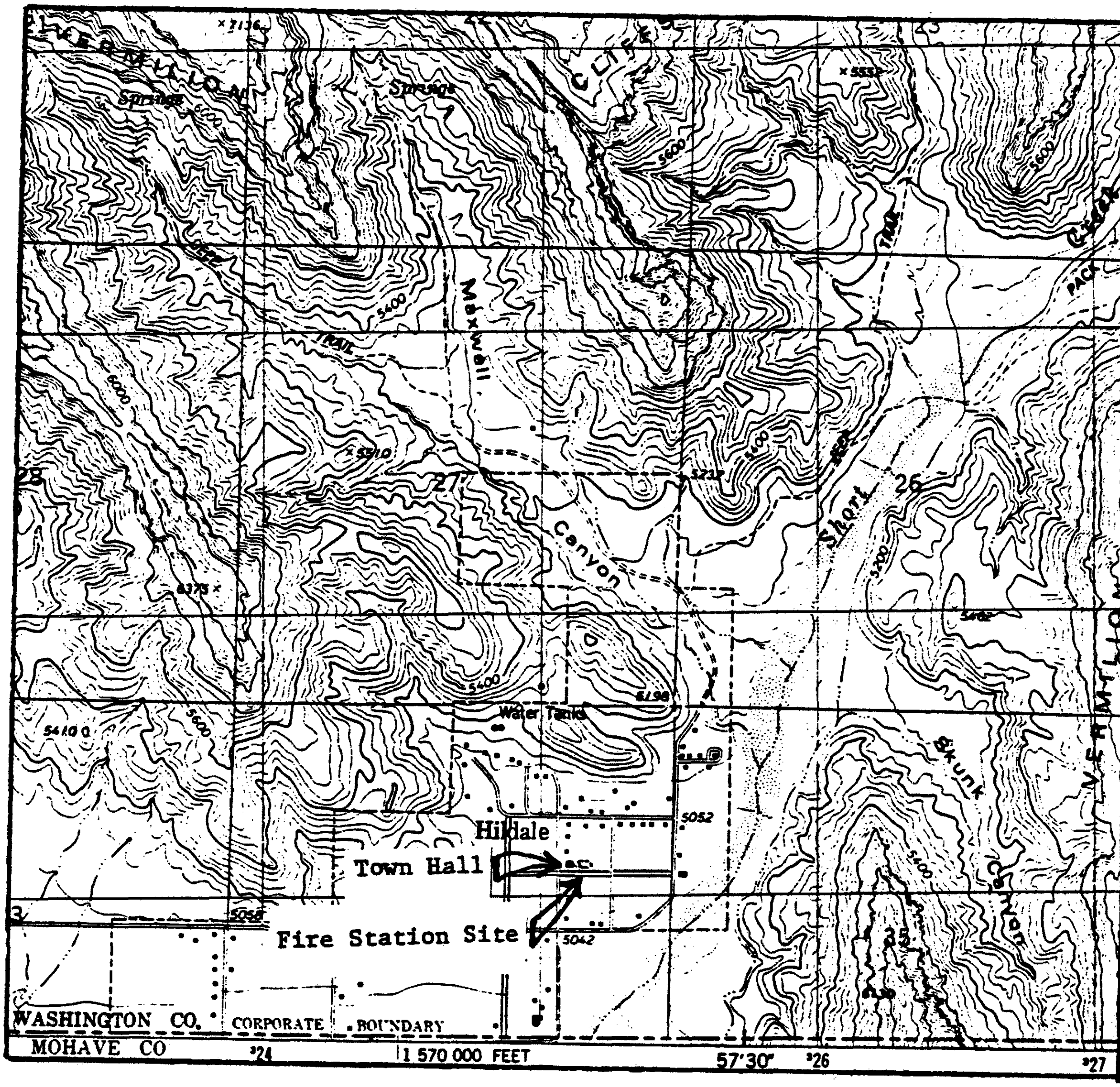
U.S. Department of Housing and Urban Development Federal Insurance Administration, 1976, Flood hazard boundary map, town of Hildale, Utah: scale 1 inch = 1000 feet.

Ward, D. B., 1979, Seismic zones for construction in Utah: Seismic Safety Advisory Council, State of Utah, 13 p.

Wilson, R. F., 1958, The stratigraphy and sedimentology of Kayenta and Moenave Formations, Vermilion Cliffs, Utah and Arizona: PhD Dissertation, School of Mineral Sciences, Stanford University.

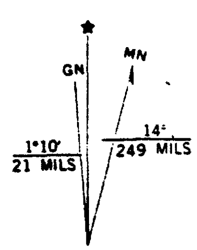
Attachment 1, Job No. 86-019

Base map from USGS 7 1/2' topographic quadrangle, Hildale, Utah

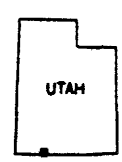


INDEX AND LOCATION MAP

SCALE 1:24 000



UTM GRID AND 1980 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



QUADRANGLE LOCATION

Attachment 2, Job No. 86-019

TEST PIT LOG*

FIRE STATION SITE

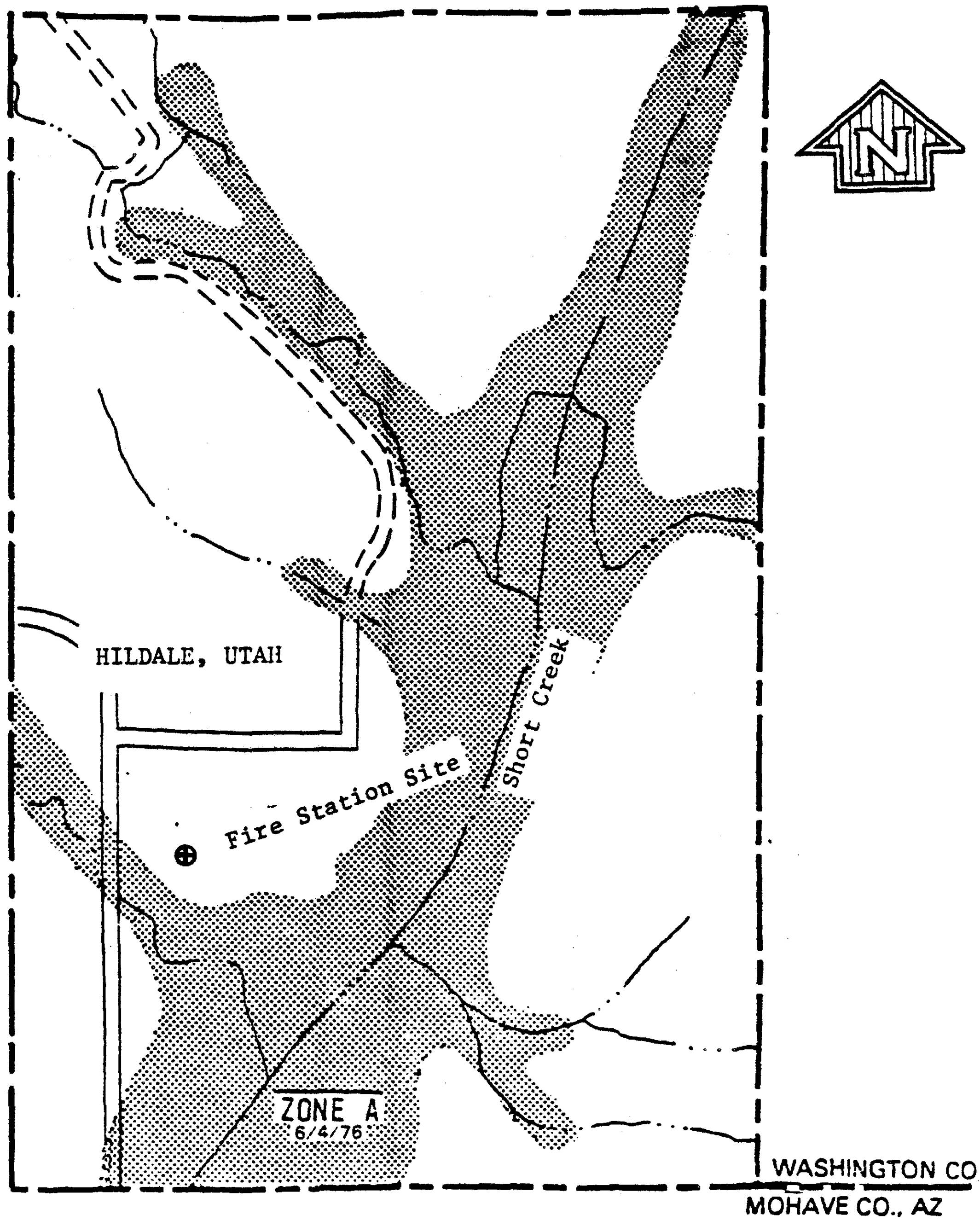
HILDALE CITY, WASHINGTON COUNTY, UTAH

0'-0.7'	Poorly graded sand with silt (SP-SM); brownish-red, soft, low plasticity, moist, weakly cemented; subangular quartz grains, 90 percent sand, rootlets present, not reactive to HCl.
0.7'-9'	Poorly graded sand with silt (SP-SM); light brownish-red, low plasticity, dry, weak cementation except for upper 2.5 feet; upper 2.5 feet hard, lower 5.8 feet firm to soft, subangular quartz grains, 90 percent sand, rare organic debris, incipient caliche development, strong reaction to HCl.

*Soils classified in accordance with procedures outlined in ASTM Standard D2489-69 (Revised 1984), Description of Soils (Visual Manual Procedure).

Attachment 3, Job No. 86-019

Modified from U.S. Department of Housing and Urban Development, Federal Insurance Administration, 1976



Flood hazard boundary map

Zone A = flood boundary of 100-year flood.

Scale 1 inch = 1000 feet

SCHOOLS

Project:			Requesting Agency:
Review of soils and foundation investigation by Dames and Moore for the proposed Jordan District Modular Elementary School			Jordan School District
By: Hal E. Gill	Date: 6-27-86	County: Salt Lake	Job No.: S-1
USGS Quadrangle: Midvale (1172)			

June 27, 1986

Mr. Theron Jaynes
Jordan School District
9361 South 400 East
Sandy, Utah 84070

Dear Mr. Jaynes:

In response to your request, a geologic review of the soils and foundation investigation report prepared by Dames & Moore for the proposed Jordan School District Modular Elementary School, at 7000 South and 1460 West, has been completed. Only available literature was utilized, no field reconnaissance was undertaken.

The Dames & Moore report was thorough and addressed all apparent geologic hazards in the site vicinity. Every effort should be made to comply with the suggestions and recommendations set forth in the report, especially those pertaining to shallow ground water. If our office can be of any further assistance, please feel free to notify us.

Sincerely,

Harold E. Gill, Geologist
Site Investigation Section

Project: Manti Elementary School Site Evaluation, Sanpete County, Utah			Requesting Agency: Sanpete School District
By: William F. Case	Date: Sept. 30, 1986	County: Sanpete County	Job No.: 86-022 / S-2
USGS Quadrangle: Manti (760)			

PURPOSE AND SCOPE

Sanpete County school superintendent Scott Bean requested a site investigation of Manti Elementary School to evaluate geologic hazards of the area. The investigation involved literature research, review of a soil and foundation report (Delta Geotechnical Consultants, 1985), and field inspection of the school site on 25 July, 1986. Construction of the school was nearing completion at the time of the field inspection. The inspection of the site was approximately one week after the Utah Geological and Mineral Survey received a request for inspection from Sanpete Shool Dstrict. The school is located between First and Second West and between Union Street and First South in the town of Manti, Sanpete County, sec. 12, T. 18 S., R. 3 E., SLBM (attachment 1).

GEOLOGY AND SOILS

Manti Canyon is incised into the edge of the Wasatch Plateau. The plateau consists of nearly horizontal bedrock which has been folded during uplift into monoclines along the western plateau boundary. Bedrock in Manti Canyon consists of the Cretaceous/Tertiary North Horn Formation overlain by the Late Tertiary Flagstaff Limestone. Rocks of the North Horn Formation consist of red and gray shales, weakly-cemented sandstones, conglomerates, and thin-bedded limestones (Schick International Inc., 1980). At higher elevations in the canyon, glacial gravels overlie bedrock. All of the geological formations in Manti Canyon are susceptible to slope failure. The largest active slope failure, the Manti Canyon landslide, is composed of rock fall debris and glacial sediment saturated by ground water. It is one of Utah's largest landslides. The landslide periodically threatens to sever the aqueduct which provides water to Manti City.

The western edge of the Wasatch Plateau has been uplifted along the Sevier fault zone. According to Schick International (1980), three potentially active faults are located at the mouth of Manti Canyon within the Sevier fault zone. Two earthquakes which were felt in the Manti area were recorded by the University of Utah Seismograph Station (Arabasz and others, 1979; Richins and others, 1984) on 16 March, 1961 and 24 May, 1982. Two large earthquakes which occurred within 50 miles of Manti in 1901 and 1921 (Arabasz and others, 1969) were probably felt and may have caused slight damage in Manti. Ward (1979), puts Manti in seismic zone UBC-3, the most active zone in Utah.

According to the geotechnical report prepared for the school site by Delta Geotechnical Consultants (1985), the site is on fill and alluvial-fan clay which overlie alluvial-fan gravel. The fan consists of bedrock clasts and glacial materials deposited by successive debris-flow events which have issued from Manti Canyon. The soils should have sufficient strength to support the school foundation provided that the alluvial-fan clay is removed and fill is compacted according to standard construction practices as recommended by (Delta Geotechnical Consultants)

HYDROLOGY

The site is on an alluvial fan which was deposited at the mouth of Manti Canyon. City Creek and South Creek flow across the fan within 2 city blocks north and south, respectively, of the school. City Creek is the original channel that Manti Creek followed after leaving Manti Canyon. A diversion dam at the mouth of Manti Canyon now channels a portion of the streamflow to the San Pitch River via the man-made South Creek channel. The diversion dam was constructed to prevent overbank flooding along City Creek. According to Federal Emergency Management Agency (1976), South Creek can contain the 100-year flood from the western city limits to Main Street , however, east of Main Street to the junction with City Creek, bridge culverts constrict the channel and shallow (1 to 3 feet) flooding could occur during a 100-year event (attachment 2). Zone AO in attachment 2 shows the extent of possible shallow flooding. The bridge culverts are presently being replaced with box culverts which will increase channel volume (James Harvey, State Division of Comprehensive Emergency Management, personal comm., 1986). The southern edge of the school grounds may experience shallow flooding during a 100-year event (attachment 2). No ground water was encountered at the school grounds in test pits which ranged from 4 to 12 feet deep (Delta Geotechnical Consultants, 1985).

CONCLUSIONS

The following conclusions regarding geologic hazards were made after completion of the site inspection:

1. Surface drainage of the site appears to be adequate except for a possible problem at the southeast corner of the property where slopes drain toward a door on the lower floor of the school.

2. The possibility of flooding of the school ground during a 100-year flood event exists until the replacement of bridge culverts is completed.

3. The structure should be designed and constructed to meet the requirements of UBC-3 seismic zone with the enhancements specified by Ward (1979).

4. The recommendations regarding foundation design presented by Delta Geotechnical Consultants should be followed.

5. No other geologic hazards were noted in the study area.

REFERENCES

Arabasz, W. J., Smith, R. B., and Richins, W. D., 1979, Earthquake studies in Utah, 1850 to 1978: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 552 p.

Delta Geotechnical Consultants, Inc., 1985, Geotechnical study proposed Manti Elementary School, First South and Second West streets, Manti, Utah: Delta Geotechnical Consultants, Inc., 9 p.

Federal Emergency Management Agency, 1986, FIRM Flood Insurance Rate Map, City of Manti, Utah, Sanpete County: Federal Emergency Management Agency, 14 p.

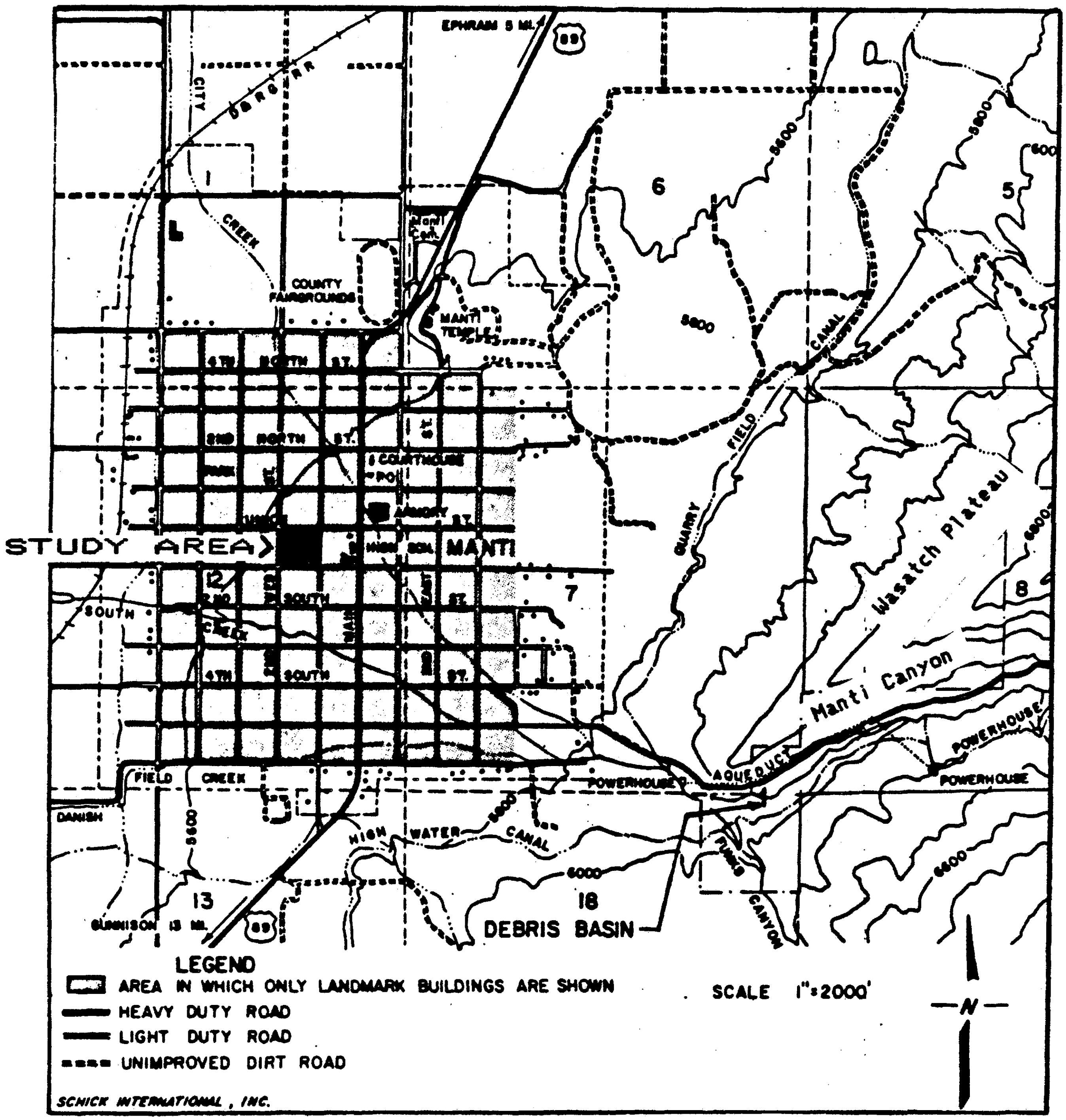
Richins, W. D., Arabasz, W. J., Hathaway, G. M., McPherson, Erwin, Oehmich, P. J., and Sells, L. L., 1984, Earthquake data for the Utah region, January 1, 1981 to December 31, 1983: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 111 p.

Schick International, 1980, Manti project, debris retention structure, prepared for Manti City and the Four Corners Regional Commission: Schick International, Inc., 40 p.

Ward, D. B., 1979, Seismic zones for construction in Utah: Seismic Safety Advisory Council, State of Utah, 13 p.

Attachment 1, Job No. 86-022

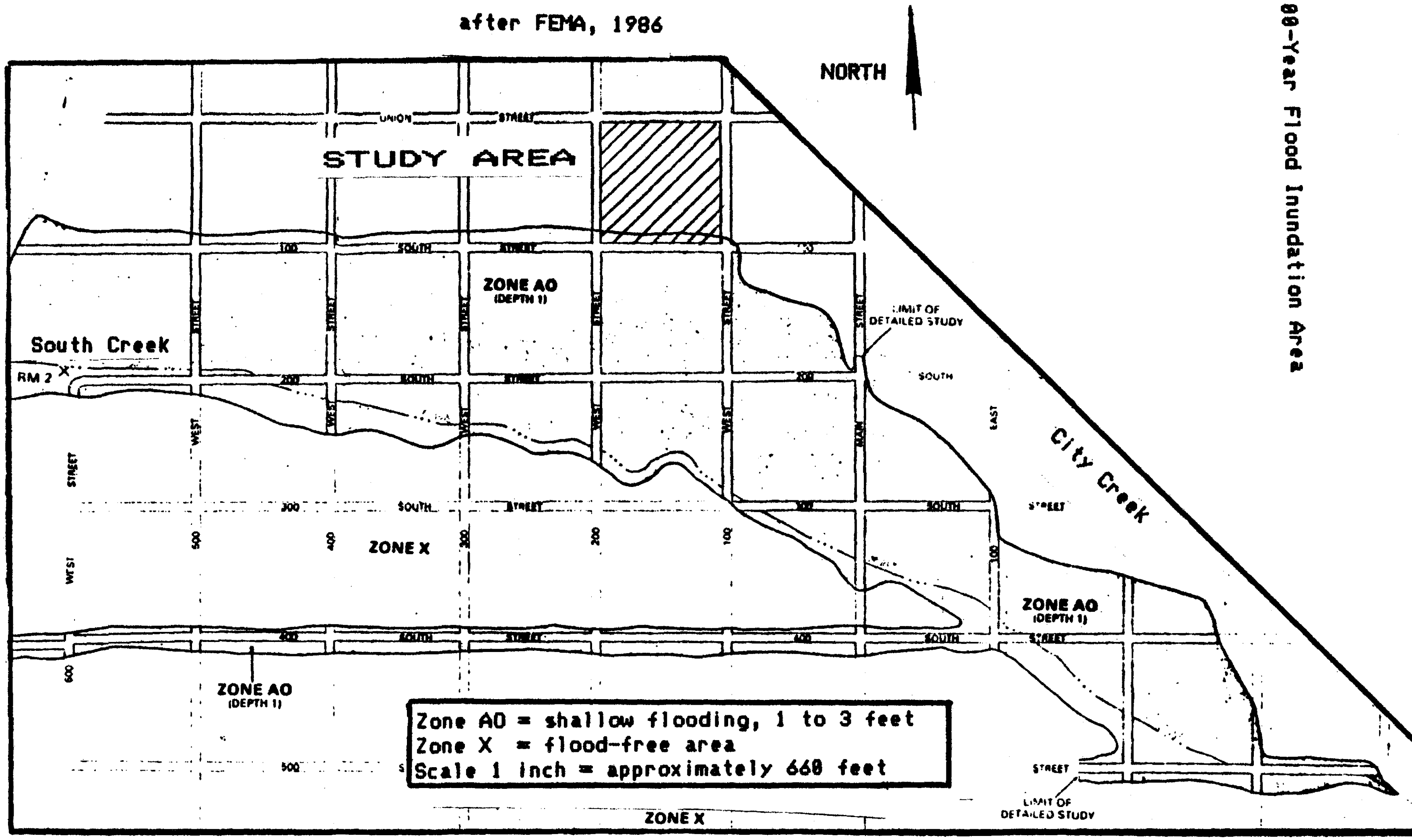
after Schick International, Inc., 1980



LOCATION MAP

MANTI CITY 100-Year Flood Inundation Area

after FEMA, 1986



Project:			Requesting Agency:
Site Evaluation Gunnison Elementary School Addition, Sanpete County, Utah			Sanpete School District
By: William F. Case	Date: Oct. 3, 1986	County: Sanpete County	Job No.: 86-023 / S-3
USGS Quadrangle: Gunnison (720)			

PURPOSE AND SCOPE

Sanpete County school superintendent Scott Bean requested that the Utah Geological and Mineral Survey (UGMS) make an investigation of an addition to the Gunnison Elementary School to evaluate geologic hazards of the site. The investigation involved a literature search, review of a soil and foundation report (Rollins, Brown, and Gunnell, 1985), and a field inspection of the site on 25 July, 1986. Construction of the school addition was nearing completion at the time of the field inspection, which took place approximately one week after the UGMS received the request. The school is located in sec. 20, T. 19 S., R. 1 E., SLBM (attachment 1) on U.S. Highway 89 (Main Street) approximately one mile south of the central business district of Gunnison.

SOILS AND GEOLOGY

According to the geotechnical report prepared by Rollins, Brown, and Gunnell (1985), the site is underlain by silty clay and gravelly, sandy silt which, in turn, overlie gravel. The Unified Soil Classification of the gravel is given as GP (poorly graded gravel) in the test pit logs but described as GM (silty gravel) and GW (well-graded gravel) in the text. The soil should have sufficient strength to support the school addition provided that the clay is removed and a granular layer is applied and compacted beneath the foundatoin according to standard construction practices as recommended by Rollins, Brown, and Gunnell.

Gunnison is located at the intersection of Sanpete Valley and Sevier River Valley. The San Pitch Mountains (Gunnison Plateau) is to the north and the Wasatch Plateau is to the northeast. The plateaus are in the Basin and Range/Colorado Plateau transition zone and have characteristics of both the Basin and Range and the Colorado Plateau physiographic provinces. The plateaus consist of east-dipping Jurassic, Cretaceaus, and Tertiary age bedrock which has been uplifted and folded at the western plateau boundary. The density of normal faulting decreases eastward across the Wasatch Plateau toward the Colorado Plateau (Witkind and others, 1982). The Basin and Range province to the west is characterized by folded mountains such as the Canyon Range, which have been tilted and uplifted by normal faults. Bedrock consists of conglomerates, sandstones, siltstones, shales, and limestones of the Cretaceous/Tertiary North Horn Formation, and the Tertiary Crazy Hollow, Green River, and Colton and the Flagstaff Limestone (Witkind and others, 1982).

The Wasatch, Elsinore, and Sevier fault zones trend into the Gunnison area but surface expression of the faults is subdued in the area (Arabasz and others, 1979). There is no record of felt earthquakes in the Gunnison area according to University of Utah Seismograph Station publications (Arabasz and others, 1979; Richins and others, 1981, 1984) even though there have been earthquakes large enough to be felt that have occurred nearby. On 24 May, 1982, a magnitude 4 earthquake which occurred near Richfield was felt in Manti but was not recorded as being felt in Gunnison (Richins and others, 1984). Two magnitude 6 earthquakes which had epicenters within 40 miles of Gunnison in 1901 and 1921 (Arabasz and others, 1979) were probably felt and may have caused slight damage in Gunnison. According to Ward (1979), Gunnison is in seismic zone UBC-3, the most active seismic zone in Utah.

HYDROLOGY

The area surrounding the site is flat and situated on coalesced alluvial fans (Witkind and others, 1982) which may have been modified by the highest transgression (Bonneville Level) of Pleistocene Lake Bonneville. The San Pitch River flows south through Sanpete Valley northeast of Gunnison and then turns northwest through Gunnison to its confluence with the Sevier River. Between 1847 and 1981 two cloudburst events occurred on the San Pitch River which flows within one-half mile of the study area (Comprehensive Emergency Management, 1981). The 1976 Flood Hazard Boundary Map for the City of Gunnison was rescinded on 30 January, 1984 (Federal Emergency Management Agency, 1984). This, in effect, indicates that the channel of the San Pitch River can contain a 100-year event. No ground water was encountered in two test pits (12 and 13 feet deep respectively) excavated by Rollins, Brown, and Gunnell on the school addition site (1985).

CONCLUSIONS

The following conclusions regarding geologic hazards were made after completion of the site inspection:

1. Surface drainage of runoff at the site appears to be adequate.

2. There is no danger of flooding during a 100-year event according to Federal Emergency Management Agency (1984).

3. The structure should be designed and constructed to meet the requirements of UBC-3 seismic zone with the enhancements specified by Ward (1979).

4. The recommendations regarding foundation design presented by Rollins, Brown, and Gunnell should be followed.

5. No other geologic hazards were noted in the study area.

REFERENCES

Arabasz, W. J., Smith, R. B., and Richins, W. D., 1979, Earthquake studies in Utah, 1850 to 1978: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 552 p.

Comprehensive Emergency Management, 1981, History of Utah floods, 1847 to 1981: State Division of Comprehensive Emergency Management, 40 p.

Federal Emergency Management Agency, 1984, Memorandum rescinding August 13, 1976, Flood Hazard Boundary Map for the city of Gunnison, Utah: Federal Emergency Management Agency, 3 p.

Richins, W. D., Arabasz, W. J., Hathaway, G. M., Oehmich, P. J., Sells, L. L., and Zandt, G., 1981, Earthquake data for the Utah region, July 1, 1978 to December 31, 1980: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 127 p.

Richins, W. D., Arabasz, W. J., Hathaway, G. M., McPherson, Erwin, Oehmich, P. J., and Sells, L. L., 1984, Earthquake data for the Utah region, January 1, 1981 to December 31, 1983: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 111p.

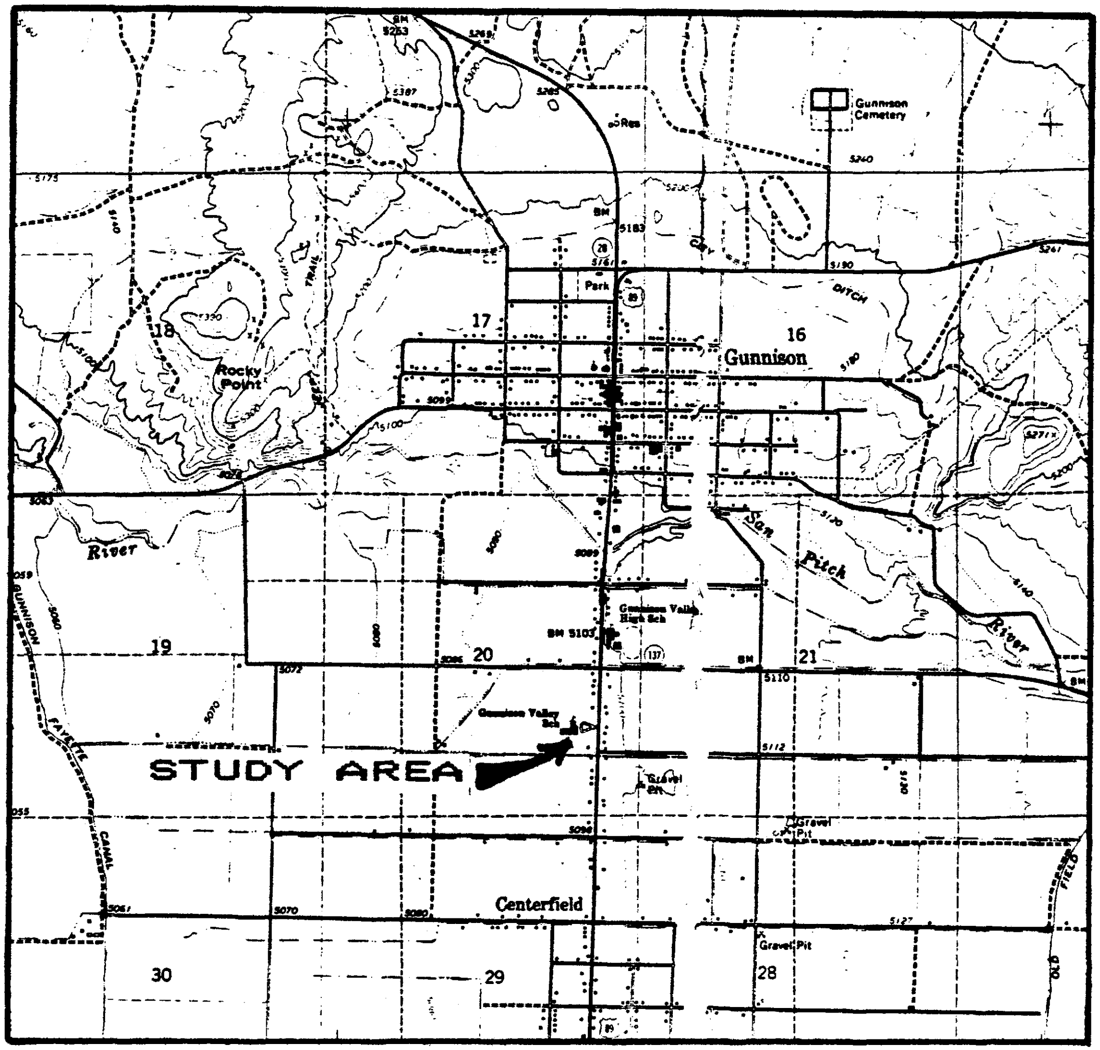
Rollins, Brown, and Gunnell, 1985, Soil and foundation investigation: Gunnison Elementary School, Gunnison, Utah: Rollins, Brown, and Gunnell, Inc., 12 p.

Ward, D. B., 1979, Seismic zones for construction in Utah: Seismic Safety Advisory Council, State of Utah, 13 p.

Witkind, I. J., Weiss, M. P., and Brown, T. L., 1982, Preliminary geologic map of the Manti 30' X 60' Quadrangle, Carbon, Emery, Juab, San Pete, and Sevier Counties, Utah: U.S. Geological Survey Open File Report 82-654, scale 1:100,000

Attachment 1, Job No. 86-023

base map USGS 7 1/2′ topographic
quadrangle: Gunnison



Scale 1 inch = 3100 feet

LOCATION MAP

Project: Geologic hazards evaluation proposed Jordan Ridge Elementary School			Requesting Agency: Jordan School District
By: Hal E. Gill	Date: 12-11-86	County: Salt Lake	Job No.: S-4
USGS Quadrangle: Midvale (1172)			

December 11, 1986

Mr. Theron Jaynes
Jordan School District
9361 South 400 East
Sandy, Utah 84070

Dear Mr. Jaynes:

In response to your request, a geologic hazards evaluation of the site proposed for Jordan Ridge Elementary School at 2636 West and 9800 South has been completed. Only available literature was utilized, a field reconnaissance was not undertaken. It is our understanding that the school will have a slab on grade foundation.

The proposed site is in an area designated as having a very low liquefaction potential and a ground-water level from 30 to 60 feet below ground surface. The Soil Conservation Service has described the soil found across the site as the Bluffdale silty clay loam. This soil type (a lean clay) typically has a 1 to 3 percent slope, medium compressibility, slow permeability, moderate erosion hazard, and a high shrink/swell potential below 16 inches. The site lies within the boundaries of an area classified in the Uniform Building Code as being Seismic Zone 3 and by the Seismic Safety Advisory Council as Zone U-4. In the event of a moderate to severe earthquake in Salt Lake County, the site could experience strong ground shaking. The structures should be designed by engineers and architects thoroughly familiar with the principles of earthquake resistant design. In addition, foundation design studies should consider the shrink/swell potential of the soil, and include an adequate drainage system design to alleviate possible erosion hazard. There are no major drainages crossing the property, however, during grading of the site the soils will be disturbed increasing the erosion potential. There are no other known hazards at the site. If our office can be of any further assistance, please feel free to notify us.

Sincerely,

Harold E. Gill

Harold E. Gill, geologist
Site Investigation Section

WATER SUPPLY

Project: Eureka Spring Study			Requesting Agency: Bureau of Public Water Supplies
By: R.H. Klauk	Date: 3/10/86	County: Utah	Job No.: 86-003/WS-1
USGS Quadrangle: Eureka, Utah (968)			

PURPOSE AND SCOPE

This investigation was conducted at the request of Ursula Trueman of the State Division of Environmental Health (Bureau of Public Water Supplies) for an unnamed spring located in the NE 1/4, sec. 8, T. 10 S., R. 2 W., Salt Lake Baseline and Meridian, Utah County, Utah (attachment 1). Eureka, Utah, located approximately 2 miles southeast of the spring, is in need of additional sources of culinary water. The purpose of this study was to identify any geological constraints that relate to possible development of the spring as one of these sources. The Town of Eureka does not have the water right for the spring and the chemical quality of the water has not been determined. This spring is not located on either the U.S. Geological Survey topographic quadrangle map (attachment 1) or the geologic maps that cover this area. Numerous other springs in the area have been identified, however, which leads to speculation that this spring may not flow during periods of reduced precipitation. Therefore, the recommendations in this report are contingent on: 1) the city obtaining a water right, (2) determination from a certified laboratory that the water is potable, and (3) verification that the spring is perennial and that flow is not significantly affected by variations in annual precipitation.

The scope of work for this investigation included a literature review, air photo analysis, and a field reconnaissance on February 21, 1986. No subsurface exploration was performed.

GENERAL GEOLOGY

The spring is located in Homansville Canyon in the East Tintic Mountains, a north-trending fault block mountain range characteristic of the Basin and Range physiographic province in west-central Utah. Bedrock in the immediate area of the spring is volcanic Tertiary-age Packard Rhyolite consisting of quartz latite porphyry, agglomerate, vitrophere, and welded tuff (Lovering and others, 1960). Lovering and others (1960) mapped outcrops of sedimentary Cambrian-age Cole Canyon Dolomite conformably overlain by a small outcrop of sedimentary Cambrian-age Opex Formation less than 2000 feet northeast of the spring. Cole Canyon Dolomite is described as having alternating dark and light layers of dolomite whereas the Opex Formation consists of limestone, shale, sandstone, dolomite, and conglomeritic limestone.

Quaternary-age unconsolidated deposits are widely distributed in the East Tintic Mountains, with deposits described as heterogeneous in size, shape, bedding, and sorting (Morris and others, 1961). They describe alluvium intertonguing with and grading into slopewash. They also describe Holocene-age alluvium as consisting of gravel, filling or partly filling the active flood plains of most streams. In major streams, alluvium consists of cobbles, gravel, sand, and silt, with thicknesses ranging from less than 1 foot to more than 15 feet (Morris and others, 1961).

Homansville Canyon, in the spring area, is oriented northeast and is less than 1/2-mile wide. Pinyon Creek, although intermittant, is the major drainage and flows along the southeast side of in the canyon. Three unnamed, intermittant drainages from the northwest side of the canyon enter Pinyon Creek in the spring area and together drain Homansville Canyon to the east. The southeast side of the canyon is much steeper, and drainages are much less extensive. The volume of alluvium transported from the northwest and deposited in the canyon appears to have forced Pinyon Creek along its present course. Lovering and others (1961) report that Quaternary alluvium, such as that found in Homansville Canyon, can be up to 50 feet thick.

Several faults have been mapped in Homansville Canyon within 1600 feet of the spring. They all trend northeast or northwest and may be what Morris and others (1961) have identified as transcurrent strike-slip faults, the dominant faults exposed in the East Tintic Mountains. None have been mapped closer than 400 feet to the spring and all are considered inactive.

SITE RECONNAISSANCE AND EVALUATION

The spring is located in Pinyon Creek which parallels Highway 6 & 50 (attachment 1). Pinyon Creek was dry except for spring flow at the time of the reconnaissance. The spring appears to discharge from the base of the stream bank nearest the highway, with flow increasing for a short distance downgradient. The bank is approximately 25 feet high and varies from 50 to 150 feet from the highway. Banks on both sides of Pinyon Creek are vegetated with grass and bushes; sand and silt was exposed in the drainage channel. Flow from the spring was estimated to be from 20 to 30 gallons per minute (gpm). Discharge from the spring varies seasonally according to local residents which is indicative of local recharge. Twenty to 30 gpm is considered to be at or near peak flow and is the result of an abnormal warm period with increased snow melt prior to the investigation. A number of iron pipes suspended immediately above the channel intersect the spring area; one pipe was leaking water. The spring is located in the vicinity of the former Town of Homanville and the pipes may be remants of a previous attempt at development.

Packard Rhyolite is exposed in a roadcut directly across Highway 6 & 50 from the spring. No faults or significant joint patterns were noted in the cut. The bank above the spring may consist of Packard Rhyolite covered by a mantle of alluvium/colluvium and the spring may be issuing from this bedrock unit. Lovering and others (1961) have identified at least two other springs south of this area (Hidden Treasure Spring and Jameson Spring) that discharge from Packard Rhyolite.

A second possible source for the spring may be ground-water inflow from valley alluvium. This source is considered less likely, however, because flow would normally be expected to increase downgradient in the drainage, which does not occur. An attempt was made to determine depth to ground water in the valley alluvium by reviewing water well records on file at the State Division of Water Rights. This proved futile, however, because logs of only 3 wells were found and all were determined to be unreliable. A well 1000 feet northeast of the spring visited during the reconnaissance had a water level estimated to be from 10 to 15 feet below the surface (attachment 1). It is not known, however, at what depth(s) and in what units the well was completed and screened.

CONCLUSIONS AND RECOMMENDATIONS

The spring either issues from Packard Rhyolite or alluvium in the bottom of the Pinyon Creek drainage adjacent to Highway 6 & 50. If the spring issues from bedrock, recharge may be perennial and from the south with flow path(s) controlled by jointing or a concealed fault zone. If the spring issues from alluvium, recharge may be from the shallow, unconfined, alluvial aquifer and therefore less reliable.

An effort should be made to determine if the spring issues from bedrock or alluvium. A spring flowing from the shallow, unconfined aquifer may be susceptible to contamination and therefore not viable for development. A spring issuing from bedrock is much less susceptible to contamination. Determination of a bedrock source can be accomplished by excavating the spring area and observing flow directly from Packard Rhyolite. Any other conditions encountered would conceivably indicate an alluvial source. If the source of the spring does prove acceptable, two other site conditions must also be considered during development. Periodic surface flow in the drainage must be diverted above the spring to prevent mixing and contamination. Development must also avert any potential pollution from salt or toxic spills on the highway.

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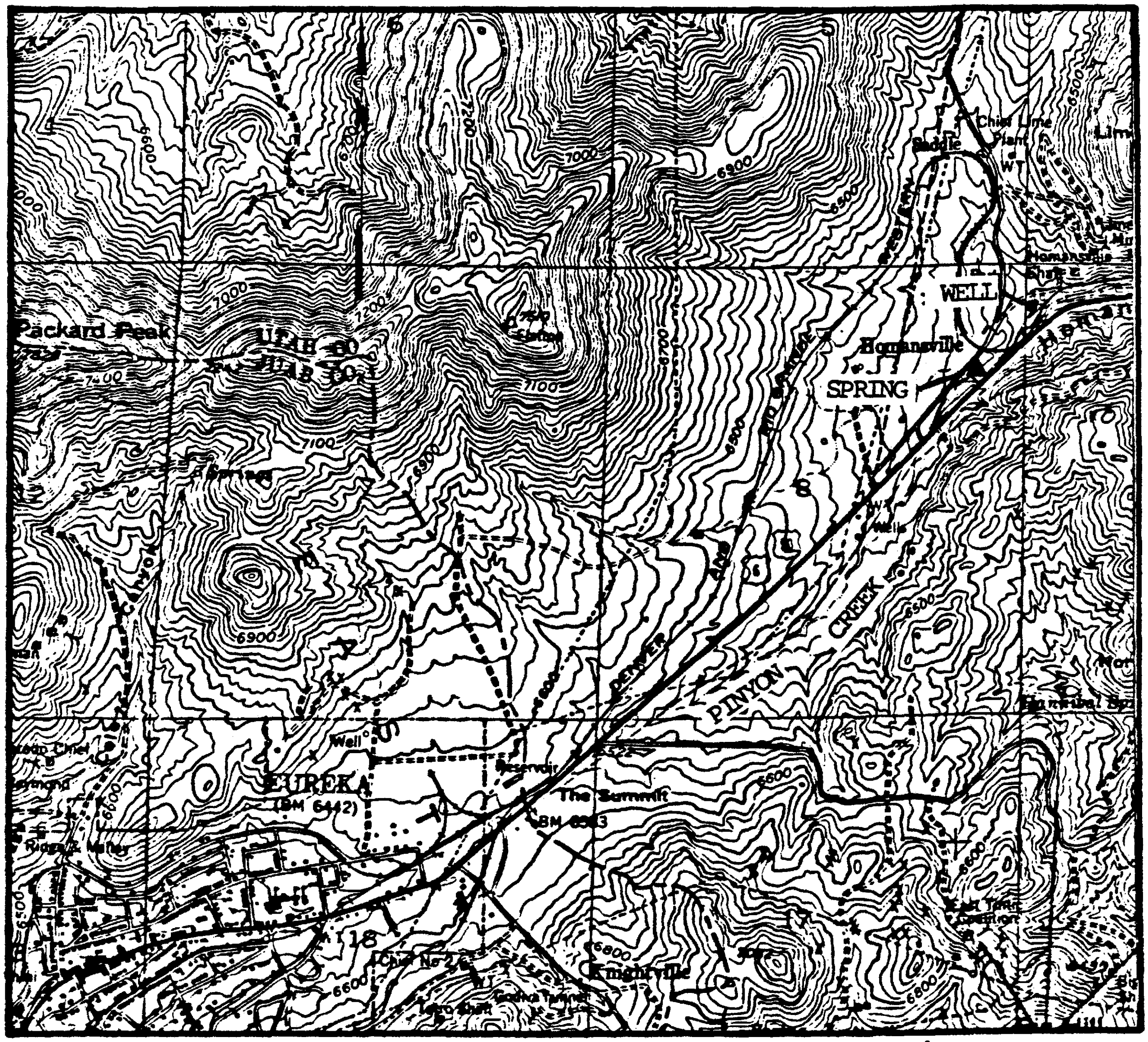

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Base map from: U.S.G.S. 7½' topographic quadrangle, Eureka, Utah.

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LOCATION MAP

Project: Spring Evaluation for the town of Tropic, Garfield County			Requesting Agency: Bureau of Public Water Supplies
By: W.F. Case	Date: 9-2-86	County: Garfield	Job No.: 86-017 /WS-2
USGS Quadrangle: Tropic Canyon (230)			

PURPOSE AND SCOPE

This investigation was conducted at the request of Dan B. Blake, Department of Environmental Health, Bureau of Public Water Supplies. The purpose of the investigation was to determine the source of a spring discovered when rip-rap was being placed in Tropic Canyon to protect a culinary water line serving the town of Tropic. Tropic subsequently installed a collection system in 1982 to take advantage of the new source of water without obtaining approval by the Department of Health. The city is now seeking approval for the spring.

The scope of the work included a literature review, interviews with Mr. Blake and John R. Call of John Call Engineering, Inc., a firm hired by the city of Tropic, and a field reconnaissance on July 24, 1986.

SETTING

The Tropic city culinary water collection system is located within Bryce Canyon National Park in Tropic Canyon near the head of the Paria River, sec. 22, T. 36 S., R. 3 W., SLBM (attachment 1). The system includes collection fields, a collection box, and associated transmission lines. The collection box is on an ancient flood terrace on a meander bend point bar, approximately 5 feet above the present channel of the Paria River. State highway 12 which connects Bryce Canyon National Park with Tropic, is approximately 50 feet from the collection box. Two collection fields are located on the flood terrace within 100 feet west of the collection box. Tropic Canyon #1 spring (Good, 1970) is the westernmost flood terrace collection field. Tropic Canyon springs #2 and #3 are across the highway to the south (Good, 1970), out of the study area. The 75-foot long rip-rap area is west of the collection box where the Paria River has eroded the flood terrace. The transmission line that was being laid when the source of water was discovered is from a collection field 500 feet west, across the river from the collection box. A 6-inch pipe which is buried in recent channel alluvium for most of its length, conveys water from the collection box to the town of Tropic, 3 miles to the south. The tributary which flows through Jolley Hollow enters the Paria River channel from the south approximately 50 feet west of the rip-rap area. The only other tributary also enters the Paria River channel from the south approximately 25 feet from the collection box. The unnamed tributary has a seep at its mouth.

GENERAL GEOLOGY

The study area is on the Paunsaugunt fault between the Paunsaugunt Plateau and the Table Cliffs Plateau (attachment 2). The plateaus are areas of flat-lying to gently folded sedimentary rocks of Tertiary and Cretaceous ages. The Pink Cliffs of the Tertiary Claron Formation for which Bryce Canyon National Park is famous are exposed on the east side of the Paunsaugunt Plateau, the source area of the Paria River. The Paunsaugunt fault is a high-angle normal fault with the downthrown side on the west, Paunsaugunt Plateau side, and the upthrown side on the east. The upthrown side of the fault is topographically lower than the downthrown side because of headward erosion by the Paria River and sheet erosion (attachment 3). Sandstones, conglomerates, and limestones of the Claron Formation crop out on the west, downthrown side of the fault and Cretaceous Straight Cliffs Sandstone/Wahweap Sandstone, and Tropic Shale are exposed on the east side of the fault (attachment 4; Robison, 1966; Good, 1970).

HYDROLOGY

There are three possible sources of water in the study area: 1) spring water from a bedrock aquifer, possibly the Straight Cliffs Sandstone/Wahweap Sandstone connected to the fault, 2) surface water in the river channel which percolates into alluvium and surfaces downstream, and 3) water in alluvium prevented from moving downward by an impermeable layer which forms a small, immobile, local water table "perched" above the regional water table.

Good (1970) reports that Tropic Canyon #1 spring issues from Paria River alluvium within a hundred yards of the Paunsaugunt fault on the east (upthrown) side. The relationship of springs in the area and the Paunsaugunt fault is ambiguous according to Good (1970); springs rise from both sides of the fault which may alternately serve as a ground-water barrier in an aquifer (attachment 3) or a ground-water conduit. The Paria River is an ephemeral stream in Tropic Canyon but thick deposits of alluvium and the wide valley in the study area attest to the volume of the river during periods of high flow. Alluvium along the bank of the channel is up to 10 feet thick. Sediment at the streambed consists of an impermeable clay layer more than one foot thick. The lateral extent of the clay is limited to the Paria River channel and does not extend up the two tributaries in the study area. Tall vegetation at the mouth of the tributary downstream of the rip-rap area indicates the presence of a seep although no surface water is evident. Water from the tributary watershed is probably filtering into alluvium and reappearing at the mouth because of subsurface clay layers. The tributary mouth just upstream of the rip-rap area has no vegetation or surface water shows. There is a possibility that subsurface water from the upstream tributary could enter the rip-rap collection area.

Before the rip-rap collection field was installed, Tropic Canyon #1 spring was the main water supply in the collection system (Good, 1970). Good (1970) reports that Tropic Canyon spring #1 had an estimated flow of 100-200 gpm on August 19, 1968. Mr. Call reported that collection areas before the the rip-rap field was installed, orginally had flows around 100 gpm but flow rates decreased substantially before the rip-rap field was installed. The source may be from a perched water table.

SITE RECONNAISSANCE

The rip-rap area is in alluvium consisting of approximately 5 feet of well-graded gravel with silt (USCS classification GW-GM) overlying an impermeable lean clay with sand (CL) in the channel bottom (attachment 5). The channel in the study area was dry during the investigation. There is no fence enclosing the collection system because of Bryce Canyon National Park regulations. The rip-rap and collection box are within 75 feet of highway 12. The rip-rap consists of boulders approximately 3 feet in diameter covered with gunite(?) which has wide cracks and is susceptible to erosion. An 8 inch diameter, white PVC pipe is exposed in the streambed, upstream and across the channel from the rip-rap. The PVC pipe is likely to become battered and cracked when the river is in high flow. Mr. Call indicated that the line is for overflow only and has no direct connection to the water supply.

CONCLUSIONS AND RECOMMENDATIONS

The source of water under the rip-rap area appears to be from bedrock because: 1) according to Mr. Call the flow varies only slightly and the water quality is consistent throughout the year, 2) the available surface recharge area in the upstream tributary is relatively small, 3) the impervious clay layer in the streambed does not allow surface water in the rip-rap area to enter the collection system, 4) the spring has been serving Tropic since 1982, and 5) the coliform count of raw water is near zero. It should be emphasized that the sampling and flow monitoring rates are, at best, occassional and not systematic throughout the year. The water quality of raw water and flow rate of the collection system should be monitored after storms and more frequently than at present. The fact that other collection areas now have a reduced flow may indicate that the source was a perched water table. While the present system appears to be adequate a better, more consistent water source should be found if Tropic is to enjoy growth in the future. Good (1970) suggests Bryce Springs.

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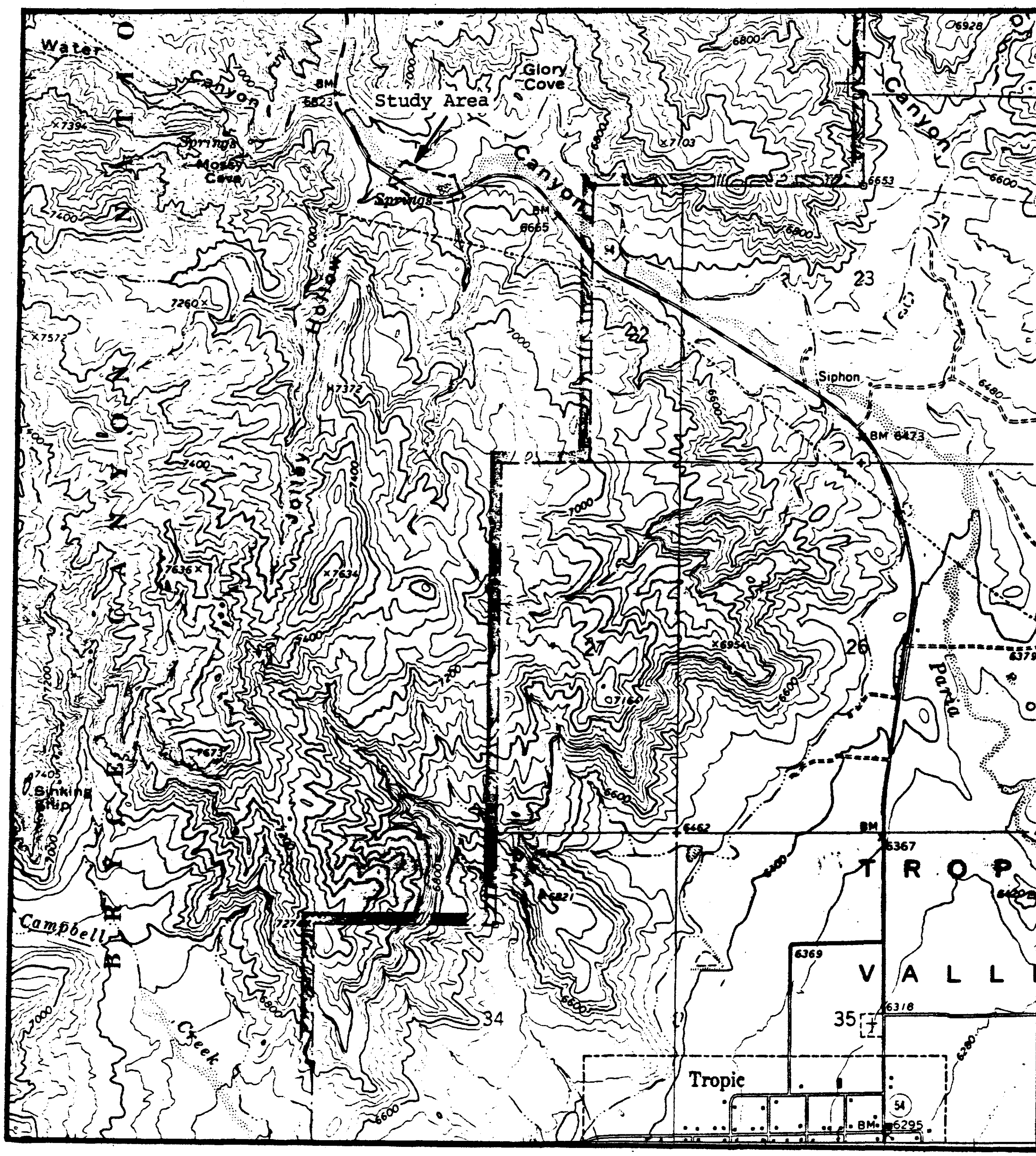

Base map from Tropic Canyon 7½' quadrangle

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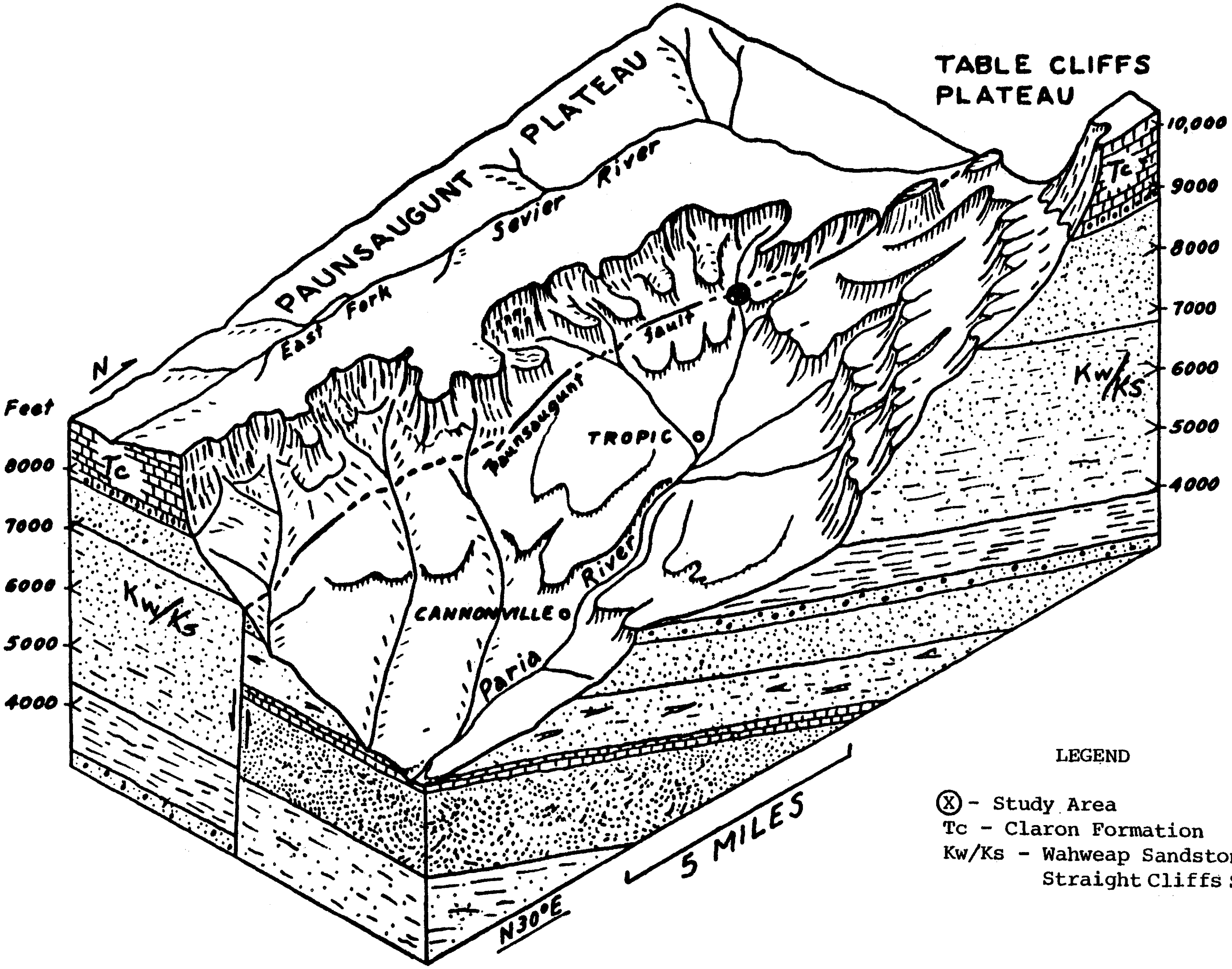
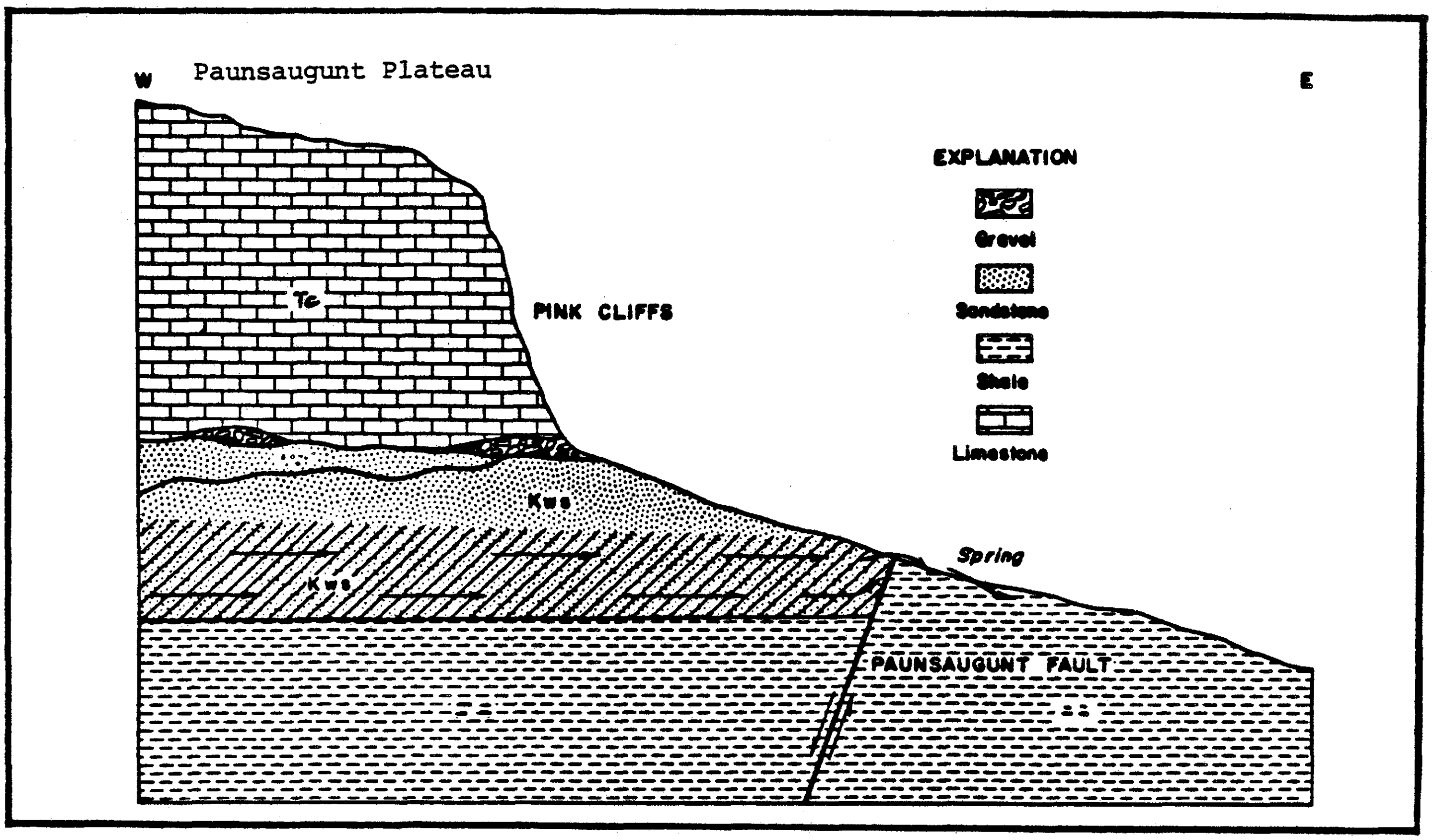


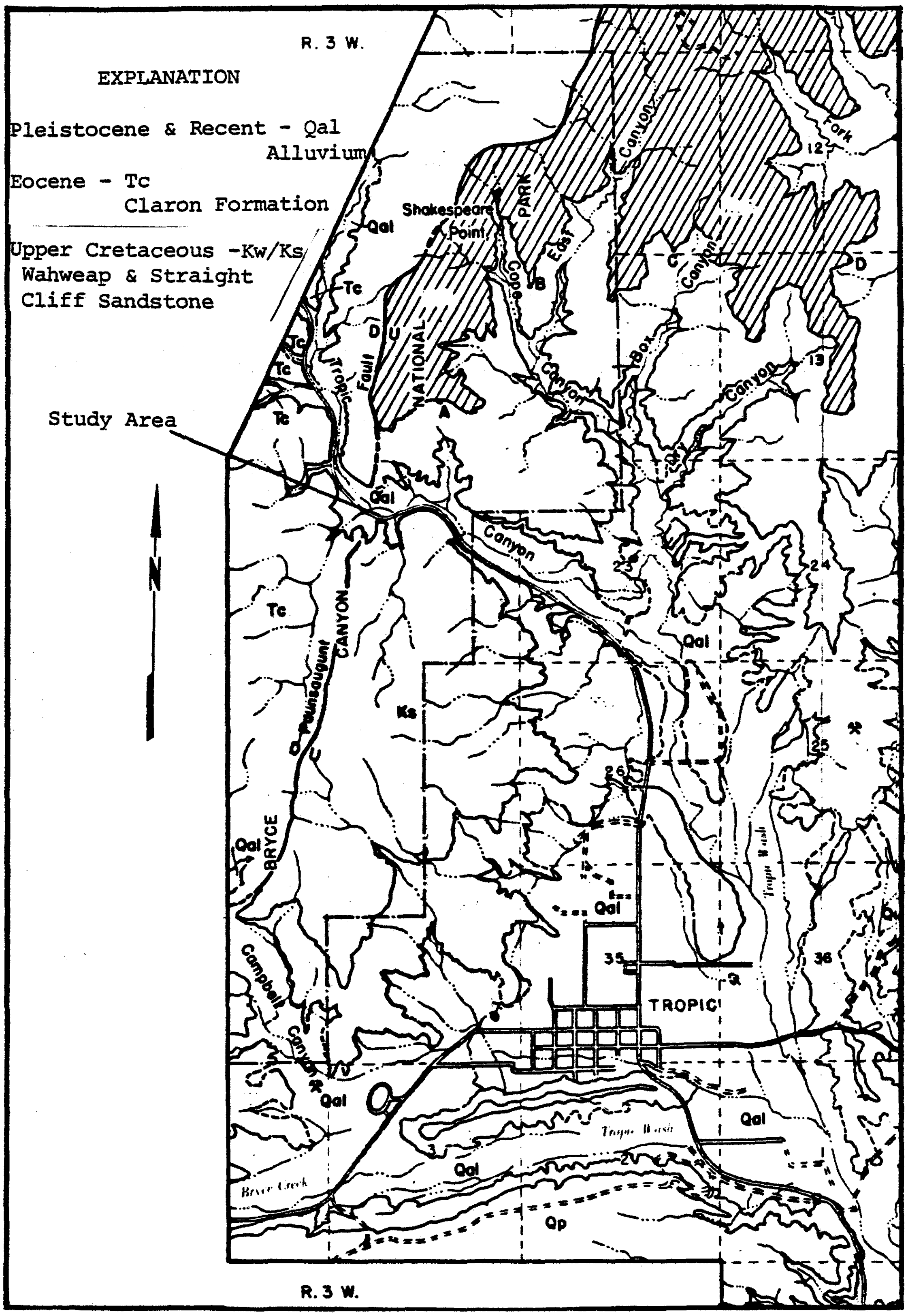
LEGEND

Ⓧ - Study Area
Tc - Claron Formation
Kw/Ks - Wahweap Sandstone
Straight Cliffs Sandstone

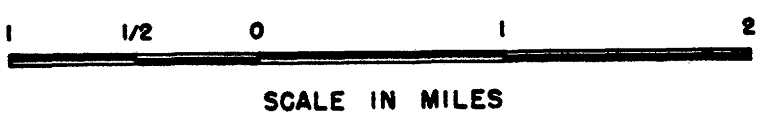
Block diagram of western portion of Tropic-Cannonville-Henrieville amphitheatre showing relation of geology and topography (from Goode, 1970).



Generalized east-west cross section showing the movement of ground water in relation to the occurence of some faultline springs. Arrows represent direction of water movement; crosshatched area represents zone of saturation. Tc, Claron Formation, Kws, Wahweap and Straight Cliffs Sandstones; undifferentiated (from Marine, 1963).



Geologic map of part of Tropic Canyon (from Robinson, 1966).



Attachment 5, Job No. 86-017

STREAMBANK & STREAMBED LOG
IMMEDIATELY UPSTREAM OF RIP-RAP AREA
TROPIC CANYON, GARFIELD COUNTY, UTAH

Streambank — Well-graded gravel with silt and sand (GW-GM); light brown, firm, non-plastic, dry, moderately indurated; angular sedimentary rock clasts up to 3-inch diameter, 50 percent gravel, 40 percent sand, strong reaction to HCl.

Streambed — Lean clay with sand (CL); gray, soft, medium plasticity, moist, not indurated; angular sedimentary rock clasts up to 1-inch diameter, 5 percent gravel, 20 percent sand, odorless, rare organic carbon, strong reaction to HCl.

Project: Spring Creek Spring Study			Requesting Agency: Bureau of Drinking Water & Sanitation
By: Hal Gill	Date: 1-14-87	County: Salt Lake	Job No.: 86-024/WS-3
USGS Quadrangle: Sugar House (1212)			

PURPOSE AND SCOPE

In response to a request from Linda Moore and Ursula Trueman, Utah State Division of Environmental Health (DEH), Bureau of Drinking Water and Sanitation, the Utah Geological and Mineral Survey (UGMS) performed a geologic investigation of the proposed site for the Spring Creek Spring Subdivision development in Salt Lake City, Utah. There are two springs on the property managed by the Spring Creek Irrigation Company and owned by private share holders. One spring is used for irrigation and the other serves as a culinary source for approximately 500 homes. The homeowners/shareholders voiced concern to the DEH regarding possible contamination of the springs by the proposed development. The purpose of the investigation was to: 1) establish the water source for the Spring Creek Springs, 2) determine if development of the subdivision could contaminate the springs, and 3) examine feasibility for development of the irrigation spring for culinary purposes.

The scope of the investigation included a review of available geologic information including two hydrologic reports on the springs done in 1948 and 1951, completing four seismic refraction lines across the property, and drilling and logging seven auger borings on site. Present during the initial site reconnaissance were Ursula Trueman, Linda Moore, Mark Allen (Water Superintendent Spring Creek Irrigation Company), and Garth Minor (Salt Lake City County Health Department).

SETTING

The area under investigation is at approximately 4600 South and 3000 East in Salt Lake City, Utah (attachment 1). The site encompasses approximately 9 acres and is platted for 13 individual lots. The property is bordered on all sides by existing homes. The two springs on site are collectively named the Spring Creek Springs; however in this report they will be referred to as the culinary spring and the irrigation spring (attachment 2). The culinary spring is in the northwest corner of the property and has been developed by the Spring Creek Irrigation Company. The spring produces on the average 1575 gallons per minute (gpm) and it supplies approximately 500 homes with culinary water in the Holiday area. The irrigation spring produces approximately 450 gpm and is used by a small number of home owners for garden and lawn irrigation (Mark Allen, oral commun., 1986). An unlined irrigation canal, running from southeast to northwest, divides the site approximately in half (attachment 2). This canal carries water from Casto Spring south of the property (attachment 1) and is owned by the Salt Lake County Water Conservancy District. The canal is not part of the culinary or irrigation systems developed at the site. There are two homes approximately in the center of the property both utilizing septic tanks and soil absorption fields for wastewater disposal (attachment 2). Several smaller structures (milk house, garage, and sheds) are scattered around the site. The property has been landscaped, creating three terraced levels across the site from east to west. The overall topography has a slope of approximately 9 to 11 percent to the west.

Development of the culinary spring included construction of a small concrete building to house a chlorinator and a large concrete tunnel (approximately 50 feet long and six feet in diameter) through which the spring water flows to a large metal water tank (attachment 2). There are no records available on the spring prior to its use as a culinary source or details of how the spring was initially developed (Mark Allen, oral commun., 1986). The irrigation spring issues from a point approximately 200 feet southeast of the culinary spring and flows in an incised channel approximately 15 feet deep along the southern property boundary (attachment 2). The spring is undeveloped at this time.

GEOLOGY

Bedrock does not crop out on the site but is exposed in the Olympic Mountain/Neffs Canyon area approximately three miles east of the property (attachment 3). From oldest to youngest the rock units are: Cambrian Tintic Quartzite and Ophir Formation; Mississippian Fitchville Formation, Gardison Limestone, Deseret Limestone, Humbug Formation, and Doughnut Formation. The Mississippian rocks consist primarily of sandstone, limestone, silty limestone, massive dolomite, and black shale. Quaternary Lake Bonneville sediments, stream, and alluvial fan deposits comprise the unconsolidated materials on site (Crittenden, 1965).

In an attempt to determine depth to bedrock and ground water on the site, four seismic reflection lines were run across the property (two north-south and two east-west, attachment 2) . Results of the seismic survey indicated a relatively high energy horizon (possibly ground water) from 2.2 to 4.4 feet beneath the eastern portion of the property. However, that result was not consistent with information obtained from Mark Allen (oral commun., 1986) which indicated that the subdivision contractor had excavated several 20 foot deep pits on the extreme east end of the property. The test pits exposed a very dense zone of cobbles and boulders to their total depth and they were dry. Numerous cobbles and boulders (up to 2 feet in diameter) were observed on the ground surface. Therefore, to determine if shallow ground water was present beneath the site seven auger borings were drilled at various locations across the property (attachment 2, attachment 4). The high density horizon proved to be a layer of very dense silty sand with clay (probably alluvial fan deposits consisting of reworked Lake Bonneville sediments) underlying the eastern half of the property (borings 1 through 5, attachment 4). Borings 6 and 7 encountered a lean clay (with the exception of topsoil) to their total depth of 15 and 19 feet respectively.

Water was encountered only in boring 4 at 2.6 feet. However, it is probable that the source of the water was a septic tank soil absorption field for the home immediately east of the boring (attachment 2), or possibly a localized perched zone created by water leaking from the structure. Ground water was not encountered in borings 6 and 7. It is in this direction (downslope to the west) that perched ground water would migrate if present.

The study area is near the base of the Wasatch Range and close to the range-bounding Wasatch fault zone. Numerous Quaternary and older faults trend near the property. Several faults (attachment 3) have been mapped in bedrock by Crittenden (1965) and Van Horn (1972) on Mt. Olympus, especially in the Neffs Canyon area. A thrust fault (much older than the Wasatch fault zone, Van Horn, 1972) trends through Neffs Canyon (attachment 3). Scott and Shroba (1985) mapped a trace of the active Wasatch fault across the property from north to south (attachment 3). Because of the great number of faults in the site vicinity, a high degree of bedrock fracturing can be expected.

HYDROLOGY

In 1948, a study to compile more information on Neffs Canyon Creek and a group of springs in the Holiday area was undertaken by John A. Ward, Assistant State Engineer. The report was titled "Report on Neffs Canyon Investigation Conducted During the Year 1948." During the study, hydrographs from three springs in the Holiday area (Dry Creek, Casto, and Spring Creek Springs, attachment 3) were compared with well and stream hydrographs in the area. The comparisons showed a close correlation between the spring hydrographs and those of streams, indicating that recharge to the spring was likely through fractures and solution channels in bedrock. Limestones and dolomites are relatively soluble and can develop a complex system of interconnecting fractures and solution voids. Cavernous limestone formations are often productive aquifers. In Utah, the Humbug and Doughnut Formations (consisting of limestone and dolomite units) are well known as excellent aquifers. The Tintic Quartzite is commonly observed along the Wasatch Front in a highly fractured state and therefore, is capable of retaining great volumes of water. As a consequence, several major springs issue from this unit. During spring runoff a stream hydrograph will commonly rise rapidly and then drop quickly when the snow has melted. A hydrograph typical of flow through unconsolidated material will rise and fall slowly, usually reaching its peak long after surface runoff has abated. The hydrographs of the three spring in the Holiday area rose and fell rapidly indicating that the water had flowed through very little if any unconsolidated sediment. In addition, samples taken from a screen placed across the flume at Dry Creek yielded fibrous material (small roots and decayed oak leaves up to 1/2 inch in diameter). Mr. Ward concluded that this was proof that water from the three Holiday springs did not move through unconsolidated sediments, but that cavernous flow was suggested. Mr. Ward also stated that "the Neffs Canyon and Norths Fork area may well be the sole source of the Holiday springs."

In 1951, a second study was undertaken to determine conclusively that the source of the water for the springs in the Holiday area was indeed Neffs Canyon and Norths Fork of Neffs Canyon. The study was done for the Spring Creek Irrigation Company by Grant K. Borg, a civil engineer in private practice. A series of dye tests were conducted during the months of April, May, June and July, 1951, to determine the source of recharge to the springs. Three separate tests were conducted with the following results. The first test was inconclusive. Approximately 1 1/4 pounds of powdered fluorescein dye in dry form (not dissolved) were introduced into the Norths Fork channel about three miles east of the springs. Only one sample collected from Spring Creek Springs, 29.5 hours after the dye was introduced, tested positive for the presence of dye. It was concluded that insufficient dye was used for detectable amounts to appear at all springs sampled. The second test proved conclusively that at least part of the supply for all three Holiday springs originates in Norths Fork of Neffs Canyon. Ten pounds of predissolved fluorescein dye were introduced into the Norths Fork channel. The dye appeared in all springs approximately 27 hours after being introduced. Mr. Borg stated that it is probable that all of the water seeping into the ground in Norths Fork of Neffs Canyon and in Neffs Canyon itself contributes to the recharge of the springs. Results of the third test were inconclusive. During the first two tests the stream channel had been kept dry for some time prior to introducing the dye. Water was diverted into the channel from a pipeline and the dye was added. The water/dye solution immediately percolated into the subsurface and reached the ground-water system. However, for the third test, water had been flowing in the channel for at least 30 days prior to the test; the soils in the channel were saturated and consequently had a reduced infiltration capacity. The dye could not infiltrate in sufficient quantity before being carried away by the stream.

CONTAMINATION POTENTIAL

Two major concerns regarding contamination of the springs on the property are: 1) that development of a subdivision will cause the spring water to become turbid, and 2) that petroleum and lawn care products may contaminate the spring. During past periods of spring runoff the irrigation company has had to take the culinary spring out of the system from four to six weeks due to turbidity. However, according to Mark Allen (oral commun., 1986) there was no report of turbidity during construction of I-215, the center line of which is approximately 550 feet east and upslope of the eastern property boundary (attachment 2). In addition, Mr. Allen reported that water samples taken at the time several 20-foot deep test pits were excavated on the site indicated no increase in turbidity. Therefore, the chances of increased turbidity due to excavations (particularly relatively shallow basement excavations) on the property are considered low.

A greater potential hazard is the possible contamination of the springs by petroleum products, nitrates in fertilizers, insect and weed sprays, and other commercial products used around the home. Petroleum products washed from driveways and streets can be controlled, for the most part, by storm drains, provided that grates are kept clear of debris and the system is adequately designed for the anticipated flow. It is not possible to keep lawn care products and pesticides from entering the subsurface. Factors of importance in determining if a pollution problem will develop include depth to bedrock, characteristics of the overlying unconsolidated deposits, and the presence or absence of a perched water table.

It is thought that there are two possible paths by which contaminants may reach the spring. The first would be by percolating down to bedrock through the unconsolidated sediments and entering the ground-water system upslope from the springs. The second path would be for contaminants to migrate laterally westward through the unconsolidated sediments on a clay lens, or other impermeable layer (bedrock), and surface at one or another of the spring discharge points. As the contaminants enter the subsurface (due primarily to lawn watering) they will be largely absorbed into the dry soil. Before the contaminants can move down to bedrock or laterally to the spring outlets the unconsolidated sediments must be saturated. Seismic line 1 on the eastern half of the property (attachment 2), indicates that the unconsolidated material at this location is at least 19 feet thick. Seismic line 4 on the western half of the site, showed that the sediment there is at least 24 feet thick. Because of the their thickness, it would require a very large volume of water introduced for a prolonged period of time to saturate the unconsolidated deposits over bedrock. Even abnormally high yearly precipitation at the site would be insignificant when compared with the absorption capability of the subsurface soils. Salt Lake County experienced above normal precipitation from 1982 through 1985 and there was no report of contamination to the culinary spring, even though the site is surrounded on all sides by subdivisions and both homes on the property utilize septic tank and soil absorption systems. All structures on the property will be torn down prior to the new development and the new homes will be on a sewer system (oral commun., Mark Allen, 1986). It appears the possibility for contamination of the culinary spring from normal activities associated with lawn care and home maintenance is slight, barring accidental spills immediately adjacent to the spring.

DEVELOPMENT OF THE IRRIGATION SPRING FOR CULINARY USE

It has been shown that water for the springs in the Holiday area, including the irrigation spring, receive water from a bedrock source probably delivered through a cavernous system developed in limestone and dolomite rock units. If the decision is made to develop the irrigation spring for culinary purposes, the UGMS feels the chances of increased turbidity due to excavations on the property are slight. However, the thickness of the unconsolidated sediments overlying the irrigation spring are less than half of those covering the culinary spring and do not afford the same protection. Less water would be required to saturate the unconsolidated sediments overlying the spring outlet. Therefore, the possibility of a contaminant spill near the point source entering the subsurface and reaching the spring is increased.

CONCLUSIONS AND RECOMMENDATIONS

1) The UGMS agrees in part with conclusions drawn by both the 1948 and 1951 investigations regarding the recharge area for the springs and the nature of the flow path through bedrock. Both investigators state that the recharge area for springs in the Holiday area is primarily Neffs Canyon and Norths Fork of Neffs Canyon. However, with the exception of Olympus Spring in Norths Fork Canyon, the surface flow in both the canyons is not continuous throughout the year. Therefore, the UGMS feels that for the springs in the Holiday area to flow year

round, a larger recharge area than just the two canyons is required. The bedrock comprising Mt. Olympus is highly fractured and much of it is limestone and dolomite capable of developing a complex system of solution cavaties. Therefore, it is considered likely that the entire mountain mass acts as a recharge area funneling snow melt and precipitation to the springs. In addition, it is felt that the trace of the Wasatch fault trending through the property (all three springs are located on this trace) acts as a more permeable pathway along which ground water at depth and under pressure due to the higher elevation of the recharge area to the east can migrate upward.

2) Because turbidity did not occur during construction of I-215 east of the area, it appears unlikely that development at the site (primarily shallow basement excavations) would cause turbidity problems. However, if the water did become turbid, it would be a temporary condition with a lower sediment load and shorter duration then that experienced each year during spring runoff.

3) Contamination of the culinary spring from hazardous materials such as petroleum products, insect and weed sprays, and nitrates is unlikely due to the thickness of unconsolidated and unsaturated sediments in the spring vicinity. However, if the unconsolidated deposits do become saturated or contaminants are spilled near the spring the potential exists for contamination of the culinary source. Therefore, the point source must be protected. The UGMS recommends a 100-foot protection zone around the culinary spring. The thickness of unconsolidated deposits overlying the irrigation spring outlet is less than half of that covering the culinary spring (approximately 10 feet as compared to 25 feet). Therefore, the protection afforded the irrigation spring is less. If the decision is made to develop the spring, the UGMS recommends a protection zone of 200 feet around the spring outlet.

4) It is vital that the unconsolidated materials on the property do not become saturated. Therefore, the UGMS recommends that drainage retention ponds not be utilized on the site. In addition, a drainage system designed to divert runoff away from the springs is necessary.

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-----1972, Map showing relative ages of faults in the Sugar House Quadrangle, Salt Lake County, Utah: U.S. Geological Survey Map I-766-B, scale 1:24,000.

Attachment 4, Job No. 86-024

Boring Logs*
Spring Creek Spring Investigation
4600 South and 3000 East, Salt Lake City, Utah

Boring 1

0.0' - 3.0'	Silty sand with clay (SM); topsoil, brown, loose, low plasticity to nonplastic, noncemented, dry.
3.0' - 4.0'	Silty sand with clay (SM); brown, loose, low plasticity to nonplastic, noncemented, dry; could not drill beyond this depth due to cobbles and boulders.

Boring 2

0.0' - 3.0'	Silty sand with clay (SM); topsoil, brown, loose, low plasticity to nonplastic, noncemented, dry.
3.0' - 7.0'	Silty sand with clay (SM); light brown, loose, low plasticity to nonplastic, noncemented, dry; could not drill beyond this depth due to cobbles and boulders.

Boring 3

0.0' - 3.0'	Silty sand with clay (SM); topsoil, brown, loose, low plasticity to nonplastic, noncemented, dry.
3.0' - 6.0'	Silty sand with clay (SM); light brown, loose, low plasticity to nonplastic, noncemented, dry; increased gravel with depth, could not drill beyond this depth due to cobbles and boulders.

Boring 4

0.0' - 3.0'	Road base pea-gravel.
3.0' - 7.0'	Silty sand with clay (SM); light brown, loose, low plasticity to nonplastic, noncemented; water level stabilized at 2.6', possible septic tank soil absorption field or perched zone due to leakage from structure immediately to the east.

Boring 5

0.0' - 5.0'	Silty sand with clay (SM); topsoil, light brown, loose, low plasticity to nonplastic, noncemented, dry.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-84, Standard Practice for Description and Identification of Soils (Visual Manual Procedure).

5.0' - 7.0'	Silty sand with clay (SM); light brown, loose, low plasticity to nonplastic, noncemented, dry; could not drill beyond this depth due to cobbles and boulders, no ground water encountered. This boring is 25' south and 39' east of irrigation spring.

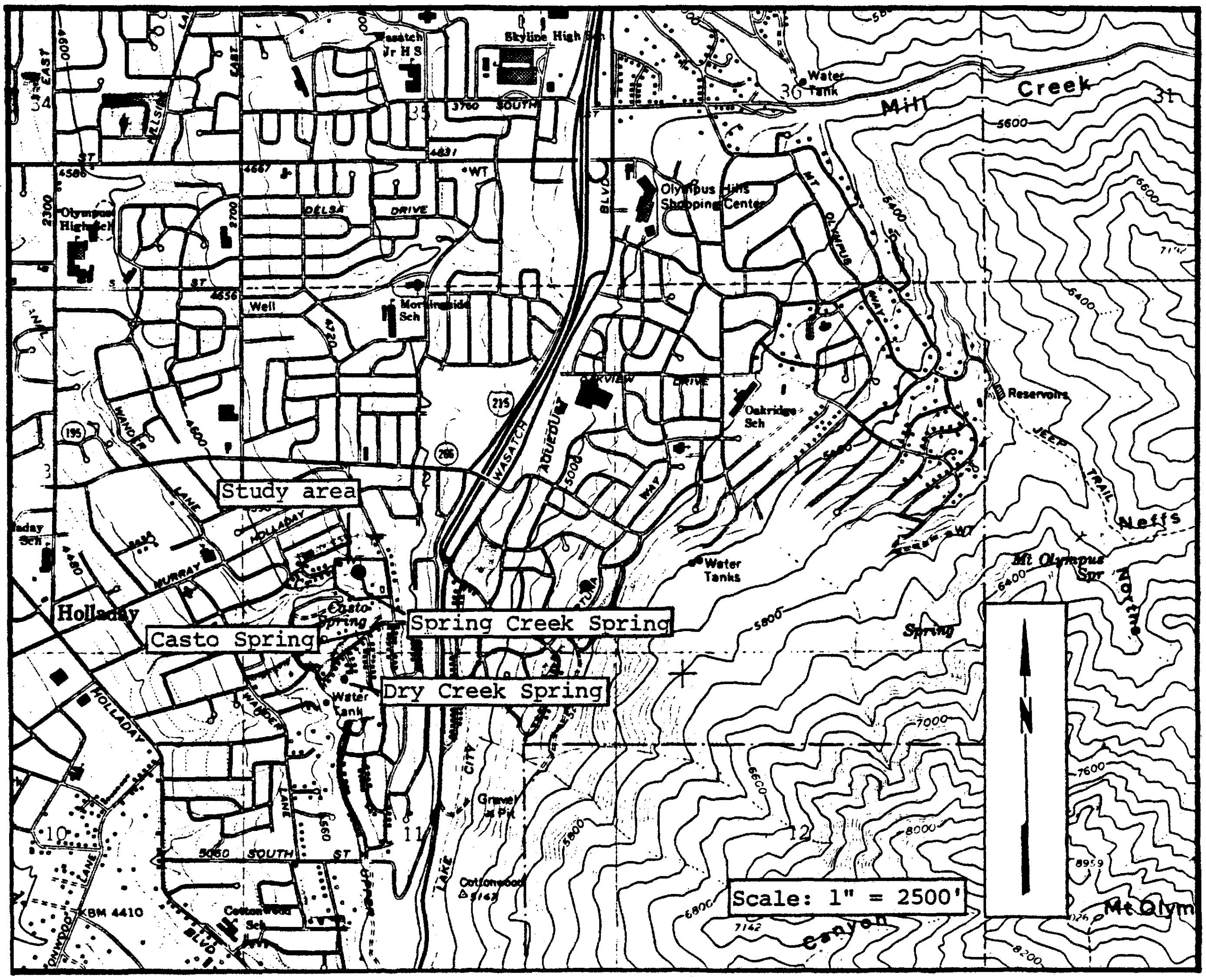
Boring 6

0.0' - 1.0'	Road base pea-gravel.
1.0' - 3.0'	Silty sand with clay (SM); dark brown, low density, low plasticity, noncemented, weak reaction to HCL, dry.
3.0' - 9.0'	Lean clay (CL); light brown, firm, medium plasticity, noncemented, weak to strong reaction to HCL, dry.
9.0' - 15.0'	Lean clay (CL); brown, hard, medium plasticity, noncemented, weak to strong reaction to HCL, dry.

Boring 7

0.0' - 4.0'	Silty sand with clay (SM); topsoil, brown, low density, low plasticity, noncemented, weak reaction to HCL, dry.
4.0' - 9.0'	Silty sand with clay (SM); brown, medium density, low plasticity, noncemented, weak reaction to HCL, dry.
9.0' - 19.0'	Lean clay (CL); red brown, hard, medium plasticity, noncemented, weak reaction to HCL, dry.

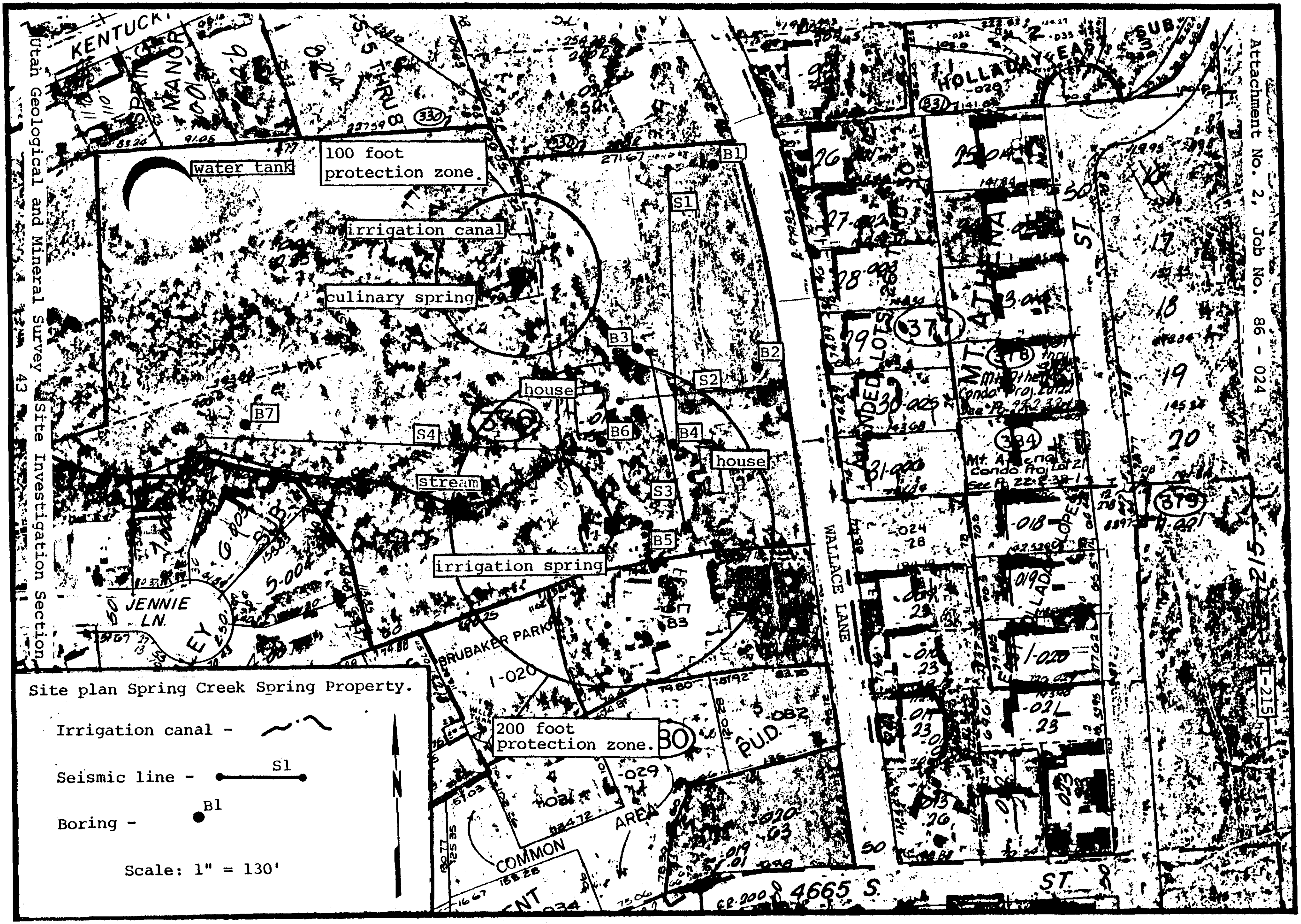
Attachment No. 1, Job No. 86 - 024

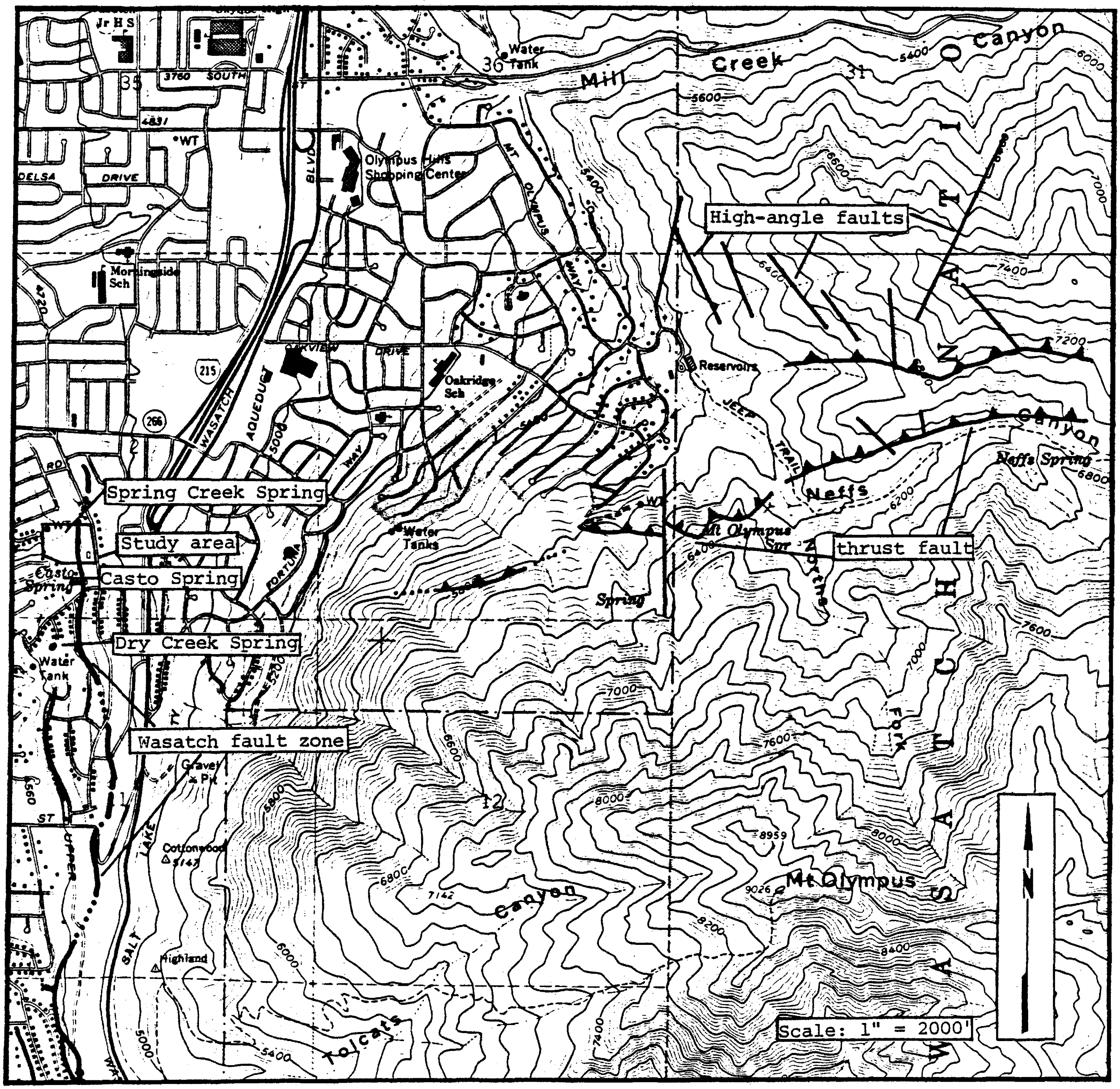


General location map - Spring Creek Spring study area.

Utah Geological and Mineral Survey Site Investigation Section

Attachment No. 2, Job No. 86 - 024





Faulting in the vicinity of the study area.

SOLID WASTE DISPOSAL

Project:			Requesting Agency:
Review of subsurface soil data in construction and background documents for the Vitro tailings remedial action project.			Division Environmental Health, Bureau of Solid and Hazardous Waste
By: W.R. Lund	Date: 2/26/86	County: Salt Lake	Job No.: 86-004/SW-1
USGS Quadrangle:			

A review has been made of the subsurface soil information presented in the following documents relating to the Vitro uranium mill tailings site:

1. "Vitro Uranium Mill Tailings Remedial Action Project (VUMTRAP) Project Manual",

2. "UMTRAP" Uranium Mill Tailings Remedial Action Project Contruction Drawings, Salt Lake City, Utah",

3. "Remedial Action Plan and Site Conceptual Design for Stabilization of the Inactive Uranium Mill Tailings Site at Salt Lake City, Utah: Appendix B of the Cooperative Agreement No. DE-FC04-81AL16309",

4. "Final Environment Impact Statement: Remedial Actions at the Former Vitro Chemical Company Site, South Salt Lake, Salt Lake County, Utah",

5. "Annex; Geotechnical Field and Laboratory Investigations at Vitro and South Clive Sites" by Dames and Moore,

6. "Characterization of Inactive Uranium Mill Tailings Sites: Vitro Site, Salt Lake City, Utah: by Colorado State University, and

7. "Engineering Assessment of Inactive Uranium Mill Tailings: Vitro Site, Salt Lake City, Utah" by Ford, Bacon and Davis Utah Inc.

The purpose of the review was to compare subsurface soil information in the Vitro remedial action contract bid documents (VUMTRAP Project Manual, and UMTRAP Construction Drawings) with soils data in the other referenced documents to determine if "material" differences exist between the official bid information and the other data sources. The majority of soils information in the Vitro bid documents is on sheets 4 and 5 of the UMTRAP Construction Drawings. A location map and graphic boring logs are presented on sheet 4, and soil test results are tabulated on sheet 5. The soil test data are generalized, with only a single set of sieve and Atterberg Limit test results reported for bore-hole intervals that range from 3 to 20 feet in length. During the review, this information was compared with both more generalized data (the Ford, Bacon, and Davis , and Colorado State University reports) and with detailed data presented for specific test samples (Dames and Moore report). Variations in data resolution made it difficult to compare data between reports on an equal basis. In addition, comparisions often had to be made across distances of several hundred feet, at a site where soil types change significantly over short horizontal and vertical intervals (see logs of bore holes V-6 and V-8 in the Dame and Moore report, and figures 41 and 42 in the Colorado State University report).

Despite problems inherent with the data and the variability of site conditions, the review showed that, in most cases, a reasonable correlation can be made between bore holes located within a few hundred feet of each other. Comparisons across distances greater than that become more difficult and are tenuous. Significant differences were found between soil types in a few closely-spaced bore holes, but they probably reflect variations in data resolution and natural variability of site soils, rather than a "material" difference in the data sets. Therefore, based on this review the UGMS concludes that a "material" difference does not exist between the official bid information and the other data source reviewed.

Project: Davis Canyon Nuclear Repository Site, San Juan County, Environmental Assessment: A UGMS Review			Requesting Agency: HLNWO
By: William F. Case	Date: 4 August 1986	County: San Juan	Job No.: 86-010/SW-2
USGS Quadrangle: Harts Point NW (375)			

DAVIS CANYON NUCLEAR REPOSITORY SITE ENVIRONMENTAL ASSESSMENT: A UGMS REVIEW

William F. Case
4 August 1986

In a Memorandum of Agreement dated May 27, 1986, the High Level Nuclear Waste Office (HLNWO) requested that the Utah Geological and Mineral Survey (UGMS) review Department of Energy (DOE) responses to the specific UGMS comments referenced by HLNWO in their "State of Utah Comments" document. This report is a review of DOE responses to UGMS comments on the 1984 Draft Environmental Assessment (EA) for the Davis Canyon nuclear waste site. DOE responses to these comments are incorporated in the May 1986 version of the Davis Canyon Site Environmental Assessment. UGMS comments to the Draft Environmental Assessment were published in section IV, UGMS Report of Investigation 202, (Eldredge, 1985). UGMS submitted approximately 122 comments to the Utah High Level Nuclear Waste Office (HLNWO). HLNWO compiled comments on the Davis Canyon draft environmental assessment from the various state agencies and consultants and passed them on to DOE as a "State of Utah Comments" document. Nine comments were attributed to UGMS in the document. Six of the comments are paraphrased from Eldredge (1985) and three comments are not from the Eldredge (1985) document. The three comments were reviewed however.

This review is organized as follows. Nine comments which were referenced to UGMS in "State of Utah Comments" are arranged in general topics and listed as COMMENT #X, followed by DOE RESPONSE TO COMMENT #X as published in the 1986 EA. The UGMS review of the DOE responses to each general topic follows the listing. The general topics are A) host rock mobility, B) petroleum potential in Paradox Basin, and C) geomorphic processes which may affect the site. Next, nineteen comments from Eldredge which are similar to those attributed to other researchers in HLNWO "State of Utah Comments" are listed but not reviewed. The researcher to whom the comment is credited and the page number in "State of Utah Comments" is given.

The following 9 comments attributed to UGMS are from the HLNWO "State of Utah Comments". The comment numbering is arbitrary and for the purposes of this review only.

A) UGMS comments on the 1984 EA and DOE responses as recorded in the 1986 EA concerning host rock mobility.

COMMENT #1: "Section 3.2.3 Stratigraphy. Figure 3-6, p. 3-13, shows the stratigraphic column with the geologic and tectonic history to the right divided into phases. Phase 2 indicates that the Paradox Basin and salt anticlines formed simultaneously with the times of the deposition of the Hermosa and Cutler Groups. This presentation leaves the impression that salt anticline activity (salt flowage) ended with the Permian. Data from Salt Valley anticline indicate that salt flowage in the salt anticlines continued well into the Jurassic and continues to the present. The problem is aggravated by statements made on p. 3-14, last paragraph: "Most of the salt flowage occurred during Permian time." Not only Permian, but post-Paradox Formation Pennsylvanian rocks (Honaker Trail) and Triassic rocks are missing over many of the anticlines. Thick Cutler sections were deposited in the troughs because the salt ..[moved].. to the anticlines. However, the Cutler in the troughs is not as thick as 15,000 ft., only along the Paradox Basin-Uncompahgre Highland boundary. Part of the Cutler along the border is Pennsylvanian in age as well. The Triassic and Glen Canyon rocks are thicker in the troughs along with the Cutler showing that the salt was very active in these ages. Figure 3-8 continues with the same error by only showing the Cutler to be thick in the troughs and not the Triassic and Jurassic. It is important to understand that salt will flow at anytime when suitable tectonic or loading stresses are placed upon it. The entire Paradox Basin can give information that would be applicable at Davis Canyon." Comment attributed to UGMS in HLNWO, page 3-3. A similar comment was cited in Eldredge, 1985, page IV-5.

DOE RESPONSE TO COMMENT #1: Figure 3-6 of the draft EA is figure 3-7 (page 3-26) of the 1986 EA and figure 3-8 is now figure 3-9 (page 3-29). Both figures are unchanged from the draft EA. Additional comments of post-Permian salt flowage have been added, giving reference to Doelling (1981). "The available evidence indicates that all of the salt anticline cores were covered by the Morrison Formation, with localized thinning of this unit implying slow upward movement of individual salt cells within the larger anticlinal cores (Shoemaker et al., 1958, p. 51; Doelling, 1981, p. 81)." "Cretaceous deposits also show localized thinning over the salt anticlines similar to that observed for the Morrison Formation, indicating slow upward movement of portions of the anticlinal cores (Shoemaker et al., 1958, p. 51; Doelling, 1981, p. 81)." No mention of present salt flowage in Salt Valley anticline area.

COMMENT #2: "Section 3.2.5. Figures 3-17 and 3-18 are incomplete and therefore lessen the impact that the problems of salt flowage and dissolution should leave with the reader. A cross-section line should be placed for figure 3-18 on figure 3-17, to show what position the repository has with respect to the diagram. The location of the repository should also be shown on figure 3-18, to indicate its position with respect to the tectonic elements." Attributed to UGMS in HLNWO, page 3-7. A similar comment was cited in Eldredge, 1985, page IV-5.

DOE RESPONSE TO COMMENT #2: Figure 3-17 is figure 3-25 and figure 3-18 is figure 3-28 in the 1986 EA. The proposed controlled area boundary and the geologic repository operations area are now shown on figure 3-25, the cross-section line representing figure 3.28 is not shown. The geologic repository operations area is not shown on figure 3-28.

COMMENT #3: "Section 3.2.5. Only one theory is presented with respect to the formation of the Needles fault zone, Huntoon's gravity sliding theory. It may not be the only mechanism in action. Other writers such as Stokes believe dissolution to be effective here. (See p. 6-105, paragraph 2)." Attributed to UGMS in HLNWO, page 3-7, however, the comment was not recorded in Eldredge (1985)

DOE RESPONSE TO COMMENT #3: Section 3.2.5.6, Dissolution. "...the Needles Fault zone is considered to be the most likely area where dissolution is occurring." Section 3.2.5.1, Faulting, references a Hite (1982a) proposal that the Needles Fault zone is a product of dissolution. Stokes is not referenced. Section 6.3.1.6.1, "The Needles Fault zone is an area of potential dissolution.".

UGMS RESPONSE TO 1986 EA, COMMENTS #1-3: DOE response adequately address these 3 comments and does not include findings of more recent work by Oviatt (1986). A basic UGMS premise concerning salt flowage and dissolution is that what has occurred in the rest of Paradox Basin can occur at Gibson Dome and Davis Canyon. Doelling (personal comm., 1986) had shown that such movements are relatively recent in many parts of the basin including the Salt Valley anticline (Doelling, 1985). Differential loading produces salt flowage features such as subsidence, diapirism, dissolution, faulting, folding, and thickness variations of salt beds found elsewhere in the Paradox Basin. A UGMS comment remarked that a general impression in the 1984 draft EA was that all salt flowage has ceased since the Permian. The DOE response in the 1986 EA is similar to the draft EA. The tectonic history as outlined on the generalized stratigraphic column of Paradox Basin, figure 3-7, implies that the salt anticlines ceased movement at the end of the Permian. Salt tectonics were active to the end of Triassic time and then gradually waned as the overall prism of new sediments deposited over the region was added. When the region was uplifted and began to be differentially unloaded, starting in mid-Tertiary time these activities again were gradually increased. Presently the salt tectonic activities appear to be active in the Paradox Basin. The Meander anticline, the Needles deformation, and deformation along the prominent salt anticlines attest to this. A diagrammatic cross-section in the 1986 EA shows no evidence of continued salt movements since the Permian and does not show that activity continued thereafter. Quaternary volcanic ashes in the Salt Valley anticline area have been faulted and folded due to salt flowage and/or dissolution (Oviatt, 1986). The DOE refers to Quaternary uplift documented in Fisher Valley and the Dolores anticline (Coleman, 1983), and postulates that Gibson Dome is presently being uplifted due to differential loading and salt flowage. If the rest of Paradox Basin is considered as a key to what could happen at Davis Canyon, then continued uplift might produce normal faults in the rock above the salt.

The relationships of salt flowage and dissolution in the surrounding region and the Davis Canyon site should be better indicated. The UGMS requested that the Davis Canyon site be indicated on a schematic cross-section (figure 3-28) showing the Needles fault zone, the Colorado River, and areas of possible salt flowage, and that the cross-section location be indicated on figure 3-25, Mapped Faults. Even though the cross-section is diagrammatic, indicating the approximate location would better indicate tectonic relationships with the site. The figures have not been revised.

Another comment requested that more than one mechanism for the formation of the Needles fault zone be discussed. In addition to Huntoon's gravity sliding of post-salt sediments over the salt, the 1986 EA considers the Needles fault zone as an area where dissolution is presently occurring. It has been argued that the Davis Canyon site is protected because it is on the opposite side of the axis of the Monument Upwarp and regional dips are therefore to the northeast, not toward the river to the west. Some researchers believe that the processes that produce grabens west of the axis may extend across the axis. If the grabens in the Needles fault zone are due to dissolution because of ground water removing salt and allowing collapse of overlying rocks, or if the grabens were produced by gravity sliding, the mechanisms could still operate on the opposite limb of the Monument Upwarp because of the slope involved or progressive eastward growth of the grabens. Stream incision, cliff retreat, or continued uplift of the Monument Upwarp would also cause post-salt rocks to gravity slide downslope and produce faults similar to the Needles fault zone. Such growth of faults and collapse features would encroach on the Davis Canyon site which is downslope.

B) UGMS comments on the 1984 EA and DOE responses as recorded in the 1986 EA concerning petroleum potential in the Paradox Basin.

COMMENT #4: "3.2.8 Mineral Resources. Pages 3-72 and 3-81, "Hydrocarbon Resources," leave the opinion that the potential for oil and gas is poor to fair around the site. This is not true. The data supports a good testing area." Attributed to UGMS in HLNWO, page 3-13. A similar comment was cited in Eldredge, 1985, page IV-8.

DOE RESPONSE TO COMMENT #4: No change in premise that potential for oil and gas is poor to fair. More data is given to support premise.

UGMS RESPONSE TO 1986 EA, COMMENT #4: The DOE response does not adequately address the comment. Cynthia Brandt, UGMS petroleum section geologist, does not agree that the hydrocarbon potential of the Davis Canyon area is low compared to other areas in the Paradox Basin as stated in the 1986 EA. The following comments are taken from a memo dated 3 July, 1986, and a 1 August, 1986, revision of the author's interpretation of the memo. The comments pertain to the DOE estimate of hydrocarbon potential in the Davis Canyon vicinity.

What the DOE considers as "minor" petroleum shows in many instances would be considered "significant" and "major" shows to the petroleum industry. For example, core GD-1, the closest borehole to the site had intervals of bleeding oil and gas in the Leadville Formation and the Paradox Formation. In addition, gas was found in the borehole when the Paradox was cored. Brandt stated that together these facts are "..generally considered a good indication that commercial quantities of hydrocarbons may be present nearby.".

Futhermore, great weight was put on two facts in the 1986 EA: 1) no DST shows in the site vicinity; and 2) no DST shows in GD-1. Brandt states the following with regard to these two facts.

> "However, DST's are not definitive in carbonate reservoirs and in complex lithology. The act of drilling through such strata may damage the area around the borehole. In such cases, a true test of the hydrocarbon's potential can be obtained only by perforating the strata; sometimes hydrochloric acid or more vigorous methods of stimulation are necessary to overcome borehole damage or to enhance natural porosity and permeability. Nonetheless, many economically successful wells have had no DST shows, but once perforated and stimulated have produced substantial quantities of hydrocarbons."

Moreover, the wells drilled in the site vicinity are spaced widely, leaving a great deal of untested acreage between wellbores. It is possible that more than one commercial field could actually be present in untested acreage of this size. Although no clear structural trap has been detected in the subsurface, many good traps are difficult to detect in the subsurface. Fields occur frequently where there is no structural trap or detectible stratigraphic trap, especially in carbonate rocks and in stratigraphically complex lithology.

Brandt concludes that the Paradox, Leadville, Honaker Trail, and Cambrian rocks have good potential to produce commercial quantities of hydrocarbons in the site vicinity. Brandt finds unrealistically pessimisticthe 1986 EA conclusion that the potential is low.

C) UGMS comments on the 1984 EA and DOE responses as recorded in the 1986 EA concerning geomorphic processes which may affect the site.

COMMENT #5: "Figure 3.34 is also misleading in presentation of repository operations area as the controlled zone is included. An appropriate presentation of the flood plains for the different events would be a figure which places the facilities in the flood plains. A statement made in the flood report used in this analysis (BGI, 1984c) and referred to in the EA "that all facilities are above the PMF and therefore flooding is not a serious consideration in repository design" is not based on any professional data analysis. The state does not agree with this approach and seeks a more professional consideration of the problem which includes the items mentioned above. Based on the results of this study and the figures portrayed, repository facilities many of which will be impacted by the 100 year event and all of which will be impacted by the PMF due to the location of the flood plains include: the salt storage pile and runoff evaporation pond, wastewater treatment facilities and holding pond, cooling towers, chemical feed building, railroad control tower, salt transfer tower and loadout structure, raw water treatment and storage facilities, potable and fire water storage tanks, storm water detention ponds, parking lot, maintenance and storage facilities, entire railroad yard and associated facilities, and suspect rail car and truck storage area. In fact, during characterization studies, six of the upper hydrostratigraphic unit test wells located at the southeast and southwest boundaries of the study area and the SC2, SC3, SC4 stratigraphic confirmation boreholes, salt runoff evaporation ponds, and sedimentation basin (mud pit), administration buildings, and alternate shaft access will be located within the 100 year flood plain of the Davis Canyon drainage. DC3, a lower hydrostratigraphic unit test well, falls within the 100 year flood plain of the Indian Creek drainage. Mitigation plans must be explained. Another problem with Figure 3-34, page 3-125 is that the patterns for flood plains suddenly end above x5091 and do not extend across the length of the geologic repository operations area?" Attributed to UGMS in HLNWO, page 3-18, not recorded in Eldredge (1985).

DOE RESPONSE TO COMMENT #5: Figure 3-34 of the draft EA is figure 3-51, page 3-166. The only apparent change is the addition of an outline representing the surface facility boundary and a Subsurface Facility Boundary label on the perimeter of the facilities. The flood plains patterns still end at 5091 feet elevation.

COMMENT #6: "3.3.1.4 Flooding. Investigations of modern and paleohydrologic conditions from channel characteristics (vegetation, bed material size) and Holocene alluvial deposits may yield additional information for verifying calculated flood levels. Such geologic investigations are also valuable in assessing debris-flow and mudflow hazards for the site and transportation corridors. These have not been evaluated in the EA. As such phenomena are potentially as destructive to surface facilities as are floods, data supporting a conclusion as to the likelihood of their occurrence should have been included." Attributed to Christenson/UGMS in HINWO, page 3-19. A similar comment is recorded in Eldredge, (1985), page IV-8.

DOE RESPONSE TO COMMENT #6: No response.

COMMENT #7: "Section 6.3.1.5.1. Statement of Qualifying Condition, beginning page 6-100: The presentation of relevant data includes long-term stream downcutting rates calculated from the geologic record, but does not include data from modern sediment yield of streams and rates of erosion based on reservoir filling in the area. Also stream downcutting is the only facet of erosion that was considered. The possibility of the retreat of scarps and cliffs through mass wasting should also be considered, as it might result in exhumation or a reduction of burial depth of the radioactive waste over time." Attributed to Christenson/UGMS in HINWO, page 6-68, a similar comment cited in Eldredge, (1985), page IV-15.

DOE RESPONSE TO COMMENT #7: "Section 6.3.1.5.1. The third source of data is modern sediment yield data from stream flow measurements and sedimentation data for reservoirs (Section 3.2.2.2), which can be used to estimate historic erosion rates over an entire drainage basin. Average annual sediment yields may be estimated by periodically sampling the sediment concentration in rivers, or by measuring the changes in reservoir volume caused by sedimentation." Table 3-3, "Denudation Rates for Watersheds in the Colorado Plateau", lists erosion rates for various stratigraphic formations and erodibility classes of lithologies within the formations. Rates are based on sedimentation in reservoirs and suspended sediment loads in streams in the Colorado Plateau.

"Section 6.3.1.5.1. Sudden failure of blocks from cliff walls and bedrock ledges appears to be the dominant mechanism of scarp retreat and therefore, valley widening in southeastern Utah (Section

3.2.2.2.2)." Rock fall is considered as the main cause of cliff retreat in Section 3.2.2.2.2. The section mentions that the Wingate Formation (erodibility class 3) and the Moss Back Member of the Chinle Formation (erodibility class 4) produce most of the rock fall deposits in the Davis Canyon area. The maximum scarp retreat rate for erodibility classes 2-5 listed in Table 3-4 ("Average Rates of Scarp Retreat on the Colorado Plateau, Based on Geomorphic Interpretations") is 2 feet (0.6 meter) / 1000 years.

COMMENT #8: "Section 6.3.1.5.3. Analysis of Potentially Adverse Conditions, page 6-103: Under the second potentially adverse condition (see "Evaluation," for the second potentially adverse condition, page 6-103), ONWI-290 is cited for the proposition that other geomorphological processes, such as mass wasting, aeolian, and glacial processes, will not significantly affect repository waste containment characteristics. A brief summary of these data should have been included in Section 6.3.1.5.1, "Relevant Data," if these data were considered in making the conclusion that the potentially adverse condition is not present." Attributed to Christenson/UGMS in HLNWO, page 6-69, not cited in Eldredge, (1985), however.

DOE RESPONSE TO COMMENT #8: Mass wasting in the form of scarp retreat has been covered in the comment above. Aeolian and glacial processes were not mentioned in the EA.

COMMENT #9: "Section 6.3.3.1.1. Statement of Qualifying Condition, beginning page 6-138: Under the section entitled "Relevant Data," a preliminary report by Bechtel (BGI 1983) is referenced as apparently including a delineation of the 500-year flood plain. This earlier Bechtel report has been superseded by a more detailed flood plain report (BGI 1984), in which the 500-year flood plain is not delineated. The proper reference should be supplied so that conclusions based on the presence or absence of the flood plain can be verified by reviewers." Attributed to Christenson/UGMS in HLNWO, page 6-74, not cited in Eldredge, (1985) however.

DOE RESPONSE TO COMMENT #9: The 500-year flood plain referenced to BGI (1983) has been changed to "..the probable maximum flood (PMF) flood plain ..".

UGMS RESPONSE TO 1986 EA, COMMENTS #5-9: DOE responses do not adequately address these comments. The draft EA did not indicate which of the facilities were in the probable maximum flood (PMF) or the 100-year flood plain. Also, the calculations of the flood plains did not exceed 5091 feet elevation, and therefore did not cover the entire Geologic Repository Operations Area (GROA). The only response in the

1986 EA is on figure 3-51. The perimeter of the surface facility area is now indicated on the figure and the subsurface facility outline is labeled. Mitigation plans for the surface facility flooding are not discussed in the section on flooding.

Another UGMS comment (Eldredge, 1985) on the possibility of determining the susceptibility of debris-flow or mudflow hazards in the area by looking at Quaternary deposits was not considered in the 1986 EA. This could be quite serious considering the aridity of the area and the type of precipitation events. Alluvial deposits could provide a valuable indicator of the occurrence and extent of such geologic hazards, including maximum flood events. It may be that the 100-year flood or the PMF will be a mudflow or debris-flow event and as such would not conform exactly to the HEC-1 and HEC-2 flooding models. In section 6.3.3.1.1 the reference to 500-year flood has been changed to PMF as suggested by a UGMS comment not included in Eldredge (1985).

Suspended sediment amounts in streams and reservoir storage decrease due to sedimentation have been included as a source of data for estimating erosion rates of formations in the Colorado Plateau as suggested by the UGMS (Eldredge, 1985). Data from Colorado Plateau watersheds are summarized on Table 3-3, page 3-18. Paradox rock types and stratigraphic formations have been classified into relative erodibility classes ranging from 1 (well-indurated) to 7 (easily eroded). The DOE assumes a range of historic denudation rates equal to 0.09-0.9 m/1000 years in the Davis Canyon area assuming the existence of rock units in erodibility classes 2-4 (section 3.2.2.2.1). However, rock units in erodibility classes 2-6 exist in the Davis Canyon area and, according to Table 3-3 the erosion rates may be much higher. For example, the erosion rate of the Chinle Formation (erodibility class 5) is as high as 2.4 m/1000 years. At this rate, the host rock would be exposed within 37,000 years if the entire overburden section was erodibility class 5. The DOE assumes an average erosion rate of 0.4 meters/1000 years (section 6.3.1.5) to justify favorable conditions of no radionuclide release within 10,000 years and no exhumation within 1,000,000 years. The subsurface facilities would be exhumed in approximately 1,000,000 years using the maximum DOE erosion rate of 0.9 m/1000 years. A more detailed and accurate estimate of waste exposure due to erosion could be determined if the thicknesses and erodibility classes of the subsurface rock units above the host rock were calculated. Erosion rates based on recent incision of the Columbia River and its tributaries could give an additional line of evidence.

A comment on the draft EA suggested that cliff retreat due to rock fall should be considered as an agent of erosion. Erosion rates of formations in erodibility classes 2-5 were estimated by DOE from a literature search. The maximum rate of cliff retreat, approximately 0.6 m/1,000 years, would result in about 600 meters of retreat in one million years. The Wingate Formation (erodibility class 3) and the Moss Back Member of the Chinle Formation (erodibility class 4) produce most of the rock falls in the site vicinity according to the 1986 EA.

Cliff retreat of these formations would remove approximately 150 meters of overburden above the host rock where the subsurface facility underlies mesas. This probably is not a problem because very little of the subsurface facilities as shown in figure 3-2, appear to underlie mesas. The surface facilities may be affected by rock fall hazards particularly because rock falls tend to be episodic.

Other geomorphic processes such as aeolian or glacial action, as suggested by a comment attributed to UGMS but not listed in Eldredge (1985) are not considered in the EA.

REFERENCES

BGI (Bechtel Group, Incorporated), 1982, Lavender Canyon sections 16 and 32 sites and Davis section 6 site precipitation and flood study: prepared for Office of Nuclear Waste Isolation, ONWI/SUB/81/E512-01600-57.

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Project: Provo City Landfill Site			Requesting Agency: Provo City
By: R.H. Klauk	Date: October 7, 1986	County: Utah	Job No.: 86-021/SW-3
USGS Quadrangle: Goshen Valley North (1008)			

In response to a request from Merrill Bingham, Provo City, the proposed city sanitary landfill site was evaluated for ground-water pollution potential. The Utah Geological and Mineral Survey (UGMS) located a water well for Provo City on the site (Klauk, 1984) and, therefore, is familiar with the geology and ground-water regime in this area. The proposed site includes all of sec. 17, T. 9 S., R. 1 W., Salt Lake Baseline and Meridian. The scope of work included a review of all known published and unpublished pertinent information for the area as well as personal communication with Dave Clark, U. S. Geological Survey hydrologist.

The water well drilled by Provo City at the western border of the site first encountered ground water from 260 to 285 feet below the surface. The major aquifer, according to the well log, however, extends from 330 to 390 feet in depth. The site slopes to the east, and depths to the shallower ground-water zone are expected to be somewhat less but still greater than 125 feet in that direction. Soil reports by Sorenson (1980) and Rollins (1983) indicate no ground water within 50 feet of the surface at the site. It is our understanding that the cells for the landfill will not be more than 26 feet below the surface and, therefore, will not be flooded by a rising water table.

Average annual precipitation at the site is less than 10 inches per year (Jeppson and others, 1968). Dave Clark (oral commun., 1986) indicates that from 30 to 35 percent of annual precipitation actually infiltrates into the soil in this area. Furthermore, part of the infiltration is taken up as soil moisture and does not enter the ground-water system. Therefore, a very small amount of precipitation is actually available for leachate formation.

Soils over most of the site to a depth of 50 feet are impermeable. However, there are areas with permeable sands. UGMS concurs with Sorenson (1980) and Robison (1986) that these areas need to have a liner emplaced. The liner would serve to impede downward migration of any leachate as well as attenuate heavy metals in any leachate formed.

Based on a review of the information available, it is concluded that at the landfill site:

1. The conditions do not exist for saturation of refuse due to a rising water table.

2. The potential for leachate formation is small.

3. A low permeability liner should be placed in cells excavated in areas of higher permeability soils.

4. With emplacement of the liner, ground-water pollution potential should be greatly reduced or totally eliminated.

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Project: Sanpete County Landfill Site			Requesting Agency: DCED
By: William F. Case	Date: 31 Dec. 86	County: Sanpete	Job No.: 86-026/SW-4
USGS Quadrangle: Manti (760) and Wales (801)			

Purpose and Scope

On the 20th of October, 1986, William R. Lund, Utah Geological and Mineral Survey (UGMS), contacted Sanpete County Commissioner Newt Donaldson at the request of Richard E. Walker, Department of Community and Economic Development (DCED), concerning a possible site evaluation for one or more sanitary landfill sites. DCED is funding the land purchase and requested a site evaluation. Commissioner Donaldson selected a landfill site about 4 miles west of Ephraim and notified UGMS on the 17th of November. Commissioner Donaldson also selected two alternate sites between Moroni and Fountain Green, Utah for evaluation if the Ephraim site proved unsuitable. The purpose of the landfill is to serve as a regional disposal site for all Sanpete County refuse. This would permit closure of several small dumps, many of which burn refuse, located throughout the county.

The scope of this investigation included a literature search, water well records research, aerial photo interpretation, and two site inspections including the logging of a test pit. Water well applications for the site and surrounding area were obtained from the Department of Natural Resources, Division of Water Rights. The site was visited on the 20th of November, 1986, with Sanpete County Commissioner Donaldson and George N. Johanson, Central Utah District Environmental Health Specialist, and again on the 24th of November, 1986, by UGMS personnel.

Location and site conditions

The 80 acre landfill site is approximately 4 miles west of Ephraim, Utah in the W 1/2 NE 1/4 sec. 2, T. 17 S., R. 2 E., SLBM (attachment 1). The site is at the juncture of the Dry Canyon, Rock Canyon, and Axhandle Canyon alluvial-fan complex and the western edge of the San Pitch River flood plain (attachment 2). The San Pitch River is approximately a mile to the east and 30 feet lower than the southeast corner of the property. Streams from Dry Canyon and Rock Canyon issue from the San Pitch Mountains which are 2 miles west of the site. The Wasatch Plateau bounds the Sanpete Valley to the east. Elevations at the site range from approximately 5500 feet at the northwest corner to 5460 feet at the southeast corner. The average slope of of the property is less than 2 percent.

Vegetation on site consists mainly of greasewood up to 5 feet high (attachment 3). Greasewood at these heights indicates overgrazing according to Hal Swenson, Soil Conservation Service soil scientist (personal comm., 24 November, 1986). Swenson and others (1981) have classified the site as semi-desert alkali flats rangeland.

Geology and Soil Classification

The site is in the Basin and Range-Colorado Plateau physiographic province transition zone. The geology of the area reflects characteristics of both physiographic provinces. That is, the mountain ranges consist of thrust-faulted bedrock bounded by range front normal faults similar to those found in the Basin and Range province to the west of the site. Uplifted, slightly dipping bedrock structures characteristic of the Colorado Plateau province are found in the Wasatch Plateau, east of the study area. Bedrock of both the Wasatch Plateau and the San Pitch Mountains consists of Mesozoic Era (245 to 66 million years ago) and Tertiary Period (66 to 1.6 million years ago) sandstones, mudstones, and limestones characteristic of the Colorado Plateau province (Witkind and others, 1982). The geologic structure of the mountains, plateaus, and valley surrounding the landfill site is the result of a complex history of thrust faulting in Mesozoic and Early Tertiary time, separation and normal faulting throughout Tertiary time, and finally Late Tertiary and Quaternary (1.6 million years ago to present) folding of bedrock due to upward squeezing of Mesozoic age salt deposits under the weight of the overlying sedimentary rock (Witkind, 1982; Villien, 1984). Witkind and others (1982) have mapped a normal fault which displaces alluvial-fan sediments that are up to 24 million years old, 1/4 mile west of the site (attachment 2). A lineament is evident on aerial photographs of the area but no ground evidence was discovered.

Alluvial-fan and flood-plain sediment in the area consists of 15 to 20 feet of clay at the surface which overlies alternating beds of gravel and clay (attachment 4). The thickness of the unconsolidated material at the site is not known, but the sediments are 342 feet thick at a nearby water well site (attachment 4). Attachment 5 is the engineering soil log of the test pit excavated at the site (attachment 1). Soil in the test pit consisted of 18 feet of horizontally laminated, lean clay (CL). No highly permeable strata or evidence of moisture were noted in the pit, although small lenses of sand and gravel were noted at a depth of approximately 15 feet in the walls of a gully near the southeastern corner of the property. The gully walls exhibited mineral efflorescence (crystals precipitated when water evaporates) indicative of ground water drawn to the surface due to capillary action (attachment 3). However, except for the streambed which had held water in the past few days due to rain (Newt Donaldson, personal comm., 20 November, 1986), no moisture was noted anywhere on the property. The USDA Soil Conservation Service description and characteristics of the upper 60 inches of soil are taken from the Soil Survey of Sanpete Valley Area (Swenson and others, 1981). The soil at the site is the Harding silt loam, a moderately to strongly saline, well-drained, deep soil that forms on 1-5 percent slopes of alluvial fans, plains, and terraces. Engineering properties of the Harding silt loam include moderate susceptibility to shrink-swell, susceptibility to frost action, medium to low shear strength, medium compressibility, fair to good compactibility, and slow permeability (0.06-0.2 inches/hour). Limitations to use as a sanitary landfill are a moderate working difficulty and possible dust hazard because of the fine-grained soil texture.

Hydrology

Water from ephemeral streams in Dry and Rock Canyons, the perennial stream that flows from Axhandle Canyon, and precipitation on the property and surrounding area to the west and north contribute to surface drainage at the site (attachment 2). Annual precipitation ranges from 8 inches in the valley to 22 inches in the higher reaches of the canyons (Swenson and others, 1982). Surface water infiltrates into the soil recharging the ground-water reservoir. Precipitation and snowmelt infiltrate when the soil is permeable, and unsaturated. When water is supplied faster than the soil infiltration rate runoff will occur. The alluvial-fan surface is coarse-grained and permeable near canyon mouths and grades to relatively impermeable fine-grained sediment where the fan merges with fine-grained flood-plain sediment. Attachment 2 shows runoff channels on the alluvial-fan complex that begin where the soil becomes fine-grained and relatively impermeable. The coarse-grained deposits close to the mountain front provides the recharge zone for artesian aquifers beneath the valley. The water which infiltrates close to the mountain front moves downslope, probably to the southeast and becomes confined in aquifers overlain by the finer sediments found at a distance from the mountains. A hydraulic head develops in the ground water because of the elevation differences between the aquifer recharge zone and the central valley area. The hydraulic head creates artesian conditions that allow water to rise in wells that penetrate the confining beds. The hydraulic head in water wells east of the landfill site (valley side) is great enough to produce flowing wells, whereas the pressure at wells at approximately the same elevation as the site allow water to rise several feet, but is not great enough to bring ground water to the surface (attachment 1). The major producing aquifer tapped by wells near the site is approximately 100 to 150 feet below the surface, although, as logs in attachment 4 show, small amounts of water appear in thin beds of coarse-grained sediments within 15 feet of the surface.

According to Swenson and others (1982), the runoff and erosion hazards of the Harding soil are moderate, although deep gullies are common in some areas. There are at least 6 gullies at the landfill site (attachment 2). Their depths range from about a foot at the western and northern property boundaries to approximately 15 feet at the southeast corner (attachment 3). The largest gully has been channelized in the southeastern quarter of the site and cuts across the natural drainage which drains into adjacent property to the east (attachment 2). All surface water from the property drains to the southeast and, once off the property, flows through a 3-foot diameter culvert beneath a county road.

Conclusions and recommendations

Geologically the site should serve as an adequate landfill area. It is unlikely that large amounts of leachate will form in the fill unless surface water or shallow ground water is allowed to enter refuse disposal trenches. Aquifers will be protected from contamination because of the upward hydraulic gradient of the ground-water system and the slow permeability and thickness of the overlying soil. Shallow water contained in coarse-grained sediments at the site should not reach local culinary wells because the wells are cased to a depth of at least 75 feet and the sediments are not continuous laterally (attachment 4). The site contains adequate soil to provide cover material with a fair to good compactibility although the presence of clay may cause workability problems when wet and dust problems when dry (Swenson and others, 1982). According to Hal Swenson (personal comm., November, 1986) reseeding the cover to control erosion may be a problem because of the alkalinity of the soil.

Surface water which originates off the property should be diverted from the site along the northern and western boundaries by a ditch at least 3 feet deep. Precipitation and snowmelt water on the site should not be allowed to pond and should be routed off the property without causing gullying of cover material. The culvert under the county road beyond the southeast corner of the property should be enlarged so that surface water will not pond and the road will not be washed out. A 10 foot or less excavation depth should be maintained for refuse disposal trenches to guarantee at least 5 feet separation (Brunner and Keller, 1972) between any shallow perched water and the bottom of the landfill. It is recommended that shallow wells be drilled to monitor any perched water so the 5 foot separation between refuse and ground water can be maintained and to monitor ground water-quality.

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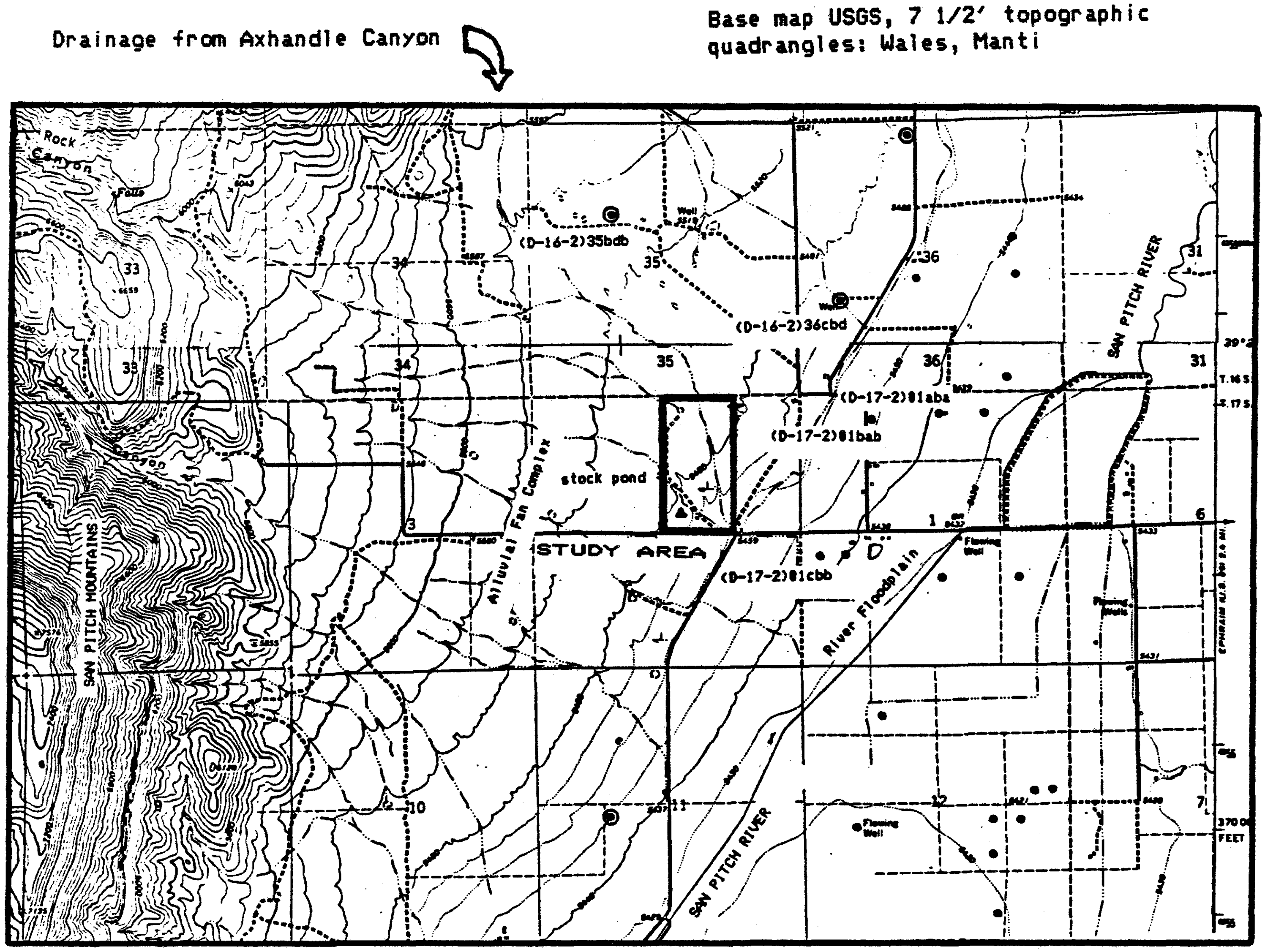
Witkind, I. J., Weiss, M. P., and Brown, T. L., 1982, Preliminary geologic map of the Manti 30' X 60' Quadrangle, Carbon, Emery, Juab, Sanpete, and Sevier Counties, Utah: U.S. Geological Survey Open-File Report 82-654, scale 1:100,000.

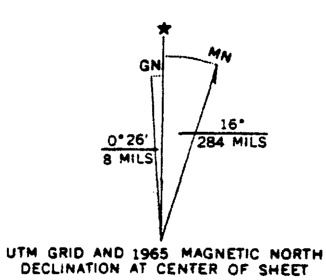
Drainage from Axhandle Canyon

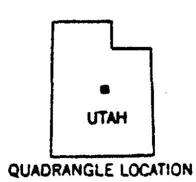
Base map USGS, 7 1/2' topographic
quadrangles: Wales, Manti



One Inch = 0.6 Miles

INDEX AND LOCATION MAP



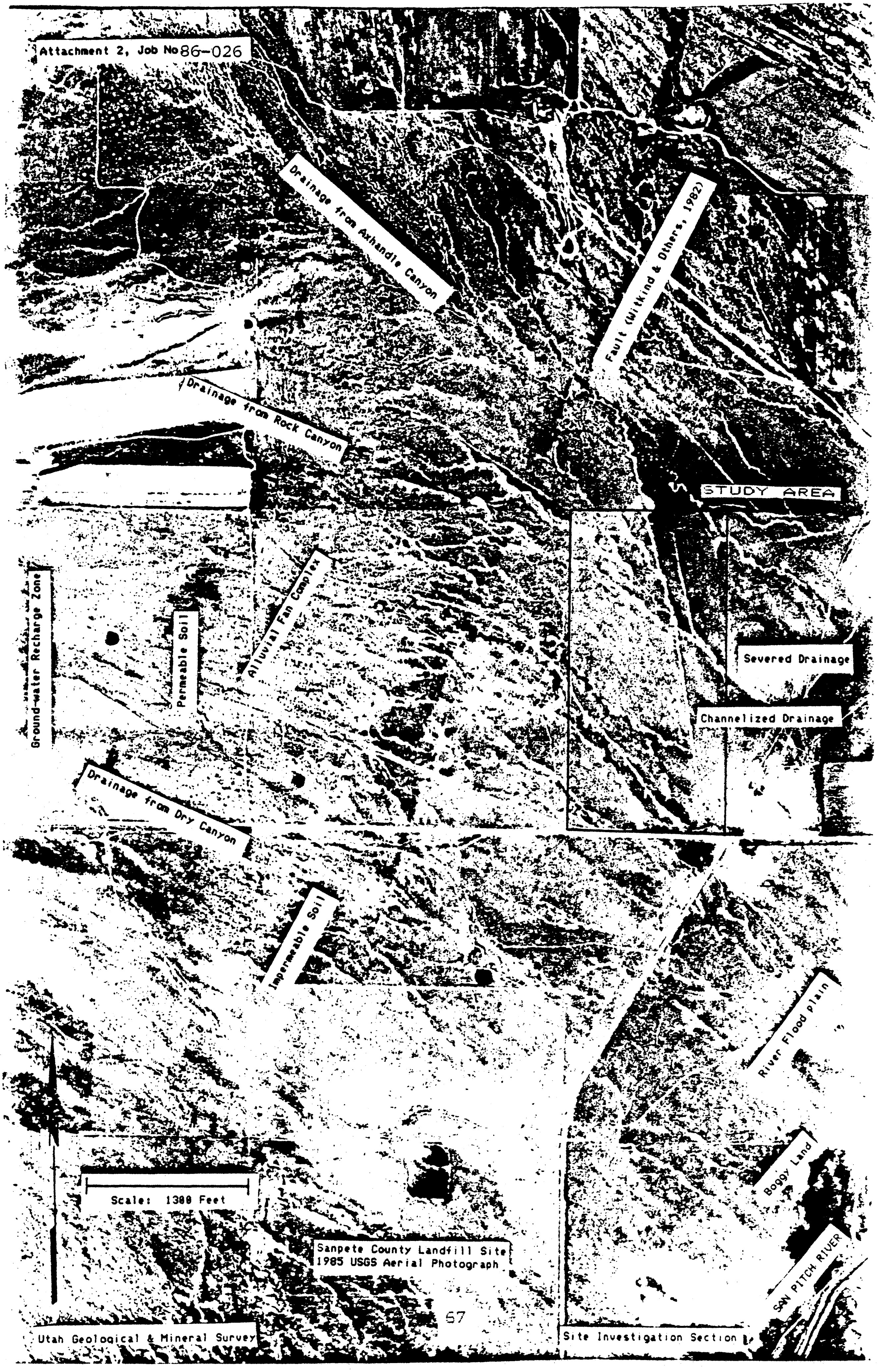


▲ Test Pit Location

● Flowing Well

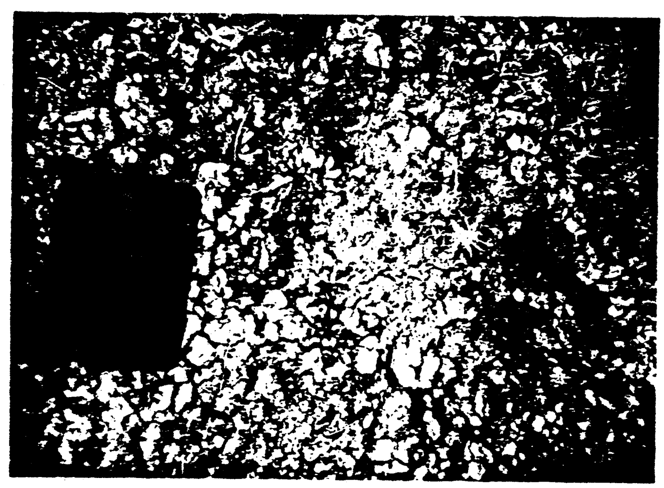
◉ Non-flowing Well

(D-17-2)01aba: Well with lithology log


Attachment 2, Job No 86-026
Drainage from Axhandle Canyon
Fault (Witkind & Others, 1982)
Drainage from Rock Canyon
STUDY AREA
Ground-water Recharge Zone
Permeable Soil
Alluvial Fan Complex
Severed Drainage
Channelized Drainage
Drainage from Dry Canyon
Impermeable Soil
River Flood plain
Boggy Land
SAN PITCH RIVER
Scale: 1300 Feet
Sanpete County Landfill Site
1985 USGS Aerial Photograph
Utah Geological & Mineral Survey
Site Investigation Section

View of site showing typical vegetative cover. Wasatch Plateau in background.

Gully approximately 15 feet deep located in southeastern quarter of property.

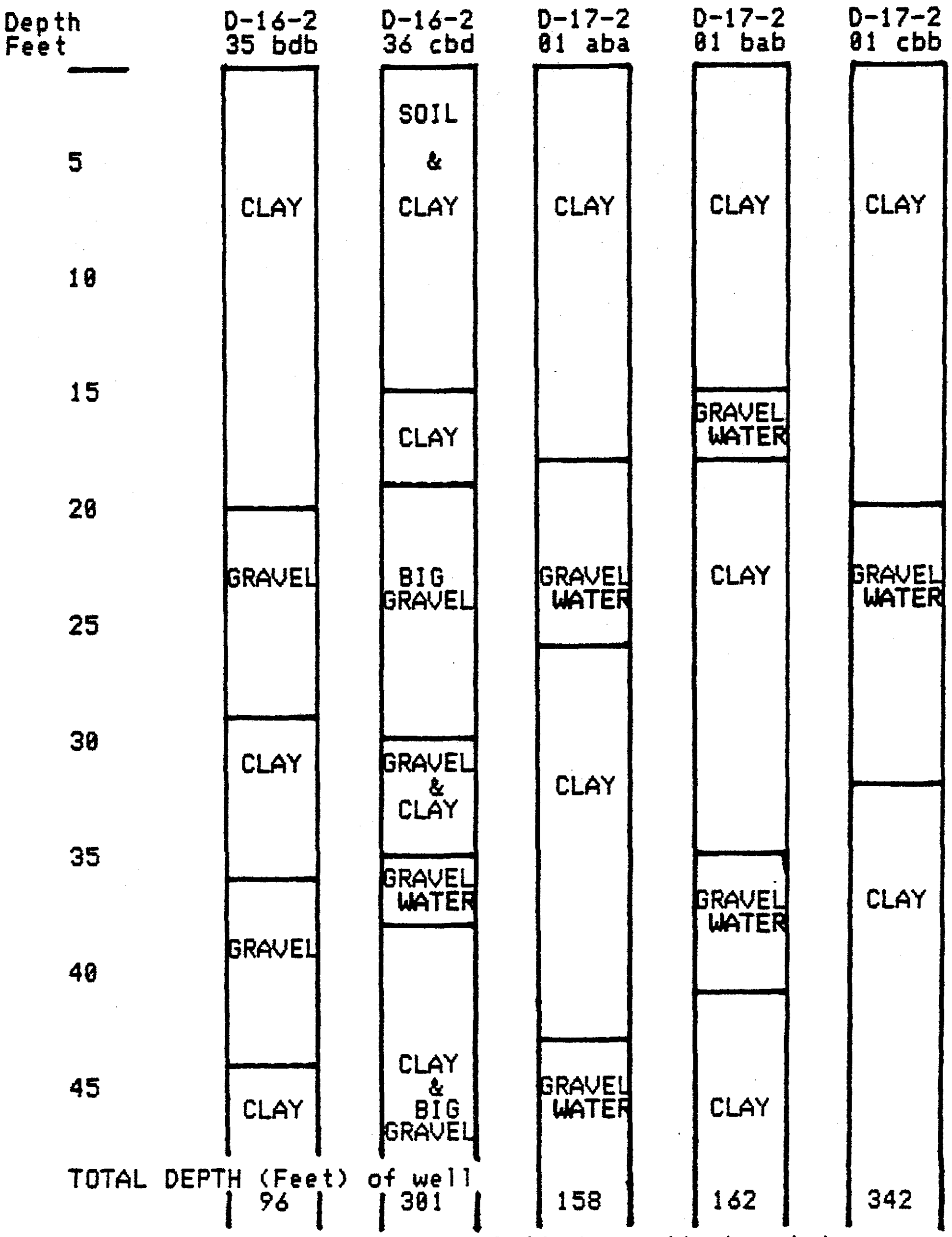


Efflorescence of alkali salts. Notebook is 7 3/4 inches long.

Attachment 4, Job No. 86-026

Lithology and ground water occurrence from 0 to 50 feet in well logs near landfill site.

Water Wells (USGS nomenclature)



notes: Locations are plotted on attachment 1.
Logs of water wells from Utah Division of Water Rights.

Utah Geological & Mineral Survey Site Investigation Section

Attachment 5, Job No. 86-026

TEST PIT SOIL LOG*

SANPETE COUNTY LANDFILL SITE

SANPETE COUNTY, UTAH

0'-18' Lean clay (CL); light brown, firm, medium plasticity, dry, weakly cemented; horizontal laminations, moderate reaction to HCl.

*Soils classified in accordance with procedures outlined in ASTM Standard D2489-69 (Revised 1984), Description of Soils (Visual Manual Procedure).

WASTEWATER DISPOSAL

Project:			Requesting Agency:
Evaluation of Raintree No. 3 and Ted Holtry No. 1 subdivisions for septic systems			Bureau of General Sanitation
By: R.H. Klauk	Date: 4/14/86	County: Weber	Job No.: 86-007/WW-1
USGS Quadrangle: Ogden, Utah (1345)			

PURPOSE AND SCOPE

In response to a request from J. Steven Thiriot, State Division of Environmental Health (Bureau of General Sanitation) and Richard Schwartz, Weber-Morgan District Health Department, two sites were investigated to evaluate soil and geologic conditions with regard to suitability for individual wastewater disposal systems utilizing septic tank and soil absorption fields. A limited moratorium has been placed on the Uinta Highlands Sewer Improvement District by the Weber-Morgan District Health Department because of septic system failures. These failures are contributing to the environmental degradation of the area by initiating seeps that are emanating from natural slopes and roadcuts. The moratorium prevents the development of new subdivisions or individual lots in existing subdivisions without evidence that the septic systems will not negatively impact soil, ground-water, surface water, or drainage conditions in the district. Site 1 consisted of lots 26 and 29 in Raintree No. 3 Subdivision and site 2 consisted of a proposed subdivision referred to as Ted Holtry No. 1 (attachment 1).

The scope of work for the investigation included a review of existing geologic, hydrologic, and soils information; air photo analysis; and a field reconnaissance including excavation and examination of test pits at each site.

RAINTREE NO. 3 SUBDIVISION

Lots 26 and 29 in the Raintree No. 3 Subdivision are located in the NE 1/4 SE 1/4 sec. 23, T. 5 N., R. 1 W., Salt Lake Baseline and Meridian (attachment 1). The subdivision is located on a topographic high formed by Lake Bonneville deposits. Erosion of sediments subsequent to Lake Bonneville receeding has created the knoll upon which the subdivision is located. Slopes on the site range from less than 2 percent to more than 70 percent. Feth and others (1966) mapped the soils in the subdivision as interbedded silt, clay, and fine sand of the Alpine Formation. Scott and others (1983), however, have reinterpreted Lake Bonneville stratigraphy and conclude that the lacustrine deposits formerly considered Alpine are part of the Bonneville lake cycle. No bedrock is exposed in the subdivision. The regional shallow ground-water table is more than 500 feet beneath the site (Bolke and Waddell, 1972). Perched ground water is present at much shallower depths as evidenced by the numerous springs identified in the area located by Erickson and Wilson (1968).

Lot 26

Lot 26 is located at the southern end of Raintree No. 3 Subdivision. The western half of the lot slopes 45 to 70 percent to the west and is covered by thick scrub oak and grass (attachment 2). The remainder of the lot slopes less than 2 percent to the south and is also partially covered by vegetation. The lot is bordered to the south and east by slopes greater than 40 percent (attachment 2).

One test pit was excavated on lot 26 (attachment 2). The pit was located at the site of a proposed drainfield, which will be designed as a deep trench system. A detailed soil log is presented in attachment 3. The deposits consisted of a topsoil zone underlain by 5.5 feet of poorly graded sand and gravel and 2 feet of fine to medium sand. The sand and gravel zone appears to represent shore-embankment gravels that overlie interbedded sand, silt, and clay that correspond to Feth and others (1968) Alpine Formation at other locations in the subdivision area.

The 5.5 feet of poorly graded GP/SP sands and gravels on lot 26 may be too permeable to meet State percolation rate requirements. The poorly graded sands (SP) in the bottom of the pit may overlie low permeability clays that would impede downward migration of effluent and eventuallly cause seepage out of the steep slopes (35 percent or greater) that are less than 50 feet from the test pit (attachment 4). If the soils are not too permeable, if low permeability silt and clay is not exposed in the deep trench, and if the trench can be constructed so as to be more than 50 feet from steep slopes a system could be placed on this lot.

Lot 29

Lot 29 is located approximately 400 feet north of lot 26 in Raintree No. 3 Subdivision (attachment 2). The lot slopes approximately 15 percent in a north-northeast direction and is vegetated with grass and scrub oak. One test pit was excavated on the lot at the approximate location of a proposed drainfield. The upper 2.5 feet of the soil profile consisted of silty clay. The remainder of the test pit exposed poorly graded sands with interbedded medium plastic clay. The soils at this site appear to consist of interbedded sands, silts, and clays of the Alpine Formation (Feth and others, 1966).

The low-permeability CL clay layers will impede downward migration of wastewater. The resulting lateral flow could eventually seep out of a roadcut bordering the lot to the north. Presently water is seeping out of this cut approximately 150 feet east of lot 26. For these reasons it is not recommended that a septic tank and soil absorption field be developed on this lot.

TED HOLTRY NO. 1 SUBDIVISION

Ted Holtry No. 1 Subdivision is located in the SE 1/4 SE 1/4 sec. 22, T. 5 N., R. 1 W., Salt Lake Baseline and Meridian (attachment 1). This subdivision is on a bench above the flood plain of the Weber River. Soils on site are mapped as Provo Formation gravel by Feth and others (1966). No bedrock is exposed at the site. The regional ground-water table is more than 400 feet below the subdivision; however, perched water is present at shallower depths as evidenced by a spring shown on the topographic map approximately 1 mile southeast of the site (Bolke and Waddell, 1972; attachment 1). The site is mostly level, with less than 5 feet of total relief. Vegetation consists of grass and weeds, with some clusters of scrub oak.

Two test pits were excavated in the subdivision (attachment 5). Test pit 1 exposed poorly graded sand and gravel to the total depth of 9.5 feet (attachment 3). Test pit 2 encountered medium plastic clay to a depth of 5.4 feet (attachment 3). The clay was underlain by a poorly graded sandy gravel to the total depth of 9.5 feet. The upper 0.2 feet of this zone was weakly cemented.

The soils in this subdivision are highly variable. The poorly graded gravel (GP) in test pit 1 is highly permeable and may not meet State percolation rate requirements. Test pit 2 has impermeable clay (CL) underlain by 0.2 feet of cemented gravel. The remainder of soil in the pit were poorly graded gravel (GP) which also may be too permeable . With highly variable and extremely permeable soils in this subdivision, each lot should be investigated individually (including percolation tests) to determine if absorption systems can be successfully installed.

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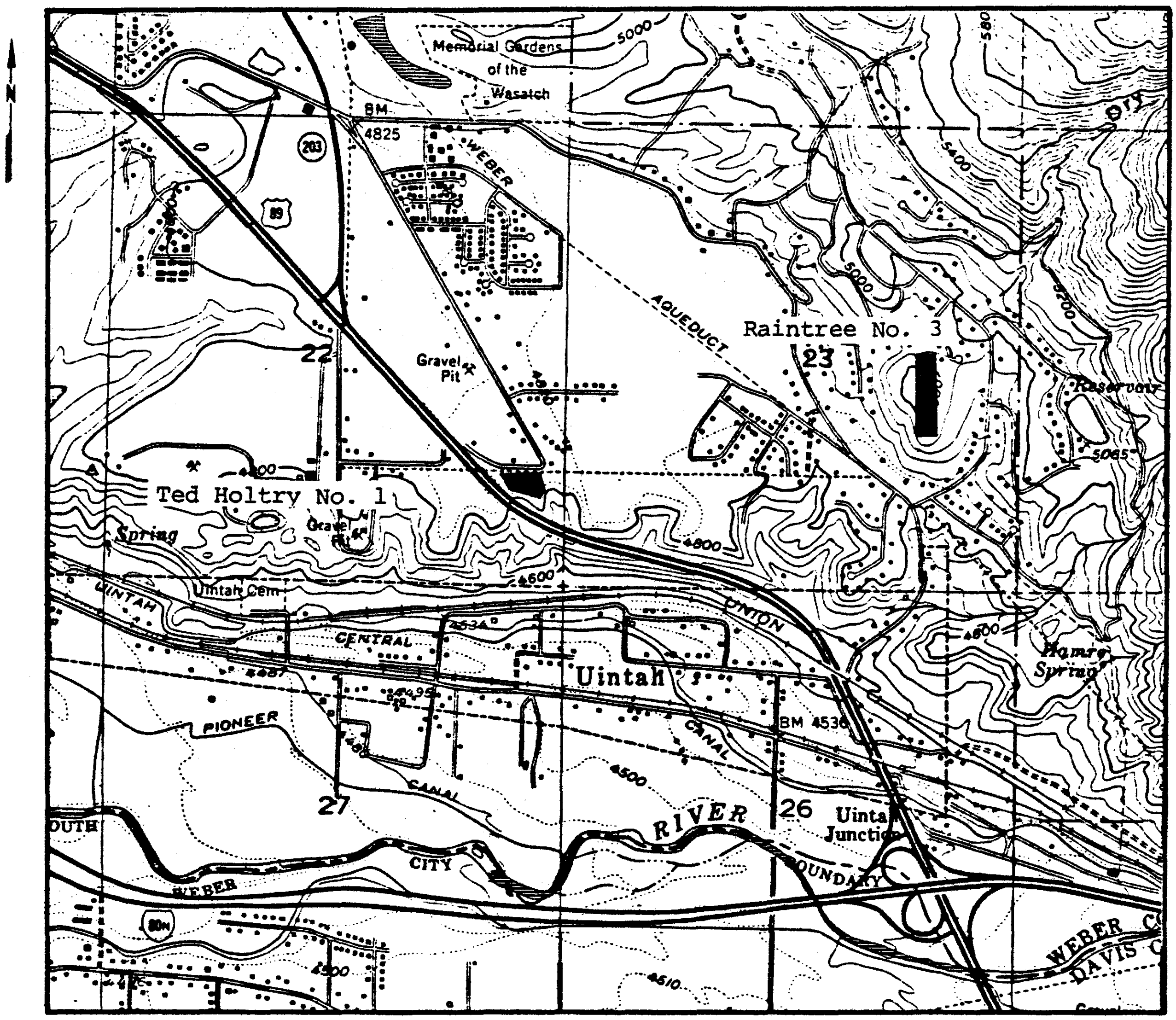
R. 1 W.



T. 5 N.

Base map from: USGS 7½' topographic quadrangle Ogden, Utah.

SCALE 1:24,000

0 ½ 1

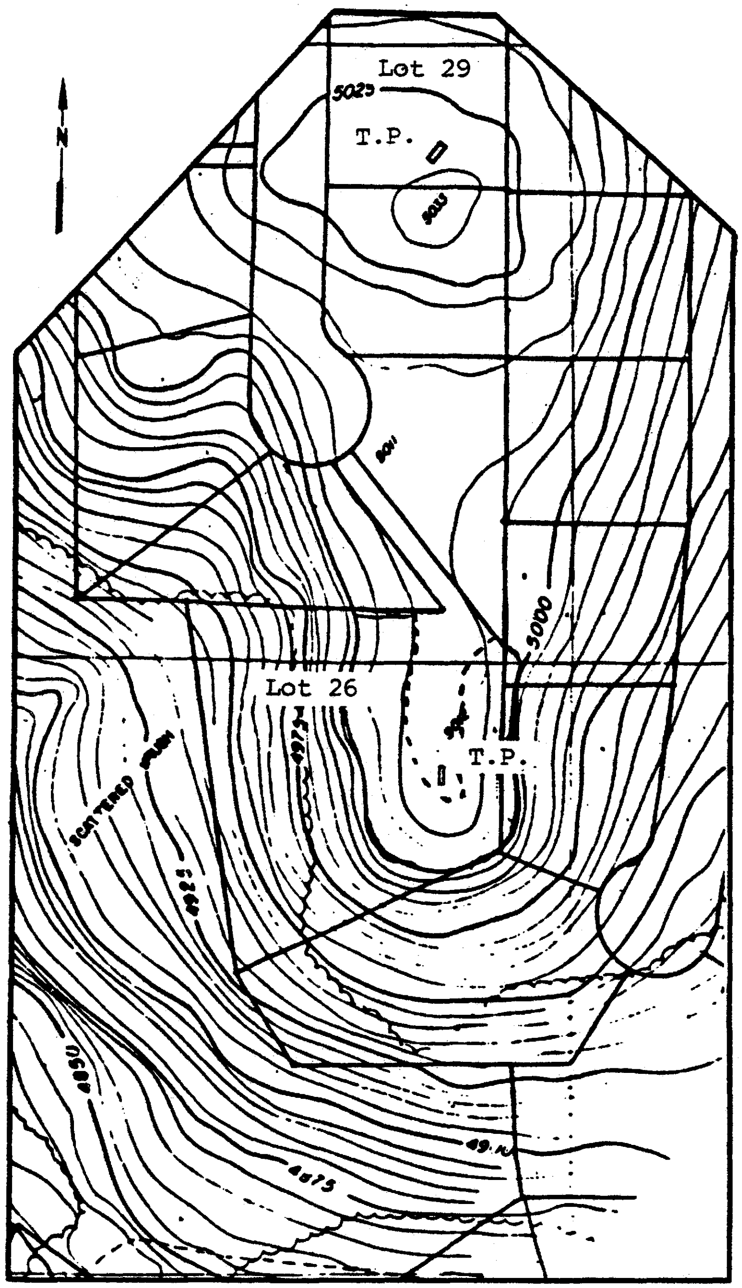
Contour Interval 40 Feet

Dotted lines represent 10-foot contours

Location Map

Utah Geological and Mineral Survey   Site Investigation Section

Attachment 2, Report No. 86-007



Scale

0 100 200 Feet

Contour Interval 5 Feet

Lot and test pit location map
for Raintree No. 3 Subdivision

Attachment 3, Job No. 86-007

Logs of Test Pits for Raintree No. 3 Subdivision *

Test Pit, Lot 26

0.0' - 0.5'	Poorly Graded Silty Sand with Gravel (SM); about 80 percent fine to medium sand; about 10 percent fines with no plasticity; about 10 percent rounded gravel to 1 inch in diameter; gray; moist, homogeneous, loose, no cementation, no reaction with HCL; numerous roots.
0.5' - 1.3'	Poorly Graded Silty Gravelly Sand (SM); about 50 percent fine to medium sand; about 30 percent rounded gravel to 2 inches in diameter; about 20 percent fines with low plasticity; reddish brown, moist, homogeneous, low density, no cementation, no reaction with HCL; numerous roots.
1.3' - 7.0'	Poorly Graded Gravelly Sand or Sandy Gravel with Cobbles (SP/GP); about 40 percent subangular to subrounded medium to coarse sand; about 40 percent subrounded to rounded gravel; about 20 percent subrounded to rounded cobbles to 5 inches in diameter; reddish brown, gravel and cobbles bedded in sand, medium to high density, moist, no cementation, no reaction with HCL; Bonneville lake-shore deposits.
7.0' - 9.0'	Poorly Graded Sand (SP); 100 percent subangular fine to medium sand; brown, moist, homogeneous, low density, no cementation, no reaction with HCL; Bonneville lake-shore deposits.

Note: No ground water encountered.

Test Pit, Lot 29

0.0' - 0.6'	Silty Clay and Clayey Silt (CL/ML); 100 percent fines with low to medium plasticity; gray, moist, homogeneous, very soft, no cementation, weak reaction with HCL; numerous roots.
0.6' - 1.3'	Silty Clay (CL); 100 percent fines with medium plasticity; reddish brown, moist, homogeneous, soft, no cementation, strong reaction with HCL; mottled appearance; numerous roots.
1.3' - 2.5'	Silty Clay (CL); 100 percent fines with medium plasticity; reddish brown, moist, homogeneous, firm, carbonate nodules, strong reaction with HCL; some roots.
2.5' - 3.8'	Coarse sand with 0.1 foot interbedded layers of clay.

	Sand (SP); 100 percent medium to coarse, subangular to subrounded sand; green, moist, homogeneous, medium density, weakly cemented, strong reaction with HCL; some roots.
	Clay (CL); 100 percent fines with medium plasticity; reddish brown, moist, firm, no cementation, strong reaction with HCL; some roots, horizontally bedded.
3.8' - 5.0'	Poorly graded sand (SP); 100 percent fine to medium, subrounded to rounded sand; brown, moist, medium density, no cementation, no reaction with HCL; no roots; horizontally bedded; Lake Bonneville deposits formerly Alpine Formation.
5.0' - 5.5'	Clay (CL); 100 percent fines with medium plasticity; reddish brown, moist, firm, no cementation, no reaction with HCL; no roots; horizontally bedded; Lake Bonneville deposits formerly Alpine Formation.
5.5' - 8.3'	Poorly graded sand (SP); 100 percent fine to medium, subrounded to rounded sand; brown, moist, horizontally stratified, medium density, no cementation, no reaction with HCL; no roots, Lake Bonneville deposits formerly Alpine Formation.
8.3' - 8.5'	Clay (CL); 100 percent fines with medium plasticity; reddish brown, moist, firm, no cementation, no reaction with HCL; no roots; horizontally bedded; Lake Bonneville deposits formerly Alpine Formation.
8.5' - 9.5'	Poorly graded sand (SP); 100 percent fine to medium, subrounded to rounded sand; brown, moist, horizontally stratified, medium density, no cementation, no reaction with HCL; no roots, Lake Bonneville deposits formerly Alpine Formation.

Note: No ground water encountered.

1.3' - 5.4'	Sandy Silty Clay (CL); About 60 percent fines with medium plasticity; about 40 percent fine sand; reddish brown, moist, homogeneous, hard, no cementation, no reaction with HCL; some roots.
5.4' - 9.5'	Poorly Graded Sandy Gravel (GP); About 70 percent rounded gravel to 0.25 feet in diameter; about 30 percent rounded medium to coarse sand; reddish brown to tan, moist, homogeneous, high density, upper 0.2 feet weakly cemented and strong reaction with HCL, remainder noncemented and no reaction with HCL; Bonneville lake shore deposits.

Note: No ground water encountered.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-84, Description and Identification of Soils (Visual Manual Procedure).

Logs of Test Pits for Ted Holtry No. 1 Subdivision

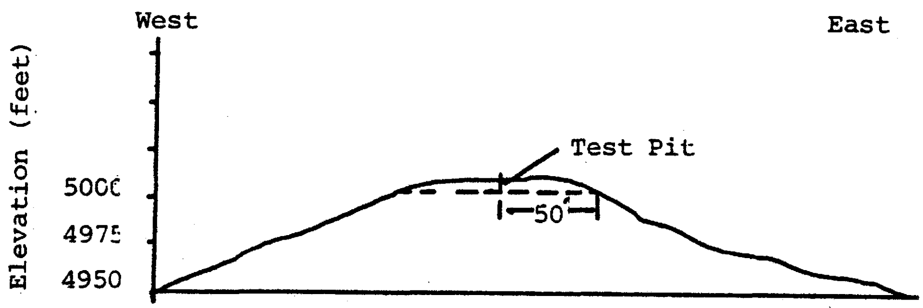
Test Pit 1

0.0' - 0.3'	Poorly Graded Silty Sand with Gravel (SM); About 50 percent rounded medium soil; about 40 percent fines with no plasticity; about 10 percent rounded gravel to 0.1 feet in diameter, dark gray, moist, homogeneous, low to medium density, no cementation, no reaction with HCL; numerous roots; slight organic odor.
0.3' - 1.7'	Poorly Graded Silty Sand with Gravel (SM); About 60 percent rounded medium sand; about 30 percent fines with low plasticity; about 10 percent rounded grvel to 0.1 feet in diameter; reddish brown, moist, homogeneous, medium density, no cementation, no reaction with HCL; roots.
1.7' - 2.9'	Poorly Graded Sandy Cobbley Gravel (GP); About 10 percent rounded gravel; about 30 percent subrounded to rounded medium to coarse sand; about 25 percent rounded cobbles to 0.3 feet in diameter; less than 5 percent fines with no plasticity; reddish brown, moist, bedded, medium density, no cementation, no reaction with HCL; no roots; Bonneville lake shore deposits.
2.9' - 6.2'	Poorly Graded Cobbley Gravel with Sand (GP); About 50 percent rounded gravel; about 30 percent rounded cobbles to 0.3 feet in diameter; about 20 percent subrounded to rounded, medium to coarse sand; tan, moist, stratified, medium to high density, no cementation, no reacton with HCL; possible topset beds.
6.2' - 9.5'	Poorly Graded Sand (SP); About 95 percent subrounded to rounded, medium to coarse sand; less than 5 percent rounded gravel to 0.1 feet in diameter; tan, moist, stratified at 25^{o} west dip, medium density, no cementation, no reaction with HCL; possible forset beds.

Note: No ground water encountered.

Test Pit No. 2

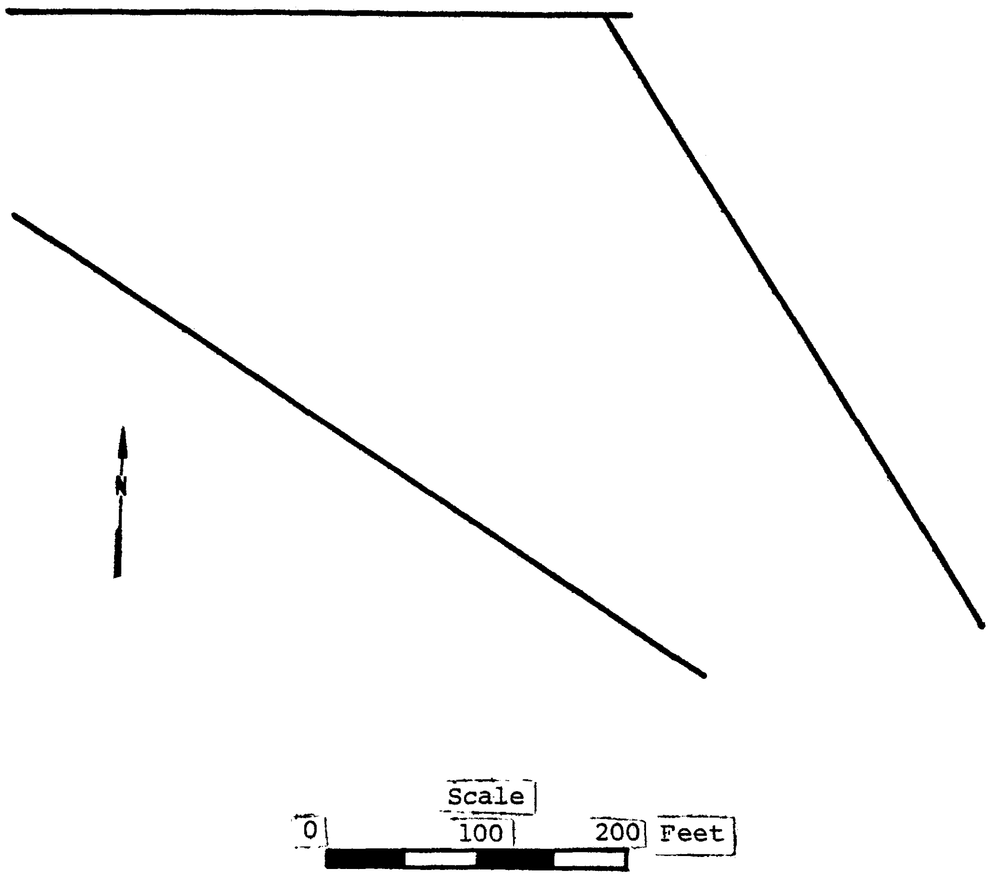
0.0' - 0.4'	Poorly Graded Silty Gravelly Sand or Silty Sandy Gravel (SM/GM); About 40 percent subrounded to rounded medium sand; about 40 percent rounded gravel to 0.2 feet in diameter; about 20 percent fines with no plasticity; dark gray, moist, homogeneous, loose, no cementation, no reaction with HCL; numerous roots.
0.4' - 1.3'	Poorly Graded Sand with Silt and Clay (SM/SC); About 80 percent medium sand; about 20 percent fines with low plasticity; dark brown, moist, homogeneous, firm to hard, no cementation, no reaction with HCL; numerous roots.



Scale 1"=100'
No vertical exaggeration

Profile across Lot 26 showing the horizontal distance from the test pit to the 35 percent or greater slopes.

Attachment 5, Report No. 86-007



Test pit location map for Ted Holtry No. 1 Subdivision (Sketch)

Project:			Requesting Agency:
Pollution potential from a large septic system drainfield, Sundance Ski Resort, Utah County, Utah			Bureau of Water Pollution Control
By: R.H. Klauk	Date: 5/27/86	County: Utah	Job No.: 86-011/WW-2
USGS Quadrangle: Aspen Grove (1128)			

In response to a request from the Bureau of Water Pollution Control, a proposed soil absorption drainfield site at the Sundance Ski Resort was investigated. The septic system is designed to service 50 condominium units to be located on the north side of the North Fork of the Provo River; projected daily wastewater flow is 10,000 gallons. This wastewater is to be pumped from the septic tank to the drainfield site located on a ski hill south of the river. The purpose of the investigation was to determine if geologic conditions exist that would permit the system to pollute the river, or if spring snowmelt could flood the system. The site is located on a ski run in the NW1/4, sec. 14, T. 5 S., R. 3 E., Salt Lake Baseline and Meridian (attachment 1). The scope of work for the investigation included a review of existing geologic information; engineering consultants reports; air photo analysis; and a field reconnaissance that included the excavation and examination of test pits on 5/13/86.

The site is located on a glacial moraine that slopes from 13 to 17 percent to the north and northwest (Baker, 1964). The moraine abruptly terminates at the flood plain of the North Fork of the Provo River 400 to 500 feet from the site. The flood plain extends from 80 to 200 feet to the river at a slope of 8 to 10 percent. The elevation of the drainfield will be 100 to 150 feet above the flood plain. Vegetation on the site consists of weeds and native grasses. No bedrock is exposed in the moraine or flood plain. Depth to ground water is not known; however, a soils investigation conducted in the flood plain did not encounter water to depths of 12.5 feet (Rollins, 1985). This depth is below the elevation of the channel, indicating the river is an influent stream through this area.

Five test pits were excavated between the proposed site of the drainfield and the river (attachment 2). Detailed soil logs are presented in attachment 3. Test pit 4 was excavated adjacent to test pit 3 to determine the extent of perched water found at a depth of 11.0 feet in the first pit. No water was encountered in test pit 4 and no springs or seeps are in the area, indicating the water is very localized probably the result of snowmelt collecting on a less pervious clay lense. Generally, soils exposed in test pits 1 through 4 consisted of topsoil underlain by silty gravels (GM) or sandy clays (CL). Cobbles and boulders are present throughout. Test pit 5, located on the flood plain, encountered unengineered fill to the total depth excavated, 10 feet. The fill was similar to soils in the other test pits.

Soils in test pits 1 through 4 are typical of glacial moraines and as such are highly variable both vertically and horizontally over short distances. These soils are permeable and well drained and of sufficient thickness to provide more than adequate renovation of wastewater. No problems are expected from spring snowmelt; the perched water found in test pit 3 was very localized and more than 300 feet from the drainfield and will not cause the system to fail. Geologic and hydrologic conditions are such that no wastewater will discharge into the North Fork of the Provo River. No conditions were found on the site that would preclude construction of a drainfield.

REFERENCES CITED

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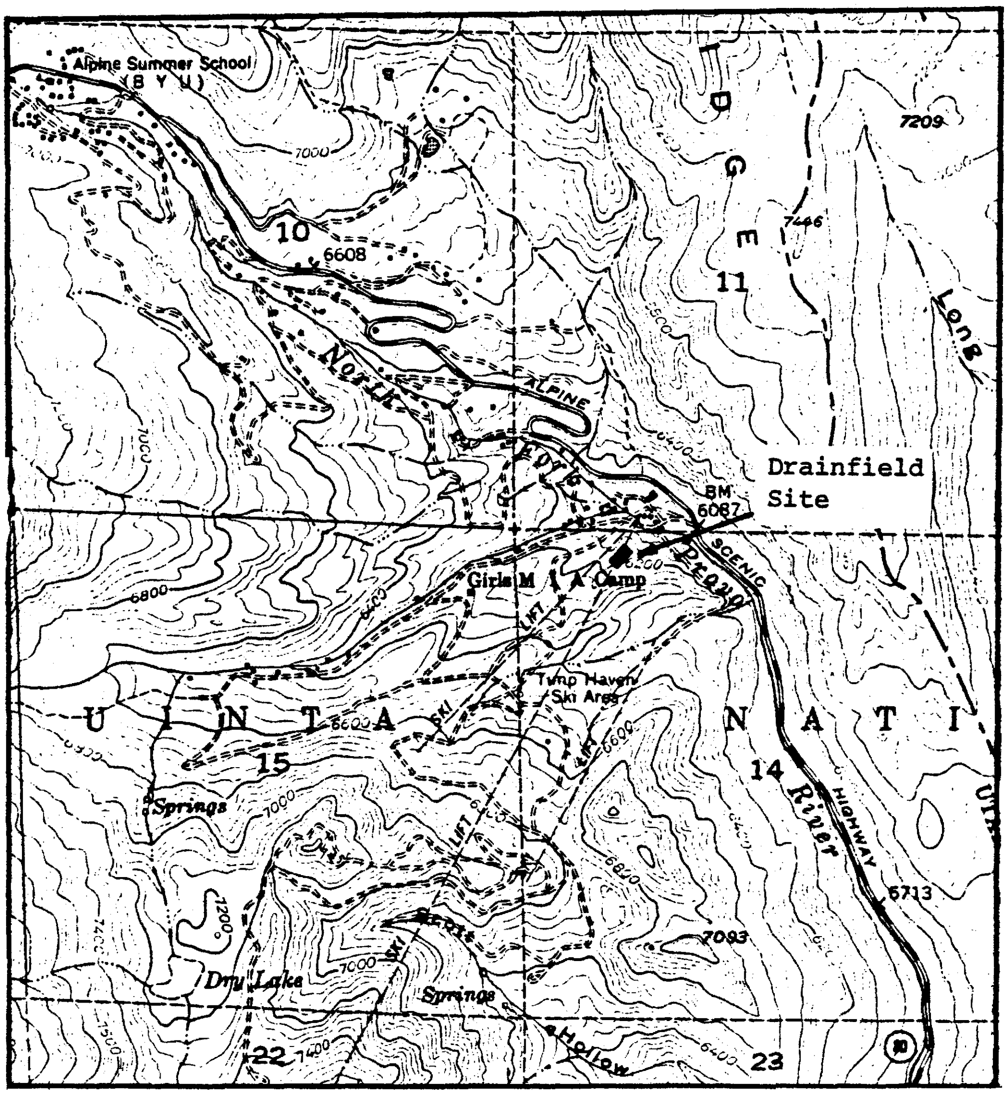
R. 3 E.

T. 5 S.

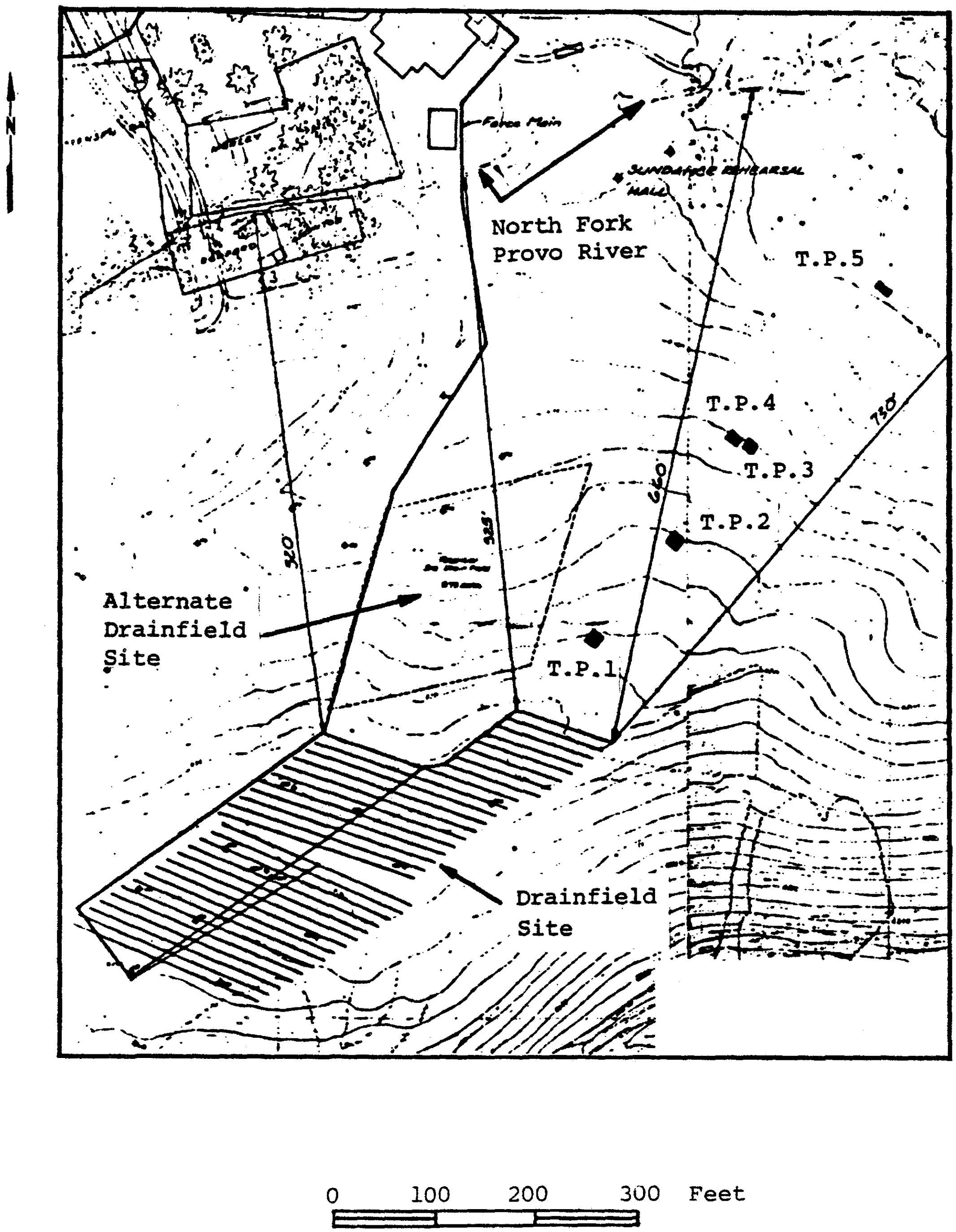


Base map from: U.S.G.S. 7½' topographic quadrangle map

Aspen Grove, Utah.

0 2000 4000 Feet

Location Map



Test Pit Location Map

Logs of Test Pits*

Test Pit 1

0.0' - 1.0'	Fill; silty gravel with sand (GM); light gray, low density, low plasticity, moist; subangular to angular, heterogeneous, no cementation, strong reaction with HCL; cobbles and boulders to 12 inches, numerous small roots; glacial moraine material reworked and graded on ski hill.
1.0' - 2.0'	Silty gravel with sand (GM); dark gray to black, low density, low plasticity, moist; subangular to angular, heterogeneous, no cementation, strong reaction with HCL, cobbles to 5 inches, numerous roots; soil formed on glacial moraine.
2.0' - 11.0'	Sandy lean clay (CL); brownish gray, firm, medium plasticity, moist; subangular to angular, heterogeneous, no cementation, no reaction with HCL below 2.5 feet in depth, cobbles and boulders to 18 inches, sparse roots; predominantly limestone and sandstone clasts; glacial moraine.

No ground water encountered.

Test Pit 2

0.0' - 1.0'	Clayey sand with gravel (SC); brownish gray, low density, low to medium plasticity, moist; subangular to angular, heterogeneous, no cementation, strong reaction with HCL, cobbles and boulders to 12 inches, numerous small roots; soil formed on glacial moraine.
1.0' - 11.0'	Silty gravel with sand (GM); light gray to brownish gray, medium density, low plasticity, moist; subangular to angular, heterogeneous, no cementation, strong reaction with HCL, cobbles and boulders to 30 inches, predominantly limestone and sandstone clasts; glacial moraine.

No ground water encountered.

Test Pit 3

0.0' - 11.0'	Located within 6 feet of test pit 4, material of similar composition. However, ground water was present at 11.0 feet.

Test Pit 4

0.0' - 1.0'	Silty gravel with sand (GM); dark gray, low density, low plasticity, moist; subangular to angular, heterogeneous, no cementation, strong reaction with HCL, cobbles and boulders to 12 inches, weathered limestone and sandstone clasts, numerous roots; soil formed on glacial moraine.
1.0' - 11.0'	Silty gravel with sand (GM); brownish gray, medium density, low plasticity, moist; subangular to angular, homogeneous, no cementation, strong reaction with HCL, cobbles and boulders to 36 inches, limestone, sandstone, and quartzite clasts, large boulders at 11 foot depth precluded excavating further; glacial moraine.
	No ground water encountered.

Test Pit 5

0.0' - 10.0'	Fill; due to caving it was not possible to log this test pit. However, examination of the bucket material indicate on-site soils obtained from the glacial moraine were used. There was some wood and trash in the fill.
	No ground water encountered.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-84, Description and Identification of Soils (Visual Manual Procedure).

Project:			Requesting Agency:
Experimental Wastewater Disposal System			Utah Bureau of Sanitation
By: R.H. Klauk	Date: 6/27/86	County: Wasatch	Job No.: 86-014/WW-3
USGS Quadrangle: Charleston, Utah (1127)			

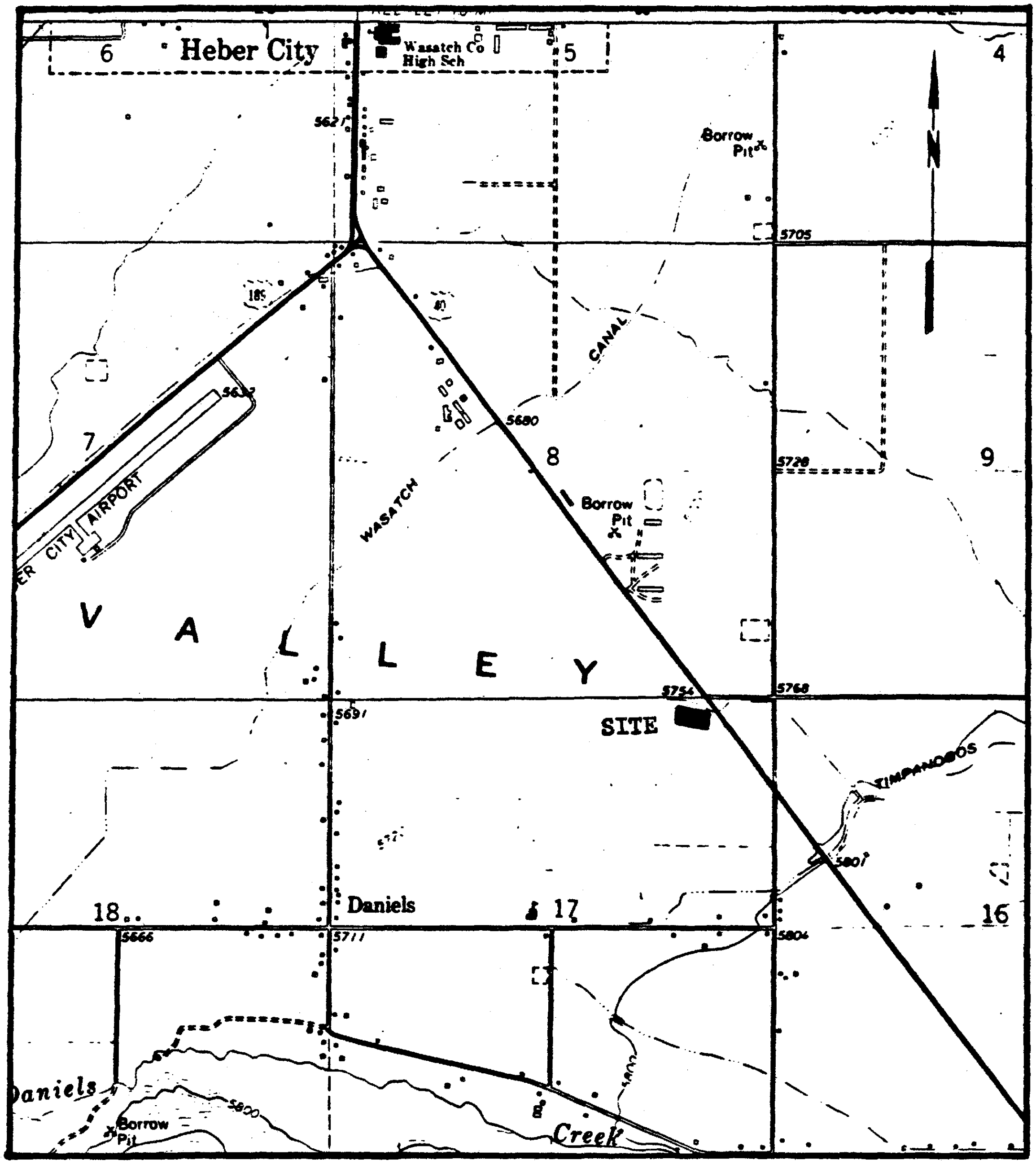
At the request of Steven J. Thiriot, Utah Division of Environmental Health (Bureau of General Sanitation) an examination was made of the site proposed for an experimental wastewater disposal system designed by the U.S. Bureau of Reclamation for a U.S. Forest Service ranger station. The site is located in the NE 1/4, NE 1/4 sec. 17, T. 4 S., R. 5 E., Salt Lake Baseline and Meridian, Wasatch County, Utah (attachment 1). The drainfield site is to be excavated to a depth of 8 feet and backfilled with soils classified under the Unified Classification System as SP, SW, SM, or GM. The drain lines are to be placed 2 feet below grade, leaving 6 feet of compacted soil below the drain lines.

Soils on the site consist of 18 inches of topsoil underlain by poorly graded gravel and sand with more than 50 percent boulders and cobbles (attachment 2). Soils were not exposed below a depth of 4 feet.

The large percentage of cobbles and boulders in the soils would be difficult to compact to achieve the permeabilities required for the drainfield. Furthermore, the guidelines presented in the contract for the fill are too vague to allow the necessary control to insure that adequate soils are used. It was determined by the Bureau of Reclamation at the time of this investigation that a new contract regarding only the experimental disposal system with stricter guidelines for the backfill needs to be written. The new contract will be written by the Bureau of Reclamation with approval by the Utah Department of Health.

Attachment No. 1, Report No. 86-014

R. 5 E.



T. 4 S.

Base map from: U.S.G.S. 7 1/2' topographic map Charleston, Utah.

Scale

0 4000 Feet

Contour Interval 40 Feet

SITE MAP

Log of Excavation*

0.0' - 1.5' <u>Gravelly silt with sand (ML)</u>; gray, medium density, low plasticity, dry; subrounded to rounded, heterogeneous, no cementation, weak reaction to HCL, cobbles to 4 inches, numerous roots; soil formed on alluvium.

1.5' - 4.0' <u>Gravelly sand - sandy gravel (SP/GP)</u>; reddish brown, medium to high density, no plasticity, moist; subrounded to rounded, heterogeneous, no cementation, no reaction to HCL, boulders to 24 inches; alluvium.

No ground water encountered.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-84, Description and Identification of Soils (Visual Manual Procedure).

Project: Kanab Creek Ranchos Expansion Individual Wastewater Disposal System Investigation, Kane County, Utah			Requesting Agency: Southwest Utah District Health Department
By: H. Gill	Date: 7/2/86	County: Kane	Job No.: 86-015/WW-4
USGS Quadrangle: Kanab (29)			

PURPOSE AND SCOPE

In response to a request from Donald J. Wudarski, Southwest Utah District Health Department, The Utah Geological and Mineral Survey (UGMS) performed a geologic investigation of a proposed extension to the Kanab Creek Ranchos Subdivision southeast of Kanab in the N1/2, NE1/4, sec. 6, T. 44 S., R. 6 W., Salt Lake Baseline and Meridian, Kane County, Utah. The purpose of the investigation was to determine if topographic and geologic conditions are suitable for installation of individual wastewater disposal systems in the subdivision.

The scope of the investigation included a review of available geologic and soils information, a field reconnaissance, and logging of a road cut and 4 test pits. The test pits ranged in depth from 5.5 to 10.0 feet. In addition, a geologic hazards evaluation was made for each proposed lot. Mr Wudarski was present during the investigation, which was performed on May 12 and 13, 1986.

SETTING

The site, consisting of 17 proposed lots, is approximately 2 miles southwest of Kanab, Utah, at the base of the Vermillion Cliffs (attachment 1). A graded road to a metal water tank at the western property boundary divides the site in half. Maximum topographic relief across the property is in an east-west direction and amounts to 150 feet over a distance of slightly less than one third mile, producing an average slope of 5 degrees to the east. A large ephemeral stream drainage (approximately 60 to 65 feet deep and in places more than 100 feet wide) trends northwest to southeast across the eastern end of the property (attachment 2). Five smaller tributaries (some as deep as 30 feet) cross the site from west to east. Most of the lots are dissected by one or more of these drainages, leaving only small ridges between drainages for placement of structures and drainfields. Vegetation is sparse and consists predominantly of sagebrush and juniper trees. Currently the land is used for recreation such as hiking and horseback riding.

GEOLOGY, SEISMICITY, AND SOILS

The site is located on a pediment surface formed on the Upper Triassic Petrified Forest Member of the Chinle Formation. The Petrified Forest Member consists of variegated light-gray, grayish-red, and purple claystone, clayey siltstone, clayey sandstone, and sandstone. Bentonitic clays possessing high shrink-swell potential are common in this formation. Outcrops of red and white siltstone and sandstone were observed on several lots. No evidence of slope instability was noted on site.

Three faults have been mapped in the near vicinity of the site. Sargent and Philpott (USGS unpublished data) mapped these faults as striking in a northwest-southeast direction and terminating at the northwestern end of the property (attachment 2). Evidence observed on site (tilted bedrock) indicates one or more of the faults may extend onto the property. There is no evidence of displaced bedding younger than the Jurassic Lambs Point Tongue of the Navajo Sandstone (Hintze, 1985). While Kanab is not located in what is normally considered a seismically active area, there have been three earthquakes of Richter magnitude 4 or greater recorded since settlement. The largest occurred in December 1887 and had an estimated Richter magnitude of 5.7 (Arabasz, Smith, and Richens, 1979)

The soils overlying bedrock on the site were well exposed in road cuts, drainages, and in the four test pits. Detailed logs of a roadcut and the four test pits are presented in attachment 3. Test pit 1, near the western boundary of the property (lot 528, attachment 2), contains red-brown silty sand with an increasing percentage of clay at depth. Test pit 2, excavated near the western property line (lot 523) , exposed silt to its total depth, with late stage II caliche development from 2.5 to 6.0 feet. Test pit 3, was near the center of the site (lot 531) and contained red-brown silty sand to its total depth with late stage II/early stage III caliche development from 2.5 to 6.5 feet. Test pit 4 was in a stream channel near the eastern property boundary (lot 518) and contained interbedded sand and silty sand lenses to 4.0 feet and red-brown lean clay from there to the bottom of the excavation. The soils observed in the road cut (adjacent to lot 532) were typical of the red-brown silty sands and lean clays previously observed in the test pits.

HYDROLOGY

There was no evidence of ground water in any of the excavations on site. Soils in test pit 4, which was in a stream channel (attachment 2), were moist, indicating the possible presence of a perched water table along the drainage or recent precipitation. A perched water table is reported to exist at an elevation corresponding roughly with the water level in Kanab Creek, approximately 4760 feet (Lund, 1979). This is approximately 230 feet below the lowest elevation at the site. The quality of this shallow aquifer is very poor. Two wells located in the Kanab Creek Ranchos subdivision were drilled into the Shinarump Conglomerate, the next rock unit stratigraphically below the Petrified Forest Member. The wells were 375 and 450 feet deep and encountered water at 342 and 380 feet. Suspended solids in the water were too high to permit its use for culinary purposes without treatment.

GEOTECHNICAL CONSIDERATIONS

Flooding and Erosion Potential

The ephemeral streams on site flow only in response to snowmelt or heavy rains that sometimes accompany summer thunderstorms. Flash floods are common in this part of the state and the deeply incised channels observed on site indicate large volumes of water periodically flow across the property. Flooding of septic tank drainfields installed in these drainages is probable. Because of the deeply incised stream channels most lots will require extensive grading and filling prior to installation of drainfields. Lateral erosion of near vertical walls along the drainages may result in locally significant channel variations that could encroach on septic tank drainfields installed in backfilled areas. Therefore, an appropriate setback distance for drainfields near stream channels should be established. Lots that could be affected by flooding and erosion include 518 through 526 on the north half of the property and 530 through 534 on the south.

Impermeable Horizons

Bentonitic clay, found throughout the Petrified Forest Member, is known for its high shrink/swell potential. Clay lenses were observed in test pits and stream banks on site and can be found on all lots at variable depths. Once saturated, these lenses may swell and completely plug the soil horizon resulting in a perched ground-water condition and failure of the drainfield. Caliche (late stage II/early stage III) was sufficiently developed to form an impermeable horizon on several of the lots, and it is probable that comparable caliche development is widespread across the property. Caliche development was observed in test pits on lots 523 and 531, and in road cuts and drainages on lots 519, 520, 521, and 532. A perched water table may form above these horizons, possibly resulting in failure of soil absorption systems. Shallow bedrock was observed on a number of lots (520 through 522, 524 through 527, and 530). Impervious bedrock may also result in perched ground-water conditions and eventually failure of drainfields. Tilted bedrock (possible fault blocks) dipping from 50 to 81 degrees to the north and northeast were observed on lots 524 and 530 (attachment 2). Effluent can migrate along joints in the tilted bedding plane to depth, although it is unlikely the effluent will reach a major culinary aquifer. In addition, effluent may migrate laterally along any of the impermeable horizons indicated above and eventually daylight on nearby slopes.

Ground-Water Contamination

The potential for contamination of ground water at this site is very low. The unconfined aquifer beneath Kanab Creek is approximately 230 feet below the site and considering the soils and bedrock conditions at the site, it is unlikely effluent would percolate to that depth. In addition, indications are that the water in this perched zone is of very poor quality and is not being put to beneficial use at this time (Lund, 1979).

SUITABILITY FOR SEPTIC TANK DRAINFIELDS

Soil and geologic considerations at the site present severe limitations for the use of soil absorption systems. Limitations are primarily related to impermeable conditions resulting from swelling clays, caliche plugged soil profiles, and shallow bedrock. In addition, flooding and erosion potential are high on most of the proposed lots. Because of these adverse conditions it is very likely that many of the lots will be unacceptable for drainfields. Only two lots, 528 and 529, appear to be without major restrictions, however, a single test pit on lot 528, is not ufficient to determine acceptability. Prior to installation of soil absorption systems, site specific evaluations, including soil investigations and percolation tests, should be undertaken for all lots.

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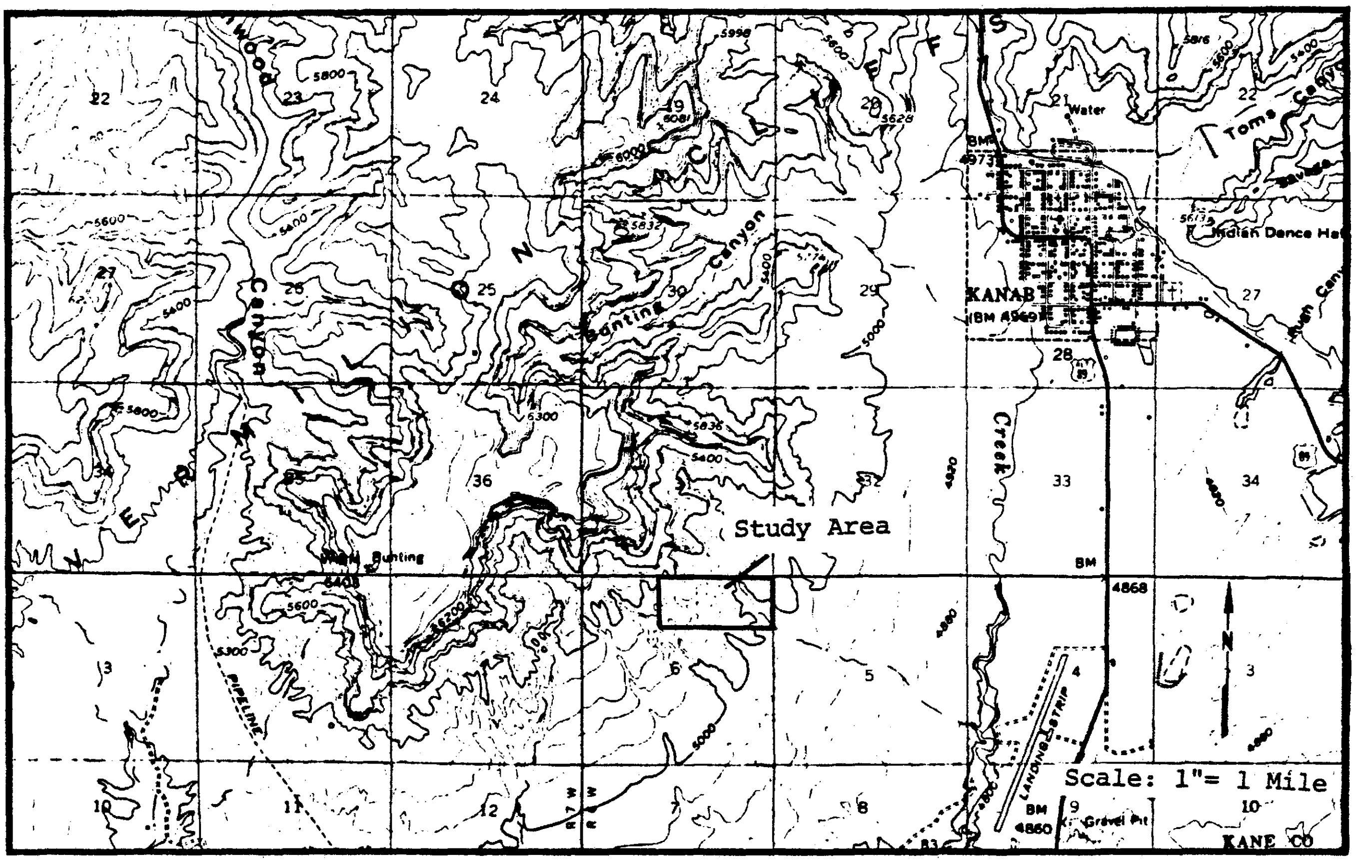
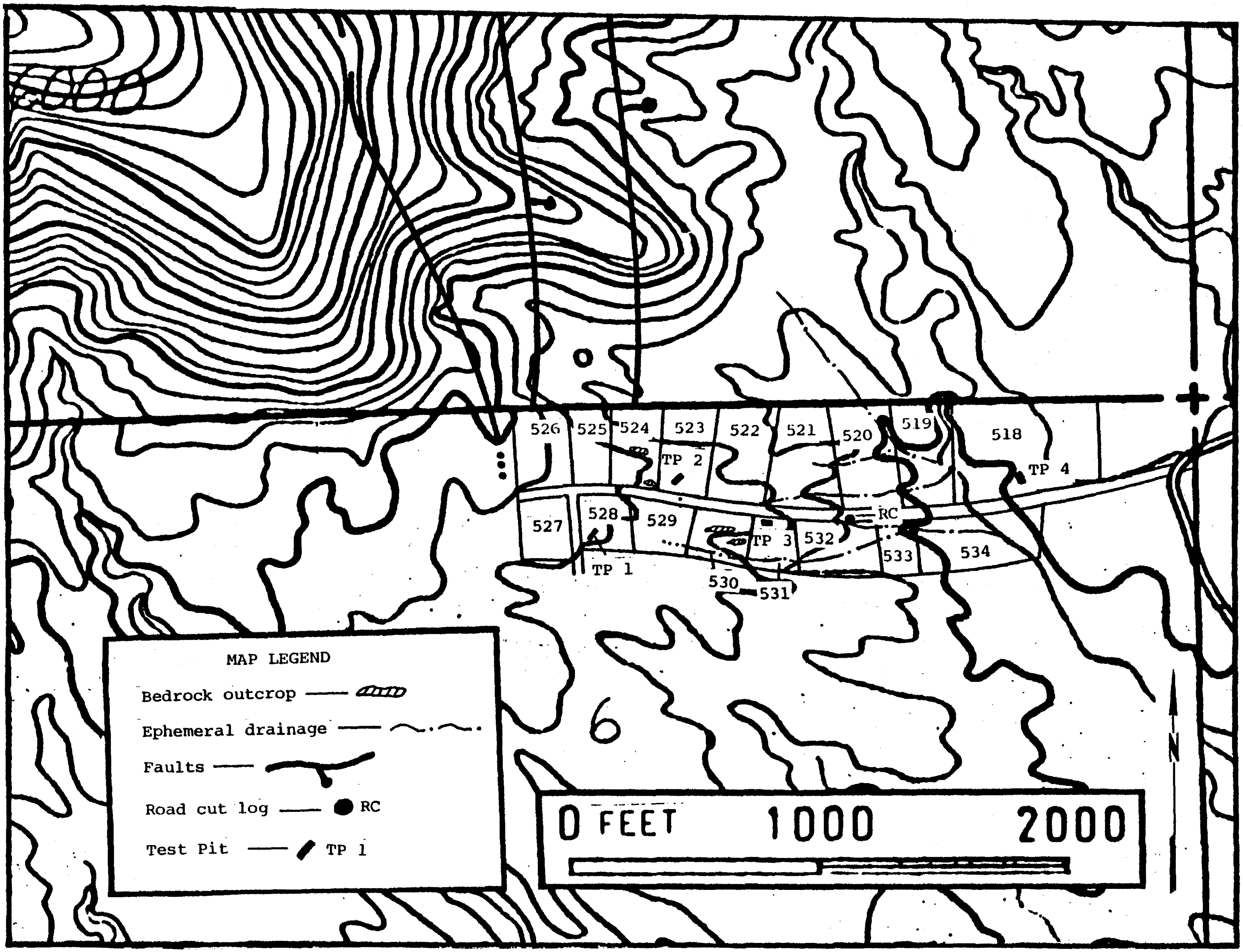
Attachment 1, Job no. 86-015



General location map Kanab Creek Ranchos expansion.



Site plan for Kanab Creek Ranchos expansion.

TEST PIT LOGS*
KANAB CREEK RANCHOS EXPANSION
N1/2, NE1/4, SEC. 6, T. 44 S., R. 6 W., SALT LAKE BASELINE AND MERIDIAN, KANE COUNTY, UTAH

Test Pit 1

0.0' - 2.0'	Silty sand (SM); topsoil, red-brown, low density, none to low plasticity, weakly cemented, dry; 60 percent sand, clay content higher due to soil development.
2.0' - 5.5'	Silty sand (SM); red-brown, medium density, none to low plasticity, weakly cemented, dry; 60 percent fine sand, clay content increases with depth.
5.5' - 10.0'	Clayey sand (SC); red-brown, medium density, none to low plasticity, weakly cemented, dry; 60 percent fine sand, trace of boulders, maximum particle size 14 inches.

Test Pit 2

0.0' - 6.0'	Silt (ML); brown, hard to very hard, low plasticity, strongly cemented, dry; consistency increases toward bottom of test pit. Late stage II caliche development from 2.5 to 6.0 feet.

Test Pit 3

0.0' - 2.5'	Silty sand (SM); topsoil, red-brown, low density, nonplastic, noncemented, dry; 60 percent sand.
2.5' - 6.6'	Silty sand (SM); red-brown, high density, nonplastic, strongly cemented, dry; early stage III caliche development from 2.5 to 6.6 feet, very dense from 5.6 to 6.6 feet, 60 percent sand, trace of boulders, maximum particle size 14 inches.

Test Pit 4

0.0' - 2.0'	Silty sand (SM); topsoil, brown, low density, low plasticity, moist; 65 percent medium sand, 35 percent fines, top 1 foot lower percentage of fines, numerous thin sand and clay lenses.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-84, Standard Practice for Description and Indentification of Soils (Visual Manual Procedure).

2.0' - 4.0'	Silty sand (SM); light gray, low density, low plasticity, noncemented, moist; 60 percent fine sand, 40 percent fines, interbedded sand and clay lenses.
4.0' - 8.0'	Lean clay (CL); red-brown, hard to very hard, medium plasticity, noncemented, moist; 20 percent sand, 80 percent fines, last 6 inches are hard with minor interbedded sands.

Road_Cut

0.0' - 2.5'	Silty sand (SM); red brown, low density, nonplastic, noncemented, dry; 30 percent fines.
2.5'- 9.5'	Lean clay (CL); red-brown, hard to very hard, medium plasticity, strongly cemented, dry; late stage II/early stage III caliche development from 2.5 to 6.5 feet and stage 1 caliche from 6.5 to 9.5 feet.

Project: Wallsburg Estates Subdivision			Requesting Agency: Wasatch County Health
By: Hal Gill	Date: 1-22-87	County: Wasatch	Job No.: 86-025/WW-5
USGS Quadrangle: Wallsburg Estates (1086)			

PURPOSE AND SCOPE

In response to a request from Phillip Wright, Wasatch County Health Department, the Utah Geological and Mineral Survey made a geologic inspection of the proposed site for Wallsburg Estates Subdivision in Wasatch County, Utah. The subdivision is in T.5 S., R. 5 E., sections 20 and 21, Salt Lake Baseline and Meridian (attachment 1). The purpose of the inspection (conducted on October 27, 1986) was to evaluate the geologic suitability of the site for individual wastewater soil absorption systems. In addition to the site reconnaissance, the scope of the investigation included a review of available geologic and soils information and logging of nine soil test pits.

SETTING

The subdivision is near the southern end of Round Valley, about two miles southeast of Wallsburg, Utah (attachment 1). It is located at the base of a gentle slope (approximately 7 percent to the west-northwest) formed by several coalescing alluvial fans. A single test pit was excavated on each of 9 plots, which contain from 1 to 4 lots, each lot ranging in size from 5.0 to 6.5 acres (attachment 2). Utah State Highway 222 crosses the western end of the property and separates plots 1 and 2 from the remainder of the subdivision. Maple and Main Creeks flow through the center of Round Valley approximately 600 and 1000 feet respectively, west of the study area (attachment 1). Two intermittent streams occur on the eastern portion of the property. The northern drainage runs through the center of plot 7 and the southern drainage runs through plots 4, 6, and 9 (attachment 2).

GEOLOGY AND SOILS

With the exception of plots 1 and 2, the entire subdivision is situated on a debris covered plain consisting of Quaternary outwash material. The debris, comprised chiefly of light-gray to red quartzite, has been derived from the Wallsburg Ridge Member of the Upper Pennsylvanian Oquirrh Formation (Baker, 1976). Plots 1 and 2 are underlain by Holocene valley fill, primarily consisting of overbank deposits from Main and Maple Creeks (attachment 2).

Soils on site are chiefly lean clays with interbedded horizons of silty sand (attachment 3). The U.S.D.A. Soil Conservation Service (SCS) soil survey of the Heber Valley area (Woodward and others, 1976) indicates that the lean clays exhibit slow to moderate permeability and a low to high shrink/swell potential. Test pit inspections showed the lean clays (CL) to be low to moderately plastic and have a firm to hard consistency. Border line lean/fat clays (CL/CH) in test pits 6 and 8 were highly plastic and had a hard consistency. The silty sand horizons (SM) observed in test pits 1, 2, 4, and 7 were approximately 4 to 7 feet thick and exhibited a low to medium density. Soils in test pits 3 through 7 showed a moderate degree of calcium carbonate cementation, affecting both the clay and silty sand units (attachment 3). The calcium carbonate appears to be associated with shallow ground water rather than having a pedogenic origin.

HYDROLOGY

Maple and Main Creeks are approximately 1000 and 1400 feet respectively, east and downslope from test pit 1. It is probable that a shallow water table exists along these two creeks (approximate elevation 5900 feet above sea level). Water was observed in test pit 1 on October 11, 1986, at 6.7 feet below the ground surface (P. Wright, oral commun., 1986). This is about 60 feet higher in elevation than the two creeks. During the site inspection standing water was not observed in test pit 1 although the bottom of the pit was wet. There is a small unlined irrigation ditch (not appearing on published maps of the area) that runs immediately north (within 10 feet) of test pit 1. It is the probable source of shallow ground water at this location. Boren Ditch is a large unlined irrigation canal crossing the eastern portion of the property (attachment 2), it was carrying water at the time of the inspection. However, no ground water was observed in the test pits at this end of the property. In addition, no water was observed in either of the two intermittent drainages that cross the site.

SUITABILITY FOR SOIL ABSORPTION SYSTEMS

According to the SCS soil survey, the slow to moderate permeability of the soils at the subdivision presents severe limitations for wastewater soil absorption systems (Woodward and others, 1976). The slow permeability was confirmed by percolation tests run at the site prior to the UGMS inspection (P. Wright, oral commun., 1986). The percolation tests showed that most of the site soils were only marginally acceptable and some failed to meet the State's required percolation rate of 60 minutes per inch (P. Wright, oral commun., 1986). The SCS data also indicated that the clay soils in test pits 5, 8, and 9 have moderate to high shrink/swell potential. Mr. Wright stated that the percolation tests were run without the normal 16 hour saturation time required for fine-grained soils. Therefore, there is a strong possibility that if correct procedures had been followed more of the percolation tests would have failed due to swelling of the clay. Once absorption systems are installed and the soils are saturated by sewage effluent, swelling of the soils could further reduce their permeability and create localized perched ground-water conditions around the drainfields eventually causing them to fail. Soil in test pits 3 through 7 were found to have a low to moderate degree of carbonate cementation (stage 1). This level of carbonate cementation normally is not significant, but it can have an affect in already low permeability clays. The carbonate occupies the intergranular spaces between soil particles and further reduces permeability. Test pits 1, 2, 4, and 7 contained silty sand lenses at varying depths that appear suitable for drainfield. installation (attachment 3). Following the UGMS site reconnaissance, a second series of percolation tests were run, this time allowing for the 16 hour saturation period. A zone on either side of the drainage running through plot 6 was found to be unacceptable. However, acceptable percolation rates were obtained at different locations around the property. This indicates that soils suitable for wastewater soil absorption systems (probably the silty sand lenses observed in some test pits) can be found on the property, however, they are not continuous across the site.

During the UGMS inspection, shallow ground water was not observed in test pits close to the Boren Ditch (test pits 5, 6, and 7). However, the test pits were a considerable distance (300, 350, and 750 feet respectively) west of the ditch. Absorption systems installed close to the unlined canal (primarily west and downgradient) may encounter shallow ground-water problems.

SUMMARY

The majority of soils observed on site were lean clays possessing moderate to slow permeability and low to high shrink/swell potential. Such soils are normally not suitable for the installation of wastewater soil absorption systems. The first series of percolation tests conducted at the site confirmed that observation, either by failing to meet or only marginally achieving the maximum allowed percolation rate. There were some coarse-grained soils (silty sands) observed during the UGMS inspection that appeared suitable. Additional tests produced percolation rates within accepted limits, indicating that suitable soils (probably the silty sands) can be found on the property. For the wastewater soil absorption system to function properly it may have to be very large. The size of the subdivision lots on the property (5 acres or greater) will allow for this contingency. The UGMS examined only one test pit on each of 9 plots and there are up to 4 lots on one plot. Therefore, the UGMS recommends soil suitability and volume should be carefully evaluated on a lot by lot basis. In addition to soil permeability, the presence of high ground water near the irrigation ditches must be considered in siting disposal systems.

Selected References

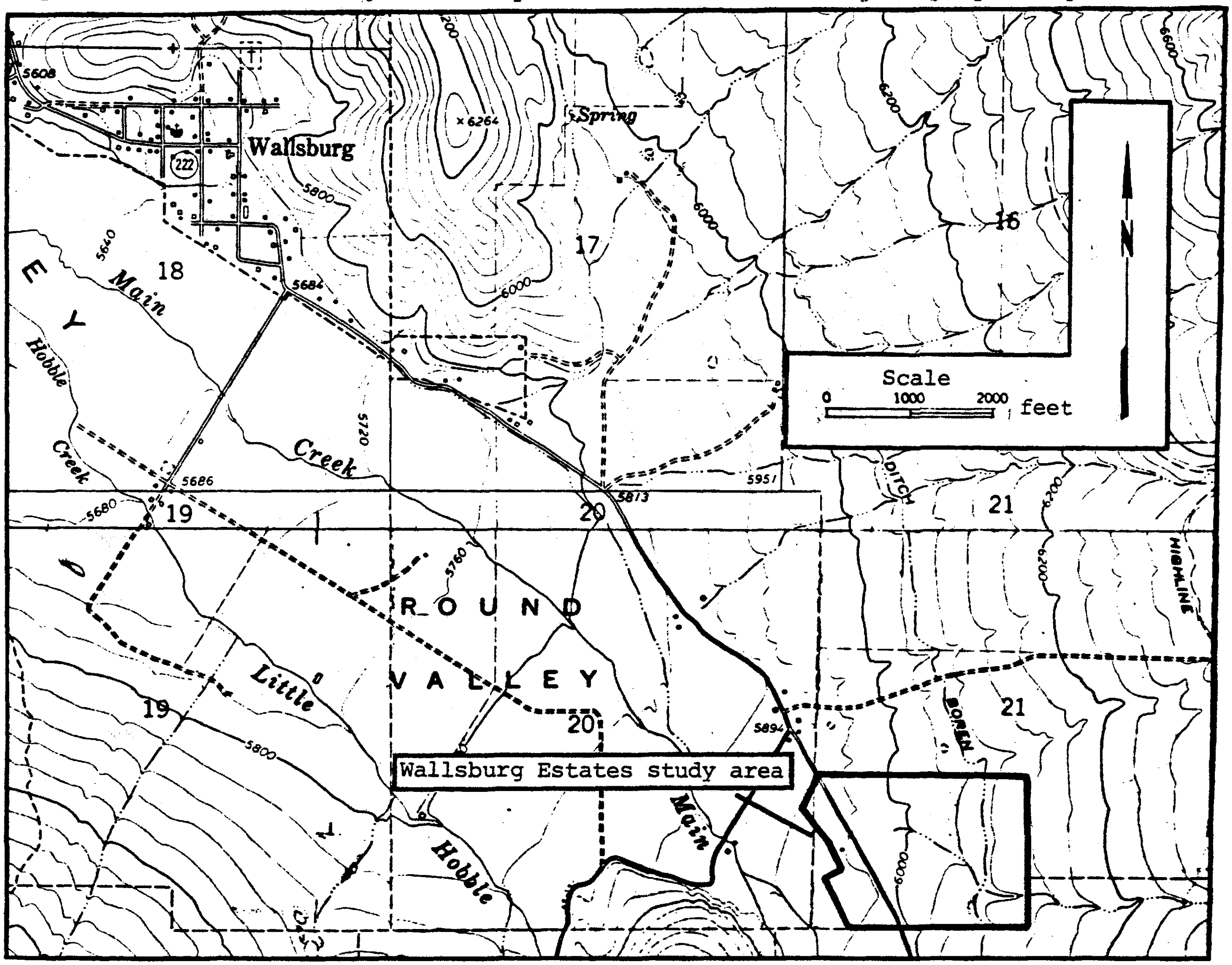
Baker, A. A., 1976, Geologic map of the west half of the Strawberry Valley Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-931, scale 1:63,360.

Mabbutt, J. A., 1977, Desert landforms: Cambridge, Massachusetts, The MIT Press, 340 p.

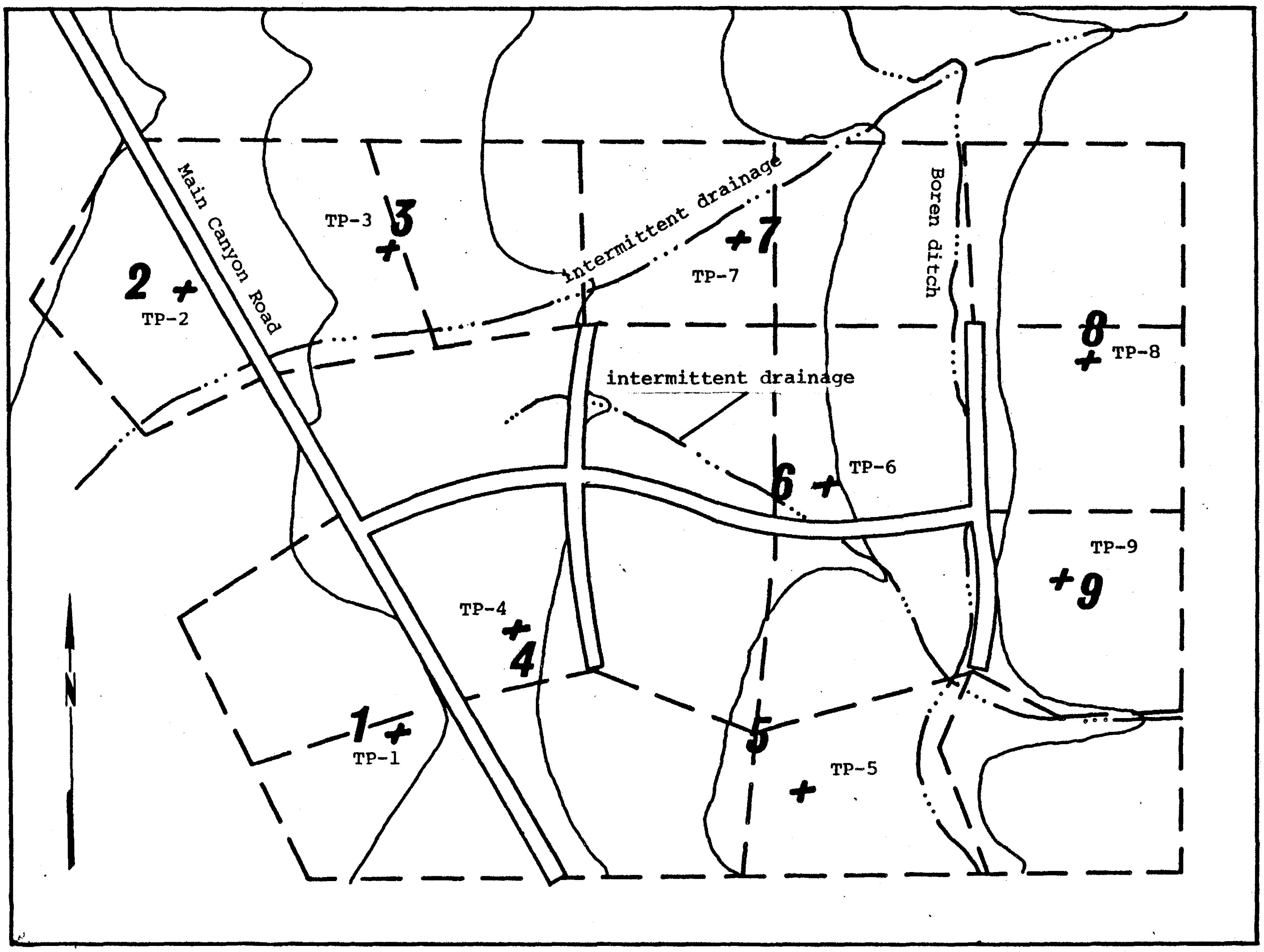
Woodward, Lowell, Jensen, D. H., and Harvey, J. L., 1976, Soil survey of the Heber Valley area, Utah, parts of

Wasatch and Utah Counties: U.S.D.A. Soil Conservation Service and Forest Service in cooperation with Utah Agricultural Experiment Station, 124 p.

Map taken form U.S. Geological Survey Charleston and Wallsburg Ridge quadrangles, Utah.



General location map Wallsburg Estates.



Plot map of Wallsburg Estates Subdivision.

Attachment 3, Job No. 86-025

Test Pit Logs*
Wallsburg Estates

<u>Test Pit 1</u>

0.0' - 2.0' Lean clay (CL); topsoil, dark brown, firm, medium plasticity, moist, noncemented, no reaction to HCL.

2.0' - 6.0' Lean clay (CL); brown, hard, medium plasticity, moist, noncemented, no to reaction to HCL.

6.0' - 7.9' Silty sand with clay and gravel (SM); brown, medium density, low plasticity, saturated, weakly cemented, strong reaction to HCL; 30 percent fines, 15 percent gravel.

Note: SCS data indicates that lean clays at this location have a low shrink/swell potential and moderate permeability. Pit depth limited by shallow ground water; water level appeared to be just below bottom of trench. Water level measured by P. Wright at 6.7 feet on October 11, 1986.

<u>Test Pit 2</u>

0.0' - 2.2' Lean clay (CL); topsoil, dark brown, soft, medium plasticity, moist, noncemented, no reaction to HCL.

2.2' - 7.9' Silty sand with clay and gravel (SM); brown, medium density, low plasticity, dry, weak cementation, strong reaction to HCL; 30 percent fines, 15 percent gravel, early stage 1 caliche development.

7.9' - 9.0' Silty sand (SM); brown, low density, low to no plasticity, moist, noncemented, weak reaction to HCL.

Note: SCS data indicates that lean clays at this location have a low shrink/swell potential and moderate permeability.

<u>Test Pit 3</u>

0.0' - 1.0' Lean clay with sand (CL); topsoil, brown, soft, low plasticity, moist, noncemented, weak reaction to HCL.

1.0' - 3.4' Lean clay with sand (CL); brown, firm, low plasticity, dry, moderately cemented, strong reaction to HCL; 20 percent sand, late stage 1 caliche development.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-84, Standard Practice for Description and Identification of Soils (Visual Manual Procedure).

3.4' - 9.0' Lean clay (CL); light brown, hard, medium plasticity, dry, weakly cemented, strong reaction to HCL; minor lenses of sand, gravel, and cobbles at depth.

Note: SCS data indicates that lean clays at this location have a low shrink/swell potential and moderately slow permeability.

Test Pit 4

0.0' - 0.8' Lean clay (CL); topsoil, dark brown, soft, medium plasticity, moist, noncemented, weak reaction to HCL.

0.8' - 5.1' Silty sand (SM); brown, low density, nonplastic, moist, moderate cementation, strong reaction to HCL; 20 percent fines, late stage 1 caliche development, last 1.5 feet is a cobble horizon.

5.1' - 6.3' Lean clay (CL); brown, firm, medium plasticity, moist, weakly cemented, strong reaction to HCL.

6.3' - 9.0' Silty sand with clay (SM); brown, medium density, low plasticity, moist, weakly cemented, strong reaction to HCL.

Note: SCS data indicates that lean clays at this location have a low shrink/swell potential and moderate permeability.

Test Pit 5

0.0 - 1.3' Lean clay (CL); topsoil, dark brown, soft, medium plasticity, moist, noncemented, weak reaction to HCL.

1.3' - 4.3 Silty sand (SM); brown, low density, nonplastic, moist, moderate cementation, strong reaction to HCL; 20 percent fines, late stage 1 caliche development.

4.3' - 9.0' Lean clay (CL); brown, firm, medium plasticity, moist, noncemented, strong reaction to HCL.

Note: SCS data indicates that lean clays at this location have a moderate to high shrink/swell potential and a slow permeability.

Test Pit 6

0.0' - 1.0' Lean clay (CL); topsoil, dark brown, soft, moderate plasticity, moist, noncemented, no reaction to HCL.

1.0' - 4.5' Lean clay/fat clay (CL/CH); brown, hard, high plasticity, moist, noncemented, no reaction to HCL.

4.5' - 7.5' Lean clay with sand (CL); brown, firm, medium plasticity, moist, weakly cemented, strong reaction to HCL.

7.5' - 9.0' Lean clay (CL); brown, firm, medium plasticity, moist, noncemented, weak reaction to HCL.

Note: SCS data indicates that lean clays at this location have a low shrink/swell potential and moderate permeability.

Test Pit 7

0.0' - 0.8' Lean clay (CL); topsoil, brown, soft, low plasticity, moist, noncemented, no reaction to HCL.

0.8' - 5.3' Lean clay (CL); brown, firm, medium plasticity, dry, noncemented, no reaction to HCL.

5.3' - 9.1' Silty sand (SM); brown, medium density, none to low plasticity, moist, weakly cemented, strong reaction to HCL.

9.1' - 11.0' Lean clay (CL); brown, firm, low plasticity, moist, noncemented, weak reaction to HCL.

Note: Stage 1 caliche development from 1.6 to 3.6 feet. SCS data indicates that lean clays at this location have a low shrink/swell potential and moderate permeability.

Test Pit 8

0.0' - 0.9' Lean clay (CL); topsoil, dark brown, soft, low plasticity, moist, noncemented, no reaction to HCL.

0.9' - 9.0' Lean clay/fat clay (CL/CH); brown, hard, high plasticity, moist, noncemented, no reaction to HCL.

Note: SCS data indicates that clays at this location have a moderate to high shrink/swell potential and slow to moderate permeability.

Test Pit 9

0.0' - 1.0' Lean clay (CL); topsoil, dark brown, soft, low plasticity, moist, noncemented, no reaction to HCL.

1.0' - 9.5' Lean clay (CL); brown, hard, moderate plasticity, moist, noncemented, no reaction to HCL.

Note: SCS data indicates that clays at this location have a moderate to high shrink/swell potential and slow to moderate permeability.

GROUND WATER

Project:			Requesting Agency:
Review of hydrogeologic report for mine water dispersion in Goshen Valley, Utah			Bureau of Water Pollution Control
By: R.H. Klauk	Date: 2/13/86	County: Utah	Job No.: 86-002/GW-1
USGS Quadrangle: Goshen, Utah (967)			

The Utah Geological and Mineral Survey (UGMS), as requested by the Bureau of Water Pollution Control, has reviewed the Dames and Moore report entitled "Ground Water Quality and Hydrogeologic Study Mine Water Dispersion Pond Seepage Impacts Goshen Valley, Utah for Sunshine Mining Company." It is understood that Sunshine Mining Company wishes to reopen the Burgin Mine and dispose of ground water pumped from the mine in a series of dispersion ponds used by Kennecott Copper Company from 1969 to 1978 for the same purpose. The pond system is unlined and located near the apex of a large alluvial fan in sec. 18, T. 10 S., R. 1 W., Salt Lake Baseline and Meridian.

The scope of work outlined in the Dames and Moore report included: 1) evaluation of existing data and reports, 2) ground-water and surface water sampling at selected locations, and 3) depth to ground-water measurements in select wells followed by preparation of piezometric maps for determining direction of ground-water movement. The report also attempts to determine ground-water migration rates, aquifer continuity, and the existance of aquifer confining layers, all from existing data.

Dames and Moore arrived at the following general conclusions in the report:

1. Evaluation of available information (including chemical analyses of October 1985 sampling) indicates former dispersion pond seepage from 1969 to 1978 has not impacted water quality in "wells of record" in Goshen Valley.

2. The general ground-water flow direction in Goshen Valley is to the north or northwest based on data collected for this study. Previous investigators determined the flow direction to be to the northeast. Flow velocities determined from limited data in previous investigations were determined to range from 24 to 150 feet per year, indicating seepage may not have had time to reach nearby wells.

3. The 300 to 400 feet of clayey sands and gravels extending from the surface and the existance of high vertical head pressures in a deep aquifer that may be preventing seepage from the dispersion ponds from reaching the upper aquifer.

4. Lack of subsurface data in the dispersion pond vicinity prevents prediction of impacts to the Goshen Valley ground-water system from re-use of the ponds to dispose of mine water.

Based on this review, UGMS has the following comments regarding the Dames and Moore report:

1. UGMS agrees that no significant impact upon water quality in existing wells is evident as a result of previous dispersion pond useage.

2. UGMS does not agree that ground-water flow in Goshen Valley is to the north or northwest for the following reasons: 1) at least two static water elevations (the Bronson well and LDS well #8) included in table 2 but omitted on plate 8 dispute the piezometric contours shown on plate 8; 2) table 2 indicates Dames and Moore was unable to measure the level in LDS #1 because of a physical barrier, but an elevation for this well is given on plate 8; 3) some static water elevations used to construct the piezometric contour map on plate 8 were taken from historical data which are invalid for this study due to declining water levels over the years; 4) static water level elevations were measured after the irrigation season, and therefore, the effects of the cones of depression for the high capacity irrigation wells are not reflected in the piezometric contours on plate 8; 4) a discrepency exists between all static water level elevations presented on plate 8 and those determined by UGMS from table 2.

3. UGMS agrees that former seepage from the dispersion ponds may not have had time to reach nearby wells.

4. UGMS does not agree with the postulation that 300 to 400 feet of clayey sands and gravels and high vertical head pressures may be confining seepage from the dispersion ponds above the upper aquifer system. There is insufficient data available in the pond area to support such conjecture. Furthermore, previous investigators have indicated all aquifers are unconfined in this area. This report provided no new evidence to indicate otherwise.

5. UGMS agrees that impacts to the ground-water system from re-use of the ponds cannot be evaluated because of lack of subsurface data in the vicinity of the ponds.

As concluded by both Dames and Moore and UGMS, lack of data in the vicinity of the disposal ponds prevents the determination that re-use will not adversely affect wells downgradient. Therefore, it is recommended that wells be drilled in the vicinity of the ponds to determine if a plume of Burgin Mine water related to the previous disposal of mine water exists. Should the plume exist, these wells would also provide direction of movement and allow sampling to identify chemical constituents in unacceptable concentrations. Drilling would also provide stratigraphic information below and downgradient from the ponds, and identify impermeable beds that could protect the aquifer(s) from contamination. Futhermore, a pump test(s) could be performed to provide accurate rates of ground-water flow and plume migration for this area. This information is vital to determine the effect re-use of the ponds will have on the ground-water environment.

Project: Moab Gasoline Leak			Requesting Agency: Southeastern Utah Health Department
By: W. Case	Date: 4/14/86	County: Grand	Job No.: 86-006/GW-2
USGS Quadrangle: Moab SE (497)			

GASOLINE LEAK INVESTIGATION, MOAB CITY

Jim Adamson, South East Utah District Health Department sanitarian, requested assistance in locating the sites for a series of bore holes to ascertain the source of a gasoline leak in the vicinity of 300 South and 100 West, Moab, Utah (attachment 1). The investigation involved literature research, interviews, and a site inspection. The site was investigated on 24 March, 1986, with Jim Adamson and Ray Klepzig, owner of Gordon's Service Center, a suspected source of the leak, located near the corner of 300 South and Main (attachment 2). John E. Keogh, Moab City Engineer, was interviewed, to determine what previous work had been done on the problem.

The area investigated consists of an alluvial plain between Mill Creek and Pack Creek (attachment 1). The general slope of the ground, now mostly covered by construction fill, is in a northwesterly direction toward the confluence of Mill and Pack Creeks. Commercial, retail, medical, and administrative buildings with associated parking lots are located in the area (attachment 2). Two single-family residences are at the western edge of the study area. Four gas stations are within three blocks of the study area and a gas station which has been closed for approximately five years is located about four blocks from the site.

Complaints of gasoline fumes were first received by Jim Adamson in December, 1985. Gasoline fumes rise along partitions in the building which contains Walker Drug, Spencer's Office Supplies, and the Medical Center. Fumes exit from an electrical outlet in examination room #5 and from the drain and floor cracks in the northwest storage room in the Medical Center. The electrical outlet was taped to prevent fumes from entering the examination room. Gasoline fumes entered Spencer's Office Supplies along natural gas and water pipes which are routed through the cement floor and in the partitions between rooms, particularly the bathroom. Mitigation includes using a small fan to blow air into the wall partition where a water faucet is located. A sidewalk hole in which a water meter is located near the southwest corner of the First Western National Bank building (attachment 2) issues gasoline fumes. Gasoline evidently has not entered the sanitary sewer system lines which branch off a trunk line buried in the center of 300 South Street. Fumes were not noted in the drop-drain storm sewer system which drains the south side of 300 South Street.

In January, Utah Gas Service Company replaced natural gas lines along the west side of the Medical Center because of complaints. The presence of fumes were confirmed by a "gas sniffer" used by the gas service company, however the type of hydrocarbon could not be discriminated. According to Adamson, the fumes smelled like gasoline. Gordon's Service Center (attachment 2) replaced gasoline lines in January 1986, because of unaccounted losses of gasoline and the possibility of being the cause of continuing complaints of fumes. On 21 and 22 March, 1986, 18 holes were bored (attachment 2) by a driller hired by Ray Klepzig and sites #10 and #11 were excavated by a backhoe. On 24 March, 1986, water table elevations in the 18 holes (table 1) were surveyed by John E Keogh, who was also hired by Klepzig. Other gas stations in the area indicated to Adamson that they have not experienced gasoline losses. Adamson tested the gas to see if it could be traced to a particular supplier and gas station, but all the stations evidently purchased their gasoline from the same wholesaler.

Table 1: Gas presence and water-table elevation in bore holes in the vicinity of 300 South and Main Street, Moab, Utah.

Bore Hole	#1 Gas Reading (note 1)	#2 Gas Reading (note 2)	Water Table Elevation,ft MSL	Hole Bottom Elevation,ft MSL	Remarks
1	20	40	4031.6	-------	
2	100	NR	-------	4032.6	hole caved, bottom damp, gravel in hole
3	100	NR	4030.3	-------	
4	100	NR	-------	4031.3	hole caved, bottom damp
5	5	NC	4031.4	-------	
6	zero	NC	4036.2	-------	
7	zero	NC	4035.7	-------	
8	zero	NC	4035.5	-------	
9	zero	NC	-------	4035.1	
10	zero	NR	4029.9	-------	oil film on water in test pit
11	100	NR	4027.8	-------	water table 9.5 ft below surface, test pit
12	100	NR	4029.9	-------	
13	100	NR	4030.3	-------	
14	10	NR	4031.1	-------	
15	10	100	4030.0	-------	
16	100	NR	4029.3	-------	
17	10	NR	4030.6	-------	
18	10	NR	4033.2	-------	

Notes:

1. Relative gas measurements using gas "sniffer" by John Swazey, Utah Gas Service Company, immediately after drilling (#1 Gas Reading) and one day later (#2 Gas Reading).
2. NR= no reading taken; NC= no change in reading value.
3. Depth for all holes was 20 feet.
4. Sites 10 and 11 were also excavated by backhoe.

The approximate location of the gasoline plume is outlined on attachment 2 based on bore holes which had a gas reading of 100. Gordon's Service Center appears to be a probable source of the plume, although it is possible that the leak may be coming from gasoline stations across Main Street on the east. The material that the gasoline is moving through is predomiantly construction fill covered with asphalt in many areas. Attachment 3 is a soil log of the test pit at site 10. The fill consists of three units; 1)an impermeable fat clay at the top of the pit, 2)a unit which has variable permeability and consists of 3 feet of clayey sand and fat clay, and 3)a 1-foot bed of impermeable, blocky, fat clay that contains pieces of carbon and plant rootlets. The lateral extent of the units is not known. The asphalt covering the fill may have an affect on where the fumes are directed and their relative strength. When the test pit at site 11 and the collapsed hole at site 2 were filled in on the 24th of March, stronger fumes were noticed in the Medical Center storage room within a few hours.

Conclusions

If the fill permeability characteristics in the study area are similar to the units logged at site 10, that is, a relatively permeable unit over a horizontal, impermeable clay unit the plume pattern would be as shown on attachment 2. Gasoline movement would be restricted by an impermeable clay horizon 3 feet beneath the surface (the bottom clay horizon in attachment 3). Movement would be above the clay within a relatively permeable unit which allows fumes to reach the surface. However, the bottom clay noted in site 10 (attachment 3) is probably not continuous over a large area. According to Jim Adamson (personal comm., 24 March, 1986) the water table at site 11 is 9.5 feet below the surface, 6.5 feet below the impermeable clay unit at site 10.

The leak may have been fixed when the gasoline lines at Gordon's Service Center were replaced, but it will take time for the system to flush itself. A mineral precipitate appeared within an hour on freshly exposed sand and clay unit while the soil was logged at site 10. This indicates that fluids move fairly rapidly through the relatively permeable unit. If the fill in the rest of the study area has similar permeability, the system should flush itself within a month. Evidently the open field to the west of the Medical Center/Walker Drug building allows for the fumes to disapate before reaching the Utah State and National Park Service buildings located northwest of the study area at approximately 200 South and 200 West. A grounds person was asked to check a water main outlet to see if there was any gasoline fumes, at that local. No fumes were detected. No complaints have been received by Jim Adamson from employees who work in the buildings.

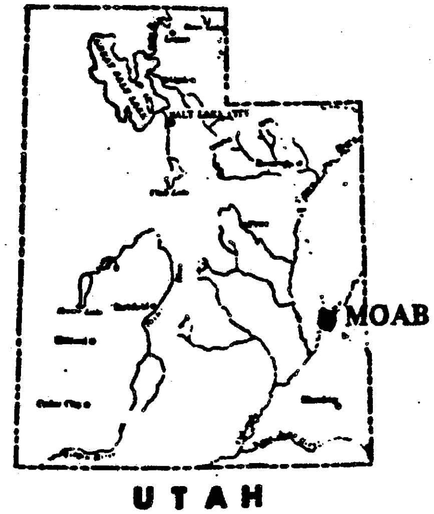
Attachment 2 shows four boring sites which would further delineate the gasoline plume. Additional borings could be completed at the discretion of the South East Utah Health District Department Sanitarian to determine the extent of the plume to the east.

Selected References

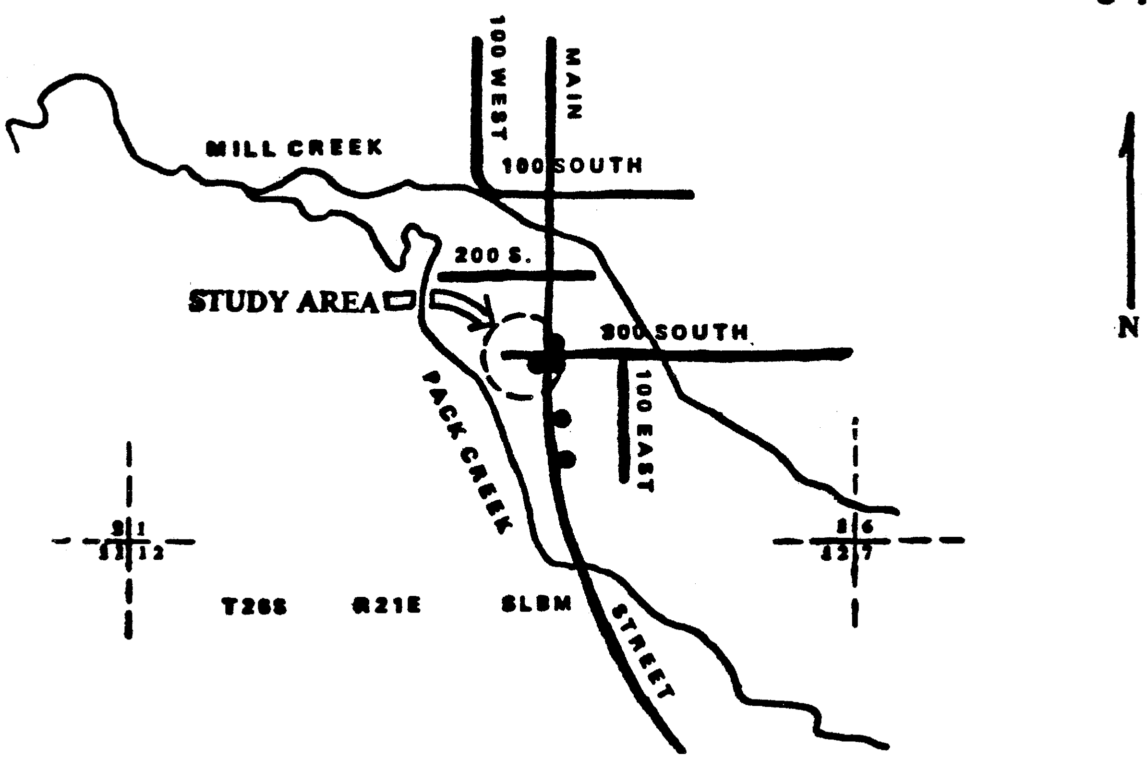
Sumsion, C. T., 1971, Geology and water resources of the Spanish Valley Area, Grand and San Juan Counties, Utah; U.S. Geological Survey and Utah Department of Natural Resources Division of Water Rights Technical Publication No. 32, 45p.

Williams, P. L, 1964, Geology, structure, and uranium deposits of the Moab Quadrangle, Colorado and Utah; U.S. Geological Survey Miscellaneous Geologic Investigations Map I-360, 1:250,000

Attachment 1, Job No. 86-006



SOUTHWESTERN MOAB CITY



Index and location map of the study area and southwestern Moab.
Filled in circles are locations of gas stations near the study area.
Base map from Times-Independent Newspaper Agency, Scale: 3.85 inches/mile.

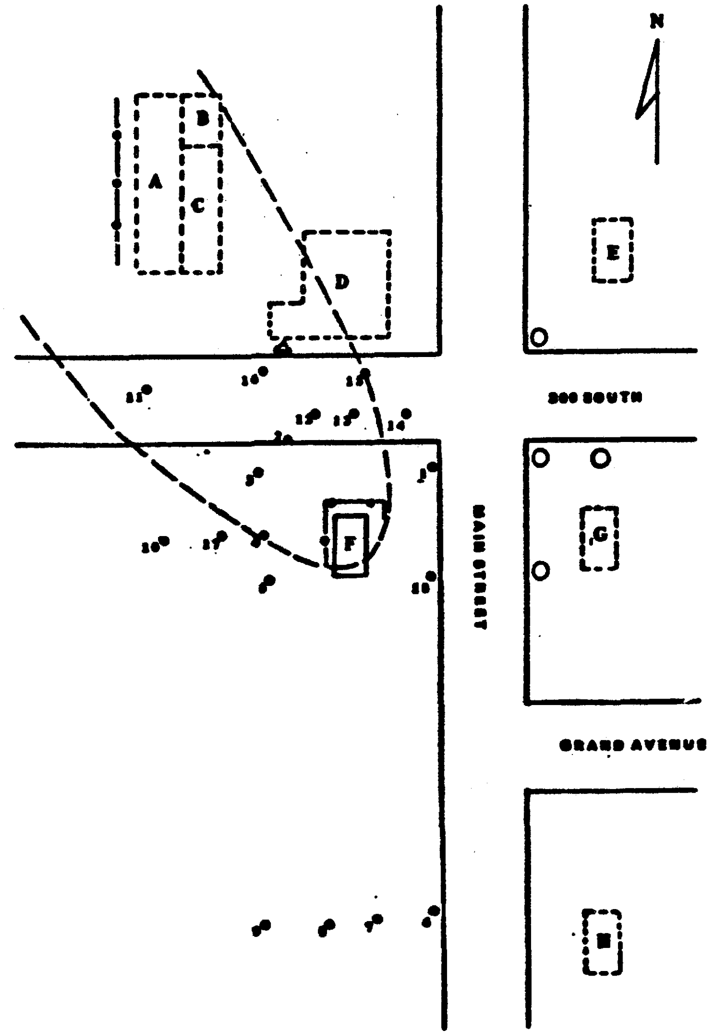
Attachment 2, Job No. 86-006

Explanation:

- A: Medical Center
- B: Spencer's Office Supplies
- C: Walker Drug
- D: First Western National Bank
- E: Mike's U-Serve
- F: Gordon's Service Center
- G: Moab U-Serve
- H: Auto-Tire Service

Symbols:

- replaced natural gas line
- replaced gasoline lines
- water meter
- bore hole site
- approximate location of buildings
- building location
- postulated gasoline leak plume
- approximate location of proposed drill sites



Diagrammatic representation of study area showing bore hole sites, buildings, and postulated gasoline plume.

Attachment 3, Job No. 86-006

Soil log at site 10, 300 South, 100 West, Moab City

0'-1' Fat clay (CH); brown, hard, high plasticity, dry, strong reaction to HCl, rootlets from surface grass, unconformable contact with lower horizon, impermeable, fill.

1'-3' Clayey sand (SC), red, low density, low plasticity, moist, subrounded, nonindurated, medium grained; with fat clay (CH), nodules and strands, brown, mottled, soft, high plasticity, moist, in beds 1 to 6 inches thick, thicker toward bottom of unit; strong reaction to HCl, conformable contact with underlying unit, permeability variable, fill.

3'-4' Fat clay (CH), brown, highly mottled, soft, high plasticity, moist, strong reaction to HCl, carbon and plant rootlets which seem to be in their original position, possible paleosoil on older fill(?), blocky structure, impermeable horizon, fill.

4' Bottom of pit.

Note: A white precipitate covered the walls of the test pit to a thickness in places of almost 1/16th inch and the floor of the pit was littered with pieces of white precipitate that had fallen from the walls. The pit had been open for a month before inspection. Within the hour it took to log the pit evaporation was such that a mineral precipitate appeared on the pit walls.

Project: Ground-water Recharge Proposals			Requesting Agency: Division of Water Rights
By: H. Gill	Date: 5/21/86	County: Salt Lake & Davis	Job No.: 86-009/GW-3
USGS Quadrangle: Sugar House, Draper, & Ogden (1212, 1171, and 1345)			

In response to a request from Jerry D. Olds, Division of ..ater Rights, a review of three ground-water recharge proposals, submitted under the Bureau of Reclamation's High Plains States Ground-Water Demonstration Program, has been accomplished. The three proposals were read in their entirety, however, comments were made only on those sections that address geology, hydrogeologic conditions, ground-water aquifers, monitoring systems, and sampling techniques.

Davis County Council of Governments Proposal

The sections on geology, ground-water hydrology, and the Delta Aquifer are very comprehensive, however, the following points should be addressed:

1) A portion of the recharge area is directly over the Wasatch fault zone. What percentage, if any, of the recharge water will be lost to the bedrock basement through this zone, and will it be of any consequence to the project?

2) The section on monitoring and sampling could be expanded to include a better explanation of sampling techniques (equipment, quality control, etc.).

Salt Lake County Water Conservancy District Proposal

The sections on geology, ground-water hydrology, area aquifers, well monitoring, and sampling techniques are very comprehensive. The only question raised deals with the Wasatch fault zone. The recharge area is immediately west of the Wasatch fault zone. What percentage, if any, of the recharge water will be lost to the bedrock basement through this zone and will it be of any consequence to the project?

Salt Lake City-County Health Department Proposal

The sections on geology and hydrology presented in this proposal are adequate, however, individuals unfamiliar with the area would require more background to make informed decisions. Once again, the recharge area in near the Wasatch fault zone. What percentage, if any, of the recharge water will be lost to the bedrock basement through this zone and will it be of any consequence to the project? In addition there were a couple of questions raised:

1) It was stated that Salt Lake City-County Health Department sampling techniques would be utilized, a description of these techniques would make for a more complete proposal.

2) The possibility for basement flooding in the area, due to the recharge program, was not addressed. Has there been any data accumulated that would substantiate or disprove this possibility?

Project: Proposed spring drainage trench site, Erda, Tooele County, Utah			Requesting Agency: Tooele County
By: William F. Case	Date: 9-22-86	County: Tooele	Job No.: 86-020/GW-4
USGS Quadrangle: Tooele (1175)			

PURPOSE AND SCOPE

Tooele County Commissioner, Reed Russell, requested that the Utah Geological and Mineral Survey assist in evaluating the site for a trench which would drain overflow from White House spring and help mitigate basement flooding of a home in the community of Erda. The proposed trench, one mile long, would convey water from White House spring across nearby fields and into a distribution system of culverts and roadside ditches. The trench location was selected by Commissioner Russell and evaluated by the Utah Geological and Mineral Survey through a literature search and field inspection accompanied by Commissioner Russell on August 18, 1986.

SETTING

Erda is approximately 4 miles north of Tooele City and is 3 miles south and 140 feet higher than the Great Salt Lake (attachment 1). Many artesian wells, springs, and surface ponds are present in the study area. White House spring is one of two springs located in the NW 1/4 corner of sec. 33, T. 2 S., R. 4 W., SLBM. Surface water flows from White House spring to low areas in fields to the north (attachment 2). The surface gradient of the fields is very low, and the slow-moving water has produced a permanent bog in the area. The flooded basement is approximately 3/4 mile north of White House spring. The house is built on a slight rise and has shallow trenches to direct surface water away from the basement on the up-gradient (south) side. The field directly east of the house has standing water in depressions, probably due to upward leakage from the same aquifer that is flooding the basement. A church in the study area (attachment 2) is considering routing effluent from an existing septic tank drainfield to the proposed distribution system.

HYDROLOGY

The Erda ground-water district, (Gates, 1965), is 5 miles east of the topographic low of Tooele Valley. Most of the ground water in the Erda district originates as precipitation on bedrock in the Oquirrh Mountains which form the eastern border of Tooele Valley (Gates, 1965). Ground water from bedrock enters valley-fill aquifers along the mountain front. The principle aquifer, in the study area, is artesian and is located at a depth of 160-270 feet in valley fill (Gates, 1965). In response to increased annual precipitation, the water level of the principle aquifer rose 10-20 feet from March 1984 to March 1985 (Arnow, 1985) and 3-6 feet from March 1985 to March 1986 (Mason and others, 1986). Ponded water in the field near the affected home represents the intersection of the shallow water table with the ground surface. The main source of recharge to the shallow water table is upward leakage from the principle aquifer (Gates, 1965). Other sources of water table recharge include infiltration of surface water including precipitation, irrigation, springs, and excess runoff; septic tank drainfields may also contribute to the recharge of the water table.

SITE RECONNAISSANCE

Robert C. Rasely, USDA Soil Conservation Service (SCS) State Geologist, was interviewed prior to the field inspection to determine the extent of problems in the Erda area. Mr. Rasely indicated that the main cause of flooded basements and fields is upward leakage from artesian aquifers in the valley fill. He mentioned that Commissioner Russell had approached the SCS and suggested that surface drainage would help mitigate the general flooding problem in Erda. However, Mr. Rasely was of the opinion that surface drainage would not make much difference.

White House spring, the boggy fields, the proposed trench site, the present church drainfield, and the distribution system which will handle water from the trench were inspected with Commissioner Russell. The owner of the property across which the trench would run was interviewed to determine the characteristics of White House spring and the boggy fields. He indicated that flow from the spring varies from year to year and that there are no springs in the perennially wet boggy fields.

CONCLUSIONS AND RECOMMENDATIONS

The trench, as proposed by Commissioner Russell, may help drain surface water from the fields and reduce the amount of standing water in the area, assuming there are no other springs in the fields. It may help mitigate the basement flooding of the home, however, any positive effects are expected to be small due to the amount of recharge to the shallow water table from artesian aquifers. The trench should be 3-4 feet deep, graded to provide steady flow from White House spring, and filled with coarse gravel. The excavation should traverse the lowest section of the boggy fields to collect as much surface water as possible. The effluent routing from the church septic tank drainfield should be considered in more detail by church administrators following consultation with local health officials.

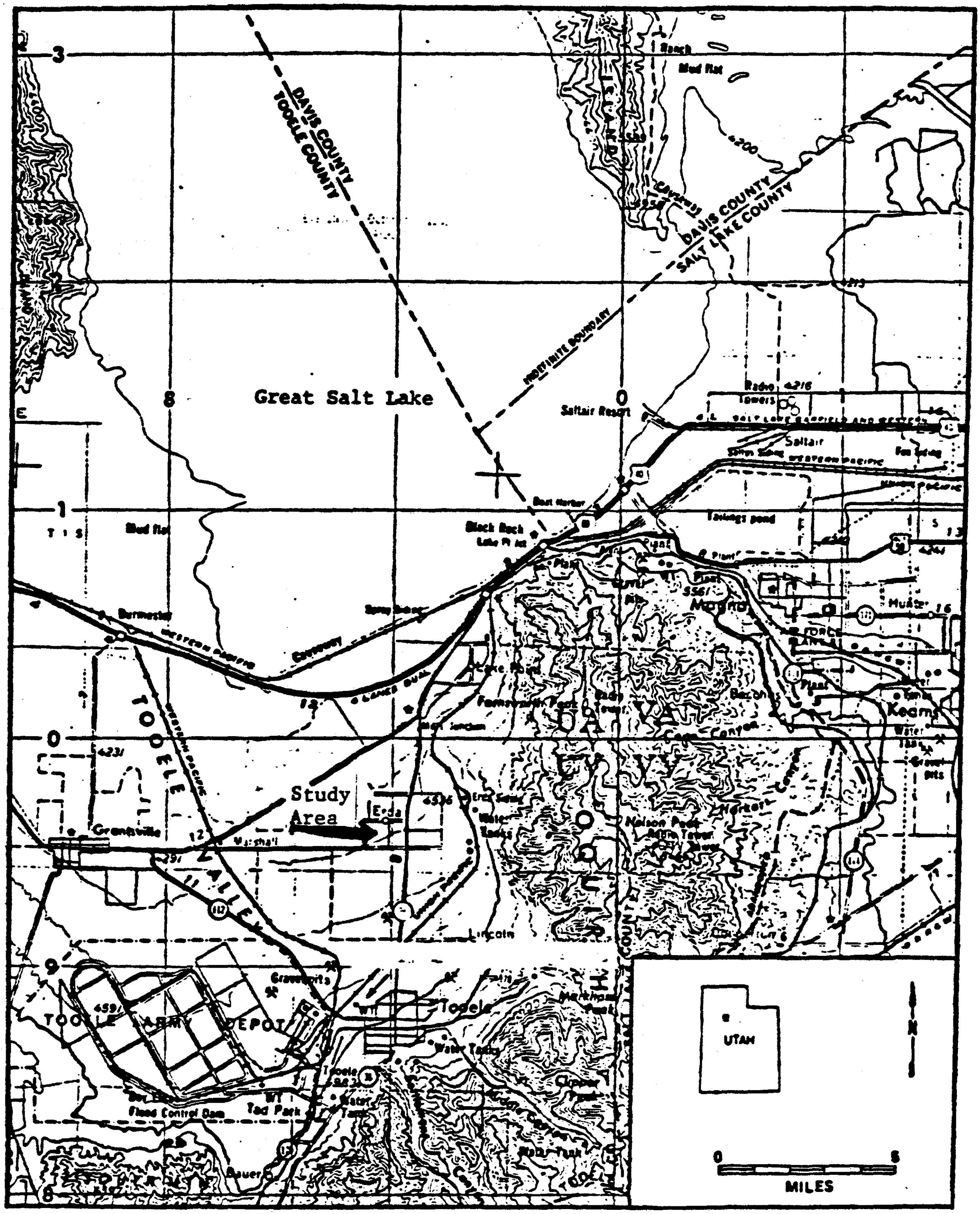
REFERENCES

Gates, J. S., 1965, Reevaluation of the ground-water resources of Tooele Valley, Utah: U.S. Geological Survey in cooperation with Utah State Engineer, Utah State Engineer Technical Publication No. 12, 65 p.

Lund, W. R., 1985, Preliminary evaluation of high ground-water conditions in Erda, Tooele County, Utah, in Mulvey, W. E., Technical reports for 1985 Site Investigation Section: Utah Geological and Mineral Survey Report of Investigation No. 208, p. 228-236.

Mason, J. L., and others, 1986, Developing a state water plan, ground-water conditions in Utah, spring of 1986: U.S. Geological Survey in cooperation with State of Utah, Cooperative Investigations Report No. 26, 83 p.

Attachment 1, Job No. 86-020

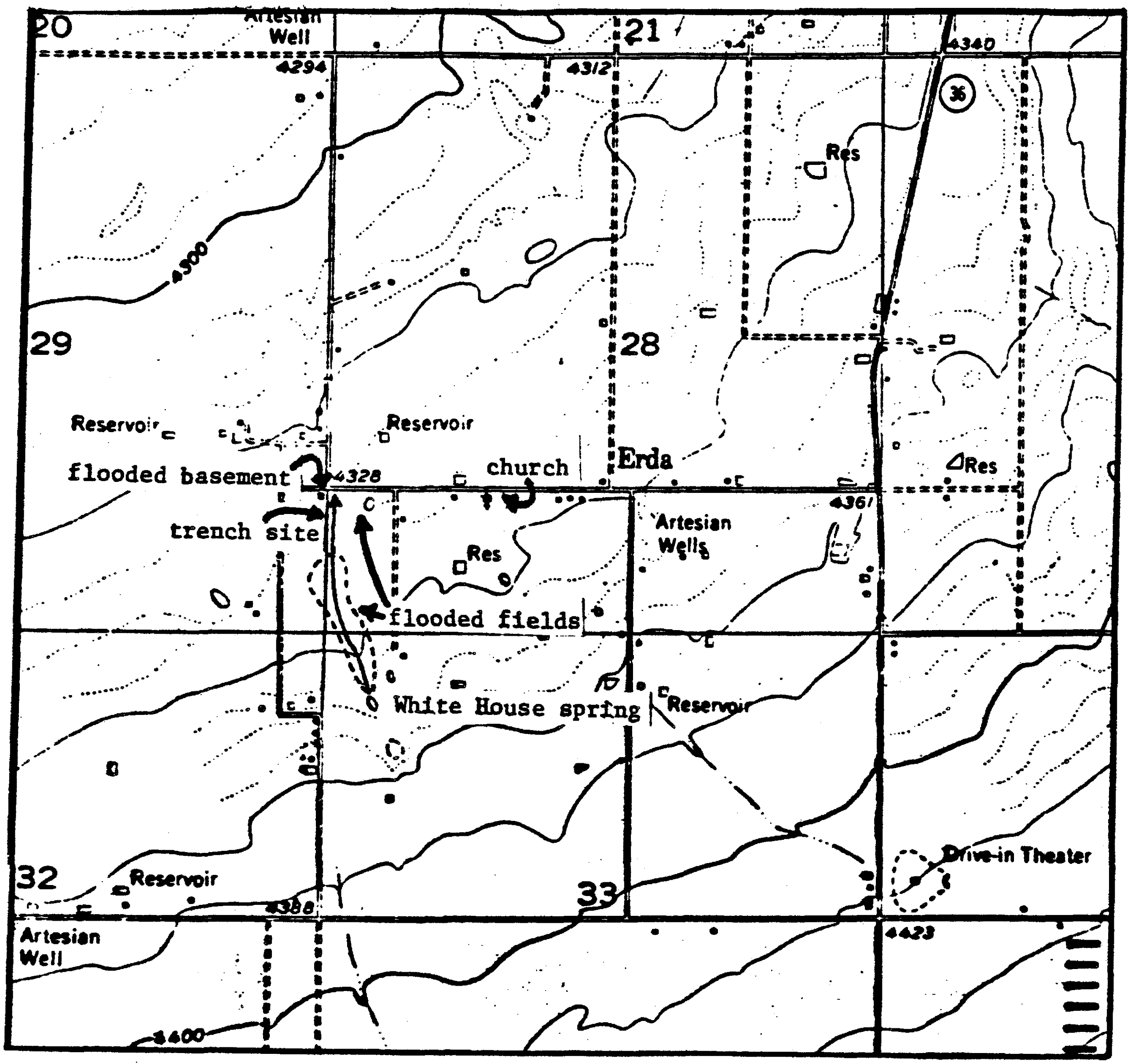


Location map

(from Lund, 1985)

Attachment 2, Job No. 86-020

Base map USGS 7 1/2' topographic quadrangle, Tooele, Utah



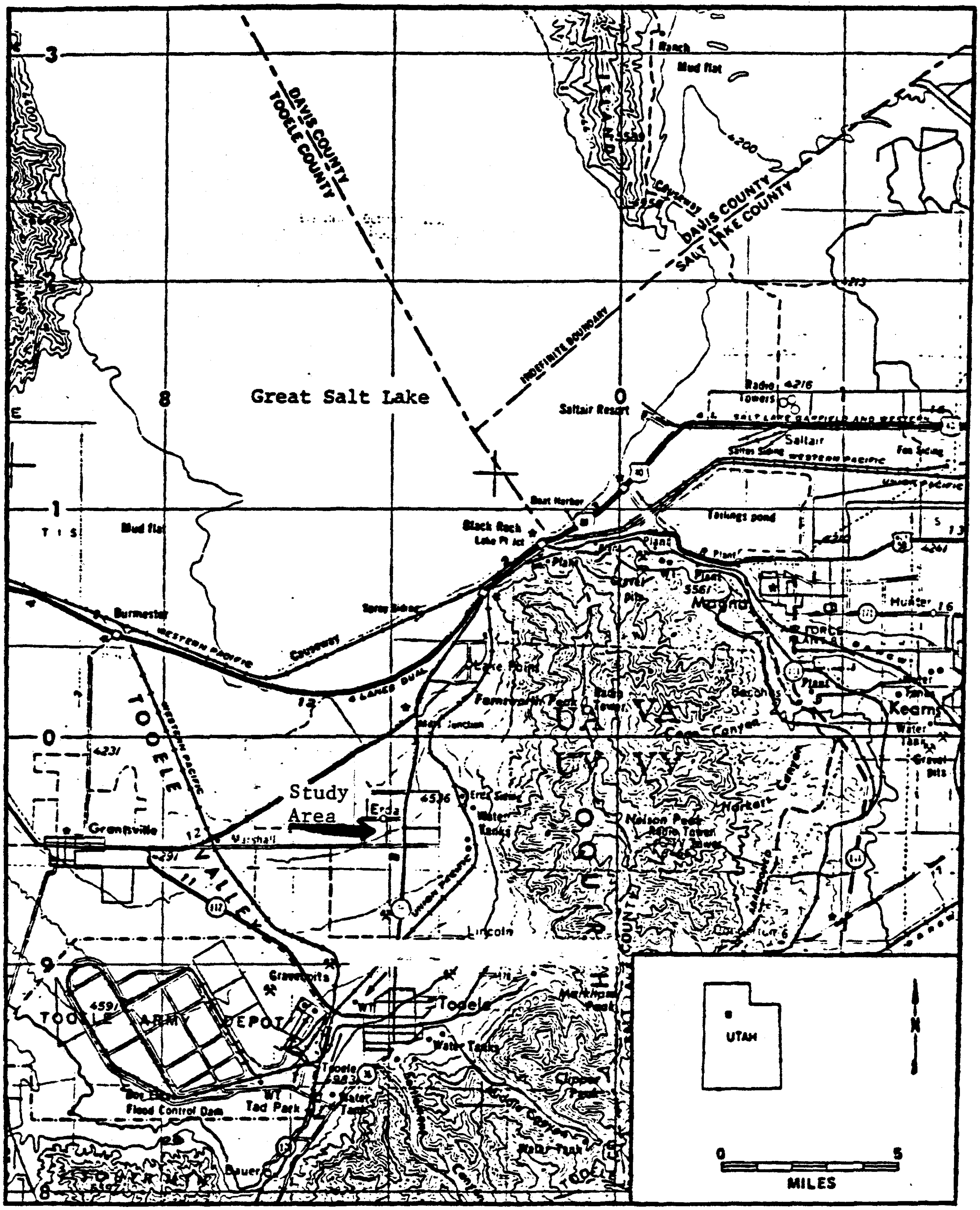
Scale 3.4 inches = one mile

Map of Study Area

Utah Geological and Mineral Survey

Site Investigation Section

Attachment 1, Job No. 86-020



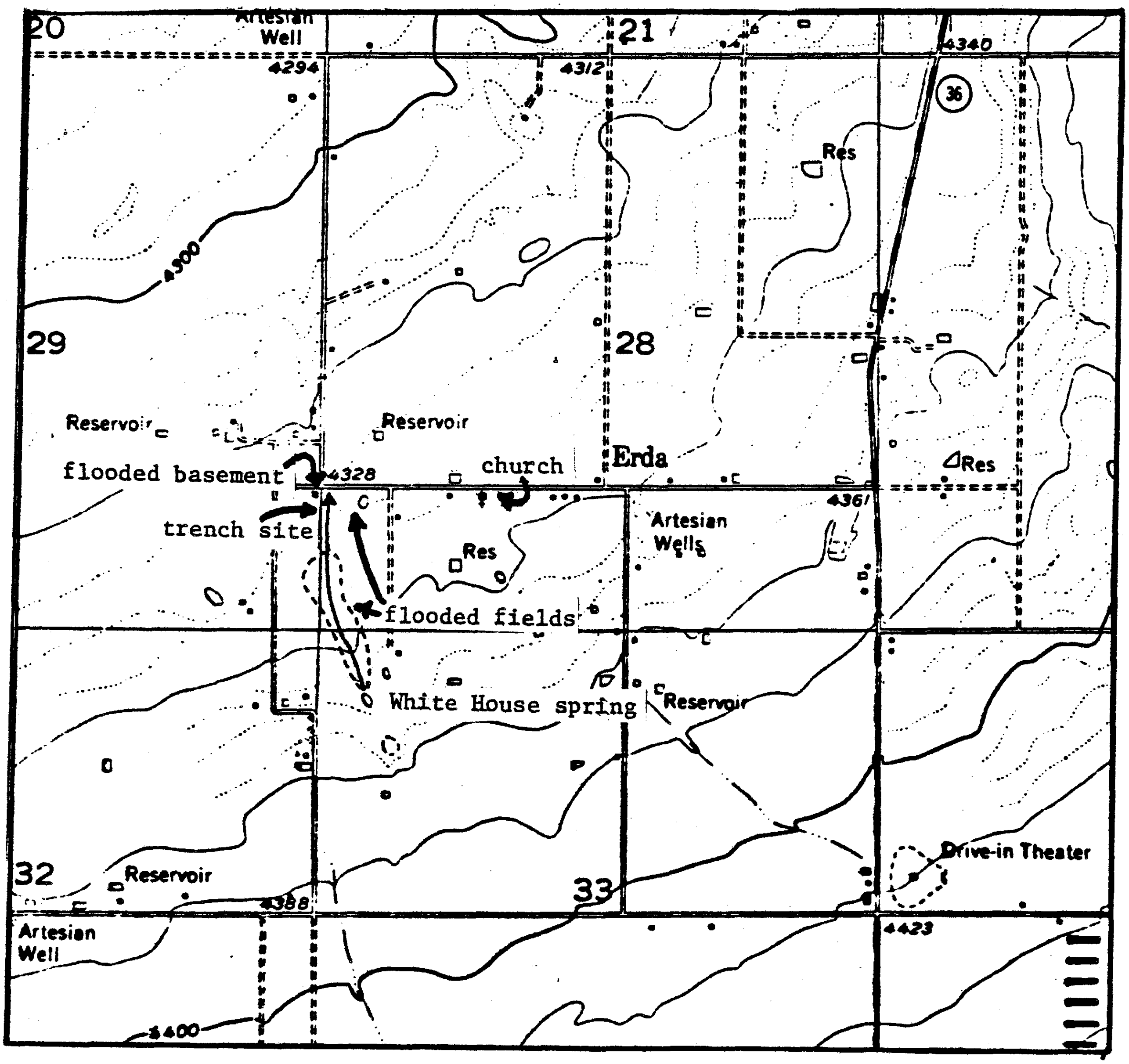
Location map

(from Lund, 1985)

Utah Geological and Mineral Survey Site Investigation Section

Attachment 2, Job No. 86-020

Base map USGS 7 1/2' topographic quadrangle, Tooele, Utah



Scale 3.4 inches = one mile

Map of Study Area

Utah Geological and Mineral Survey

Site Investigation Section

GEOLOGIC HAZARDS

Project: Investigation of trench excavation 4100 South 6400 West, Salt Lake City, Utah			Requesting Agency: Utah Industrial Commission
By: William F. Case	Date: 1/31/86	County: Salt Lake	Job No.: 86-001/GH-1
USGS Quadrangle: Magna Quadrangle (1214)			

An investigation of a trench excavation at approximately 4100 South, 6400 West, Salt Lake County (attachment 1) was conducted on Wednesday, 22 January 1986, with Walter M. Folconer, Compliance Inspector, Occupational Safety and Health Division of the Industrial Commission of Utah. Ron Ludlow, Director of the Occupational Safety and Health Division, contacted the Utah Geological and Mineral Survey on 22 January and requested an determination of geologic and hydrologic conditions at the site. The trench was excavated for the purpose of laying 2 pipes, a 24-inch concrete pipe and a 30-inch steel pipe which will serve as water transmission and drainage conduits for the future E. Vern Breeze reservoir, owned by the Granger-Hunter Improvement District. Mr. Ken Hoover, owner of Bahk, Ltd., the firm installing the pipes, was present during the investigation. No personnel were in the trench at the time of inspection.

Mr. Hoover mentioned that the trench had been investigated by a soil scientist from the firm of Rollins, Brown, and Gunnell on 21 January, 1986. Mr. Hoover stated that the resulting report indicated that there was no danger of cave-in of the near-vertical trench walls because the materials were cemented by caliche. The Rollins, Brown, and Gunnell report was not available for review.

The geologic materials present in the trench consist of strata of Provo Lake (Miller, 1980) silts, sands, and gravels interspersed with sands and gravels of fluvial-channel and alluvial-fan deposits. The alluvial-fan deposits consist of poorly-bedded boulder gravels in a matrix of light reddish-brown silt and sand. The clasts are angular, up to one foot in diameter, and coated with silt and clay films. The fan deposits were episodically deposited within the lacustrine deposits, particularly the light reddish-brown bedded silts. The fluvial-channel deposits consist of well-bedded pebble gravels with a minor matrix of sand and silt, and some thin sand lenses. The fluvial-channel deposits were deposited in eroded channels in the alluvial-fan and lake-silt sediments. Lacustrine pebble gravels were deposited near the top of the section. The gravels have very little matrix and are well-bedded. A dark-brown to black granular soil and man-made fill are at the top of the geologic section. All materials except the topsoil and fill are slightly to moderately cemented with caliche. The amount of caliche present seems to increase toward the top of the section. The lacustrine pebble gravels directly beneath the topsoil contain layers of caliche approximately 1/4-inch thick and the clasts are almost completely covered with calcium carbonate.

The trench excavation is "L-shaped" (attachment 2). The east-west arm runs parallel to 4100 South for approximately 100 feet. The north-south arm runs perpendicular to 4100 South at approximately 6500 West for the same distance. The depth of the trench at the "elbow" is 26 feet. The average width of the trench bottom is 9 feet. The two conduits will connect with the reservoir at the south end of the north-south arm.

The trench materials are classified as "hard, compacted soil" because of the semi-consolidated nature of the sediments resulting from the caliche cementation. The walls are not as competent as solid rock or cemented gravels, nor are they as loose as uncemented soils. They had maintained a near-vertical slope with very little sluffing for at least one day. It is important to note, however, that the investigation was conducted in the morning when the temperature was at or below freezing. No standing water on the trench floor or seeps in the trench walls were noted. The topsoil and fill on the surface along the north side of the east-west arm and the west side of the east-west arm were loose and showed evidence of sluffing into the trench. Cracks up to one-inch wide were common in the soil and there were areas on the trench walls where dark soil "stains" due to flowage of moist soil were visible. There is not sufficient room to slope the north wall of the east-west trench because of the close proximity of 4100 South street. The fact that Utah Power & Light poles and a storm sewer are located between the trench wall and the street presents additional problems. Traffic along 4100 South could also produce vibrations and provide dynamic loading of the upper loose materials. It is recommended that the loose soil and fill to a depth of approximately 3 feet be scraped at least two feet away from the north wall of the east-west trench and the walls of the north-south trench. The south wall of the east-west trench already has a shelf which has trapped falling material. Because of caliche cementation, the trench walls stand at near-vertical angles with only minor evidence of sluffing to date. However, the degree of cementation is uneven, and the material in which the trench is excavated should still be considered a "hard, compact soil". Therefore, regulations regarding slope lay-back angles, or the use of shoring and/or trench boxes should be followed.

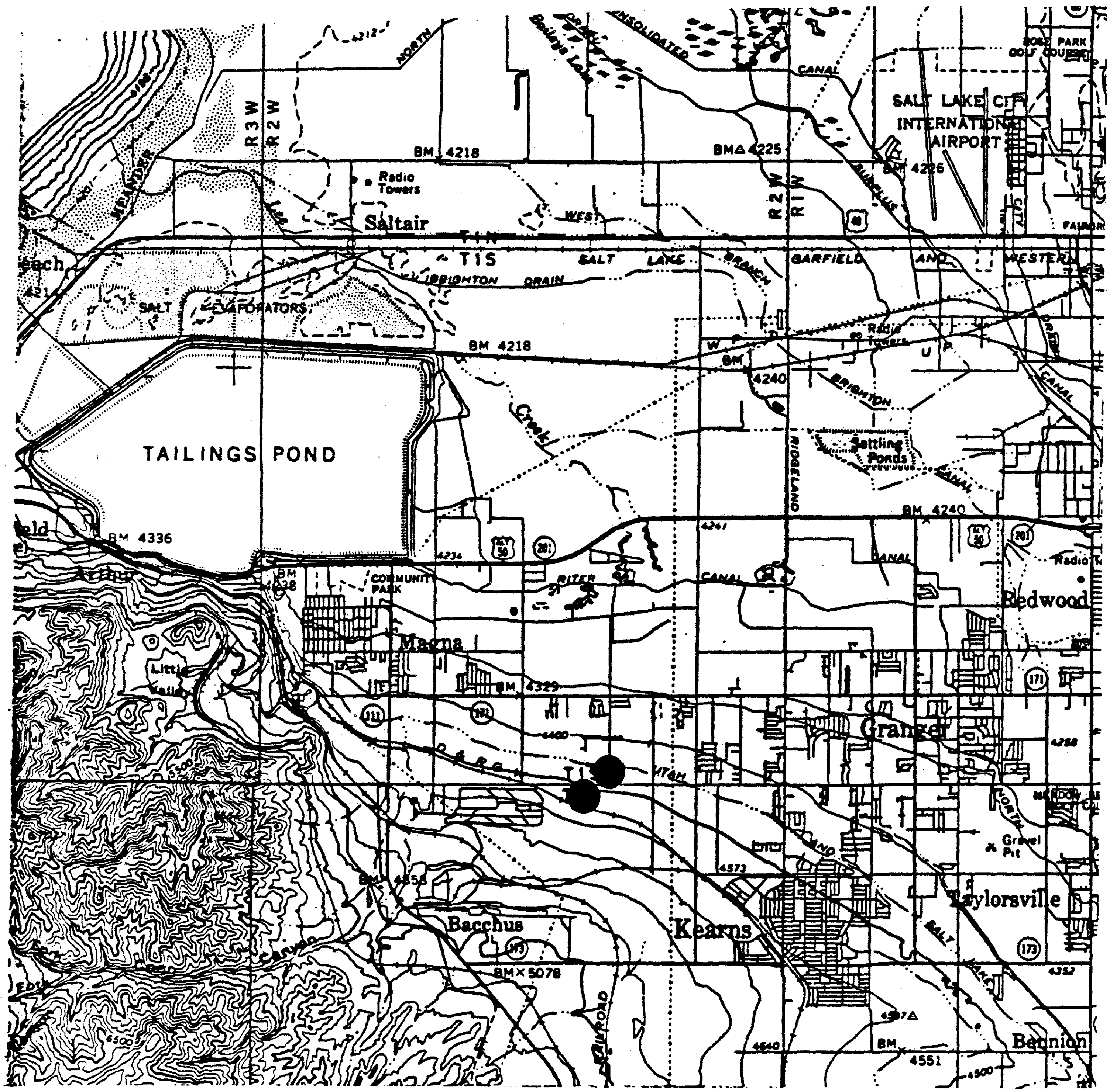
A trench, which extends approximately 100 feet north of 4100 South along 6400 West street, was inspected on 23 January, 1986, at the request of Ron Ludlow. Mr. Ludlow, Walt Folconer, and Ken Hoover were present during the investigation. The trench is approximately 14 feet wide and the floor grades northward from 22 feet beneath the surface at the south end to 5 feet at the north end. The earth materials are similar to the first trench except for the following; 1) the matrix is darker reddish-brown, 2) there is no topsoil, only fill and a large clast (up to 2 feet in diameter) gravel veneer overlying the lacustrine pebble gravels, 3) locally the lacustrine bedded silts have been deformed similar to that observed in turbidite deposits, and 4) the geologic units (lacustrine silts and gravels, and alluvial-fan deposits) are more uniform and thicker.

The trench materials hold near-vertical slopes due in part to caliche cementation throughout the geologic section. The trench had been open for six weeks prior to the investigation. The only noticeable feature was flowage of surface fill and spoil into the trench. The trench bottom was dry and no seeps were noticed in the trench walls. The inspection took place in the afternoon when the air temperature was above freezing. The material is classified as "hard, compacted soil" and as such requires a slope of 1/2:1, or the use of properly designed shoring and/or a trench box.

SELECTED REFERENCES

Miller, Robert D, 1980, Surficial geologic map along part of the Wasatch Front, Salt Lake Valley, Utah; United States Geologic Survey Miscellaneous Field Studies Map MF-1198, scale 1:100,000.

Industrial Commission of Utah, 1976, Employer-employee safe practices for excavation and trenching operations: Occupational Safety and Health Division, 16 p.



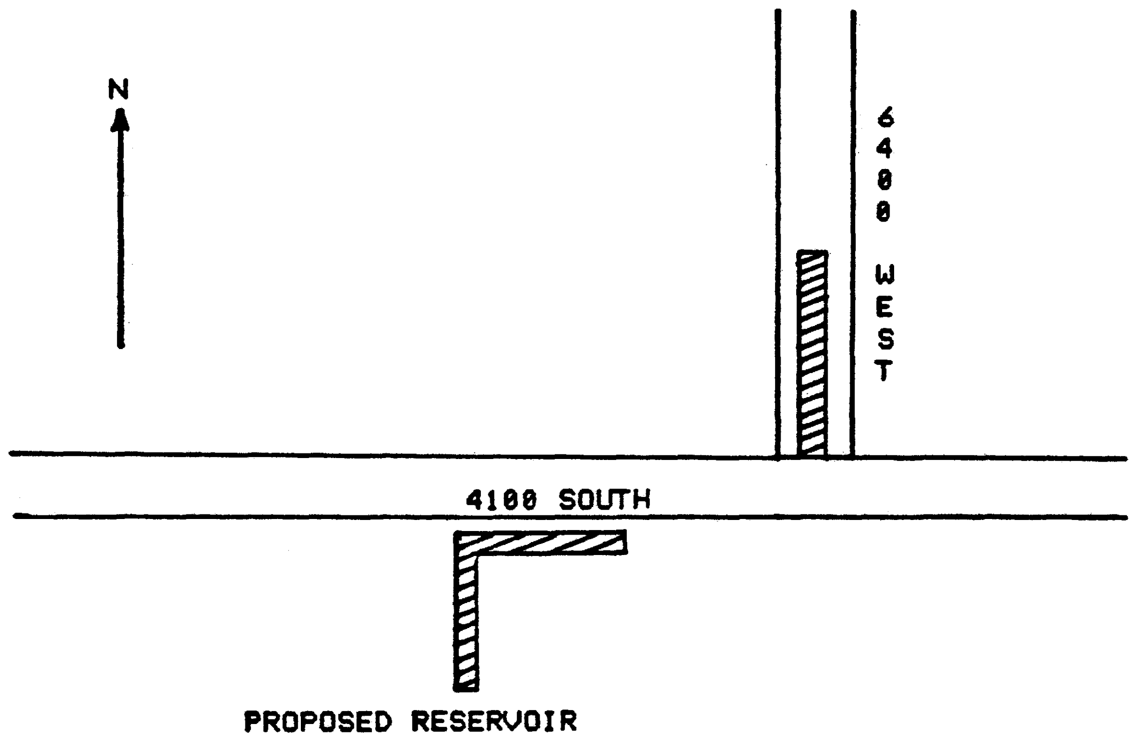
Attachment 1: Index map showing approximate location of trench.

● Approximate location of trench.

Scale 1:100 000

Base: Central Wasatch Topographic Map

N



Attachment 2: Sketch map of trenches.

No Scale

Project:			Requesting Agency:
Soils investigation for area around 300 South and 400 West, Salt Lake City, Utah			Utah UOSH
By: H. Gill	Date: 3/25/86	County: Salt Lake	Job No.: 86-005 /GH-2
USGS Quadrangle: Salt Lake City North Quadrangle 1254			

On March 12, 1986, Mr. Don Anderson, Compliance Supervisor Industrial Commission of Utah, UOSH Division, requested the Utah Geological and Mineral Survey (UGMS) to investigate a trench site at 300 south and 400 west in Salt Lake City, Utah. His primary concern was the type of soils found in this area, and more specifically, if the soils normally occur in a highly cemented state. At the time of the request, the trench had been closed, therefore, the UGMS investigation was limited to a literature review for the area and no field reconnaissance was undertaken. The following are the results of that literature search.

1) Bauman, R. D., 1965, Foundation characteristics of sediments Salt Lake metropolitan area: Utah Geological and Mineralogical Survey Special Studies 10, 40 p.

The following boring logs are not to their complete depths as recorded in the publication, but only to the depth pertinent to this request.

Hole #141: Main Street and 400 south (3000 ft. northeast of trench site)

0.0' - 3.0'	Coarse sand and brick (fill)
3.0' - 7.0'	Sandy silt with gravel (ML/SM)
7.0' - 10.0'	Gray-brown sandy clay (CL)
10.0' - 13.0'	Brown fine sand (SP)
13.0' - 30.0'	Brown- to gray clay with lenses of sand, silt and gravel (CL)

Hole #191: 100 south and Main Street (3250 ft. northeast of trench site)

0.0' - 1.0'	Bricks, mortar, and gravel (fill)
1.0' - 13.0'	Brown, coarse sand, gravel, and cobbles (SP/GP)
13.0' - 14.0'	Brown, fine to coarse sand (SP)
14.0' - 20.0'	Brown, coarse sand, gravel, and cobbles (SP/GP)

Hole #182-W: Main Street and South Temple (3575 ft. northeast of trench site)

0.0' - 39.0'	Clay and boulders, possibly a debris flow (CL)
39.0' - 70.0'	Blue clay (CH)

Note: cemented sand at 146 feet deep.

Hole #140: State Street and 500 south (4000 ft. east of trench site).

0.0' - 3.0'	Cinder and gravel fill
3.0' - 17.0'	Loose, tan silty sand (SM)
17.0' - 24.0'	Soft, gray silty clay (CL)

Hole #188: Main Street and 100 north (5000 ft. northeast of trench site)

0.0' - 12.0'	Very dense, sand with gravel (SP)
12.0' - 24.0'	Loose, tan silty sand (SM)

2) The following soil logs are from excavation inspections performed under the UGMS Excavation Inspection Program.

Site #80-10: 47 west and 200 south (2000 ft. northeast of trench site)

0.0' - 5.0'	Fill material
5.0' - 25.0'	Gravelly sand (SP)
25.0' - 30.0'	Silty clay (CL)
30.0' - 32.0'	Gravelly sand with cobbles (SP)

Site #82-04: 50 south and 200 west (2250 ft. northeast of trench site)

0.0' - 4.0'	Trash and asphalt (fill)
4.0' - 11.0'	Sandy gravel (GP)
11.0' - 20.0'	Silty, clayey sand (SC)

Site # 82-02: 100 south and West Temple (2500 ft. northeast of trench site)

0.0' - 3.0'	Silty sand (SM)
3.0' - 8.0'	Sandy gravel/ gravelly sand (GP/SP)
8.0' - 16.0'	Silty sand with gravel interbeds (SM)

3) Scott, W. E., and Shroba, R. R., 1985, Surficial Geologic map of an area along the Wasatch Fault zone in the Salt Lake Valley, Utah: U.S. Geological Survey Open-File Report 85-448, 18 p.

The area in question is mapped by Scott and Shroba as fine-grained alluvium and mixed lake, marsh, and alluvial deposits. The soils are described as: silt, clay, and sand; locally very minor pebble gravel, and organic rich. Deposited by streams in low-gradient areas at the outer edge of alluvial fans near the center of the valley. These units are approximately 3 to 9 feet thick.

In summary, soil logs from foundation reports and UGMS excavation inspections were examined. There were no examples found closer than 2000 feet from the trench site. The logs observed in the trench area indicate that the subsurface soils to a depth of at least 20 feet are primarily coarse grained deposits with a few areas having silty clay and clay lenses present. Sediments deposited in an environment such as found at the site (on the outer edge of an alluvial fan) can be extremely variable. However, it is likely that the coarse deposits observed in the soil logs cover a wide area and would extend beneath the trench site. The only indication of cemented deposits was found in Hole #182-W, and that was at 146 feet beneath the surface. Because we were unable to inspect the trench, we cannot say conclusively that the sediments were noncemented, however, it is unlikely that the sediments in the upper 10 feet would be highly cemented.

Project:	Requesting Agency:
Geologic hazards review for Division of State Lands and Forestry proposed land acquisition. Garfield County, Utah, section 20 T. 37 S. R 11 E.	Division of State Lands and Forestry

By:	Date:	County:	Job No.:
William E. Mulvey William R. Lund	4/24/86	Garfield	86-008 /GH-3

USGS Quadrangle:
#178 Bullfrog, Utah

PURPOSE AND SCOPE

In response to a request from Scott C. Flandro of the Division of State Lands and Forestry, the Utah Geological and Mineral Survey reviewed the literature for potential geologic hazards in section 20 T.37 S. R.11 E. on the Bullfrog 7.5 minute USGS topographic quadrangle (attachment 1). The Division of State Lands and Forestry is presently considering acquiring this land for future lease to the public for development of facilities associated with the Bullfrog Marina complex. In the literature review the following potential geologic problems are addressed; flooding, ground water, erosion, soil problems, and seismicity.

GEOLOGY AND SOILS

The parcel of land is located in the southeast corner of the Cane Springs Desert approximately three miles north of the Bullfrog Basin Campground. State road 276 passes through the site providing good year-round access. Average annual precipitation in the region is from 5 to 8 inches, which supports a mixed plant community of grasses, forbs, and shrubs. Bedrock in section 20 is the Jurassic-age Entrada Sandstone which is exposed in a low escarpment on the western half of the site. The bedrock is mantled by a mixture of Quaternary-age alluvial and eolian material creating a low undulating topography. These unconsolidated deposits range in depth from 2 to 15 feet (H.H. Doelling, pers. comm., 1986). The alluvial deposits are the remnants of an older Quaternary-age erosional surface which consists of boulders, cobbles, and pebbles, and may contain a layer of caliche, secondarily deposited calcium carbonate, a foot to several feet thick. Although no detailed geologic mapping has been conducted on the site, deposits mapped one-half mile south of section 20 revealed a well developed caliche horizon (H.H. Doelling, per. comm., 1986). The older alluvial deposits are overlain by sandy soils and sand dunes derived from weathering of the local sandstone bedrock. Soils in the region are generally shallow and well drained due to the nature of their parent material. These soils have a high potential for blowing and drifting and are easily eroded when disturbed by construction and development. Soil surveys for the region indicate that soils in the northwest quadrant of the section may contain small quantities of gypsum (U.S. Soil Conservation Service, Henry Mountains Area Soil Survey).

GEOLOGIC HAZARDS

FLOODING

Flood hazard for the site is low. Sudden cloudburst storms may cause localized flows in small ephemeral drainages on the site. Modification of these drainages during and after construction could lead to the ponding of water for short periods of time.

GROUND WATER

No shallow ground water is present in unconsolidated deposits. The Entrada Sandstone is a poor aquifer, and springs in the Entrada would be small. Ground-water wells in the Entrada sandstone on Section 20 would be poor water sources for facilities located on the site.

EROSION

Surface erosion potential on the site is moderate. Gentle slopes and low annual precipitation help to reduce surface erosion, but sudden cloudburst storms combined with the lack of ground cover vegetation may pose localized erosion problems. Modification of small ephemeral drainage channels by development may also increase localized erosion. Surface erosion due to blowing and drifting sand may also be a potential problem to development.

SOIL PROBLEMS

In general, soils at the site are well drained. However, soil horizons plugged by thick caliche deposits can create localized drainage problems for individual wastewater disposal systems. Well developed caliche deposits may make excavations for foundations difficult. Soils in the northwest quadrant of section 20 may contain gypsum, which is potentially damaging to structures. When in contact with concrete, gypsum reacts with the lime in the cementcausing it to deteriorate. Secondly, gypsum is easily dissolved upon contact with ground and/or irrigation waters which can lead to differential settling and/or cracking of structure foundations.

SEISMICITY

Potential damage to structures on site from earthquake induced ground shaking is slight. The property is located in Zone U-1 as established by the State Seismic Safety Advisory Council (USSAC) and Uniform Building Code (UBC). Utah is divided into four USSAC or three UBC seismic zones, with Zone 1 being the least hazardous (lowest projected earthquake probability and magnitude) see attachment 2.

CONCLUSIONS AND RECOMMENDATIONS

Overall, the potential for geologic hazards at the site is low, with the exception of localized erosion and problems associated with the presence of gypsum and caliche in area soils. Facilities built on the site should be designed with these geologic limitations in mind. The UGMS recommends that site specific investigations be conducted for geologic hazards, foundation design, and wastewater disposal once facilities are actually planned for development on the site.

REFERENCES

Doelling, H.H., 1975, Geology and mineral resources of Garfield County, Utah: Utah Geological and Mineral Survey Bulletin 107, 175 p.

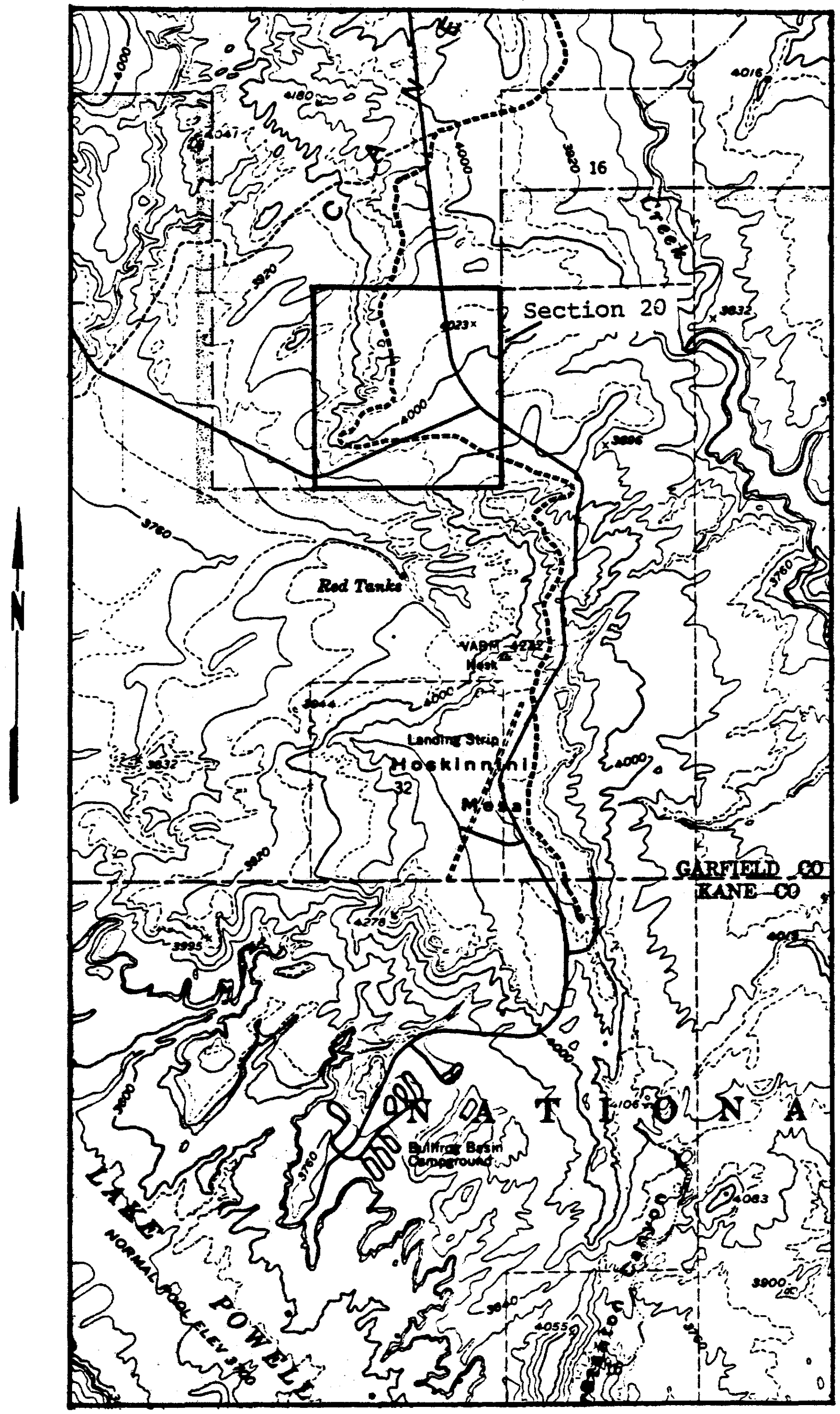
Downs, Joseph, and Swenson, Harold, Henry Mountains Area Soil Survey, U.S. Soil Conservation Service, unpublished data.

Hood, J.W., and Danielson, T.W., 1981, Bedrock aquifers in the lower Dirty Devil River Basin area, Utah, with special emphasis on the Navajo Sandstone: State of Utah Department of Natural Resources Technical Publication 68, 1143 p.

Hunt, C.B., 1953, Geology and geography of the Henry Mountains region, Utah: U.S. Geological Survey Professional Paper 228, 234 p.

Attachment No. 1, Job No. 86-008

T. 37 S.



Proposed State Lands and Forestry land acquisition.
Section 20 T. 37 S. R. 11 E.
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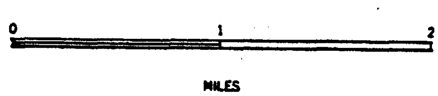

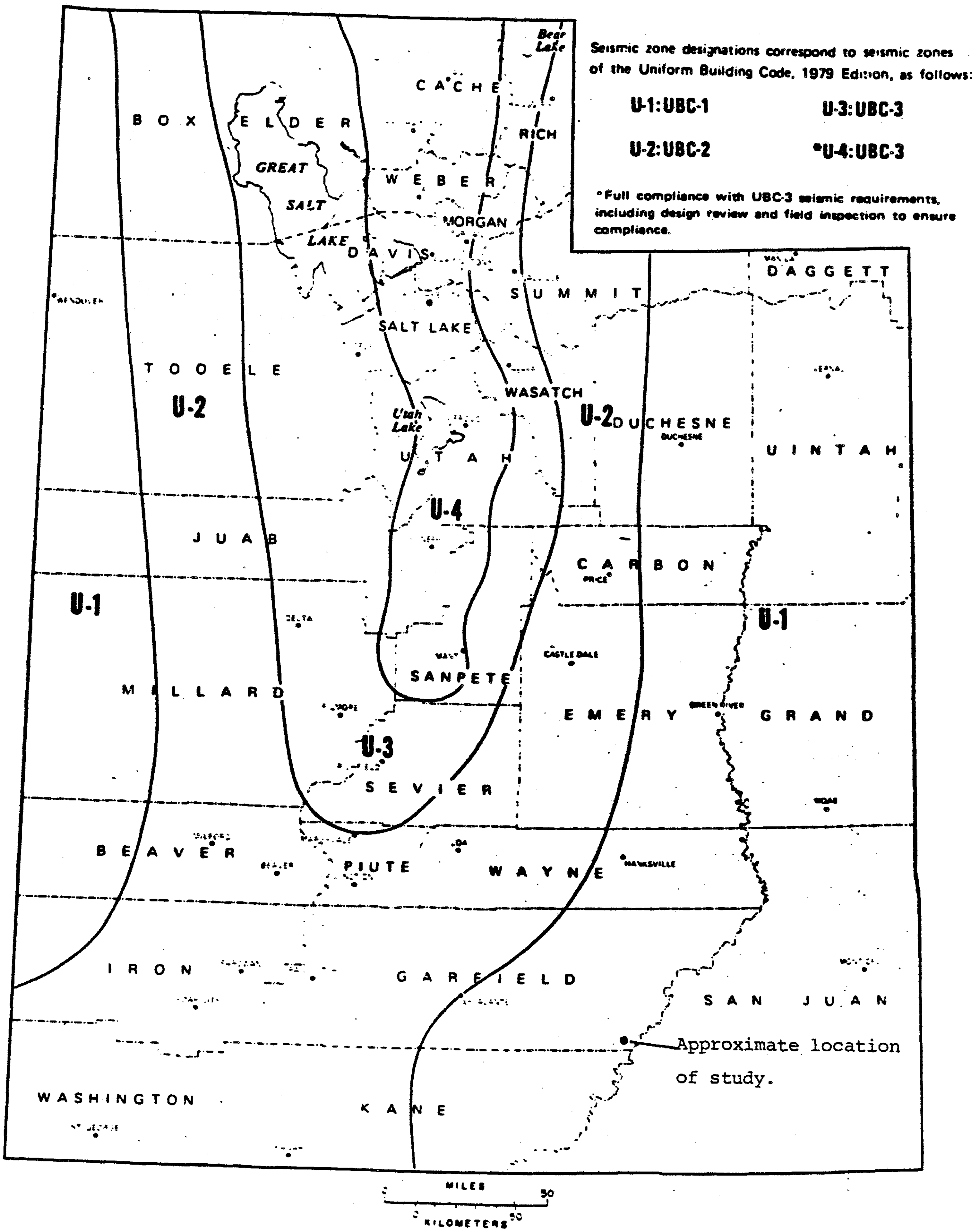

Figure 1
SEISMIC ZONES
January 1980
(Recommended by the Utah Seismic Safety Advisory Council)

Project:			Requesting Agency:
Investigation of Right-of-Way, Red Creek tributary, Duchesne County, Utah			Division of State Lands & Forestry
By: William F. Case	Date: 6/18/86	County: Duchesne	Job No.: 86-012/GH-4
USGS Quadrangle: Wolf Creek (1123)			

BACKGROUND AND SCOPE

Max M. Wall, Land Specialist, Department of Natural Resources, Division of State Lands and Forestry requested a geological assessment by the Utah Geological and Mineral Survey of the suitability of a road site right-of-way across state lands. The application for the right-of-way was filed with the State Lands office late in 1985. The site is located in Duchesne County, T. 1 S., R. 9 W., sec. 22, N1/2SE1/4, Uintah Special Meridian (attachment 1). The right-of-way will connect private lands with the Fruitland/Tabiona road which parallels Red Creek in the study area. The proposed right-of-way will run along the bottom of a Red Creek tributary valley, around the point of a intervalley ridge and across Red Creek (attachment 1). The Utah State Office of Planning and Budget suggested that the Division of State Lands request an on-site investigation of the area because of the following concerns: a) evidence indicating that soils in the area are highly erodible, b) reported slumping and springs at the Red Creek crossing site, and c) possible damage to the riparian community that exists along the drainage where the road is planned. The scope of work included a literature review, air photo analysis, and an on-site inspection. Robert C. Rasely, U.S. Department of Agriculture Soil Conservation Service State Geologist assisted in the field investigation. Field work was accomplished on 10 June, 1986.

GEOLOGY

The site is located on the north flank of the western part of the Uinta Basin, an east-west structural trough between the Uinta Mountains on the north and plateaus on the south. The Uinta Basin developed sometime during early Tertiary time. South of the study area, early Tertiary sediments which filled the Uinta Basin dip gently toward the axis of the basin. Folded, late Cretaceous rocks exposed on the north flank of the basin dip steeply toward the axis of the basin in the study area. The bedrock consists of Late Cretaceous Mesaverde Formation nonmarine sandstones interbedded with shale and coal. The shale and coal rock units are easily eroded and occur in valleys and talus slopes. Two abandoned coal mines are located on Red Creek approximately one mile downstream from the study area near the contact with the Early Tertiary Currant Creek Formation. The right-of-way follows the bottom of a strike valley eroded in a shale bed. The sandstones are medium-grained, well-sorted, and sufficiently indurated to form ridges, but are relatively soft and erodeable. Red Creek has incised a valley perpendicular to the strike of the sandstone units (attachment 1). The valley is relatively straight and may be fault controlled. An ancient debris-flow deposit which originated in an area of shale bedrock crosses the Fruitland/Tabiona road just south of the proposed Red Creek crossing. The deposit is vegetated by pine trees up to two feet in diameter.

HYDROLOGY AND SEDIMENT SOURCES

Precipitation in the area occurs mainly as thunderstorms that produce large amounts of water in a short time, a situation very conducive to erosion. Red Creek is a perennial stream which has a source area just north of the study area. A catchment basin on Red Creek, approximately 1/4 mile north (upstream) of the right-of-way contained water in aerial photos taken during August 1969 but has since silted up and breached. Water and sediment from Red Creek eventually reach Starvation Reservoir via the Strawberry River. The tributary through which the proposed right-of-way will run is intermittent. It was flowing during the field investigation. A few springs issue from the toe of shale talus slope along the east side of the Fruitland/Tabiona road near the study area. A cold spring near the proposed Red Creek crossing issued from a carbonaceous shale which had a distinct sulphurous odor. Sediment sources for Red Creek in the vicinity of the study area include: a) Late Cretaceous Mancos Shale in the headlands, b) sediment from the catchment basin of the breached earthen dam, c) soil mantle failures due to undercutting by Red Creek, d) bank deposits of Red Creek, e) sandstones and shales of the Late Cretaceous Mesaverde Formation, f) sediment derived from bank erosion and soil mantle failures in tributary valleys, g) debris-flow deposit, and h) coal mine tailings. The high sediment load of Red Creek has caused enough concern downstream to have initiated a critical erosion project (Soil Conservation Service, 1986) to begin mitigating the erosion problem. Red Creek is a major source of sediment and salt entering Starvation Reservoir.

SUMMARY

The proposed right-of-way through the tributary valley of Red Creek is over soft shale bedrock and stream-bank deposits. Both are highly erodeable and if disturbed would contribute to the already high sediment load of Red Creek. If a road is cut on the steep sandstone slopes, the thin soil mantle and poorly indurated sandstone bedrock will likely fail. Such slope failures would contribute to the Red Creek sediment load. There is evidence of mantle failure due to oversteepening by erosion upstream from the proposed site. No slumps were discovered at the crossing site as was reported by the Office of Planning and Budget. A nick point in the gradient of Red Creek was noticed at the contact between the Mesaverde Formation and the Currant Creek Formation. Red Creek may be adjusting its gradient to increased flow during the past few years or adjusting to something that has affected base level or gradient downstream. In the future, headward erosion may increase the gradient of Red Creek which will increase stream velocity and erosion of banks and canyon walls near the study area.

CONCLUSIONS AND RECOMMENDATIONS

The slopes and valley bottoms of the tributary canyon and Red Creek are sensitive to oversteepening and erosion. Without appropriate engineering, i.e. properly designed cut-and-fill slopes and drainage, road construction in the study area would increase the already high sediment load of Red Creek. There is evidence of high seasonal flows and erosive activity along Red Creek. Therefore, it is recommended that the Red Creek crossing consist of a bridge spanning between canyon walls with abutments in sandstone to protect the riparian zone and to maintain the integrity of the structure during floods and protect it from erosion.

SELECTED REFERENCES

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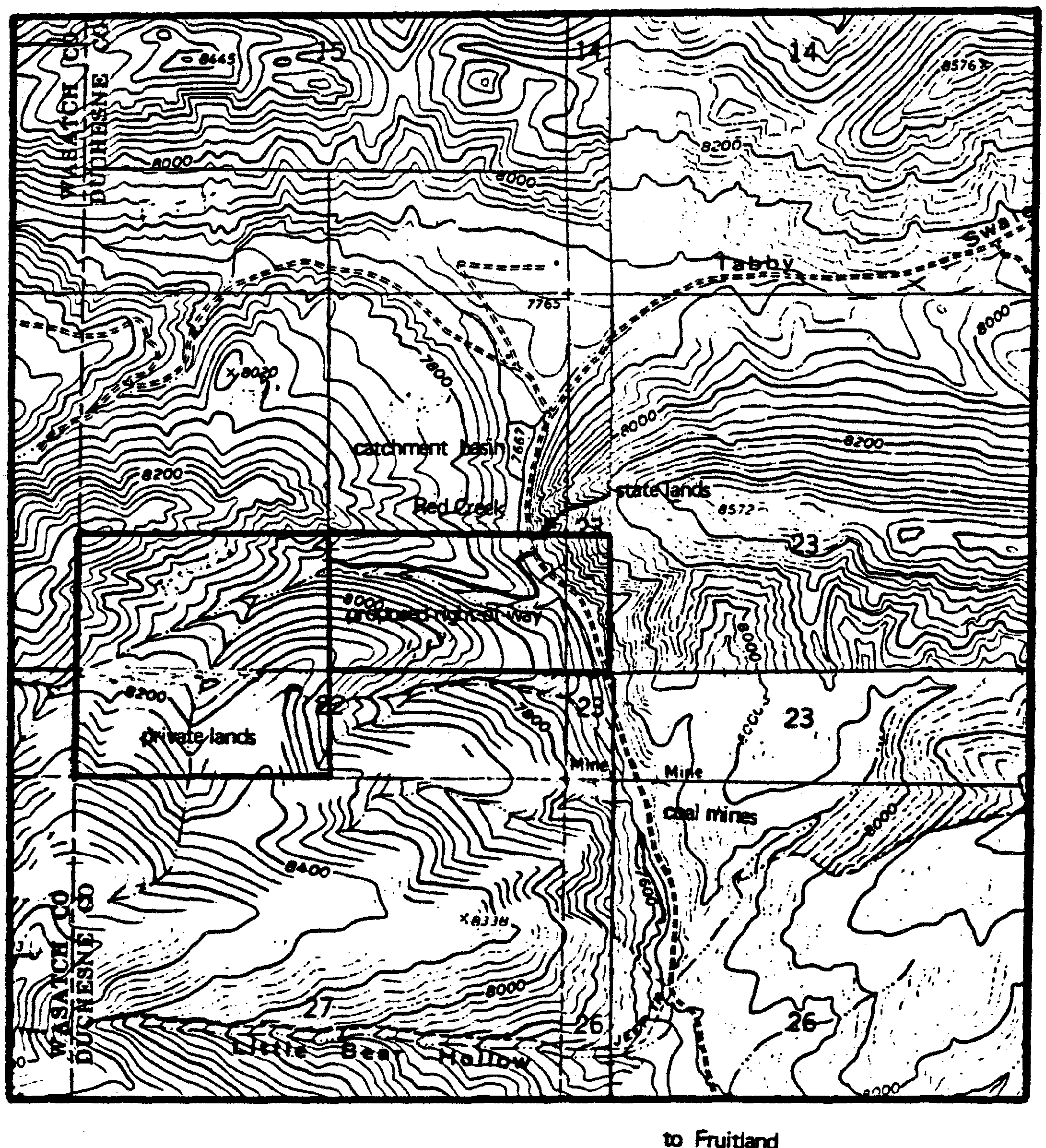
Soil Conservation Service, 1986, Preauthorization report Sand Wash critical erosion area project: U.S. Department of Agriculture Soil Conservation Service, 17 p.

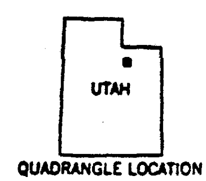
White, R. S., 1985, Erosion/sedimentation yield model Sand Wash, Duchesne County, Utah: U.S. Department of Agriculture Soil Conservation Service, Davis, California, 10 p.

Attachment 1, Job No. 86-012

Base map from USGS 7½' topographic quadrangles Wolf Creek, Raspberry Knoll, Hanna, and Tabby Mountain, Utah



Location Map



Scale 1" = 2,000'

Utah Geological and Mineral Survey

Site Investigation Section

Project:			Requesting Agency:
Salt Lake County Fault map update			Salt Kake City Dept. of Public Works
By: W. Mulvey H. Gill	Date: 6/25/86	County: Salt Lake	Job No.: 86-013 /GH-5
USGS Quadrangle: Draper (1171), Sugarhouse (1202), Fort Douglas (1253), North Salt Lake (1254)			

PURPOSE AND SCOPE

In response to a request from the Salt Lake City Department of Public Works (DPW), the Utah Geological and Mineral Survey (UGMS) has reviewed current literature pertaining to mapped faults in Salt Lake County. The purpose of the review was to update Salt Lake City water system maps. The Wasatch fault zone had been located previously on these maps (in red). The UGMS has replotted the fault in green using the most current fault traces mapped by other researchers in the Salt Lake Valley (Scott and Shroba, 1985). The following discussion addresses topics relating to surface faulting events along the Wasatch fault in the Salt Lake Valley.

CHARACTERISTIC EARTHQUAKES AND FAULT SEGMENTATION

Detailed paleoseismological investigations involving exploratory trenching and geomorphic analysis of tectonic features along the Wasatch fault zone is the basis for the characteristic earthquake model (Schwartz and Coppersmith, 1984). The model suggests that individual faults and/or fault segments may generate essentially the same size or characteristic earthquakes, having a narrow range of magnitudes near the maximum. From data collected at selected sites along its 230 mile (370 km) length, researchers determined that the surface displacement per faulting event was from 5.2 to 8.5 feet (1.6 to 2.6 m) with the average being 6.6 feet (2 m). Differences in fault morphology and timing of faulting events along the Wasatch fault support the theory that large faults such as the Wasatch fault are composed of a number of segments. These segments act independently, with only one segment being affected during a surface rupturing earthquake. The investigations suggest that the Wasatch fault is composed of six to ten segments, with each segment made up of single or multiple fault traces. Segments range from 18.6 to 43.0 miles (30 to 70 km) in length. The Salt Lake Valley segment is thought to be 22 miles (35 km) long, bounded on the north by the Ensign Peak salient and the south by the salient at the Point of the Mountain.

RECURRENCE INTERVALS/DISPLACEMENT

Along the Salt Lake Valley segment, net displacement of 48 feet or 6.6 feet per event (14.5 m or 2 m per event) on a moraine with an estimated age of 19,000 ± 2,000 years before present (bp) at the mouth of Bells Canyon gives a recurrence interval of 2400-3000 yrs (Schwartz and Coppersmith, 1984). Recurrence intervals in these areas are not as well constrained as other segments along the Wasatch fault but agree overall with recurrence intervals for other section of the fault. Values for surface displacement are based on evidence derived from trenching and mapping of fault scarps near the mouth of Little Cottonwood Canyon. The study of fault scarps produced by past surface faulting events can be used as the basis for approximating the pattern, location, and amount of surface faulting accompanying earthquake in the future.

DESCRIPTION OF FAULTS AND SUSPECTED FAULTS

The Salt Lake Valley segment of the Wasatch fault zone is composed of three separate fault systems, they are from north to south the: Warm Springs, East Bench, and Wasatch faults. The Warm Springs and East Bench faults are much less complicated than the Wasatch, which has a zone of branching faults, grabens, and back-tilted terrain up to 1640 feet (500 m) in width. Two other faults, the Virginia Street and the University Hospital, along with a zone of deformed sediments in the downtown area are present along the Salt Lake segment. These features will be discussed in the following text.

WARM SPRINGS FAULT

The Warm Springs fault forms the northern portion of the Salt Lake segment. The main trace of the fault bounds the Ensign Peak salient, the west-trending spur of the Wasatch Range immediately north of Salt Lake City. Much of the evidence for defining the age of faulting in the area has been removed by quarrying and/or urban development. Therefore, much of the interpretation and observations were made from G.K. Gilbert's work in the area during the late 1800's. Evidence from those investigations suggested that the scarp in the area represented three faulting events, the last of which may have been quite recent, possibly less than a few thousand years.

EAST BENCH FAULT

This prominent scarp trends northwest to southeast along 1300 East to Highland Drive. In places the scarp is 164 feet (50 m) high, most likely representing pre- as well as post-Lake Bonneville faulting events. Scott and Shroba (1985), state that most likely half the total scarp height may relate to post-Lake Bonneville faulting. The fault has been active throughout Quaternary time, more so than the fault traces to the east along the mountain front. Evidence that supports this theory is the shallow depth to the bedrock along the mountain front. Had recent faulting displaced the bedrock, post-faulting erosion would have covered the downthrown portion of the fault with large amounts of sediment.

WASATCH FAULT ZONE SOUTH OF MT. OLYMPUS

The Wasatch fault zone south of Mt. Olympus is the most complex of the three systems, composed of branching fault scarps of post-Lake Bonneville age (Scott and Shroba, 1985). In comparison to the East Bench fault scarps, the Wasatch fault south of Mt. Olympus is quite close to the mountain front. Scarps in this zone are relatively fresh in appearance apparently being the youngest faulting events on the Salt Lake segment. The fault zone runs from just north of Casto Springs to Corner Canyon along the Point of the Mountain salient. In the fault zone between Big

Cottonwood Canyon and Bells Canyon numerous well developed grabens 328 to 656 feet (100 to 200 m) wide are visible. Faulting in this region has back-tilted the west sloping late-Holocene and Pleistocene fan-delta deposits to the east. Detailed investigations by Swan and others (1980) at the mouth of Little Cottonwood Canyon show that several surface faulting events occurred along this portion of the fault since 19,000 bp, and possibly one to two more events since 8,000 bp.

VIRGINIA STREET FAULT

A striated fault plane in Tertiary bedrock was exposed is an abandoned quarry just north of Virginia St. in northeast Salt Lake City (Pavlis and Smith, 1979). In 1966, Van Horn had observed probable faulting of Lake Bonneville sediments at this location. These sediments have since been removed by development in the area. No estimate of the total offset across the fault was made, but a marl bed was offset several centimeters. The lack of a conspicuous fault scarp along strike beyond the abandoned pit suggests that any vertical offset of the Bonneville lake cycle is probably small (Scott and Shroba, 1985).

UNIVERSITY HOSPITAL FAULT

Faulted alluvial deposits were observed beneath undisturbed Bonneville Lake cycle sediments in the excavation for a University of Utah Medical Center addition (Scott and Shroba, 1985). Displacement of the faulted units averaged less than 3.3 feet (1 m) but in some areas was more than 8.2 feet (2.5 m). Because the overlying transgressive sediments from the Bonneville Lake cycle were undisturbed, the latest movement on this fault must have occurred prior to that time.

LATERAL SPREAD/GROUND FAILURES

Faulted and deformed deposits were observed in Salt Lake City excavations for the Hall of Justice and other buildings some blocks to the northeast (Scott and Shroba, 1985). Due to their nature and form these ground failures are thought to relate to lateral spreading and not directly to tectonic faulting. Features such as these can however, be initiated by earthquake induced ground shaking. (HJ on map).

Selected References

Cluff, L.S., 1980, Wasatch fault zone, Utah earthquake potential, fault mechanisms, and related earthquake hazards: San Francisco, Woodward Clyde Consultants, 17 p.

Pavlis, T.L., and Smith, R.B., 1979, Slip vectors on faults near Salt Lake City, Utah, from Quaternary displacements and seismicity, in Arabasz, W. J., and others, eds., Earthquake studies in Utah 1850-1978: Special publication of the University of Utah Seismograph Station, Salt Lake City, p. 375-381.

Schwartz, D.P., and Coppersmith, K.J., 1984, Fault behavior and characteristic earthquakes: Examples from the Wasatch and San Andreas fault zones: Journal of Geophysical Research, v. 89, no. B7, p. 5681-5698

Scott, W.E., and Shroba, R.R., 1985, Surficial geologic map of an area along the Wasatch fault zone in the Salt Lake Valley, Utah: U.S. Geological Survey Open-File Report 85-448, scale 1:24,000.

Swan, F.H., III, Schwartz, D.P., and Cluff, L.S., 1980, Recurrence of moderate to large magnitude earthquakes produced by surface faulting on the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 70, p. 1431-1462.

Project: Overview of communication power line routes, Logan Peak, Cache County, Utah			Requesting Agency: Utah Dept. of Public Safety and University of Utah
By: W.F. Case G.E. Christenson	Date: 7/2/86	County: Cache	Job No.: 86-016 /GH-6
USGS Quadrangle: Logan (1444); Logan Peak (1443); Temple Peak (1467); Boulder Mtn. (1442)			

Steve Proctor (Utah Department of Public Safety), Ed Ridges (University of Utah), and Gary E. Christenson and William F. Case (Utah Geological and Mineral Survey) participated in a helicopter reconnaissance on June 26, 1986, to evaluate geologic conditions along three possible routes for a power line to a proposed communication facility on Logan Peak, Cache County, Utah. Mill Hollow and Providence Canyon are proposed routes from the north and west and a route from the east including Cowley Canyon was also considered (attachment 1). A route up Dry Canyon on the northwest was flown but is not being considered at this time. The routes are located on the following USGS 7 1/2 minute topographic quadrangles; Logan Peak, Logan, Boulder Mountain, and Temple Peak, Utah.

Mill Hollow, Dry Canyon, and Providence Canyon are all steep, narrow canyons which provide the shortest routes to the top of Logan Peak. These canyons are characterized by steep bedrock ledges and cliffs of Paleozoic limestone and sandstone along flanks and upper parts (Williams, 1958), with canyon bottoms filled to variable depths with alluvium, avalanche deposits, and debris-flow deposits. Many avalanches dating from the winter of 1985-86 were evident in all three canyons, originating near ridges and reaching valley bottoms. Conditions for avalanches were apparently very good in 1986, and these conditions will likely occur again during the design life of the power line. The avalanche deposits consist of a mixture of snow, rock, soil, trees, and other vegetation. No major active landslides were observed along the three routes. Because of the steep canyon walls and stream gradients, however, flash flooding and debris-flows are a probable canyon hazard.

The route up Cowley Canyon and west to Logan Peak follows existing roads and jeep trails. The route does not follow canyon bottoms except for the easternmost segment in Cowley Canyon. This section is steep-sided and the road in the bottom crosses the creek several times. Problems with flash flooding and debris flows may develop in this area, although none were noted during the reconnaissance. Most of the remainder of the route traverses low ridges and hillsides through bedrock consisting of less resistant Tertiary rock types (Williams, 1958). Localized slumping with at least one debris flow and avalanche were noted in the steeper slopes in these deposits, although none affected the proposed route. The bedrock is generally buried by soil, colluvium, and other unconsolidated deposits except on ridge crests. Bedrock exposures were evident along some parts of the route that traverse ridges in this area. The final approach to Logan Peak is not as steep as other routes but will encounter well-indurated bedrock in the uppermost part. No significant avalanche hazard was noted on this route.

Based on observations made during the 2-hour helicopter reconnaissance, the following conclusions were made regarding geologic hazards along each route.

Mill Hollow, Dry Canyon, and Providence Canyon:

1. Avalanche hazard is sufficiently severe to preclude the use of overhead power lines.
2. Avalanches may block or remove portions of any maintenance roads serving the power line, but in general, would not be a threat to buried facilities.
3. Shallow bedrock requiring blasting to excavate will be encountered in upper canyon areas.
4. Slopes are sufficiently steep in upper canyon areas that backfill in any excavated trenches would be subject to severe erosion hazards.
5. Flash flooding and debris flows may cause local scour and deposition in valley bottom areas and affect buried facilities.
6. No significant active landslides were noted.

Cowley Canyon and the eastern approach:

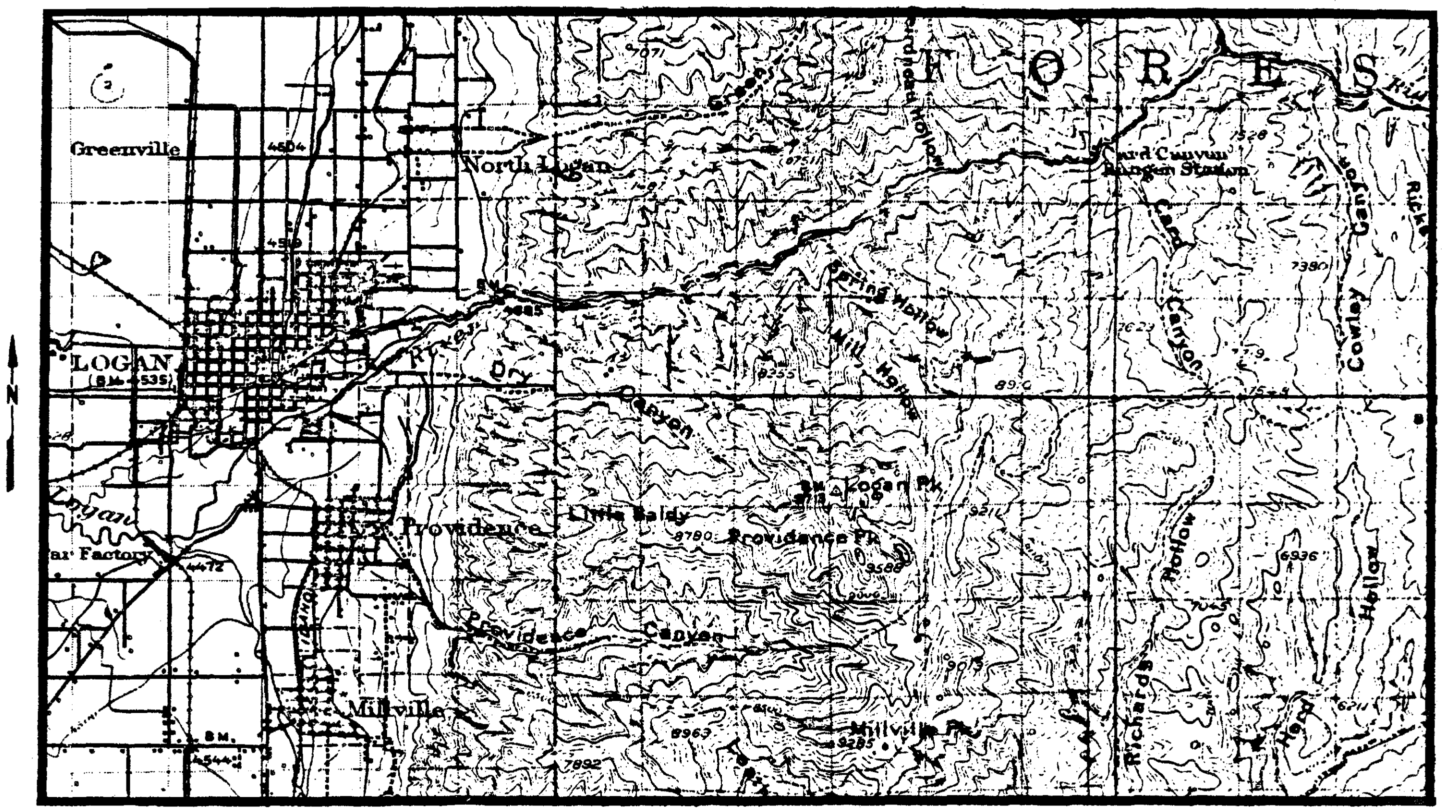
1. Flash flooding may occur along the Cowley Canyon segment where the road crosses the canyon floor.
2. Active slumps occur in the steep slopes of upper Cowley Canyon and from Cowley Canyon to the base of Logan Peak, although no slumps affecting the road and proposed route were noted.
3. Shallow bedrock may be encountered along the route, but it should be rippable with conventional equipment.
4. The approach from the base to the top of Logan Peak is not as steep and has fewer ledges and cliffs compared to other routes, although the final segment will be across a zone of shallow bedrock which may require blasting to excavate.
5. No significant avalanche hazard was noted.

It is difficult to assess the relative suitability of these routes without detailed engineering geologic studies and exact route locations. The steep, rugged terrain of the Mill Hollow, Dry Canyon, or Providence Canyon routes will make both construction and maintenance of the line difficult and subject to geologic hazards. Considering ease of maintenance and likelihood of geologic hazard-related problems, it appears that the Cowley Canyon route is the most feasible. However, careful attention must still be paid to stream crossings and slope conditions to avoid possible flood, landslide, erosion, and avalanche problems. It is recommended that engineering geologic studies be performed along the route selected to identify geologic hazards so that mitigating measures can be taken during construction.

REFERENCE

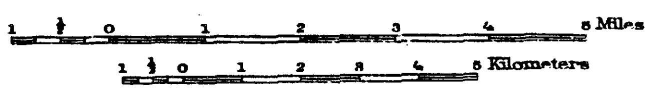
Williams, J. S., 1958, Geologic atlas of Utah, Cache County: Utah Geological and Mineralogical Survey, Bulletin 64, 104 p.

Attachment 1. Job no. 86-016



Location map for Logan Peak.

Scale:



Project:			Requesting Agency:
Soil Investigation for Utah Occupational Saftey and Health Division for a trench at 5500 West and 4700 South			Industrial Commission of Utah
By: Hal E. Gill	Date: 10-29-86	County: Salt Lake	Job No.: GH-7
USGS Quadrangle: Magna (1214)			

October 29, 1986

Ronald V. Ludlow
Program Director
Industrial Commission of Utah
UOSH Division
P.O. Box 45580
Salt Lake City, Utah 84145

Dear Mr. Ludlow:

In response to your request the soil sample (B7361-001-87) submitted to this office, and obtained from 5500 West and 4700 South, West Valley City, Utah, has been described. The soil was classified according to the Unified Soil Classification System following procedures outlined in ASTM Standard D2488-84, "Standard Practice for Description and Identification of Soils (Visual Manual Procedure)". No laboratory tests were performed on the sample. The soil classification is as follows:

> Clayey sand with gravel (SC); 50 percent subrounded to subangular, fine to coarse sand; 20 percent subrounded to rounded, medium to coarse gravel; 30 percent clay fines with low plasticity, slow dilatancy, low dry strength and toughness; strong reaction to 10 percent hydrochloric acid; maximum gravel size 2 inches; moist.

On October 15, 1986, the trench site from which the soil sample was obtained was inspected. Because the pipeline project for which the trench was excavated is ongoing, the exact location from which the soil sample was collected had been backfilled. The trench was approximately 7 feet deep. On the day of the inspection, the upper 5 feet of the trench wall had been laid back to a slope of approximately 0.5:1 and the lower 2 feet were vertical. Geologic deposits in the area are Provo Formation and younger lacustrine sediments of Lake Bonneville, comprised chiefly of sand and gravel in beach deposits, bars, spits, and deltas. Soils exposed in the trench wall were as follows:

0.0' - 1.0'	Lean clay with gravel and sand (CL); brown, 15 percent subrounded, medium to coarse gravel; 20 percent subrounded-subangular, fine to medium sand; 65 percent fines; low plasticity, stiff, dry; road base fill, stiff due to compaction by vehicles, however, numerous voids were still present between gravel clasts.
1.0' - 3.0'	Clayey sand with gravel (SC); this horizon appears to be the same as sample (B7361-001-87) sent to our office. See previous soil classification for description; soil density low to medium in the trench wall, the wall was laid back and soils were disturbed making them less dense.
3.0' - 4.0'	Silty sand (SM); light brown, 5 percent subrounded cobbles; 15 to 20 percent silt fines; 80 percent subrounded to subangular, fine to coarse sand; low density, nonplastic, weakly indurated, strong reaction to 10 percent hydrochloric acid, dry; 6-inch to 1-foot thick calcified zone interbedded within clayey sand unit.
4.0' - 5.0'	Clayey sand with gravel (SC); same as 1.0' - 3.0' above.
5.0' - 7.0'	Lean clay with sand (CL); yellow brown, 15 percent fine sand; 85 percent fines; medium plasticity, firm, moist; appeared stable in 2-foot vertical cut.

The soil sample and soils observed at the trench site do not conform to any of the four categories of soil/rock presented in your letter of October 7, 1986. In addition, we are not familiar with the use of the term "compaction" when referring to in place, natural soils. As generally used in engineering and geologic terminology, compaction applies to the densification of a soil by the application of mechanical effort. In the natural state, soils can exhibit either density (if course grained) or consistency (if fine grained) but not compaction. Therefore, in our view neither the sample submitted to our office or the soils observed in the trench are compacted. If we can be of any further assistance please do not hesitate to contact us.

Sincerely,

Harold E. Gill

Harold E. Gill, geologist
Site Investigation Section

Project:		Requesting Agency:
Soils investigation for the State Street and 2100 South area, Salt Lake City, Utah.		Utah UOSH

By:	Date:	County:	Job No.:
R.H. Klauk	9-17-86	Salt Lake	86-018 /GH-8

USGS Quadrangle: Salt Lake City South Quadrangle (1213)

In response to a request from Don Anderson, Compliance Supervisor Industrial Commission of Utah, UOSH Division, the Utah Geological and Mineral Survey (UGMS) investigated a utility trench excavated on the Salt Lake County office complex site (State Street and 2100 South) in Salt Lake City, Utah on September 15, 1986. The purpose of the investigation was to determine the type of soils comprising the trench walls. At the time of the investigation the trench was backfilled and, therefore, only a review of existing soils information for the area could be conducted.

Gill (1985) reported that soils in a large excavation for the new Salt Lake County office complex consisted of 7 feet of fill (silty clay) overlying 10 feet of moist silty clay to a total depth of 17 feet. The inspection could not be conducted earlier in the year because the contractor was pumping ground water out of the excavation. Seiler and Waddell (1984) report shallow ground water to be from 5 to 10 feet below the surface at this location. The walls of the excavation were sloped to prevent collapse. Van Horn (1979) identified soils in this area as marsh deposits consisting of silt and clayey silt (locally pebbly and sandy). He states that these soils "probably would be unstable during earthquakes and in steep-walled excavations."

It is very conceivable that the soils described above would have been exposed in the trench. Furthermore, part of the excavation extended into the roadway beneath the pavement, and would have exposed unconsolidated fill in the upper levels of the trench walls.

References Cited

Gill, H.E., 1985, Report of excavation inspection county office complex: unpublished Utah Geological and Mineral Survey log 85-06, 1 p.

Seiler, R.L., and Waddell, K.M., 1984, Reconnaissance of the shallow-unconfined aquifer in Salt Lake Valley, Utah: U.S. Geological Survey Water-Investigations Report 83-4272, 34 p.

Van Horn, Richard, 1979, Surficial geologic map of the Salt Lake City south quadrangle, Salt Lake County, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1173, scale 1:24,000.

Project: Green Valley slope failure investigation			Requesting Agency: Utah CEM/Washington County Sheriff
By: G.E. Christenson	Date: 9/5/86	County: Washington	Job No.: H86-1/GH-9
USGS Quadrangle: St. George SW (38)			

INTRODUCTION

At the request of Ken Campbell, Washington County Sheriff, and the Utah Division of Comprehensive Emergency Management, an investigation was made of a slope failure in the Green Valley area of St. George (attachment 1). The scope of investigation included a literature review, analysis of air photos, and field reconnaissance. The field reconnaissance was performed on August 18, 1986, with Sheriff Campbell, Tony Hafen (Washington County Civil Defense Director), and various representatives of the Green Valley Sports Village, including the engineer and contractor for the subdivision. The UGMS was contacted because the slope failure had undermined the patio portion of Building U of the Green Valley Sports Village, and the sheriff was concerned about the threat to life posed by the failure. At the time of the investigation, Building U had been evacuated. Water and sewer service to the building were cut off by the slope failure.

GENERAL GEOLOGY

The slope failure occurred on the northeast-facing slope of a bench south of the Santa Clara River in St. George (attachment 1). The bench is a Pleistocene-age stream terrace and is underlain by sand and gravel deposited on an erosion surface cut on the Petrified Forest Member of the Triassic-age Chinle Formation (Christenson and Deen, 1983). The gravel exceeds 8 feet thick as exposed in the main scarp of the slope failure, and reportedly is as much as 30 feet thick in the area. The gravels are strongly cemented with calcium carbonate in the upper part, but become less strongly cemented with depth. The underlying Chinle Formation is composed of green and purple bentonitic shale and dips gently to the northeast. The contact between the gravel and shale was not exposed in the area, but is probably irregular with local channel cuts and fills and dips to the east toward the river.

DESCRIPTION AND HISTORY OF SLOPE FAILURE

The slope failure occurred in the back yard of Building U of the Sports Village, undermining the patio and severing utility lines. According to the engineer for the subdivision, problems were first realized when a water line behind Building U broke around July 5.

This was repaired, and the geotechnical firm of J.H. Kleinfelder and Associates was called in to perform a study and make recommendations to stabilize the area. Kleinfelder drilled several test holes in the area about 3-4 weeks ago and is in the process of preparing a report. However, sliding occurred again on Friday, August 15, rupturing water and sewer lines. Principal movement occured at or following this time, but was apparently continuing at the time of investigation. The patio slab at Building U had been undermined and was supported by jacks between the slab and the top of the slide. Continued movement was indicated by development of a gap between one of the jacks and the slab since it had last been tightened. It was decided by the developer that action needed to be taken to stabilize the slide prior to completion of the Kleinfelder report. At the advice of Ralph Rollins of the engineering consulting firm of Rollins, Brown, and Gunnell, a keyway was being excavated across the toe of the slide to a depth of 10-15 feet, presumably keyed into shale beneath the basal slide plane, and backfilled with gravel. The fill is to act as a drain and buttress to prevent further movement. The face of the slope failure is also being graded to a smooth surface to fill in cracks and prevent infiltration of water during rainstorms.

The main headwall scarp of the landslide extends the length of Building U and continues northwestward beyond the adjacent Building T. The slope failure is a rotational slump about 270 feet wide and about 100-150 feet long. The head has dropped about 8 feet below original grade. The toe area had been disturbed by repair activities at the time of investigation, but reports indicate that the toe was just above the sand traps on a golf course near the base of the slope. Transverse cracks and minor scarps occur within the slide mass with many cracks open to depths of 3-4 feet or more. The PVC casing in a hole drilled by J. H. Kleinfelder and Associates in the back yard of Building U prior to movement was reportedly sheared off at a depth of about 30 feet. The hole is presently on the head of the slide about 25 feet northeast of the main scarp, indicating that the slide plane at this point is at a depth of 30 feet. At the northwestern end of the keyway trench, the basal slide plane of the left flank of the slump was exposed. The contact between the slide mass, characterized by broken and sheared purple shale, and the underlying green shale was marked by a prominent slickensided slide plane. At this end of the keyway, the slide plane was 3-4 feet below the ground surface. A spring producing about 1 gallon/minute was present to the southeast near the center of the slide at about the level of this slide plane. At the time of original sliding, water was also reported to have been discharging onto the golf course from the toe of the slide near the base of the slope.

CAUSE OF SLOPE FAILURE

The bentonitic shales of the Chinle Formation are prone to failure in slopes, particulary when wet. Modern and Pleistocene-age slope failures in this formation are evident in many areas around St. George, and one occurred in a road cut in Green Valley about 1/4 mile northwest of this site (Christenson and Deen, 1983). The presence of this shale in the slope was the principal cause of the slope failure. Movement was probably initiated as ground water perched on the shales underlying the terrace gravels saturated and reduced the shear strength of the shale to the point that it could not support the weight of material in the slope. Once failure initiated, additional water introduced into the slide by broken water and sewer lines probably contributed to further movement.

There is little evidence that the slopes in the area had failed previously, and long-time residents report that no natural seeps or springs were present on slopes prior to development on the benchtop. The bench is of limited areal extent and collects no water except that which is applied to the surface either through precipitation or irrigation. The gravels underlying the surface contain a relatively impermeable calcium carbonate-cemented (caliche) caprock several feet thick, and it is unlikely that significant amounts of surface water penetrated this zone prior to development. However, this caprock has been extensively broken up and removed during development, and infiltration of water from both precipitation and lawn watering has probably increased significantly. This water percolates downward through the gravel to the underlying shale, forming a perched water table and wetting the upper shale layers. The gravel/shale contact probably dips to the east, allowing water to migrate laterally toward the northeast-facing slopes. Vegetation on the slope indicated that some seepage had been occurring. Thus, the most probable cause of the slope failure was the introduction of ground water into slide-prone shales underlying the subdivision. Precipitation records from the Utah State Climatologist indicate that precipitation totals for June, July, and early August were at or below normal, with principal rainfall occurring July 21-24 (0.69 in), August 6 (0.13 in), and August 14 (0.15 in.). Rainfall, thus does not appear to be a significant source of ground water, and water applied to the surface by man is a more likely source. The slope failure may have occurred in this area because more water was applied in the immediate vicinity or because a low area in the upper surface of the shale exists here, causing water from throughout the subdivision to collect and saturate this slope.

Other common causes of slope failures such as removal of support at the base of the slope or weighting the top of the slope do not appear to be important factors. The head of the slide was beneath the patio floor slab but did not undercut major bearing walls of the building, indicating that the weight of the building was not a major contributing factor. Fill material had been placed beneath the building and onto the slope to extend the back yard. This may have contributed somewhat to weighting the head of the slide. Cracks connecting with the main scarp of the slope failure extend to the northwest, beyond Building T, through fill material at the top of the slope, indicating that instability extends beyond the main slide area. The thickness and steepness of fill placed on the slopes behind buildings appears to increase to the northwest and the entire slope may be potentially unstable.

RECOMMENDATIONS

To stabilize the slope failure, many options are available including: 1) improved drainage to keep surface water from infiltrating into gravels and into the slide mass, 2) reduction in lawn watering, 3) placement of a buttress fill at the toe of the slide as is presently underway at the site, 4) placement of piles or caissons through the slide into more stable underlying material, 5) removal and replacement with engineered fill, 6) placement of horizontal drains or pumps to remove water from the slide plane, or 7) any combination of these. It is recommended that a detailed site investigation be performed to define the slide plane and to quantify important parameters such as strength of materials, magnitudes of driving and resisting forces, and the role of ground water. Such a site investigation has at least in part already been performed by Kleinfelder, although the principal failure had not occurred at the time of their study. The Kleinfelder report should be reviewed to assess its adequacy and applicability under present conditions.

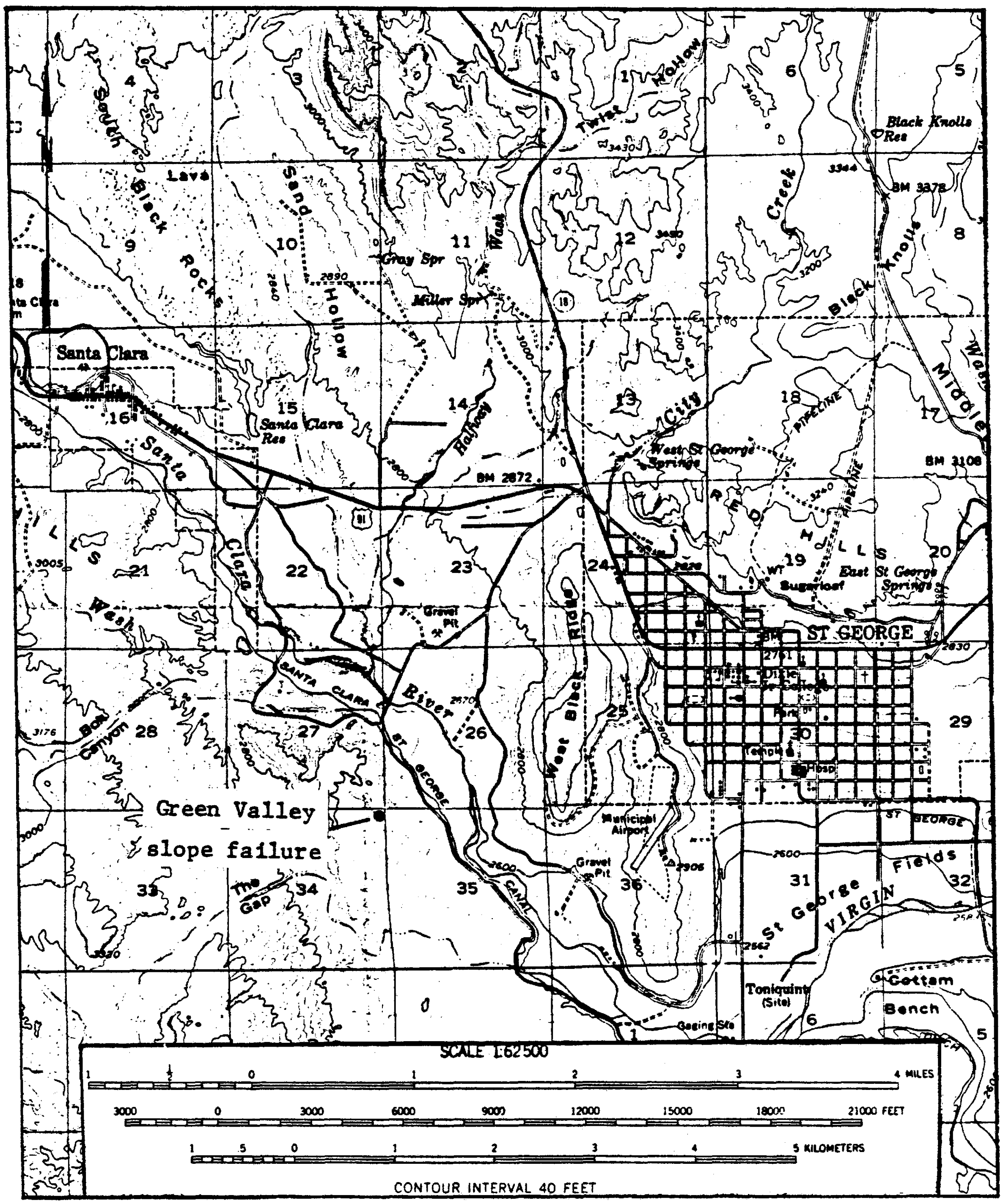
It is also recommended that a study be performed of the entire slope to determine if other areas are unstable. As stated above, cracks are present in the slope below Building T (west of the slide), which indicate that this slope is unstable. The study should identify any springs, seeps, or other cracks along the slope. It should also include boreholes along the top of the slope to determine the depth to shale, depth to ground water (if present), and moisture content and strength of the shale. An evaluation of the slope stability based on these investigations should then be made and, if necessary, recommendations to mitigate potential slope stability problems should be included. The potential for unstable slopes exists throughout the Green Valley area on all hillsides underlain by the Petrified Forest Member of the Chinle Formation. The extent of this unit is mapped in Christenson and Deen (1983), and this should be consulted to identify where potential problems may occur. Any further development in such areas should be preceeded by detailed reports addressing these problems with recommendations to mitigate the associated hazards. The reports should be prepared and reviewed by qualified geologists and engineers prior to approval by the city.

REFERENCE

Christenson, G.E., and Deen, R.D., 1983, Engineering geology of the St. George area, Washington County, Utah: Utah Geological and Mineral Survey Special Studies 58, 32 p.

Attachment 1 Job No. H86-1

Base map from: USGS 15' Topo Quad
St. George, Utah



Location Map, Green Valley slope failure

Utah Geological and Mineral Survey

Hazards Section

APPENDIX

List of 1986 Applied Geology Publications

Special Studies

Lund, W. R., editor, 1986, Engineering geologic case studies in Utah: Utah Geological and Mineral Survey Special Study 68, 94 p.

Reports of Investigation

Klauk, R. H., 1986, Engineering geology for land-use planning for Research Park, University of Utah, Salt Lake City, Utah: Utah Geological and Mineral Survey Report of Investigation 204, 30 p.

Klauk, R. H., and Mulvey, W. E., 1986, Engineering geology for land-use planning for a parcel of state-owned land east of Washington, Washington County, Utah: Utah Geological and Mineral Survey Report of Investigation 212, 34 p.

Lund, W. R., and Case, W. F., 1986, Geologic evaluation of a proposed wastewater treatment plant site, Washington County, Utah: Utah Geological and Mineral Survey Report of Investigation 206, 22 p.

Mulvey, W. E., compiler, 1986, Technical reports for 1985, Site Investigation Section: Utah Geological and Mineral Survey Report of Investigation 208, 278 p.