UTAH GEOLOGICAL AND MINERAL SURVEY

REPORT OF INVESTIGATION

NO. 208

TECHNICAL REPORTS FOR 1985
SITE INVESTIGATION SECTION

Prepared by

UTAH GEOLOGICAL AND MINERAL SURVEY

a division of

DEPARTMENT OF NATURAL RESOURCES AND ENERGY

STATE OF UTAH

Note: This report has not been edited to Utah Geological and Mineral Survey standards.

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SITE INVESTIGATION SECTION

Compiled by
William E. Mulvey

1986

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ILLUSTRATIONS

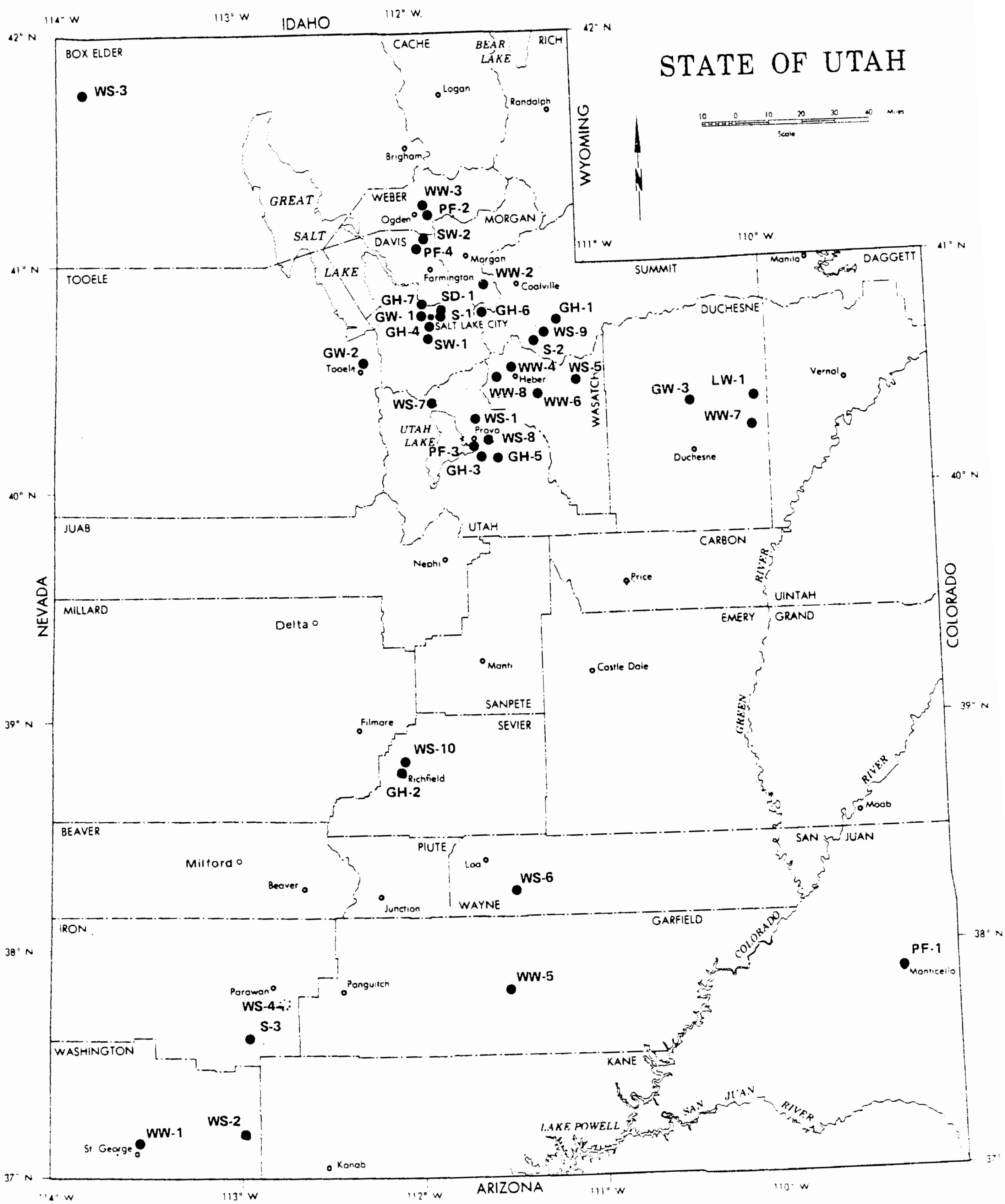


FIGURE 1. Location map.

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. 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 major goal of the UGMS, and 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 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 thirty-nine special purpose technical studies done by the Site Investigation Section in 1985 (fig. 1) which recieved 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 oringinal graphics, most of which were produced using a copying machine. This report represents the third 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 10, 1986

PUBLIC FACILITIES

Project:			Requesting Agency:
Geologic site investigation for a proposed fire station, Monticello, Utah			City of Monticello
By: G.E. Christenson K.M. Harty	Date: 4/17/85	County: San Jaun	Job No.: PF-1
USGS Quadrangle: Monticello SE (249)			

85-009

BACKGROUND AND SCOPE

In response to a request from Richard C. Terry, City Administrator for the City of Monticello, Utah, the Utah Geological and Mineral Survey made a geologic evaluation of a proposed fire station site. The proposed facility is to be built in downtown Monticello on a vacant lot adjacent to the existing fire station on the north side of 100 South between Main and 100 West (attachment 1). The new station will be built slab-on-grade with no basement. The scope of work included a literature review, air photo analysis, examination of a water well log (well location shown in attachment 1), field reconnaissance, and excavation of a 9.5 foot deep test pit on the proposed building site. Field work was performed on March 21, 1985. Monticello Public Works Director, Clyde Christensen, was present during the field investigation.

SOILS AND GENERAL GEOLOGY

The site and surrounding area are part of the Great Sage Plain, an upland plateau surface covered by unconsolidated Quaternary-age loess and eolian (wind-deposited) sands that reach thicknesses of up to 10 feet (Witkind, 1964). These deposits are generally reddish-brown to light brown in color, and vary from very fine-grained sand with small amounts of silt and clay to coarse-grained sand (Huff and Lesure, 1965). U.S. Soil Conservation Service maps show soils at the site to consist of the Monticello loam (Olsen and others, 1962). This soil is an eolian, well-drained, very fine sandy loam that covers the northern two-thirds of the city. Calcium carbonate horizons associated with buried soil layers are present in this unit (Olsen and others, 1962; Biggar and others, 1982; Woodward-Clyde Consultants, 1982a). At the site, soil encountered in the upper 8.6 feet of the test pit (attachment 2) is a fine-grained loess deposit (Monticello loam) which has weathered in-situ to a fine-grained silty clay with sand. Secondary calcium carbonate in the form of stringers and thin beds was encountered throughout most of the lower 4 feet of the weathered loess unit exposed in the test pit (attachment 2).

Underlying the surficial eolian deposits in the Monticello area are Quaternary-age alluvial-fan and pediment gravels derived from the Abajo Mountains. These materials vary in thickness but generally do not exceed 25 feet (Witkind, 1964). The gravels contain abundant sand, cobbles, and boulders, with clasts primarily composed of quartz diorite porphyry. Moderate- to highly-weathered alluvial-fan and pediment gravels were encountered in the lower eleven inches of the test pit (attachment 2). Thin coatings of calcium carbonate are found on cobbles and gravel.

The gravels were deposited on an eroded bedrock surface of Cretaceous Mancos Shale, Dakota Sandstone, and Burro Canyon Formation (Witkind, 1964; Haynes and others, 1972; Christenson, 1985). Mancos Shale is the uppermost bedrock unit and crops out to the west of Monticello. Although not encountered in the test pit, the Mancos Shale probably underlies the pediment gravels at the site. This is indicated in the log of a water well located four blocks south of the site (attachment 1) in which blue clay bedrock (Mancos Shale ?) was encountered beneath gravels at a depth of 25 feet.

Active faults are generally absent in southeastern Utah. The nearest potentially active fault to the site is a dip-slip fault trending N.70° W. which crosses U.S. Route 160 twelve miles north of Monticello. The fault is believed associated with the Shay Graben system, and may have experienced rejuvenated movement during Quaternary time (0 to approximately 2 to 3 million years before present)(Anderson and Miller, 1979; Woodward-Clyde Consultants, 1982b). The largest earthquake within a 50-mile radius of Monticello since 1850 was a magnitude 2.3 event which occurred in October, 1971, 12.5 miles east of the city (Arabasz and others, 1978).

HYDROLOGY

Monticello is on a broad, gentle interfluve between Montezuma Creek and one of its tributaries draining eastward from the Abajo Mountains (attachment 1). Within Monticello, a number of special flood hazard areas were delineated in 1976 on maps prepared by the U.S. Department of Housing and Urban Development Federal Insurance Administration. According to the maps, the western edge of the new fire station property lies in one of these zones. Based on this field reconnaissance, however, the site was not found to be on the flood plain of any significant drainage and it is unlikely that flooding on or near the proposed building site will occur.

Although all soils were moist, no ground water was encountered in the test pit. Ground water is generally absent in loess throughout Monticello, but is locally present in the underlying gravels where it is perched on top of the Mancos Shale (Clyde Christensen, oral commun., March 21, 1985). The log of the well drilled south of the site indicates ground water at a static level of 235 feet below the surface. This depth corresponds to the contact between Mancos Shale (?) and an underlying light-colored sandstone bedrock (probably Dakota Sandstone). Nine wells drilled in the past along the western margin of Monticello encountered aquifers at the Dakota and Burro Canyon Formations, at depths of around 540 feet below ground level (Witkind, 1964).

CONCLUSIONS AND RECOMMENDATIONS

The proposed fire station site is free from most geologic hazards. Topographic relief is minimal, thereby eliminating danger of slope instability. Ground water is below foundation depths. Flood hazard is low. The Monticello area is in both Uniform Building Code and Utah Seismic Safety Advisory Council seismic zone 1, which has the lowest seismic risk in the state. This low-risk zone corresponds to earthquakes with a maximum modified Mercalli intensity of V to VI, which generally results in only slight damage to building structures. It is recommended that the fire station conform to building specifications outlined for this zone.

Surficial materials present at the proposed site generally afford suitable conditions for construction of the fire station. It is possible that the silty clays encountered at the site may be expansive, i.e., subject to a volume increase with application of moisture. However, examination of the existing fire station on the adjacent lot showed no evidence of foundation or wall cracking indicative of expansive clays, and no foundation problems are reported in this part of the city (Clyde Christensen, oral commun., March 21, 1985). Nevertheless, it is recommended that a detailed soils/foundation investigation be performed by a qualified soil engineer prior to construction.

SELECTED REFERENCES

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro, Inc., 35 p.

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

Biggar, N.E., Harden, D.R., and Gillam, M.L., 1982, Quaternary deposits in the Paradox Basin, in Wiegard, D.L., ed., Geology of the Paradox Basin, 1981 Field Conference: Rocky Mountain Association of Geologists, p. 129-146.

Christenson, G.E., 1985, Quaternary geology of the Montezuma Creek-Lower Recapture Creek area, San Juan County, Utah: Utah Geological and Mineral Survey Special Study 64, (in press).

Feltis, R.D., 1966, Water from bedrock in the Colorado Plateau of Utah: U.S. Geological Survey in cooperation with Utah Oil and Gas Conservation Commission, Utah State Engineer Technical Publication No. 15, 82 p.

Haynes, D.D., Vogel, J.P., and Wyant, D.G., 1972, Geology, structure, and uranium deposits of the Cortez Quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-629, scale 1:250,000.

Huff, L.C., and Lesure, F.G., 1965, Geology and uranium deposits of Montezuma Canyon area, San Juan County, Utah: U.S. Geological Survey Bulletin 1190, 102 p.

Olsen, M.E., and others, 1962, Soil survey of the San Juan area, Utah: U.S. Department of Agriculture Soil Conservation Service in cooperation with Utah Agricultural Experiment Station, 49 p.

U.S. Department of Housing and Urban Development Federal Insurance Administration, 1976, Flood hazard boundary map, City of Monticello, Utah: Community No. 490212, scale 1:10,000.

Utah Seismic Safety Advisory Council, 1979, Seismic zones for construction in Utah: Delbert Ward, Executive Director, 13 p.

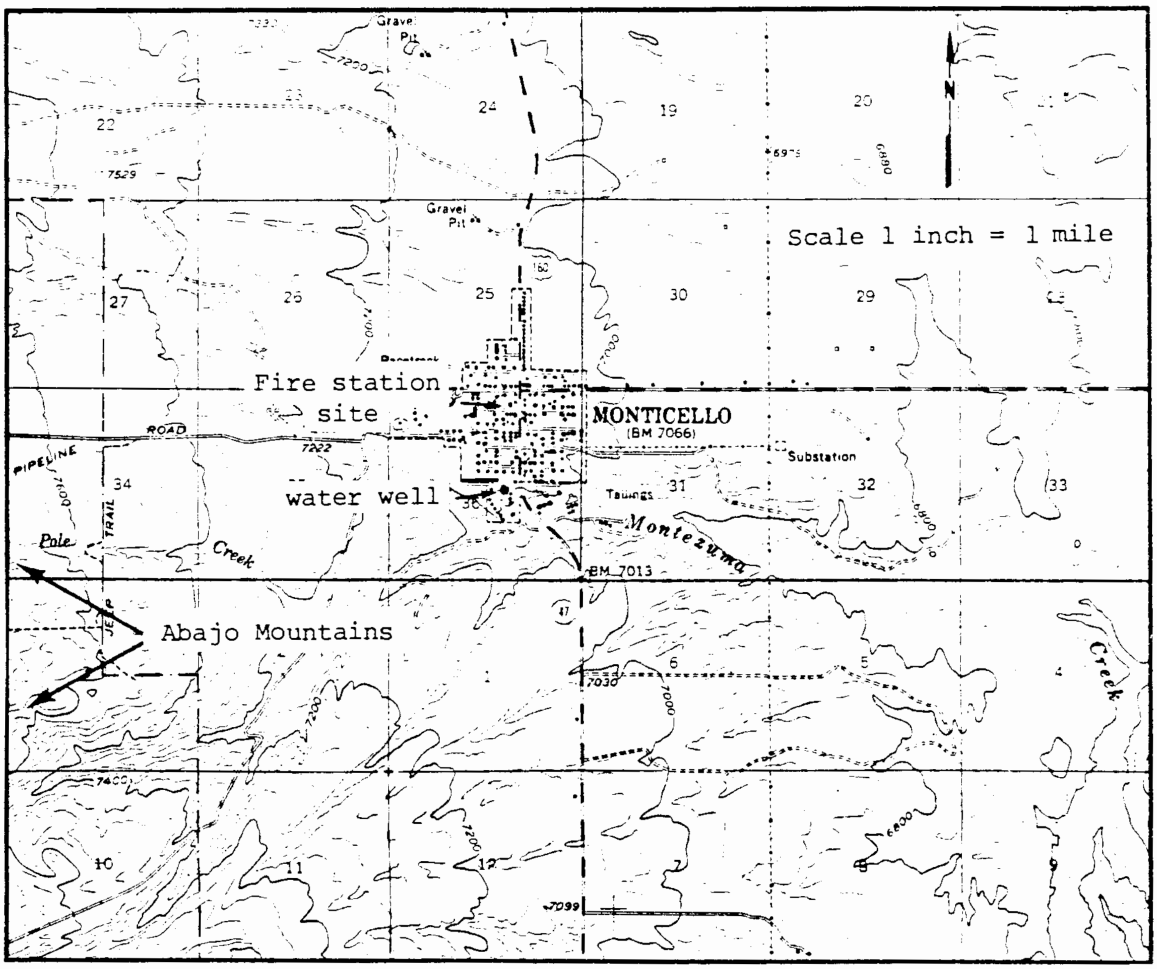
Witkind, I.J., 1964, Geology of the Abajo Mountains area, San Juan County, Utah: U.S. Geological Survey Professional Paper 453, 110 p.

Woodward-Clyde Consultants, 1982a, Geologic characterization report for the Paradox Basin study region, Utah study areas: Volume II, Gibson Dome: ONWI-290, chap. 6.

------1982b, Geologic characterization report for the Paradox Basin study region, Utah study areas: Volume III, Elk Ridge: ONWI-290, chap. 4.

Attachment 1, Job No. PF-1

Base map from USGS 15' topographic quadrangle Monticello, Utah



Location map

TEST PIT SOIL DESCRIPTION*

Subsurface depth	
0.0' - 4.6'	Lean clay with sand (CL); reddish-brown, firm to stiff, medium plasticity, nonindurated, moist; eolian, upper 6 inches fill material.
4.6' - 8.6'	Lean clay with sand (CL); reddish-brown to white, firm to stiff, medium plasticity, weakly indurated, moist; eolian, secondary calcium carbonate stringers and thin beds.
8.6' - 9.5'	Clayey gravel with sand (GC); yellow, medium dense, medium plasticity; non- to weakly indurated, moist; 10 percent cobbles, maximum particle size 8 inches, calcium carbonate pebble coatings, limonite staining in matrix, weathered Abajo pediment and alluvial-fan gravels.

*Soils classified according to procedures in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure) and D2487-83, Classification of Soils for Engineering Purposes. Percentages recorded for various size fractions are field estimates.

Project: Geologic hazards investigation, Physical Education Building, Weber State College			Requesting Agency: Division of Facilities, Construction and Management
By: W.R. Lund G.E. Christenson	Date: 10/1/85	County: Weber	Job No.: PF-2
USGS Quadrangle: Ogden (1345)			

#85-033

PURPOSE AND SCOPE

The purpose of this report is to provide supplemental information on geologic hazards at the proposed site of the new physical education building (fieldhouse) on the Weber State College campus (attachment 1). Certain geologic hazards at the site are addressed in a soil and foundation report by Dames and Moore (1984). That report discusses foundation conditions (soil and ground water), slope stability, liquefaction potential, and ground-shaking hazards, but does not address surface fault-rupture or flooding/debris-flow hazard. A detailed study of the surface fault-rupture hazard in the area has been recently completed by Woodward-Clyde Consultants (1985) for the nearby Allied Health Sciences Building. This work, which was done subsequent to completion of the Dames and Moore report for the physical education building, has direct application to the physical education building site. Based on a review of these reports, the Utah Geological and Mineral Survey recommended additional investigations at the physical education building site, including excavation of an exploratory trench to evaluate surface fault-rupture hazard (letter from Genevieve Atwood to Chris Nelson dated May 28, 1985). It was recommended that, prior to excavating a long exploratory trench, the feasibility of trenching be evaluated by excavating exploratory test pits at the site to determine ground-water conditions, cut-slope stability, stratigraphic relationships, and the extent of site disturbance by man. In addition to subsurface investigations, which were performed on August 8, 1985, the scope of work for the supplemental UGMS study included a review of pertinent literature and geotechnical reports, air photo analysis, and geologic field reconnaissance.

GEOLOGY

Much of the Weber State College campus is underlain by deposits of Pleistocene Lake Bonneville. These include a variety of materials ranging from poorly bedded beach sand and fine gravel to well-bedded, deep-water sand, silt, and clay. Locally, alluvial channel fills, alluvial-fan deposits, colluvial/slope-wash material, and man-placed fill buries the lake deposits. The well-bedded, deep-lake deposits on campus are cut in many areas by high-angle shears and locally are folded and contorted (Dr. F. Pashley, oral commun., November, 1984; Woodward-Clyde Consultants, 1985).

Conditions at the physical education building site are similar to those elsewhere on campus. A playing field presently exists at the site, and considerable site grading has taken place to level the field. Dames and Moore borings indicate thick man-placed fill along the west edge, with variable thicknesses of fill and sand overlying well-bedded deep-lake deposits elsewhere. Deformation similar to that reported at the Allied Health Building is reported in lake beds at the physical education building site by Dames and Moore (1984) from borehole data. The deformation, in conjunction with the subdued hummocky topography present in this part of the campus, indicate that the site may have been involved in landsliding. The nature and age of the landsliding is not known except that it occurred following deposition of the bedded materials during and/or after Lake Bonneville was at its highest level 14,000 - 16,000 years ago. If the deformation reported by Dames and Moore at the physical education building site formed at the same time as the shears exposed in the Allied Health Building excavation, then it would be between 16,000 and about 13,000 years old.

The physical education building site is 600-700 feet west of the main trace of the Wasatch fault as mapped by Woodward-Lundgren and Associates (1970). A possible (class III) fault is shown traversing the site (attachment 1). However, experience has shown that many class III "faults," which were delineated on the basis of photo-lineaments and not field checked, do not represent faults.

SUPPLEMENTAL GEOLOGIC HAZARD INVESTIGATIONS

Surface fault rupture

Because of the proximity of the site to the most recently active trace of the Wasatch fault, it was recommended that a trench be excavated across the site to determine whether or not fault traces are present which may have been active during recent prehistoric earthquakes in the area. The trench would serve the same purpose as the excavation for the Allied Health Building in terms of exposing subsurface relationships. However, excavation of two exploratory test pits along the preferred trench alignment (attachment 2) indicated that trenching was not feasible. Unstable walls and shallow ground water caused extensive caving in test pit 1, making it and other excavations in the area of the playing field unsafe. A trench across the field to lay a drainage pipe excavated a week prior to the test pits was reportedly stable, at least for the time necessary to lay the pipe. However, detailed geotechnical investigation of a trench normally takes at least a week, and conditions at test pit 1 were too unstable even for placing shoring to brace trench walls.

The principal purpose of the test pits was to evaluate stratigraphic relationships at the site to determine if dating of past fault events would be possible. The stratigraphy has been modified by grading to construct the playing field, and this disturbance and removal of the younger materials makes it impossible to accurately date fault traces exposed in a trench at that location. Therefore, the decision was made not to trench.

Based on existing information, including interpretation of aerial photographs taken prior to construction of the playing field, it is believed unlikely that a recently active trace of the Wasatch fault traverses the site. Because a trench could not be excavated, however, it is not absolutely certain that a fault does not exist. Due to the proximity of the Allied Health Building and its similar position relative to the main trace of the Wasatch fault, it is recommended that the results of the Woodward-Clyde Consultants (1985) investigation for that building be used in assessing the surface fault-rupture hazard at the physical education building site. Earthquake probabilities given in table 1 of the Woodward-Clyde Consultants report also apply to the physical education building site.

Slope stability

Because a trench could not be excavated, no additional information on age and type of deformation recorded in borings by Dames and Moore (1984) was obtained. It is not known whether the deformation was caused by tectonic faulting or landsliding, perhaps accompanying earthquakes. However, this same distinction could not be made at the Allied Health Building even with extensive exposures in the foundation excavation.

At the Allied Health Building, it was determined that shearing and tilting of beds, whatever the origin, occurred when Lake Bonneville was at its highest level and site soils were saturated. However, failure of the cut slope at the Allied Health Building both at slopes of 1:1 and 1.5:1 indicate that these materials are also unstable under present conditions when excavations are made below the water table. Excavations below the water table are planned for the racquetball courts adjacent to the gymnasium, and care must be taken as outlined by Dames and Moore (1984, p. 17) to insure stability when excavating below the water table.

Flooding/debris-flow hazard

The hazard of clear-water flooding at the site is low. Flood hazard boundary maps prepared for the Federal Insurance Administration (U.S. Dept. of Housing and Urban Development, 1977) do not place the site in any known flood hazard area. Debris-flow and debris-flood hazards were determined for most major Wasatch Front drainages in Davis and Weber Counties in a study by Weiczorek and others (1984). No major drainages occur directly upstream from the site, although drainages both north (Strongs Canyon) and south (first unnamed drainage north of Beus Canyon) were rated as having high debris-flood hazard. However, this rating is assigned at the mouth of the canyon where the debris load and discharge are greatest and where most deposition of material would occur. A wide zone (3200 feet) of gently sloping terrain separates the physical education building site from the mountain front, with no througn-going channels in the area. Because of this, the debris-flow/debris-flood hazard at the site is considered low.

CONCLUSIONS

The UGMS concurs with the conclusions and recommendations made in the Dames and Moore (1984) report and recommends they be followed closely. In summary, their conclusions regarding geologic hazards are: 1) seismic design should conform to standards for Uniform Buliding Code seismic zone 3, 2) cut slopes below the water table are potentially unstable and must be dewatered, flattened, and/or supported to insure stability, 3) liquefaction potential is low, and 4) ground water is shallow. In the absence of site-specific investigations regarding surface fault rupture at the site, the conclusions regarding the surface fault-rupture hazard presented in the Woodward-Clyde Consultants report for the Allied Health Building represent the best available information. The hazard at that site was considered low, and this is probably also true at the physical education building site. Flooding and debris-flow hazard at the site is low.

REFERENCES

Dames and Moore, 1984, Soils and foundation investigation, proposed new physical education facility, Weber State College Ogden, Utah: consultant's report for Utah State Division of Facilities Construction and Management, June 25, 25 p.

U.S. Department of Housing and Urban Development, 1977, Flood hazard boundary map, City of Ogden: Federal Insurance Administration, community-panel no. 490189 002A.

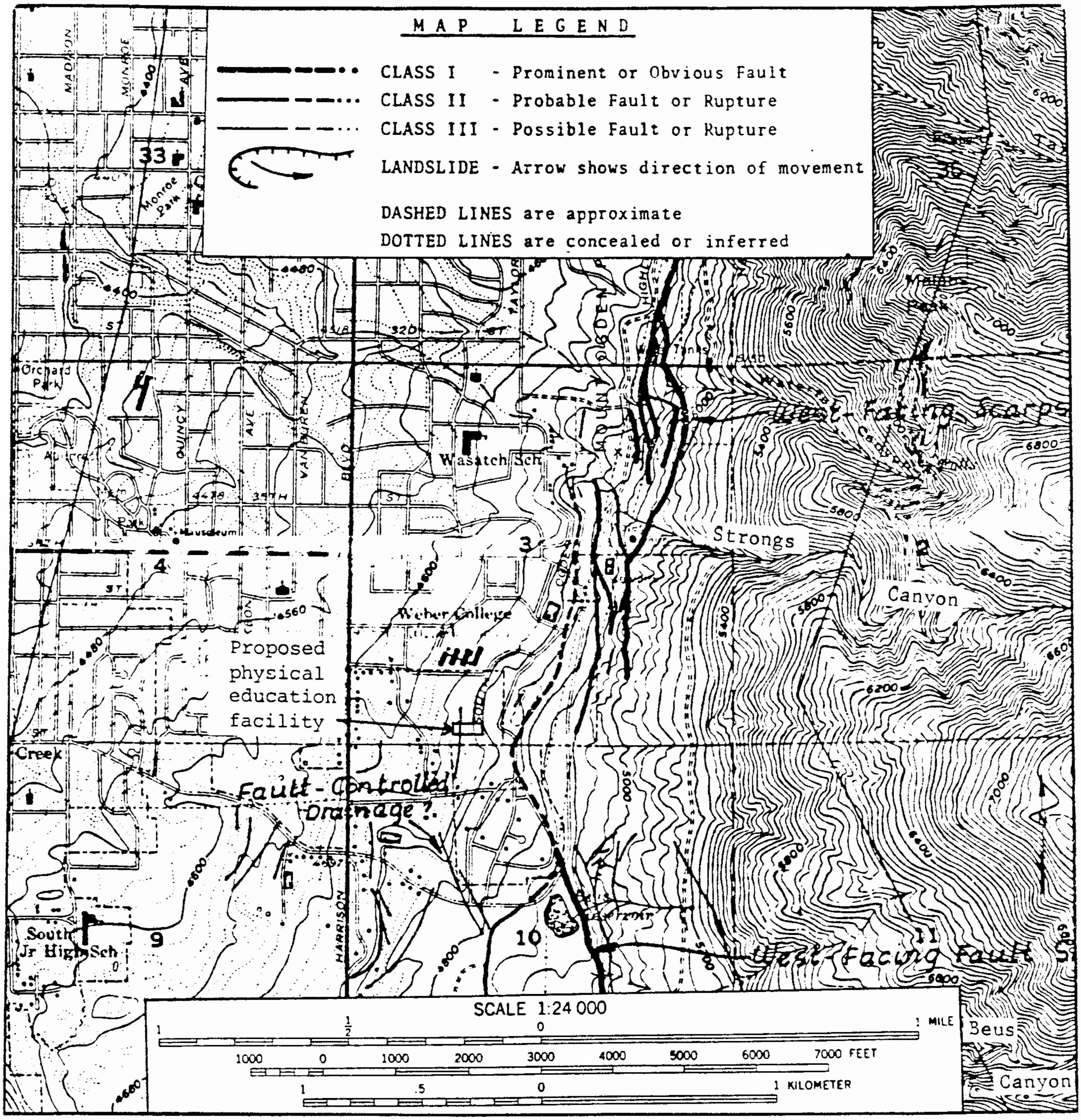
Wieczorek, G.F., Ellen, Steven, Lips, E.W., and Cannon, S.H., 1983, Potential for debris flow and debris flood along the Wasatch Front between Salt Lake City and Willard, Utah and measures for their mitigation: U.S. Geological Survey Open-File Report 83-635, 45 p.

Woodward-Clyde Consultants, 1985, Evaluation of fault activity and potential for future tectonic surface faulting, Allied Health Science Building Site, Weber State College, Ogden, Utah: consultant's report submitted to Henry J. Degenkolb Associates for Utah State Division of Facilities Construction and Management, 10 p.

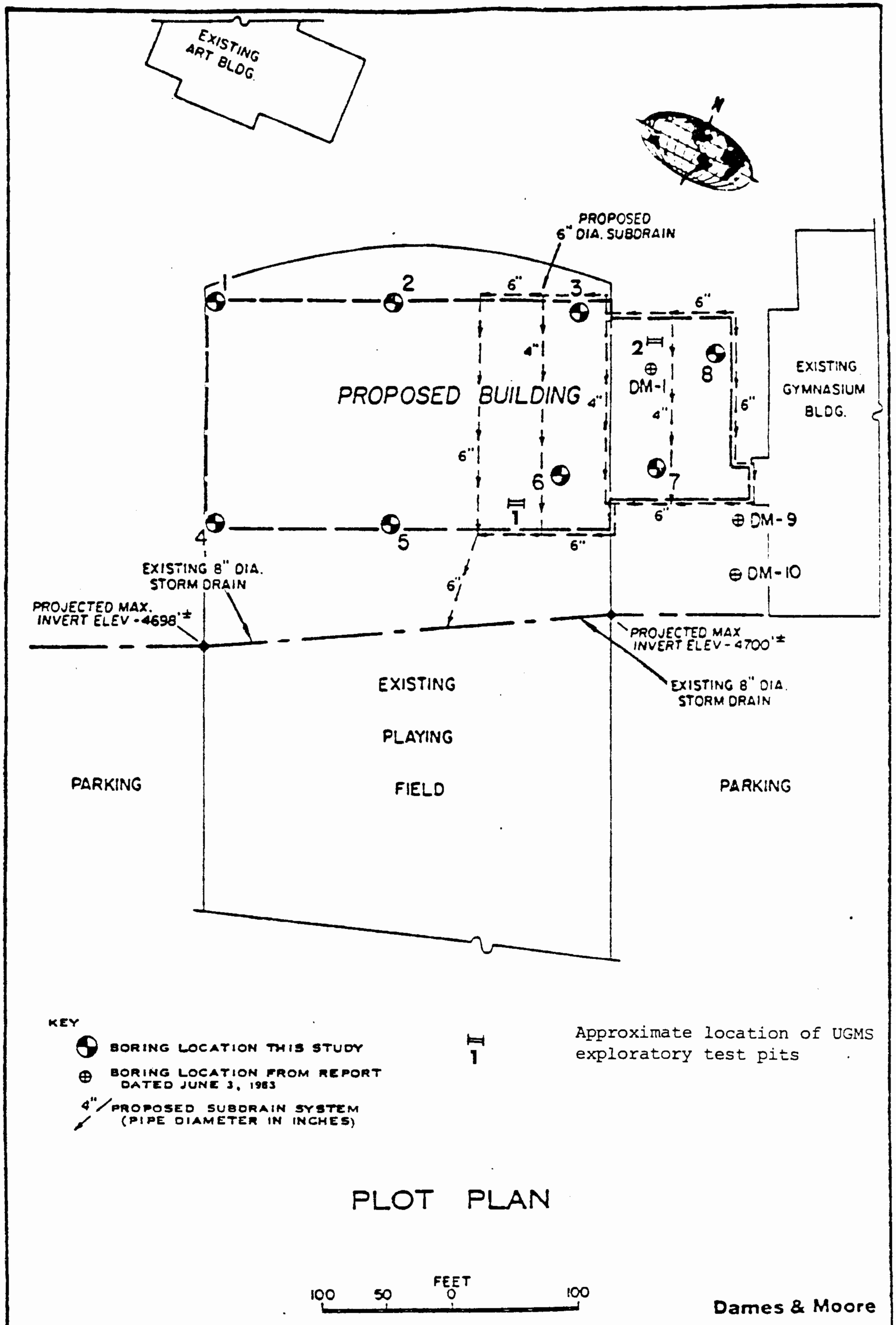
Woodward-Lundgren and Associates, 1970, Wasatch fault-northern portion, earthquake fault investigation and evaluation, a guide to land-use planning: Report for Utah Geological and Mineral Survey, 27 p.

Base map from USGS 7½' topo. quad
Ogden, Utah

Attachment 1, Job No. PF-2



Approximate location of the proposed physical education facility on the Weber State College campus. Fault traces are taken from Woodward - Lundgren and Associates (1970).


EXISTING ART BLDG.
N
PROPOSED 6" DIA. SUBDRAIN
PROPOSED BUILDING
EXISTING GYMNASIUM BLDG.
DM-1
DM-9
DM-10
EXISTING 8" DIA. STORM DRAIN
PROJECTED MAX. INVERT ELEV -4698'±
PROJECTED MAX INVERT ELEV - 4700'±
EXISTING 8" DIA. STORM DRAIN
EXISTING
PLAYING
FIELD
PARKING
PARKING
KEY
BORING LOCATION THIS STUDY
BORING LOCATION FROM REPORT DATED JUNE 3, 1983
4" PROPOSED SUBDRAIN SYSTEM (PIPE DIAMETER IN INCHES)
Approximate location of UGMS exploratory test pits
PLOT PLAN
FEET
100 50 0 100
Dames & Moore

Project:			Requesting Agency:
Engineering geologic investigation for a 100,000 gallon water tank, Springville City, Utah			Springville City
By: G.E. Christenson	Date: 7/17/85	County: Utah	Job No.: PF-3
USGS Quadrangle: Granger Mountain (1045)			

#85-025

PURPOSE AND SCOPE

In reponse to a request from Randy Drummond, Capital Projects Director for Springville City, a geologic investigation of a proposed site for a 100,000 gallon water tank was performed. The tank is to be in the bottom of an unnamed canyon near the confluence of the Right and Left Forks of Hobble Creek in the Wasatch Range about 6 miles east of Springville (attachment 1). The tank will be a buried, reinforced concrete structure placed with its base at stream level in the bottom of the canyon. It will be recessed into the hillside west of the stream, with the stream and road being diverted to the east around the tank. The stream will be placed in a culvert so that the road can be constructed on fill over the culvert. The canyon is narrow and steep-sided and will be filled to a depth of 10-15 feet above its present level by the tank and road.

The scope of work for this investigation included a literature review, analysis of 1:62,500 scale air photos, and brief field reconnaissance on July 2, 1985. Existing road cuts were observed during the field reconnaissance, but no test pits were excavated. Robert Robison, Utah County Geologist, and Robert Gunnell, project engineer, were present during the field investigation.

GEOLOGY

Bedrock at the site consists of sandstone, limestone, and quartzite of the Upper Pennsylvanian-age Wallsburg Ridge Member of the Oquirrh Formation. No outcrops were observed near the site during the field investigation, but the rocks reportedly strike roughly north-south and dip 30 degrees to the east (Baker, 1976). Hillsides and the valley bottom are buried beneath variable thicknesses of residual soil, slope wash, colluvium, and alluvium. The depth to bedrock at the site is not known, but road cuts along the valley bottom expose 15-20 feet of unconsolidated material, consisting chiefly of non-indurated silty and clayey gravel with sand, cobbles, and boulders. Clay beds several inches thick occur locally and beds representing probable debris-flow, stream-flow, and colluvial deposits are present. Slumping and erosion is occurring in road cuts at various places in the canyon.

The site is about 3000 feet east of the Hobble Creek fault, but no Quaternary activity has been documented on this fault (Baker, 1978). The nearest known Quaternary fault is the Wasatch fault about 3 miles west of the site (Anderson and Miller, 1979). Investigation along this segment of the Wasatch fault at the mouth of Hobble Creek Canyon have determined it to be capable of producing 7.0-7.5 magnitude earthquakes every 1700-2600 years (Schwartz and Coppersmith, 1984).

Other than slumping in man-made cuts, no active landslides were observed during the field investigaion. However, several probable debris-slide or avalanche scars were visible on hillsides in this and adjacent canyons on air photos taken in 1953. Steep hillsides, debris-flow deposits in the canyon bottom, and the overall thickness of unconsolidated deposits on lower slopes indicate that mass wasting processes are active in the area, altnough no recent events were evident.

No ground-water seepage was visible in road cuts. However, evidence for flow of water along permeable zones in unconsolidated deposits was present in the form of iron and manganese oxide staining and removal of fine-grained material through subsurface erosion (piping). In springtime, some flow of water through unconsolidated material probably occurs. During the rest of the year, the water table is determined by the level of flow in the stream.

CONCLUSIONS AND RECOMMENDATIONS

Foundation and ground-water conditions at the depth of the final grade for the water tank are unknown. Bedrock may be encountered in the excavation, but soils are generally coarse-grained and no adverse soil foundation conditions are anticipated based on the present investigation. Placing the water tank in the canyon bottom will expose it to flood and debris-flow hazards during spring runoff and/or summer thunderstorms. It is important to provide adequate drainage around the tank for stream flow and to prevent plugging of the culvert. Little can be done to mitigate debris-flow hazards except relocation or excavation of a debris basin upstream. No deep-seated slumping was evident that would undermine the tank, but slumping in road cuts and in cuts made for the tank may occur during and after construction, presenting construction and maintenance hazards. No evidence for recent avalanches at the site was present, but due to the steepness of slopes and lack of vegetation to anchor snow on upper slopes, the possibility of an avanlacne cannot be discounted.

The hazard due to surface fault rupture is low, but the area is in Uniform Building Code (UBC) seismic zone 3 and Utah Seismic Safety Advisory Council (USSAC) seismic zone 4, the zones of nighest risk in the respective zonation schemes in Utah. Because of this, earthquake-resistant design and construction as recommended for seismic zone 3 in the UBC should be followed, with inspection and monitoring as recommended for USSAC zone 4 (Utah Seismic Safety Advisory Council, 1979).

REFERENCES

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro, Inc., 35 p.

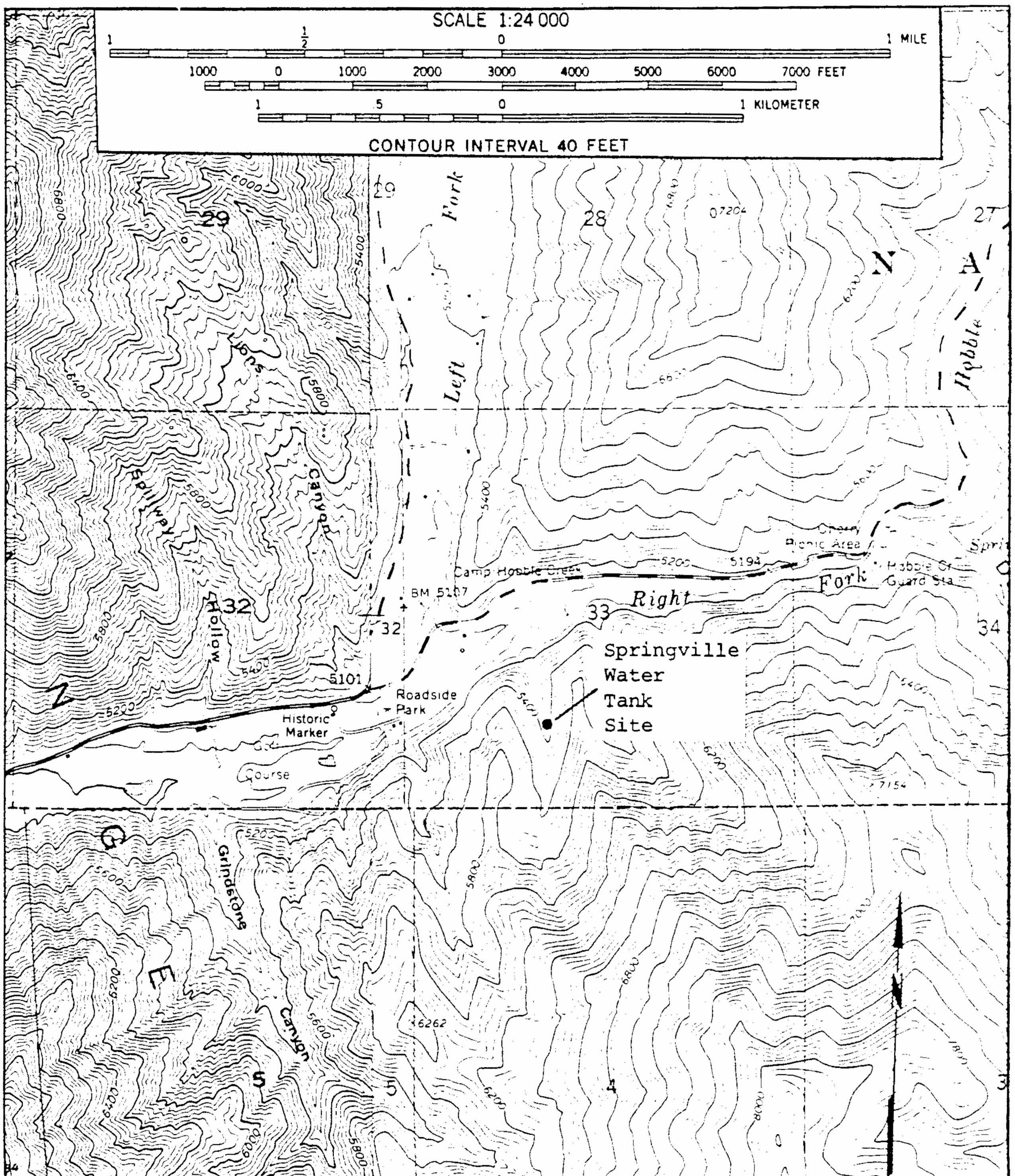
Baker, A.A., 1976, Geologic map of the west half of the Strawberry Valley Quadrangle, Utah: U.S. Geological Survey Map I-931, 1:63,360 scale.

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.

Utah Seismic Safety Advisory Council, 1979, Seismic zones for construction in Utah: Delbert Ward, Executive Director, 13 p.

Attachment 1, Job No. PF-3

Base Map from USGS 7½ min. topoquad
Granger Mountain, Utah
Springville, Utah



Location Map

Utah Geological and Mineral Survey

Site Investigation Section

Project:			Requesting Agency:
Geologic hazards investigation for a proposed watertank site, Layton City			Layton City
By: G.E. Christenson	Date: 8/16/85	County: Davis	Job No.: PF-4
USGS Quadrangle: Kaysville (1320)			

#85-028

PURPOSE AND SCOPE

At the request of Bill Flanders, Layton City Engineer, an investigation of a proposed site for a 2-million gallon concrete water tank was performed. The tank will be about 130 feet in diameter and, if conditions allow, will be completely buried. The site is north of Layton just east of State Route 89 at Hill Field Road in section 1, T. 4 N., R. 1 W. (attachment 1). The scope of work for this investigation included a literature search, air photo analysis, and field visits on July 19 and July 31, 1985. No subsurface investigation was performed. Present during the field visit on July 19 were Mr. Flanders, Michael Lowe (Davis County Geologist), Steve Personius (U.S. Geological Survey), and Alan Nelson (U.S. Geological Survey). Messrs. Personius and Nelson are presently involved in detailed mapping of the Wasatch fault zone in Davis and Weber Counties.

GEOLOGY AND HYDROLOGY

The site is in a small gully at the front (west) of the shoreline bench formed by Pleistocene Lake Bonneville when the lake was at its maximum between about 14,000 - 16,000 years ago (Currey and others, 1984). The bench is underlain by a variety of materials, including bedrock, shoreline sands and gravels, alluvium, debris-flow deposits, and colluvium. Bedrock of the Precambrian Farmington Canyon complex, chiefly schist and gneiss (Bryant, 1984), and shoreline sand and gravel are exposed in an abandoned gravel pit north of the site. In the site vicinity, the top of the bench is covered with boulders and cobbles and is probably underlain by alluvium and debris-flow deposits from Hobbs Creek (attachment 1). These deposits are younger than the Lake Bonneville beach gravel and were deposited between the time the lake receded from this level (about 14,000 years ago) and the time the stream cut down and became entrenched too deeply to flood the benchtop. The thickness of the alluvium and debris-flow deposits is unknown, but the water tank site may be stratigraphically below these deposits. Shoreline and near-shore deposits of Lake Bonneville and possibly bedrock are likely to be encountered in the excavation with perhaps a thin covering of colluvium derived from the overlying alluvium and debris-flow deposits.

The site is along the Ogden segment of the Wasatch fault zone. This fault zone is considered capable of generating earthquakes up to magnitude 7.0 - 7.5, with surface fault rupture and severe ground shaking (Schwartz and Coppersmith, 1984). Zones of greatest deformation along normal faults such as the Wasatch fault are found on the downthrown (west) side where ground cracking may occur in a zone several hundred feet wide. The site is about 650 feet east of the major, most recently active trace of the fault as mapped by Cluff and others (1970) (attachment 2). It is on the upthrown (east) side of the fault, and thus is not within the zone of expected surface fault rupture. The most recent earthquake causing surface faulting along this trace is thought to have occurred within the last 500 years (Schwartz and Coppersmith, 1984). A scarp representing a possible parallel fault of unknown age is found 350 feet east of the site (attachment 2). Other smaller possible faults are mapped from air photos adjacent to the site (Cluff and others, 1970) but are not identifiable on the ground, either because they are not present or are obscured by the oak brush cover and location of the site in a gully probably formed subsequent to faulting. Because of the lack of surficial evidence for faulting at the site, no trenching was attempted.

The gully in which the site is located lacks a significant drainage area and does not present a flood hazard. Hobbs Creek is 350 feet to the south and is incised 30-40 feet below the top of the bench. As a result, flood hazard from this creek is low, as is the hazard from debris flows and debris-laden floods. Studies by Wieczorek and others (1983) following the debris flows of 1983 in Davis County determined the debris-flow and debris-flood hazard, even at the mouth of Hobbs Canyon below the site, to be low.

The site is bounded by gentle slopes which show no evidence of instability. Materials anticipated to occur in the slope (bedrock, coarse granular soils) are generally stable, although cut slopes in the granular soils may be subject to caving and ravelling.

CONCLUSIONS AND RECOMMENDATIONS

Because the site is along the Wasatch fault, the potential for severe ground shaking accompanying earthquakes is high. The site is in Uniform Building Code (UBC) seismic zone 3 and Utah Seismic Safety Advisory Council (USSAC) seismic zone U-4, the zones of highest seismic risk in Utah in the respective zonations. Construction should incorporate earthquake-resistant design required for UBC seismic zone 3, with inspection and monitoring as outlined for USSAC seismic zone U-4. With regard to fault rupture hazard, the site is 650 feet from the major trace of the Wasatch fault. It is on the upthrown side, and the potential for surface rupture is relatively lower here than elsewhere in the fault zone. To further evaluate the fault rupture hazard, it is recommended that the walls of the open excavation for the tank be inspected by a UGMS geologist or other qualified engineering geologist for evidence of fault offsets. If none are found or if those found predate the most recent prehistoric earthquakes along the major fault trace as surficial evidence suggests, the hazard is reduced and the site can be considered suitable. If major, recently active faults are found, alternate sites should be considered. However, whether or not evidence for faulting is found, the site is still within the Wasatch fault zone and, in the event of a large earthquake, tank failure due to offset in the foundation is possible.

The site is relatively free of hazards not related to seismic activity. Flood and debris-flow hazards are low, and slopes are presently stable. Soil types at the foundation level are not known and may include bedrock, sand and gravel, and/or very coarse-grained bouldery deposits. Although expensive to excavate, bedrock generally provides a more stable foundation, particularly with respect to ground response during earthquake shaking. Ground water is not anticipated. A thorough soil foundation investigation should be performed prior to construction to evaluate bedrock, excavation, and ground-water conditions; engineering properties of soils at the foundation level; and response of site materials to seismic ground shaking. This report should also include recommendations for maximum cut slopes during excavation and construction.

REFERENCES

Bryant, Bruce, 1984, Reconnaissance geologic map of the Precambrian Farmington Canyon complex and surrounding rocks in the Wasatch Mountains between Ogden and Bountiful, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1447, scale 1:50,000.

Cluff, L.S., Brogan, G.E., and Glass, C.E., 1970, Wasatch fault, northern portion, earthquake fault investigation and evaluation: unpub. report by Woodward-Clyde and Associates for the Utah Geological and Mineral Survey, 27 p.

Currey, D.R., Atwood, Genevieve, and Mabey, D.R., 1983, Major levels of the Great Salt Lake and Lake Bonneville: Utah Geological and Mineral Survey Map 93, scale 1:750,000.

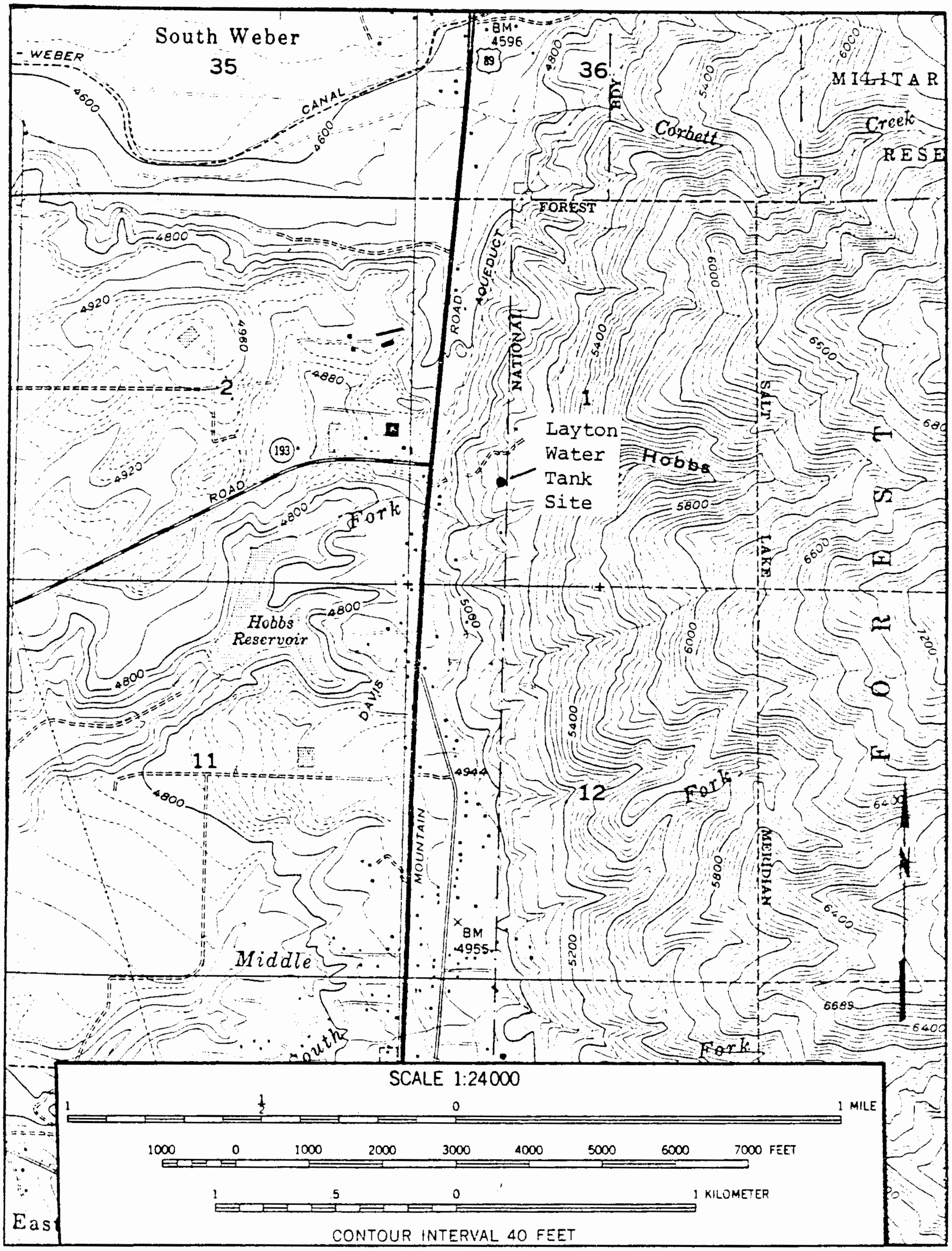
Feth, J.H., Barker, D.A., Moore, L.G., Brown, R.J., and Veirs, C.E., 1966, Lake Bonneville: Geology and hydrology of the Weber Delta District, including Ogden, Utah: U.S. Geological Survey Professional Paper 518, 76 p.

Miller, R.D., 1980, Surficial geologic map along part of the Wasatch Front, Salt Lake Valley, Utah: U.S. Geological Survey Miscellaneous Field Investigations Map MF-1198, scale 1:100,000.

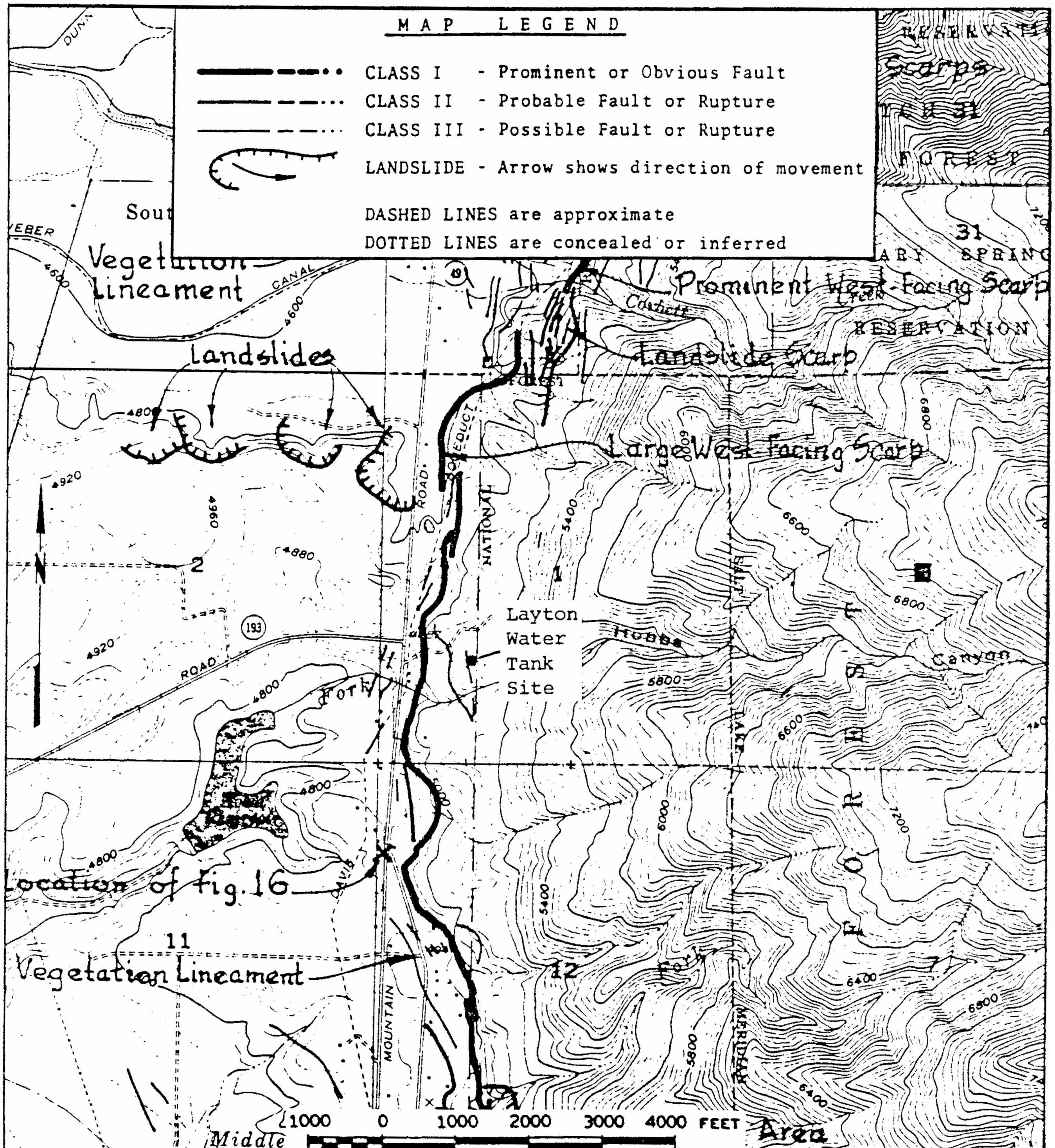
Schwartz, D.P., and Coppersmith, K.J., 1984, Fault behavior and characteristic earthquakes: examples from the Wasatch and San Andreas fault zones: Journal of Geophysical Research, v. 89, no. B7, p. 5681-5698.

Wieczorek, G.F., Ellen, Stephen, Lips, E.W., Cannon, S.H., and Short, D.N., 1983, Potential for debris flows and debris floods along the Wasatch Front between Salt Lake City and Willard, Utah, and measures for their mitigation: U.S. Geological Survey Open-File Report 83-635, 45 p.

Base map from: USGS 7½ min. topo quad
Kaysville, Utah



Location Map



Map showing known (Class I) and suspected (Class II, III) traces of surface fault rupture, Wasatch fault zone (from Cluff and others, 1970).

SCHOOLS

Project: Granite School District Site Investigation			Requesting Agency: Granite School District	
By: H. Gill	Date: 1/29/85	County: Salt Lake		Job No.: S-1
USGS Quadrangle: Magna (1214)				

85-001

In response to a request from Mr. Henry J. Middleton, Staff Assistant for Administrative Services, Granite School District, an engineering geologic investigation was conducted on January 16, 1985, of the proposed site for a new elementary school. The site investigation consisted of a review of maps, memos, and reports available for the area; a field reconnaissance; and excavation of three test pits. A tire-mounted backhoe was provided by Granite School District.

SITE LOCATION AND DESCRIPTION

The site is in Salt Lake Valley at 5600 South and 5200 West (attachment 1). The 13-acre property is bounded on the north and south by houses, on the west by 5200 West Street, and on the east by undeveloped ground. The overall topography is flat (approximate 1.5 degree slope to the southwest), however, details of the microtopography across the site were obscured by heavy snow cover (approximately 1 to 1.5 feet deep). The exact position of the school on the site was not known at the time of the investigation (H. Middleton, oral commun., 1985), however, an attempt was made to locate the test pits in the general area of the structure (attachment 2). The three test pits were excavated on the western end of the property, adjacent to but not on the suspected building site, to avoid disturbing the soils beneath the foundation.

SOILS AND HYDROLOGY

The site is underlain by Lake Bonneville nearshore deposits on which a thin layer of topsoil has formed (attachment 3). The lake sediments in the test pits were almost entirely silty sand, and exhibited low to medium density, no plasticity, and were nonindurated. The distribution of fine-grained material ranged from 5 to 50 percent (attachment 3). Ground water was not encountered in any of the test pits and it is estimated that the depth to the unconfined water table is greater than 40 feet (Seiler and Waddell, 1984). The absence of irrigation canals and ditches in the site vicinity indicates that a shallow perched water table is not present. The area is in a very low liquefaction potential zone (J. Keaton, oral commun., 1985).

SEISMICITY

The site lies within Uniform Building Code (UBC) seismic zone 3, and Utah Seismic Safety Advisary Council (USSAC) seismic zone U-4. These zones are similar, and represent areas where ground shaking corresponding to intensity VIII and higher of the modified Mercalli intensity scale may be expected (attachment 4). Fault scarps at the base of the Wasatch Range attest to the occurrance of large prehistoric earthquakes in the Salt Lake Valley. Several Quaternary faults are mapped near the site. The two closest faults are approximately 2 1/3 miles east (Van Horn, 1979), and 2 1/2 miles southwest (Tooker and Roberts, 1971) of the property. Renewed movement along these faults, or others in Salt Lake Valley would produce strong ground shaking at the site, the intensity of which would depend on the magnitude and duration of the earthquake, the location of the epicenter, and local geologic conditions.

Conclusions and recommendations

1. Based on geologic conditions at the site the property is considered suitable for construction of the proposed school.

2. The site is in UBC seismic zone 3 and USSAC seismic zone U-4 and in the event of a moderate to severe earthquake in the Salt Lake Valley the school would experience strong ground shaking. It is unlikely that fault rupture would occur at the property. It is recommended that the school be designed at a minimum to meet UBC requirements for zone 3 construction.

3. Geologic hazards associated with slope stability, shallow ground water, or liquifaction are not present at the site.

4. The UGMS site investigation addressed the geologic hazards that may affect a facility built at this site. Examination of soils in test pits in the general vicinity of the proposed school did not reveal any identifiable problem soils. However, prior to the start of construction, it is recommended that a complete soils investigation be performed for foundation design purposes.

Selected References

Arabasz, W. J., Smith, R. B., and Richins, W. D., editors, 1979, Earthquake studies in Utah 1850 to 1978: University of Utah Seismograph Stations, Department of Geology and Geophysics, University of Utah, 548 p.

Dames & Moore, 1979, Report of fault study UDOT/UDPS complex, Salt Lake County, Utah: Utah State Building Board, 8 p.

Everitt, B. L., 1980, Depth to wet season water table Jordan Valley, Utah: Utah Geological and Mineral Survey unpublished map, scale 1:60,000.

International Conference of Building Officials, 1976, Uniform building code: Whittier, California, p. 132-140.

Marsell, R. E., and Threet, R. L., 1960, Geologic map of Salt Lake County, Utah: Utah Geological and Mineral Survey Bulletin 69, scale 1:125.000.

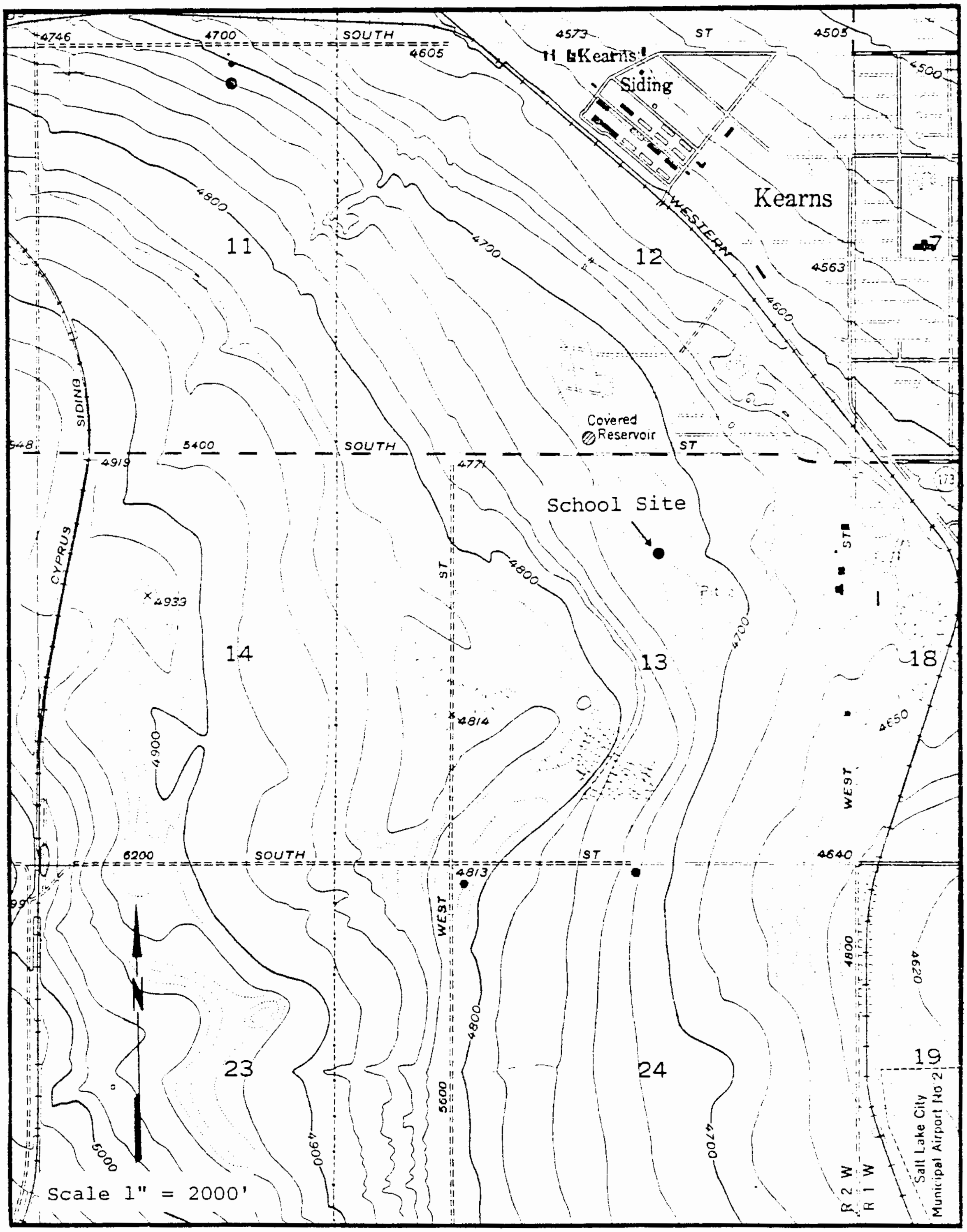
Seiler, R. L. and Waddell, K. M., 1983, Reconnaissance of the shallow unconfined aquifer in Salt Lake Valley, Utah: U.S. Geological Survey Water-Resources Report 83-4272, 34 p.

Tocker, E. W., and Roberts, R. J., 1971, Geologic map of the Magna Quadrangle, Salt Lake County, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ 923, scale 1:24,000.

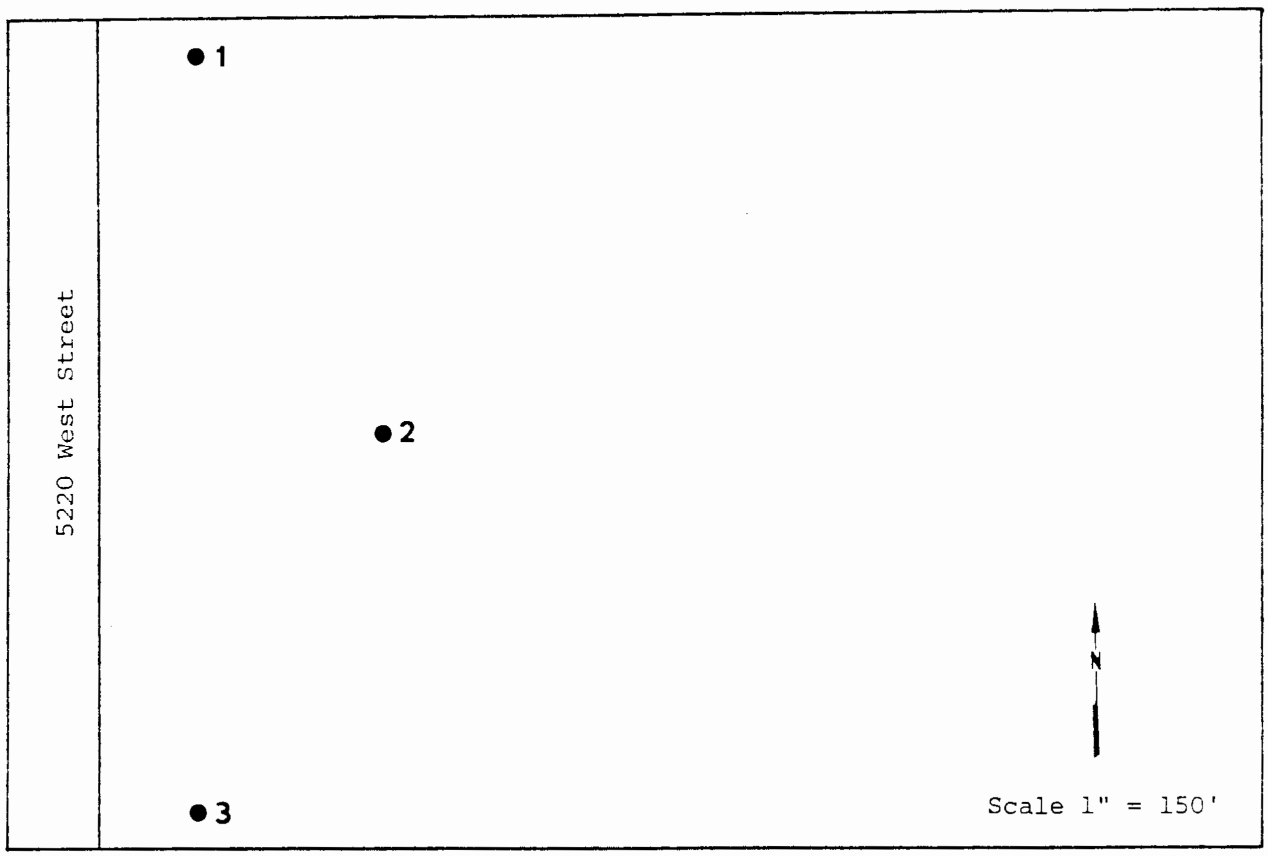
Van Horn, Richard, 1979, Surficial geologic map of the Salt Lake City South Quadrangle, Salt Lake County, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1173, scale 1:24,000.

Ward, D. B., 1979, Seismic zones for construction in Utah: Seismic Safety Advisory Council, Salt Lake City, 13 p.

Attachment 1, Job No. S-1



General location map, elementary school, Granite School District.



Test pit locations, proposed elementary school site.

Logs of Test Pits*

Test Pit 1

0.0' - 1.0' Silty sand (SM); topsoil, dark brown, medium dense, very low plasticity, weakly indurated, moist; 35 percent fines, upper 1.0 feet frozen.

1.0' - 2.8' Silty sand (SM); brown, medium dense, nonplastic, nonindurated, dry; 25 percent fines.

2.8' - 3.9' Sandy silt/silty sand (ML/SM); tan, firm, nonplastic, nonindurated, dry; 50 percent fines.

3.9' - 6.3' Sand (SP); light brown, low density, nonplastic, nonindurated, dry; 5 percent fines.

6.3' - 9.8' Sandy silt/silty sand (ML/SM) and sand (SP); alternating lenses of sand and sand/silt to the total depth of the test pit. Sandy silt/silty sand (ML/SM); tan, firm, nonplastic, nonindurated, dry; 50 percent fines. Sand (SP); light brown, low density, nonplastic, nonindurated, dry; 5 percent fines.

Test Hole 2

0.0' - 1.0' Silty sand (SM); topsoil, dark brown, medium dense, very low plasticity, weakly indurated, moist; 35 percent fines, upper 1.0 feet frozen.

1.0' - 4.4' Silty sand (SM); brown, low density, nonplastic, nonindurated, dry; 15 percent fines.

4.4' - 8.4' Silty sand (SM); tan, medium dense, nonplastic, nonindurated, dry; 40 percent fines.

8.4' - 9.8' Silty sand (SM); yellow brown, medium to low density, nonplastic, nonindurated, dry; thin lenses of silty clay (CL) interbedded with sand, firm, medium to low plasticity, weakly indurated, dry; 5 percent fines.

9.8' - 10.4' Sandy silt/silty sand (ML/SM); tan, firm, nonplastic, nonindurated, dry; 50 percent fines.

Test pit 3

0.0' - 0.9'	Silty sand (SM); topsoil, dark brown, medium dense, very low plasticity, weakly indurated, moist; 35 percent fines, upper 1.0 feet frozen.
0.9' - 2.8'	Silty sand (SM); brown, medium dense, very low plasticity, nonindurated, dry; 30 percent fines.
2.8' - 9.6'	Silty sand (SM); light tan, medium dense, nonplastic, nonindurated to weakly indurated, dry; 40 percent fines.

*Soil descriptions conform to ASTM Standard D 2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various size fractions are field estimates.

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building; standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbed persons driving motor cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: *Earthquake Information Bulletin 6 (5), p. 28, 1974.*

Project:			Requesting Agency:
Geologic investigation of two proposed high school sites, Cedar City			Iron County School District
By: G.E. Christenson	Date:	County: Iron	Job No.: S-2
USGS Quadrangle: Cedar City (1238)			

85-010

PURPOSE AND SCOPE

The purpose of this investigation by the Utah Geological and Mineral Survey (UGMS) was to evaluate geologic conditions at two alternate sites being considered for construction of a new high school by the Iron County School District. The sites are adjacent to one another in northern Cedar City west of Highway 130 (attachment 1). The Iron County School District is interested in identifying geologic hazards at the sites to help select the most suitable location for purchase and construction. The scope of work included a literature review, air photo analysis, excavation of three test pits, and a field reconnaissance. The field work was performed on March 19, 1985, with assistance from Kimm Harty (UGMS).

GEOLOGY AND SOILS

Both sites are located on alluvial-fan deposits at the base of the Hurricane Cliffs. The principal alluvial fan in the area was deposited by Fiddlers Creek, but smaller drainages to the south also contributed sediment to this fan. Soils consist of silty sand with thin beds of fine gravel containing silt and sand (attachment 2). Bedrock in the source area of the alluvial-fan deposits consists chiefly of Cretaceous-age sandstone, siltstone, and shale (Averitt and Threet, 1973).

Ground subsidence in alluvial soils has been documented in the Cedar City area and elsewhere along the base of the Hurricane Cliffs in southwestern Utah. Detailed studies by the Utah Geological and Mineral Survey found that subsidence was the result of hydrocompaction or soil collapse upon wetting (Kaliser, 1978, 1982). Hydrocompactible soils occur in sediments deposited without sufficient water to permit normal consolidation, such as in mudflow and debris-flow deposits in arid and semi-arid areas. No diagnostic field characteristics for the recognition of hydrocompactible soils have been identified, although silty soils containing low to high amounts of soluble solids seem particularly susceptible. Kaliser (1978) produced a map of the Cedar City area showing relative susceptibility of soils to hydrocompaction. Both sites are in an area of susceptible soils. The hazard has been reduced somewhat at the sites by deep wetting accompanying flood irrigation over the past forty years. Also, materials exposed in test pits appear to be relatively well sorted, finer-grained, stream-deposited alluvium typical of the distal portions of alluvial fans and not mudflow or debris-flow deposits which are common near the mountain front. In addition, the rocks in the drainage basin of Fiddlers Creek contain fewer soluble materials than do the rocks to the south, so alluvial-fan deposits derived from them contain fewer soluble solids and may be less susceptible to hydrocompaction than those to the south where gypsum is common and subsidence has been most pronounced. Unpublished data from the U.S. Soil Conservation Service indicates a range in soluble solid content (chiefly gypsum) in the predominant soil type (Braffits Series) of 0.1 to 1.5 percent (Gordon Crandell, oral commun., March 19, 1985). Soils in areas where hydrocompaction has occurred range in soluble solid (chiefly gypsum) content from less than one to over 30 percent (Kaliser, 1978, 1982).

FAULTING AND SEISMICITY

The Hurricane fault generally follows the base of the Hurricane Cliffs south of Cedar City, but the location of the fault is uncertain from Cedar City northward. No evidence for Quaternary displacement along the fault in this area has been documented (Averitt and Threet, 1973; Anderson and Miller, 1979; Earth Science Associates, 1982). To the south, Quaternary displacement on the fault is well documented. Recent movement during the last 10,000 years has not been demonstrated at any locality along the fault. A trench excavated about one mile east of the sites during the investigation for the Fiddlers Canyon Elementary School did not encounter evidence of faulting in surficial deposits to a depth of 12-13 feet (Lund, 1981). The Fiddlers Canyon Elementary School site was along the projected trend of a bedrock fault in the area. Field reconnaissance and study of aerial photography at the high school sites did not yield any evidence for faulting in near-surface materials, although leveling and terracing for irrigation and cultivation at the sites may have obscured any subtle evidence of faulting.

Although evidence for Holocene movement on the Hurricane fault is absent, particularly in the Cedar City area, the zone is seismically active. Two historic earthquakes with maximum modified Mercalli intensities (MMI, attachment 3) of VII and estimated Richter magnitudes of 5 have occurred in Cedar City (Arabasz and others, 1979; Earth Science Associates, 1981). They were part of an earthquake swarm in 1942, and a similar magnitude earthquake occurred in Parowan 18 miles to the northeast in 1933. In 1981, a magnitude 4.5 event occurred 15 miles southwest of Cedar City (University of Utah Seismograph stations, unpub. data). The largest earthquake near the site occurred in 1902 in Pine Valley 32 miles to the southeast (MMI - VIII, estimated magnitude 6.3). Earth Sciences Associates (1982) has calculated an average recurrence interval of 200-300 years for earthquakes of magnitude 6 (MMI- VII to VIII) in the Cedar City area.

HYDROLOGY

Alluvial-fan surfaces such as those at the base of the Hurricane Cliffs are commonly subject to flash floods, mudflows, and debris flows. However, because the sites are on the distal portions of the Fiddlers Creek alluvial fan and are nearly one mile south of the principal drainageway, the hazard from flash flooding is low. Also, the construction of catchment basins along Fiddlers Creek and others drainages to the south combined with diversion and channelization of these streams has reduced flooding potential. The nature of sediments at the site indicates that mudflows and debris flows have not been common in the recent geologic past, and engineered structures upstream, including the highway and major canal east of the highway, have reduced the potential for such flows reaching the area.

The U.S. Department of Housing and Urban Development Federal Insurance Administration (1974) does not include the sites in any flood hazard zones.

However, flooding from overflow and obstruction of irrigation canals traversing the sites was occurring at the time of the field inspection. Proper diversion, containment, and control of flow in these canals will be required if a school is to built at either site.

The depth to ground water at the site is greater than 10 feet (attachment 2), and was measured at around 100 feet in March, 1974 (Bjorklund and others, 1978). Soils are coarse grained and well drained. No shallow impermeable layers capable of forming a perched water table were encountered in test pits. Narrow saturated zones may exist beneath unlined irrigation canals due to leakage, but shallow ground water is not anticipated at the sites.

CONCLUSIONS AND RECOMMENDATIONS

Both sites are potentially suitable for construction of the proposed high school. Soil conditions and geologic hazards at the sites are essentially identical, and from the geologic standpoint (based on current knowledge) both are equally suited. The following conclusions and recommendations apply to either site:

1. Soils should be tested for gypsum content and susceptibility to hydrocompaction during soil/foundation investigations prior to construction. Testing should extend to a minimum depth of 70 feet (Kaliser, 1978) in at least two boreholes completed in soils which will underlie the school building. More extensive testing of shallow soils is also recommended.

2. The sites are in Uniform Building Code (UBC) seismic zone 2, and construction should, at a minimum, conform to specifications for that zone. The proximity of the site to the potentially active Hurricane fault and occurrance of magnitude 6 earthquakes with maximum modified Mercalli intensities of VII-VIII indicate that construction specifications for UBC zone 3 may be more appropriate. Compliance with UBC seismic zone 3 specifications was recommended by UGMS for the Fiddlers Canyon Elementary School (Lund, 1981), and is also recommended for construction at this site.

3. Flood hazard is low provided canals and flood control structures are maintained. Shallow ground water is not anticipated.

4. Natural slopes at the sites are gentle (2.5 - 5 percent) and stable. Vertical cut slopes in the loose materials, however, may be subject to failure.

REFERENCES

Arabasz, W.J., Smith, R.B., and Richins, W.D., editors, 1979, Earthquake studies in Utah, 1850 to 1978: University of Utah Seismograph Stations, Salt Lake City, 552 p.

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro, Inc., 35 p.

Averitt, Paul, and Threet, R.L., 1973, Geologic map of the Cedar City Quadrangle, Iron County, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-1120, scale 1:24,000.

Bjorklund, L.J., Sunsion, C.T., and Sandberg, G.W., 1978, Ground-water resources of the Parowan-Cedar City drainage basin, Iron County, Utah: Utah Department of Natural Resources Technical Publication No. 60, 93 p.

Earth Science Associates, Inc., 1982, Seismic safety investigation of eight SCS dams in southwestern Utah: Consultants report for the U.S. Soil Conservation Service, 2 volumes.

Gregory, H.E., 1950, Geology of eastern Iron County, Utah: Utah Geological and Mineral Survey Bulletin 37, 153 p.

Kaliser, B.N., 1978, Ground surface subsidence in Cedar City, Utah: Utah Geological and Mineral Survey Map 46 and Report of Investigation 124, 22 p.

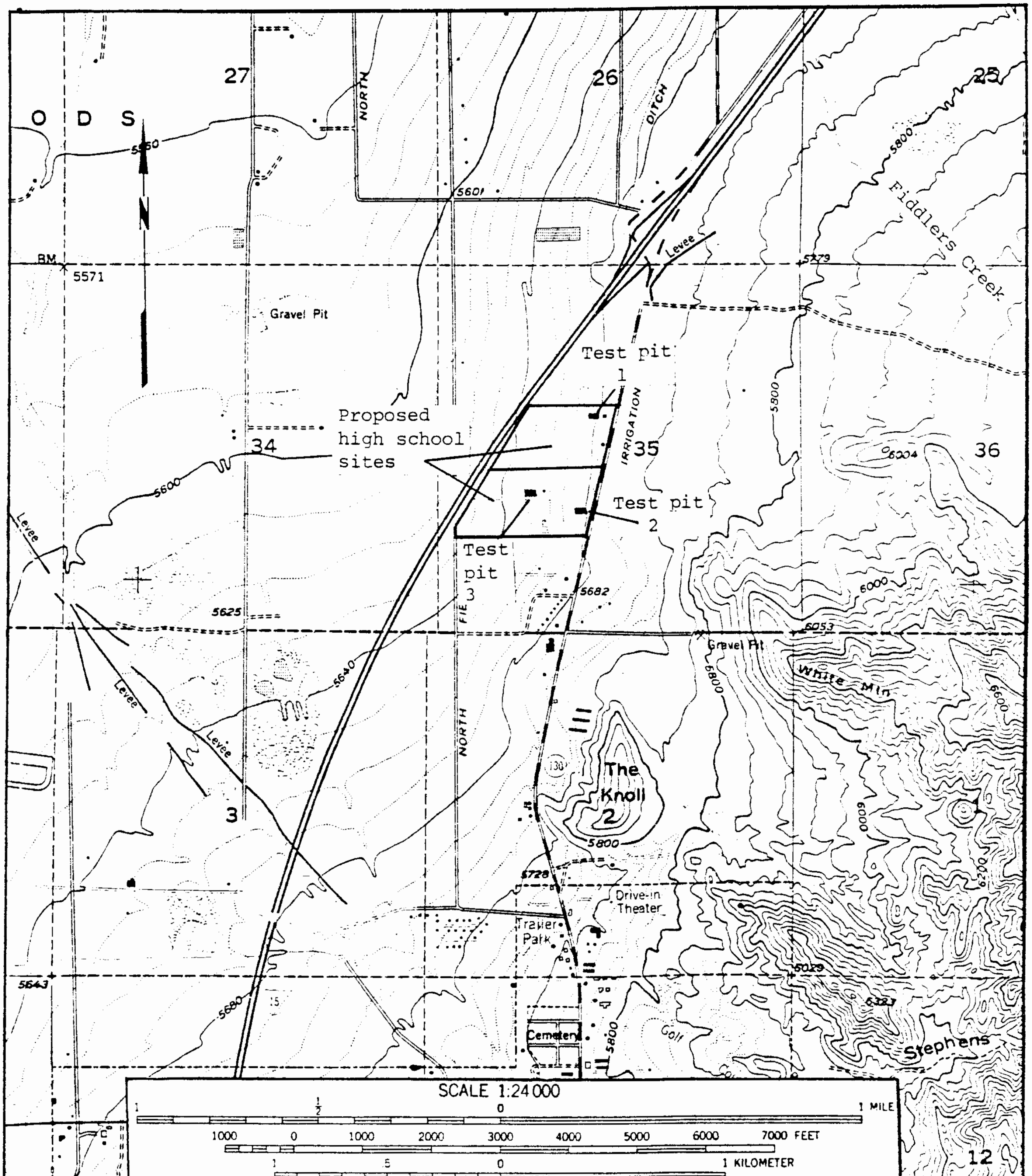
------, 1982, Hydrocompaction affecting Cedar City, Utah, in Blount, C.W., ed., Proceedings, 19th Annual Engineering Geology and Soils Engineering Symposium: Pocatello, Idaho, p. 145-160.

Lund, W.R., 1981, Fiddlers Canyon elementary school site: Utah Geological and Mineral Survey memorandum to J. Clair Morris, Iron County School District Superintendent, 10 p.

Thomas, H.E., and Taylor, G.H., 1946, Geology and ground-water resources of Cedar City and Parowan Valleys, Iron County, Utah: U.S. Geological Survey Water Supply Paper 993, 210 p.

U.S. Department of Housing and Urban Development Federal Insurance Administration, 1974, Flood hazard boundary map, Cedar City, Utah: Community No. 490074A, scale 1:12,000.

Base map from USGS 7½' topo quad
Cedar City, Utah



Location map

Utah Geological and Mineral Survey

Site Investigation Section

Attachment 2, Job No. S-2

LOGS OF TEST PITS
Iron County School Site Investigation
Cedar City

Test Pit 1	Soil Description*
0.0' - 1.4'	Poorly graded gravel with silt and sand (GP-GM); light brown, loose to low density, nonplastic, moist, nonindurated; upper 0.4 feet dark brown plowed horizon, gypsum clast found below plowed zone.
1.4' - 2.4'	Silty sand (SM); light brown, medium dense, nonplastic, moist, nonindurated.
2.4' - 2.8'	Poorly graded gravel with silt and sand (GP-GM); light brown, loose to low density, nonplastic, moist, nonindurated.
2.8' - 10.0'	Silty sand (SM); light brown, medium dense, nonplastic, dry to moist, nonindurated; thin beds and lenses of gravel, voids visible in sand layers.

Test Pit 2

0.0' - 0.7'	Poorly graded gravel with silt and sand (GP-GM); light brown, low to medium density, nonplastic, moist, nonindurated.
0.7' - 2.8'	Poorly graded sand with silt (SP-SM); light brown, low to medium density, nonplastic, moist, nonindurated.
2.8' - 3.2'	Well-graded gravel with silt and sand (GW-GM); light brown, low to medium density, nonplastic, moist, nonindurated.
3.2' - 5.1'	Silty sand (SM); light brown, medium density, nonplastic, moist, nonindurated.
5.1' - 11.2'	Silty sand (SM); light brown, medium density, nonplastic, dry, nonindurated.

Test Pit 3

0.0' - 3.8'	Silty, clayey sand (SM-SC); light brown, medium dense, low plasticity, dry, nonindurated; vesicular, upper 1 foot dark brown plowed horizon with roots and organic mat.
3.8' - 5.6'	Poorly graded sand with silt and gravel (SP-SM); light brown, medium density, nonplastic, dry, nonindurated.
5.6' - 10.0'	Silty sand (SM); light brown, medium density, nonplastic, dry, nonindurated.

Note: No ground water encountered in any test pits.

*Soils classified according to procedures in ASTM standard D2489-69 (Revised 1975), Description of Soils (Visual Manual Procedure) and D2487-83, Classification of Soils for Engineering Purposes.

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building; standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures: considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbed persons driving motor cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: *Earthquake Information Bulletin 6 (5), p. 28, 1974.*

Project:			Requesting Agency:
Geologic hazards investigation of a school site in Kamas, Summit County, Utah			South Summit School District
By: G.E. Christenson	Date: 5/24/85	County: Summit	Job No.: S-3
USGS Quadrangle: Kamas (1208)			

#85-021

PURPOSE AND SCOPE

The purpose of this investigation by the Utah Geological and Mineral Survey (UGMS) was to evaluate geologic hazards at an elementary school site in Kamas, Utah for the South Summit County School District. The site is presently being graded in preparation for construction north of 300 South Street at 500 West Street, just east of the recently completed South Summit Middle School (attachment 1). A detailed soil foundation investigation was not performed for the new school. The foundation design is being based on a soil report by Rollins, Brown, and Gunnell done in 1979 for the adjacent middle school (Dale Allsop, oral commun., May 16, 1985). Only a preliminary reconnaissance and soil description by Chen and Associates (letter of August 7, 1984 from Kerry Parkinson to Dale Allsop) has been performed at the new school site. It consisted of a single test pit and field soil description at this and two other potential school sites in Kamas. The scope of work by the UGMS included a literature review, air photo analysis, field reconnaissance on May 10, 1985 with inspection of existing foundation excavations, and review of the Chen and Associates (1984) and Rollins, Brown, and Gunnell (1979) reports.

GEOLOGY

The site is at the mouth of Beaver Creek Canyon on an alluvial fan deposited by Beaver Creek as it enters Rhodes Valley. At this locality, the fan surface slopes gently northward toward Beaver Creek which flows along the north edge of the site. Based on inspection of excavations and descriptions in the soil foundation reports, soils consist of poorly stratified, well-graded gravel with varying amounts of clay, silt, and sand with abundant rounded cobbles and boulders. These coarse-grained deposits appear to underlie the entire site with little variation except in the upper few feet where a clayey, organic topsoil layer is present. No bedrock is exposed at the site or is expected to be encountered in any excavations. The nearest bedrock crops out about one block south of the site and consists of red sandstone and shale of the Pennsylvanian-age Morgan Formation (Baker, 1970).

The nearest known active fault capable of producing a major earthquake is the Wasatch fault about 30 miles west of Kamas (Anderson and Miller, 1979). Several small to moderate earthquakes not identified as associated with known faults have been recorded in the Kamas area. The nearest earthquake occurred in 1972 about 2.5 miles southwest of Kamas and was of Richter magnitude 2.2. The largest earthquake within a 20 mile radius was a magnitude 4.3 event, also in 1972, about 10 miles south of Kamas near Heber City (University of Utah Seismograph Stations, 1985).

HYDROLOGY

Beaver Creek is the principal drainage in the Kamas area, and water from the creek is diverted into canals at several localities east (upstream) of the site. The main channel is only a few feet deep, and the water level is about at the ground surface along the north edge of the site. The report by Chen and Associates states that total relief at the site prior to construction was 13 feet. Grading for the school foundation has lowered the site at least 5 feet below the original high point, indicating that the site is now less than 8 feet above stream level. Despite the lack of relief along Beaver Creek, the Federal Insurance Administration (U.S. Department of Housing and Urban Development) has not delineated a special flood hazard zone along the creek (James Harvey, oral commun., May 1985). Existing records of cloudburst floods, taken chiefly from newspaper accounts, do not list any cloudburst flood events in Kamas (Butler and Mansell, 1972; Utah Division of Comprehensive Emergency Management, 1981; Wooley, 1946), although it is not certain whether this is due to a lack of flooding or a lack of reporting. The creek diversions upstream lessen the flood hazard, but it is still believed that overbank flooding may occur along the north edge of the site.

No ground water was encountered to 7.5 feet in the test pit by Chen and Associates, and none was reported to 12.5 feet at the adjacent site by Rollins, Brown, and Gunnell in 1979. Shallow ground water occurs in unconsolidated deposits over much of Rhodes Valley, but generalized water-table elevation contours (September, 1966) indicate a depth to water of over 50 feet at the site (Baker, 1970). Because of these data, and in view of the high permeability of soils at the site, shallow ground water is not expected except in the immediate vicinity of canals and streams. Local perched water tables may develop over shallow bedrock if present, but otherwise soils should be well drained.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made regarding the school site:

1. Soils appear similar to those at the adjacent South Summit Middle School site described by Rollins, Brown, and Gunnell in 1979. Although general recommendations made in that report apply to this site, use of specific laboratory and field test data from that report for foundation design purposes without verification from detailed subsurface investigations at the new site is not recommended.

2. Slope stability should not be a problem because slopes are gentle and little site grading is necessary.

3. Flooding from Beaver Creek may occur, particularly along the north edge of the site, and flood control measures should be taken to mitigate this hazard.

4. The site is along the west edge of Uniform Building Code (UBC) seismic zone 2 and is at the boundary between Utah Seismic Safety Advisory Council (1979) seismic zones 2 and 3. At a minimum, construction should conform to UBC specifications for seismic zone 2. If an added factor of safety is desired, because of the location near the boundary between seismic zones 2 and 3, construction specifications for zone 3 should be followed.

REFERENCES

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro, Inc., 35 p.

Baker, C.H., Jr., 1970, Water resources of the Heber-Kamas-Park City area, north-central Utah: Utah Department of Natural Resources Publication No. 27, 79 p.

Butler, Elmer, and Marsell, R.E., 1972, Developing a state water plan-cloudburst floods in Utah, 1939-69: U.S. Geological Survey and Utah Division of Water Resources Cooperative Investigations Report no. 11, 103 p.

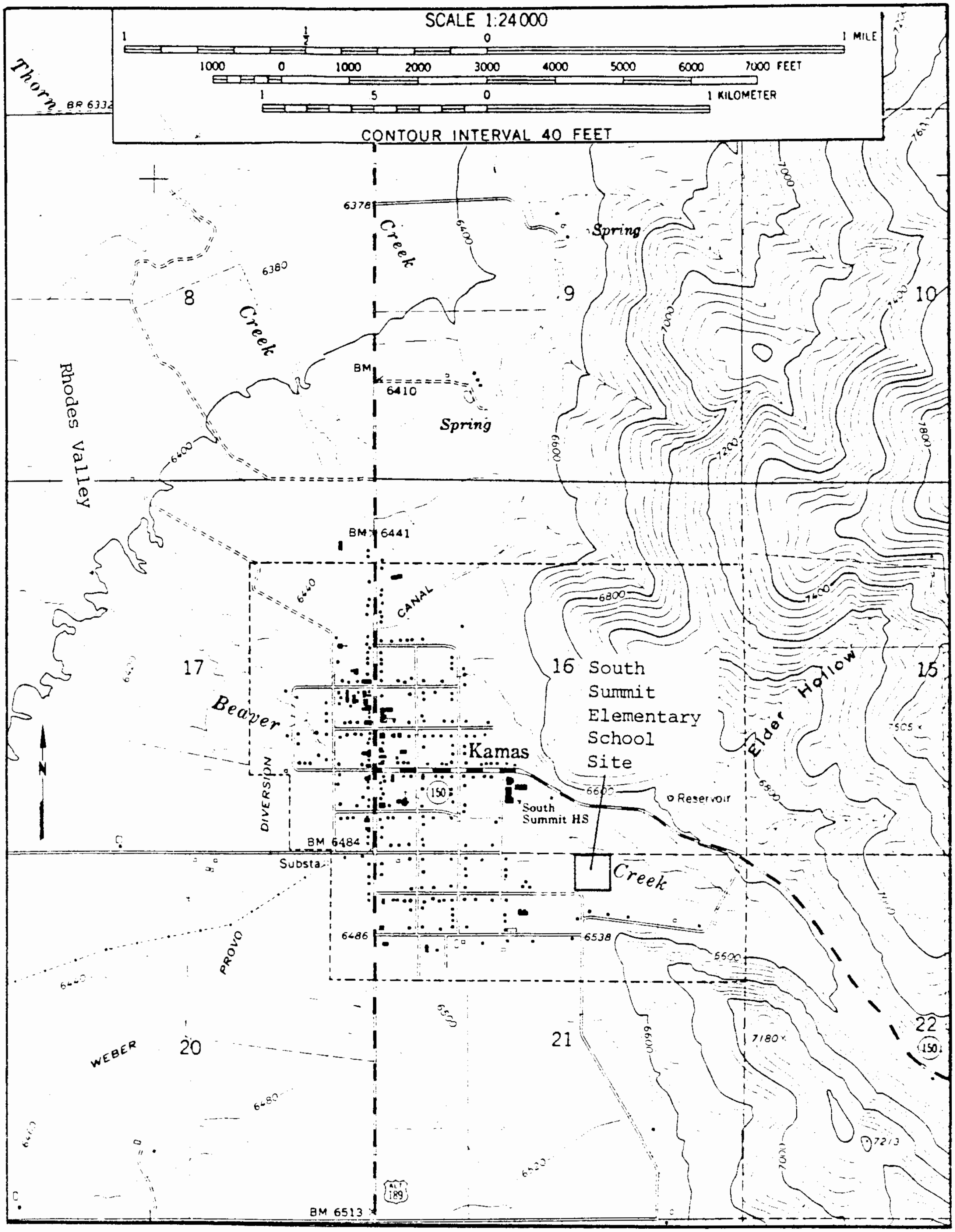
University of Utah Seismograph Stations, 1985, unpublished earthquake catalog data.

Utah Division of Comprehensive Emergency Management, 1981, History of Utah Floods, 1847 to 1981: Floodplain Management Status Report.

Utah Seismic Safety Advisory Council, 1979, Seismic zones for construction in Utah: Delbert Ward, Executive Director, 13 p.

Wooley, R.R., 1940, Cloudburst floods in Utah, 1850-1938: U.S. Geological Survey Water-Supply Paper 994, 128 p.

Base map from: USGS 7½ min. topoquad. Kamas, Utah



Location Map

SUBDIVISIONS

Project:			Requesting Agency:
Review of geotechnical report for Canyon View Park Subdivision, Salt Lake City			Salt Lake City Planning
By: G.E. Christenson	Date: 7/15/85	County: Salt Lake	Job No.: SD-1
USGS Quadrangle: Sugar House (1212)			

#85-023

In response to a request from Douglas Wheelwright, Salt Lake City planner, a review of the geotechnical investigation for the Canyon View Park Subdivision by Sergent, Hauskins, and Beckwith (SHB), Consulting Geotechnical Engineers, was performed. The subdivision is at the mouth of Emigration Canyon on a bench south of the creek (sec. 11, T. 1 S., R. 1 E., SLBM). The objectives of the SHB investigation as stated in the report were to: 1) evaluate physical properties of subsoils beneath Kennedy, Crestview, and Wasatch Drives, 2) provide recommendations for pavement design, and 3) assess the stability of the existing slope along the northeast edge of the subdivision under both static and dynamic (earthquake ground shaking) conditions. The Utah Geological and Mineral Survey (UGMS) does not have the expertise to evaluate engineering analyses for pavement design and seismic slope stability. However, the UGMS can review the validity of geologic considerations input into these analyses. The scope of work for our review included a literature review, air photo analysis, and brief site reconnaissance. Craig Nelson, Salt Lake County Geologist, was present during the site visit on June 28, 1985.

No significant geologic considerations are involved in pavement design, although geology is an important considerations in the data input into the computer model used for the slope stability analysis. On page 6 it is stated that a ground acceleration of 0.2g accompanying a magnitude 6.5 earthquake was used as the maximum credible ground acceleration at the site. This value is commonly sited as an acceleration in rock that has a 90 percent chance of not being exceeded in 50 years (Algermissen and Perkins, 1976; Utah Seismic Safety Advisory Council, 1979). Therefore, this is closer to a design or maximum probable ground acceleration, and is not the maximum credible ground acceleration. A magnitude 6.5 earthquake is also not the maximum credible earthquake for the area, and the Wasatch fault is considered capable of generating earthquakes in the range of 7.0 to 7.5 (Schwartz and Coppersmith, 1984). However, because the slope is unstable at ground accelerations of less than 0.2 g, it would also be unstable at higher accelerations. This is presented only as a point of information because it is generally not necessary to design residential subdivisions to withstand maximum credible events which have average recurrance intervals along specific segments of the Wasatch fault of 1700-3000 years (Schwartz and Coppersmith, 1984).

Subjects of possible geologic importance from the standpoint of hazards which this report does not address include the potential for surface fault rupture, distance to nearest and most recently active fault, flood or debris-flow hazard, or soil/foundation conditions. Although adverse conditions may not exist at the site, the engineering geologic analysis to make this determination is not included in this report and the UGMS recommends that it be completed prior to development.

REFERENCES

Algermissen, S.T., and Perkins, D.M., 1976, A probabilistic estimate of maximum acceleration in rock in the contiguous United States: U.S. Geological Survey Open-File Report 78-416, 45 p.

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

Utah Seismic Safety Advisory Council, 1979, Seismic zones for construction in Utah: Delbert Ward, Executive Director, 13 p.

WATER SUPPLY

Project: Water Analysis of Springs for the Manila Culinary Water Company				Requesting Agency: Manila Culinary Water Company
By: R.H. Klauk	Date: 5/7/95	County: Utah		Job No.: WS-1
USGS Quadrangle: Timpanogos Cave (1129)				

85-013

BACKGROUND AND SCOPE

This report presents the results of an evaluation by the Utah Geological and Mineral Survey (UGMS) of water sample analyses (attachments 1 and 2) supplied by the Manila Culinary Water Company for two springs located in the NW 1/4 of sec. 16, T. 5 S., R. 2 E., Salt Lake Baseline and Meridian, Utah County, Utah (attachment 3). Spring A is presently developed for culinary purposes and spring B is being considered for similar use. The samples were collected and analyzed as a result of recommendations made in an earlier UGMS report by Klauk (1984) to help better define the characteristics of spring B. To fully evaluate the analyses, a review was made of published and unpublished geologic and hydrologic information pertinent to the area. Attachment 4 presents water analyses from other sources.

SPRING CHEMISTRY

An evaluation of common ions identified springs A and B as calcium-magnesium bicarbonate-chloride-sulfate (Ca-Mg HCO_3-Cl-SO_4) in character, and dilute (total dissolved solids less than 1000 mg/l), with total dissolved solid (TDS) contents of 458 and 467 mg/L, respectively (attachment 5). Both samples are enriched in Ca and HCO_3 with respect to other cations and anions. Spring A is slightly acidic (pH = 6.65) and spring B is slightly basic (pH = 7.48). These pH values may be incorrect, however, if they were determined in the laboratory and not at the sampling site (Hem, 1970). Analyses of Wadley and Wade springs located 1.0 and 1.5 miles, respectively, southeast of spring A are of similar character and have slightly basic pH values (Fairbanks, 1982). Total dissolved solid concentrations were not included with the analyses, but specific conductance, which provides rough estimates of TDS, indicates both springs are dilute. Water analyses presented by Fairbanks (1982) for the undifferentiated aquifer (unconfined ground water in basin-fill deposits partially recharged by bedrock inflow) at the margin of Utah Valley and for surface water from Grove Creek, show these waters are also calcium-magnesium bicarbonate-chloride-sulfate (Ca-Mg HCO_3-Cl-SO_4) in character, slightly and moderately basic, respectively, and dilute (attachments 4 and 5). Wadley and Wade Springs, the undifferentiated aquifer, and Grove Creek, are enriched in Ca and HCO_3 with respect to other cations and anions. Attachment 6, however, shows that total concentrations for individual ions are greatest for the springs. The following discussion identifies similarities and differences between springs.

Spring A is perennial, flowing from a maximum of 200 gallons per minute (gpm) in the fall to a minimum of 150 gpm at other times of the year (Klauk, 1984). Wadley and Wade Springs, also perennial, are each estimated to flow at 1000 gpm (Appel and others, 1982). Spring B commenced flowing during the past two years but rates of flow have not been measured. All four springs have high concentrations of Ca and HCO_3 which, according to Drever (1982), is characteristic of perennial deep circulation. The high concentrations are thought to be due to contact with rocks for longer periods of time. Rock types most likely to be found along the flow paths of these deeply circulating waters are interbedded sandstone and cherty limestone, shale and shaley limestone, and interbedded dolomite with weathered sandstone (attachment 7). Wadley Spring and Wade Spring both issue from Mississippian Limestone (Great Blue Limestone?) (Appel and others, 1982). Spring A issues from a solution cavity in calcareous tufa (Klauk, 1984). Spring B issues from colluvium possibly covering calcareous tufa. The calcareous tufa ($CaCO_3$) deposit at spring A suggests the circulating water has been in contact with limestone, probably at low temperatures (White, 1970). Springs that deposit calcareous tufa contain more CO_2 in solution at depth than can be retained at surface temperatures and pressures (White and others, 1963). As pressure decreases, CO_2 is given off and pH increases causing precipitation of $CaCO_3$ (calcareous tufa). Depletion of $CaCO_3$ may also account for the large percentage of Mg present in springs A and B. The weight ratio of Mg/Ca in pure dolomite is 0.61 (White and others, 1963). The ratios for springs A and B are 0.74 and 0.85, respectively, indicating precipitation/depletion of Ca has occurred.

An abundant source of CO_2 is needed to explain calcareous tufa depositing springs. Hem (1970) suggests metamorphism of limestone occurs to liberate the needed CO_2. Increases in CO_2 also account for increases in HCO_3; CO_2 allows more limestone and dolomite to dissolve which, in turn, allows for water to move up saturation curves to higher HCO_3 concentrations (Langmuir, 1974). This results in the supersaturated condition with respect to HCO_3 reported by Fairbanks (1982) for Wadley and Wade Springs. Sulfate is also present in significant concentrations in springs A and B. Matthess (1982) indicates SO_4 can be present in fractures in sedimentary rocks; this may be the source for the significant amounts found in the springs in the study area. White and others (1963) use ion weight ratios to identify water having circulated through different geologic environments. Attachment 4 presents ratios, in addition to Mg/Ca, for the springs discussed in this study. The ratios used include Ca/Na, K/Na, HCO_3, SO_4/Cl, F/Cl, and B/Cl. Qualitatively, as a group, these ratios show significant variability between springs. This indicates indicates each spring has a unique flow path.

CONCLUSIONS

Springs A and B, as well as Wadley and Wade springs, all have chemical characteristics indicative of deeply circulating water. Chemical ratio variability indicates springs A and B have separate flow paths. The flow path for spring B may require more head to allow the cirulated water to reach the surface. If the above normal precipitation for the past three years supplied this additional head, sustained periods of normal or lower than normal precipitation may also reduce the head, causing spring B to cease flowing during these sustained periods.

REFERENCES CITED

Appel, C.L., Clark, D.W., and Fairbanks, P.E., 1982, Selected hydrologic data for northern Utah Valley, Utah; 1935-1982: Utah Department of Water Rights, Hydrologic-Data Report No. 39, 97 p.

Baker, A.A., and Crittendon, M.D., Jr., 1961, Geologic map of the Timpanogos Cave Quadrangle, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ-132, scale 1:24,000.

Drever, J.I., 1982, The geochemistry of natural waters: Englewood Cliffs, New Jersey, Prentice-Hall Inc., 388 p.

Fairbanks, P.E., 1982, Chemical changes in ground water of northern Utah Valley, Utah: Logan, Utah State University, M.S. Thesis, 92 p.

Hem, J.D., 1970, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Klauk, R.H., 1984, Spring and debris flow evaluation for the Manila Culinary Water Company: Utah Geological and Mineral Survey Site Investigation Technical Report No. 84-038, 6 p.

Langmuir, Donald, 1971, The geochemistry of some carbonate ground waters in central Pennsylvania, in Back, William, and Freeze, R.A., eds., Chemical hydrology: Stroudsburg, Pennsylvania, Hutchinson Ross Publishing Company, p. 234-256.

Matthess, Georg, 1982, The properties of ground water: New York, John Wiley and Sons, 406 p.

White, D.E., 1970, Geochemistry applied to the discovery, evaluation, and exploitation of geothermal energy resources: Geothermics, Special Issue 2, p. 58-80.

White, D.E., Hem, J.D., and Waring, G.A., 1963, Chemical composition of subsurface waters: U.S. Geological Survey Professional Paper 440-F, p. F1-F67.

Attachment 1, Job No. WS-1

CHEMTECH

28 EAST 1500 NORTH
OREM, UTAH 84057
(801) 226-8822

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Manila Culinary Water Co.
765 W. 2600 N.
Pleasant Grove, UT 84602

LAB NO.: U003790

DATE SAMPLED: 11-28-84

TIME SAMPLED:

SAMPLED BY:

LOCATION: Spring 'A'

COMMENTS:

PARAMETER	LEVEL	
Alkalinity as $CaCO_3$, mg/l	306	125
Ammonia as NH_3-N, mg/l	<.1	
Arsenic as As, mg/l	<.01	.01
Barium as Ba, mg/l	<.01	1.0
Bicarbonate as HCO_3, mg/l	373	
Boron as B, mg/l	0.082	
Cadmium as Cd, mg/l	<.01	.01
Calcium as Ca, mg/l	90.7	
Carbonate as CO_3, mg/l	0	

PARAMETER	LEVEL	
Chloride as Cl, mg/l	11.9	250
Chromium as Cr (Hex.), mg/l	<.01	.05
Chromium as Cr (Total), mg/l	<.01	
Conductivity, umhos/cm	708	
Copper as Cu, mg/l	<.01	1.0
Fluoride as F, mg/l	1.41	1.2
Hardness as $CaCO_3$, mg/l	389	[illegible]
Hydroxide as OH, mg/l	0	
Iron as Fe (Dissolved), mg/l	<.01	.3
Iron as Fe (Total), mg/l	0.040	
Lead as Pb, mg/l	0.032	.05
Magnesium as Mg, mg/l	41.0	
Manganese as Mn, mg/l	<.01	.05
Mercury as Hg, mg/l	<.0002	
Nickel as Ni, mg/l	0.010	
Nitrate as NO_3-N, mg/l	0.242	45
Nitrite as NO_2-N, mg/l	<.005	
Phosphate as PO_4-P, mg/l	0.011	
Potassium as K, mg/l	0.52	
Selenium as Se, mg/l	<.002	
Silica as SiO_2 (Dissolved), mg/l	7.77	
Silver as Ag, mg/l	<.01	
Sodium as Na, mg/l	11.0	
Sulfate as SO_4, mg/l	54	250
Total Dissolved Solids, mg/l	458	500
Turbidity, NTU	0.20	
Zinc as Zn, mg/l	0.010	
pH Units	6.65	7

CHEMTECH

CHEMTECH

28 EAST 1500 NORTH
OREM, UTAH 84057
(801) 226-8822

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION

CLIENT: Manila Culinary Water Co.
765 W. 2600 N.
Pleasant Grove, UT 84062

LAB NO.: U003791

DATE SAMPLED: 11-28-84

TIME SAMPLED:

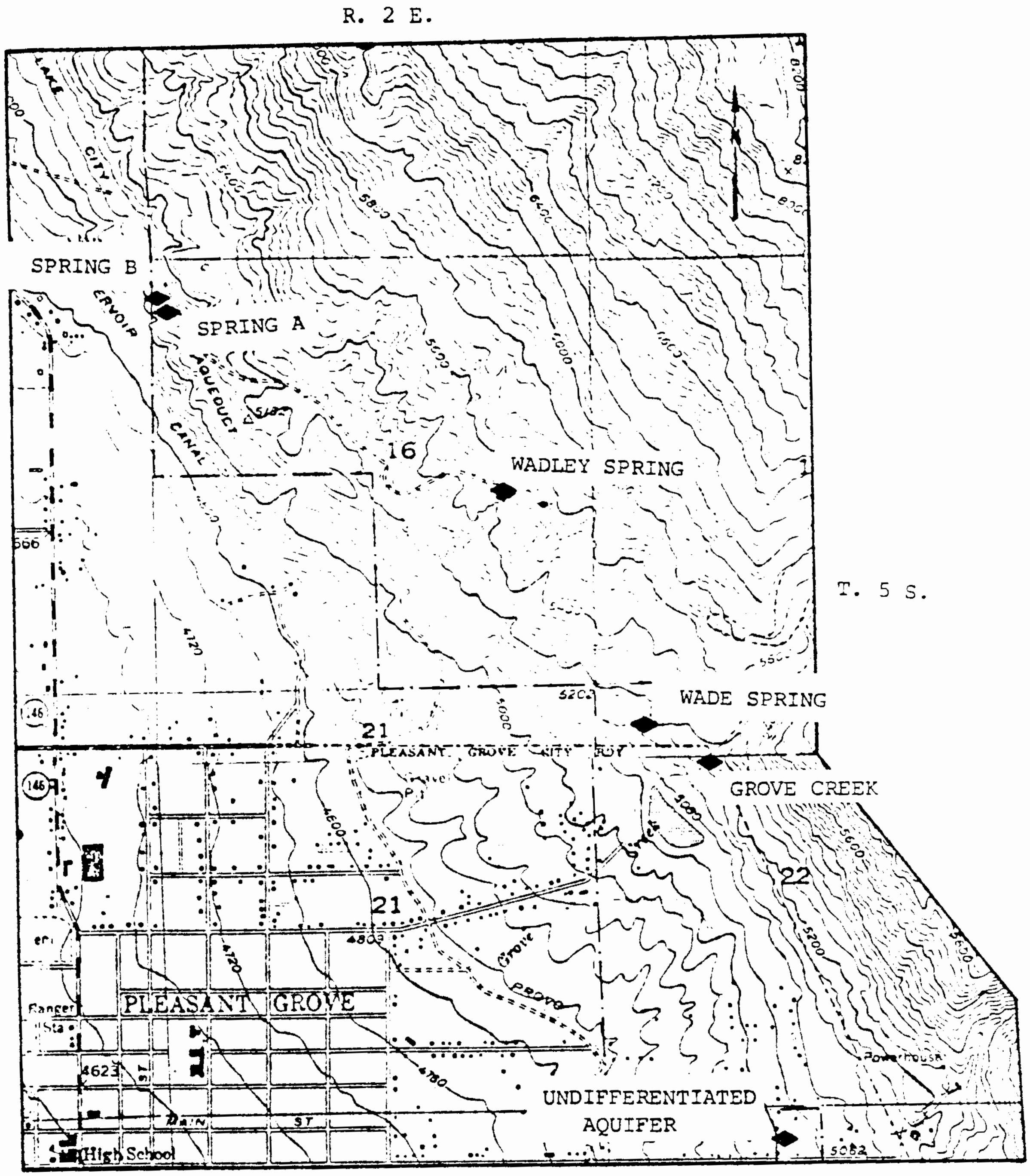
SAMPLED BY:

LOCATION: Spring 'B'

COMMENTS:

PARAMETER	LEVEL	
Alkalinity as $CaCO_3$, mg/l	287	
Ammonia as NH_3-N, mg/l	<.1	
Arsenic as As, mg/l	0.010	.01
Barium as Ba, mg/l	<.01	1.0
Bicarbonate as HCO_3, mg/l	350	
Boron as B, mg/l	0.120	
Cadmium as Cd, mg/l	<.01	.01
Calcium as Ca, mg/l	82.3	
Carbonate as CO_3, mg/l	0	
Chloride as Cl, mg/l	14.8	250
Chromium as Cr (Hex.), mg/l	<.01	.05
Chromium as Cr (Total), mg/l	<.01	
Conductivity, umhos/cm	693	
Copper as Cu, mg/l	0.015	1.0
Fluoride as F, mg/l	1.27	1.2
Hardness as $CaCO_3$, mg/l	298	
Hydroxide as OH, mg/l	0	
Iron as Fe (Dissolved), mg/l	<.01	.3
Iron as Fe (Total), mg/l	1.34	
Lead as Pb, mg/l	0.032	.05
Magnesium as Mg, mg/l	42.8	
Manganese as Mn, mg/l	0.017	.05
Mercury as Hg, mg/l	<.0002	
Nickel as Ni, mg/l	0.012	
Nitrate as NO_3-N, mg/l	0.275	45
Nitrite as NO_2-N, mg/l	0.011	
Phosphate as PO_4-P, mg/l	0.017	
Potassium as K, mg/l	0.82	
Selenium as Se, mg/l	<.002	
Silica as SiO_2 (Dissolved), mg/l	8.03	
Silver as Ag, mg/l	<.01	
Sodium as Na, mg/l	13.8	
Sulfate as SO_4, mg/l	90	250
Total Dissolved Solids, mg/l	467	500
Turbidity, NTU	6.5	
Zinc as Zn, mg/l	0.020	
pH Units	7.48	7

CHEMTECH
Site Investigation Section



Base map from: U.S.G.S. 7½' topographic quadrangle maps Timpanogos Cave and Orem, Utah.

SCALE 1:24 000

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS

Location map of the study area in Utah County, Utah.

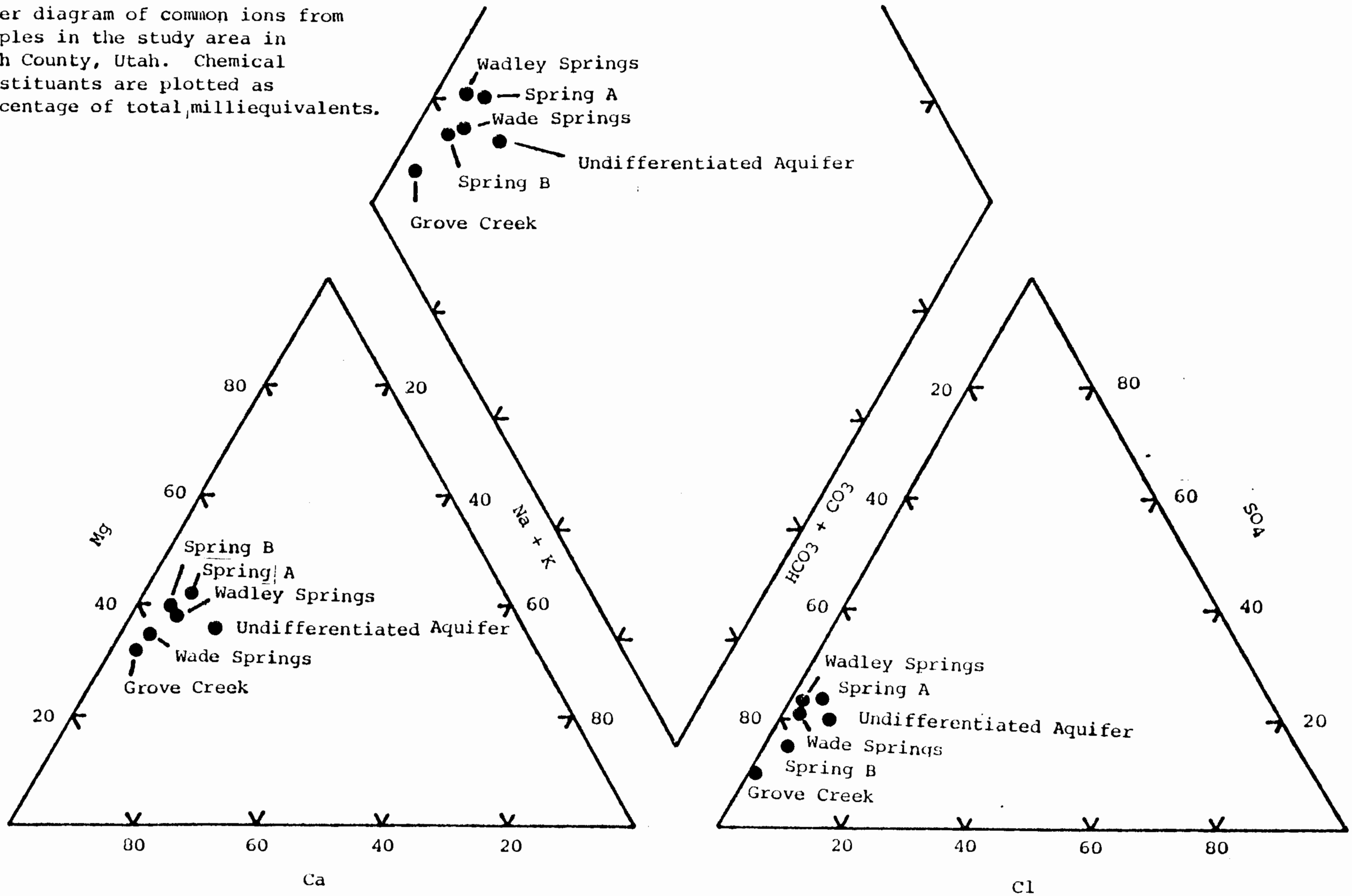
Table 1: Chemical analyses of spring, well, and surface waters in the Pleasant Grove area, Utah County, Utah.

		SPRING A	SPRING B	WADE SPRING	WADLEY SPRING	UNDIFFERENTIATED AQUIFER	GROVE CREEK
Temperature ^{o}C		--	--	16.00	16.00	20.00	12.00
pH		6.65	7.48	7.80	7.30	7.70	8.40
TDS	mg/l	458.00	467.00	--	--	--	--
HCO_3	mg/l	373.00	350.00	354.00	376.00	278.00	200.00
Na	mg/l	11.00	13.00	7.30	11.00	20.00	2.70
K	mg/l	0.52	0.82	0.60	0.70	1.10	0.50
Ca	mg/l	90.70	82.30	88.00	93.00	59.00	43.00
Mg	mg/l	41.00	42.80	31.00	39.00	26.00	13.00
SiO_2	mg/l	7.77	8.03	8.50	9.20	11.00	5.40
B	mg/l	0.08	0.12	0.02	0.02	0.04	--
F	mg/l	1.41	1.27	0.90	0.50	0.40	0.60
Cl	mg/l	11.90	14.80	7.50	9.30	18.00	1.70
SO_4	mg/l	54.00	90.00	90.00	81.00	59.00	18.00
Ratios by weight							
Ca/Na		9.44	6.85	13.72	9.67	3.38	17.92
Mg/Ca		0.74	0.85	0.58	0.69	0.73	0.50
K/Na		0.02	0.03	0.06	0.38	0.03	0.08
HCO_3/Cl		17.97	13.26	27.62	23.69	8.94	65.60
SO_4/Cl		3.29	4.25	8.90	6.46	2.41	7.40
F/Cl		0.22	0.16	0.23	0.10	0.04	0.63
B/Cl		0.02	0.03	0.01	0.01	0.01	--

-- Indicates analysis not provided or ratio not completed.

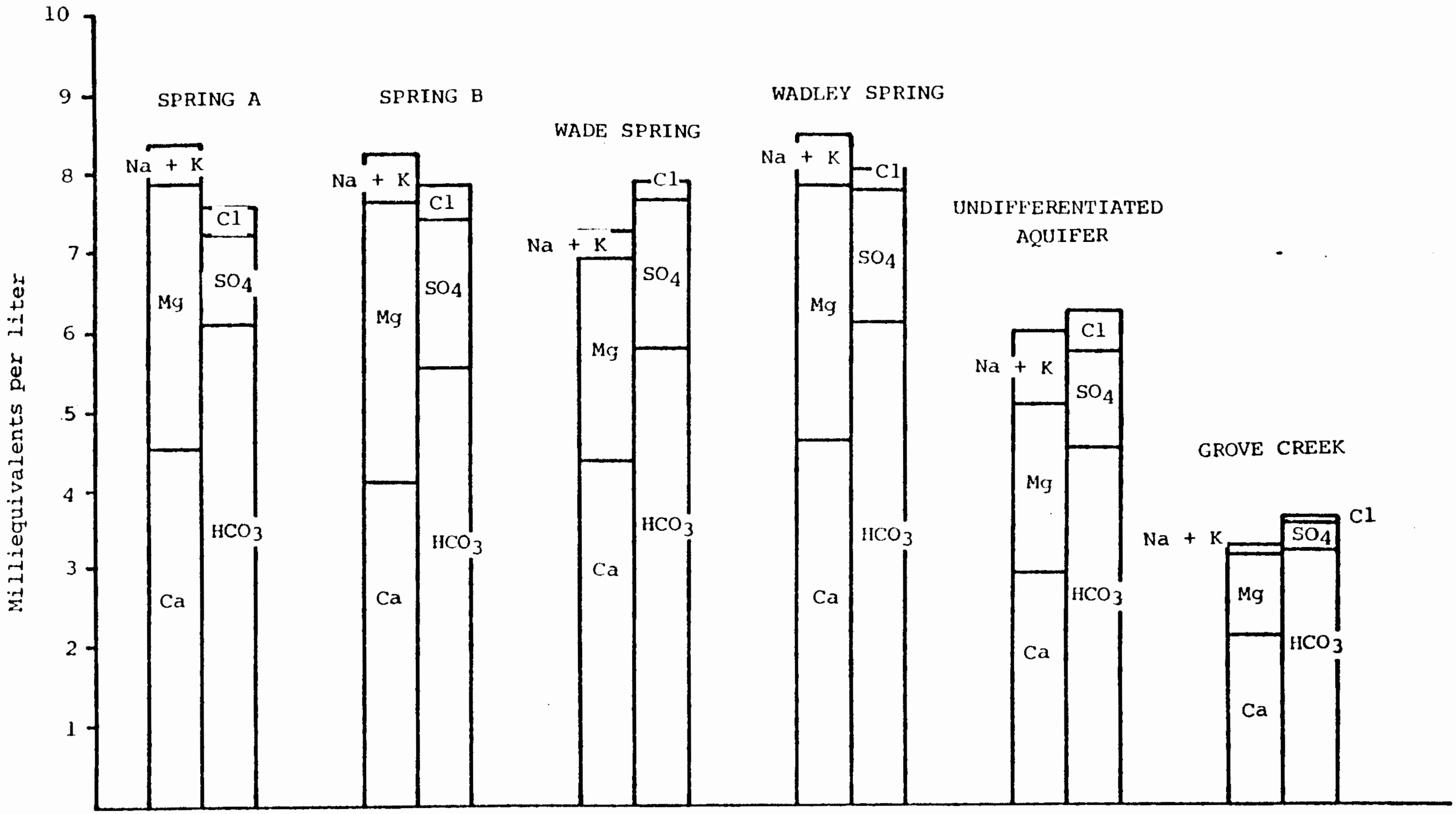
Data for springs A and B are from attachments 1 and 2.
Data for Wade Spring, Wadley Spring, the undifferentiated aquifer and Grove Creek are from Fairbanks, 1982.

Piper diagram of common ions from samples in the study area in Utah County, Utah. Chemical constituents are plotted as percentage of total milliequivalents.



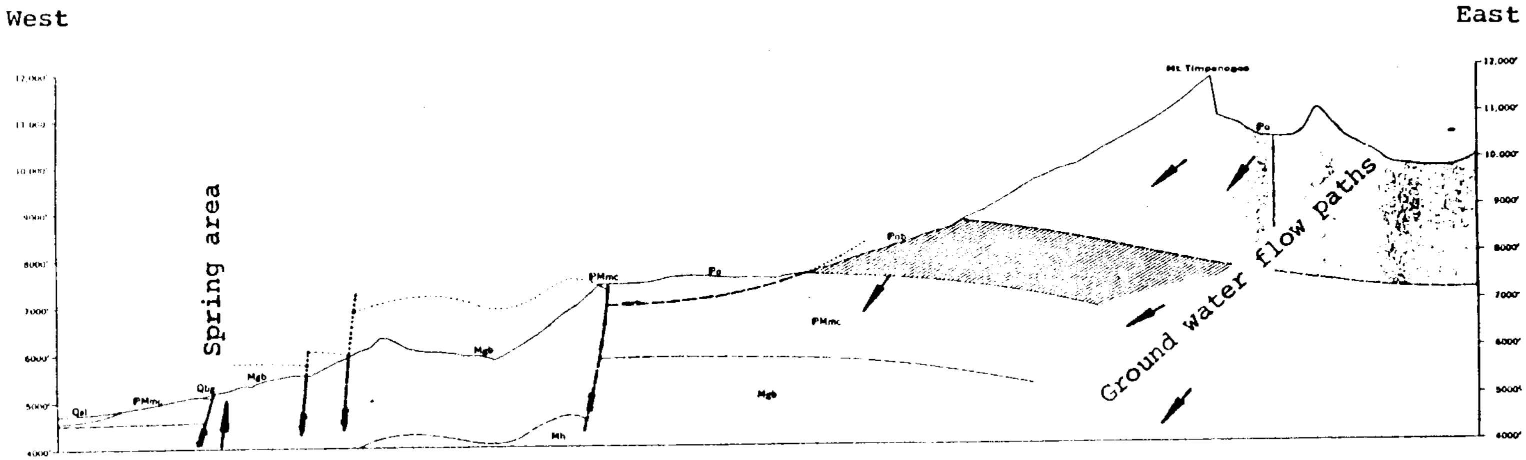
Utah Geological and Mineral Survey

Site Investigation Section



Composition of water from the study area, Utah County, Utah.

Cross-section through the study area depicting the possible deep circulation paths for recharge to the springs.



Scale 1:48,000
No Vertical Exaggeration

Cross-section modified from: Baker and Crittendon, 1961.

EXPLANATION

Symbol	Unit
Qal Qt Qls Qbg	**Alluvial deposits**
Po / Pob	**Oquirrh formation**
PMmc	**Manning Canyon shale**
Mdo	**Doughnut formation**
Mgb	Great Blue limestone
Mh	Humbug formation

Contact
Dashed where approximately located, dotted where concealed

Fault, showing dip
Dashed where approximately located, dotted where concealed
U, *upthrown side;* D, *downthrown side*

Utah Geological and Mineral Survey

Site Investigation Section

Project:			Requesting Agency:
Virgin, Utah Water Purification Project			Virgin, Utah
By: R.H. Klauk	Date: 5/7/85	County: Washington	Job No.: WS-2
USGS Quadrangle: Virgin (75)			

85-014

PURPOSE AND SCOPE

This report presents the results of an investigation by the Utah Geological and Mineral Survey (UGMS) to assess geologic hazards for a water project for the town of Virgin, Utah. The investigation was performed at the request of Russell B. Cornelius, City Clerk. The project consists of a small diversion dam on North Creek, a storage reservoir, and a water purification plant. The project will provide the town of Virgin with the capacity to purify 150 gallons per minute of water from North Creek for culinary purposes. At the time of the investigation, the diversion dam was near completion, the storage reservoir was complete, and the foundation had been poured for the water purification plant. The scope of work for the study included a review of existing geological literature, interpretation of air photography, and a field reconnaissance on March 25 and 26, 1985.

SETTING

The town of Virgin is located on the Kolob Terrace in the upper Virgin River basin of the Colorado Plateau physiographic province. The Kolob Terrace is cut into the south flank of the Markagunt Plateau and consists of two uneven plateaus separated by a line of prominent cliffs (Gregory, 1950). Streams tributary to the Virgin River have incised into these plateaus forming canyons. North Creek is one such stream.

The upper Virgin River basin encompasses 1300 square miles and ranges from semi-arid in the south near Virgin to subhumid further north (Cordova, 1981). Cordova (1981) also reports mean annual precipitation ranges from 8 to 12 inches at Virgin to more than 30 inches in the higher elevations at the headwaters of North Creek.

The diversion dam is located on North Creek, approximately 3 miles northeast of the town of Virgin in sec. 12, T. 41 S., R. 12 W. Salt Lake Baseline and Meridian (attachment 1). The purification plant and storage reservoir are located in sec. 23, T. 41 S., R. 12 W., 0.4 and 0.8 miles, respectively, northeast of Virgin, above and west of the flood plain of North Creek.

GEOLOGY, STRUCTURE, AND SEISMICITY

Geologic units exposed in the study area range in age from Triassic to Quaternary and consist of consolidated rocks and unconsolidated surficial deposits. Bedrock includes the Triassic Shinarump Conglomerate Member of the Chinle Formation, the Moenkopi Formation, the Jurassic Navajo Sandstone, and Tertiary basalt (attachment 2). Quaternary unconsolidated material consists of alluvium along streams and undifferentiated surficial deposits in other areas (attachment 3). Bedrock in the study area generally dip to the east or northeast at angles from about 2° to 40°; the greater dip angles are found near faults (attachment 2). Two major faults near Virgin are the Hurricane fault 5 miles to the west and the Cougar Mountain fault 7 miles to the east (attachment 2). Joints, especially in the Navajo Sandstone and Shinarump Conglomerate Member, are also common.

The upper Virgin River basin is in both Uniform Building Code (UBC) and Utah Seismic Safety Advisory Council (USSAC) seismic zone 2. This indicates the sites are in an area where an earthquake of modified Mercalli intensity VII can be expected. See attachment 4 for an explanation of the intensity scale. Several earthquakes have occurred in this area, but only one had a Richter magnitude of 4 or greater (Arabasz and others, 1979). No surface faulting has been associated with any of these earthquakes, although surface rupture is suspected on the Hurricane fault during late Pleistocene time (Anderson and Miller, 1979). No other Pleistocene or younger faults are known in the site vicinity.

HYDROLOGY

North Creek receives flow from snowmelt in the higher elevations of its drainage basin, and from torrential summer rains and influent ground water (Gregory, 1950). Ground water occurs in both bedrock and unconsolidated deposits in the upper Virgin River basin (Cordova, 1981). The regional water table is generally at or near the base level of the most deeply incised perennial streams (Cordova, 1981). Localized perched water-table conditions exist above the regional water table; water accumulates above low permeability clay strata or bedrock.

SITE CONDITIONS

Diversion Dam

At the diversion dam site North Creek has incised into the Middle Red Member of the Moenkopi Formation and possibly into the more resistent underlying Virgin Limestone Member and subsequently aggraded to the present base level depositing alluvium of unknown depth (attachment 3). The Middle Red Member consists of red, fine-grained, thin-bedded, siliceous, calcareous, and gypsiliferous sandstone with occaissional lenses of fossiliferous, nodular limestone. The limestone in the Virgin Limestone Member varies from even-bedded, dark blue, and massive to earthy, irregular and slabby (Gregory, 1950). Between and below these limestone strata are beds of red, brown, and blue-gray shale and thin calcareous sandstone. Coarse-grained alluvium, containing boulders to 4 feet in diameter forms the active stream bed at the dam site.

The diversion dam is constructed of boulders obtained on site to a height of approximately 6 feet across the channel. Backfill has been placed partially across the channel on the downstream side of the dam to within 2 feet of the crest. At the time of the field reconnaissance, concrete was being poured into the void spaces between boulders to prevent dislodgement by flash floods during spring and summer thunder storms. Previous floods in North Creek have been of sufficient size to move large boulders as evidenced by their presence below the dam. Floods of this magnitude could conceivably overtop the dam, but the dam is unlkely to fail. Should the dam fail, the small amount of impoundment water presents only a small flooding hazard. Attachment 5 shows the diversion dam with backfill on the downstream side.

Storage Reservoir

The storage reservoir site sloped to the north-northeast at a grade of approximately 10 to 15 percent. Part of the reservoir is excavated in the Virgin Limestone Member of the Moenkopi Formation, and the remainder consists of an embankment constructed of clay soil obtained on site. After completion and filling, the reservoir leaked (Thomas Thompson, city councilman, personnel comm., 1985). Mortensen and others (1971) report that on-site soils have low to high susceptability to piping, however, no evidence of leakage through the embankments was observed indicating that the water loss occurred into alluvium or bedrock.

Purification Plant

The purification plant site is located on an alluvial surface that slopes approximately 13 percent to the east. East of the site the slope abruptly terminates against a hogback that slopes to the west. A road cut in the hogback exposes dark red to brown, shale-like sandstone with interlayered gypsum of the Lower Red Member of the Moenkopi Formation (Gregory, 1950). Soils exposed in a 3-foot deep trench on the site consist of sandy, silty, clay with occaissional gravel and cobbles up to 6 inches in diameter (attachment 6). These soils are similiar to those described by Mortensen and others (1971), and formed from material deposited on the alluvial surface by runoff from local high-intensity storms. No evidence of gypsum or other hazardous soil conditions were noted in the excavation, however, Mortensen and others (1971) do identify site soils as having moderate shrink-swell potential. Depth to ground water is greater than 100 feet at this location.

At the time of the reconnaissance, the foundation for the plant had been poured and consisted of a cement pad inside a continuous rectangular one foot thick footing with approximate dimensions of 10 feet by 25 feet. A backflushing pit had been excavated north of the foundation.

CONCLUSIONS

A major flood on North Creek could overtop the dam, possibly dislodging some of the boulders used in its construction. However, this possibility is remote and damage would not necessarily be severe to the dam. The small size of the impoundment precludes hazard from flooding due to dam failure. Leakage at the storage reservoir can be alleviated by a liner, the installation of which is already planned (Thomas Thompson, personal commun., 1985). Minor flooding from sheet wash could affect the purification plant site but is not considered a significant hazzard. Gypsum or other adverse soil conditions were not observed during the reconnaissance of the plant site. It is suggested, however, that soil samples be taken and tested for shrink-swell potential.

All three sites are in UBC and USSAC seismic zone 2. Existing structures should have been and future structures should be constructed to meet UBC seismic requirements for zone 2.

REFERENCES

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Fugro, Inc., Long Beach, California, 35 p., scale 1:500,000.

Arabasz, W.J., Smith, R.B., and Richins, W.D., (editors), 1979, Earthquake studies in Utah, 1850 to 1979: University of Utah, Department of Geology and Geophysics, 548 p.

Cordova, R.M., 1981, Ground-water conditions in the upper Virgin River and Kanab Creek basins area, Utah, with emphasis on the Navajo Sandstone: Utah Department of Natural Resources Technical Publication No. 70, 87 p.

Gregory, H.E., 1950, Geology and geography of the Zion Park region Utah and Arizona: U.S. Geological Survey Professional Paper 220, 200 p.

Marshall, C.H., 1956, Photogeologic map of the Virgin NW quadrangle Washington County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-149, scale 1:24,000.

Mortensen, V.L., and others, 1971, Soil survey of Washington County area, Utah: U. S. Department of Agriculture, Soil Conservation Service, 140 p.

LOG OF EXCAVATION
Purification Plant Site

Soil Description*

0.0 - 3.0'	Silty clay (CL); tan, hard, medium to high plasticity, dry, nonindurated, 20-30 percent sand, some gravel and isolated cobbles, maximum particle size 6 inches.

NOTE: No ground water encountered.

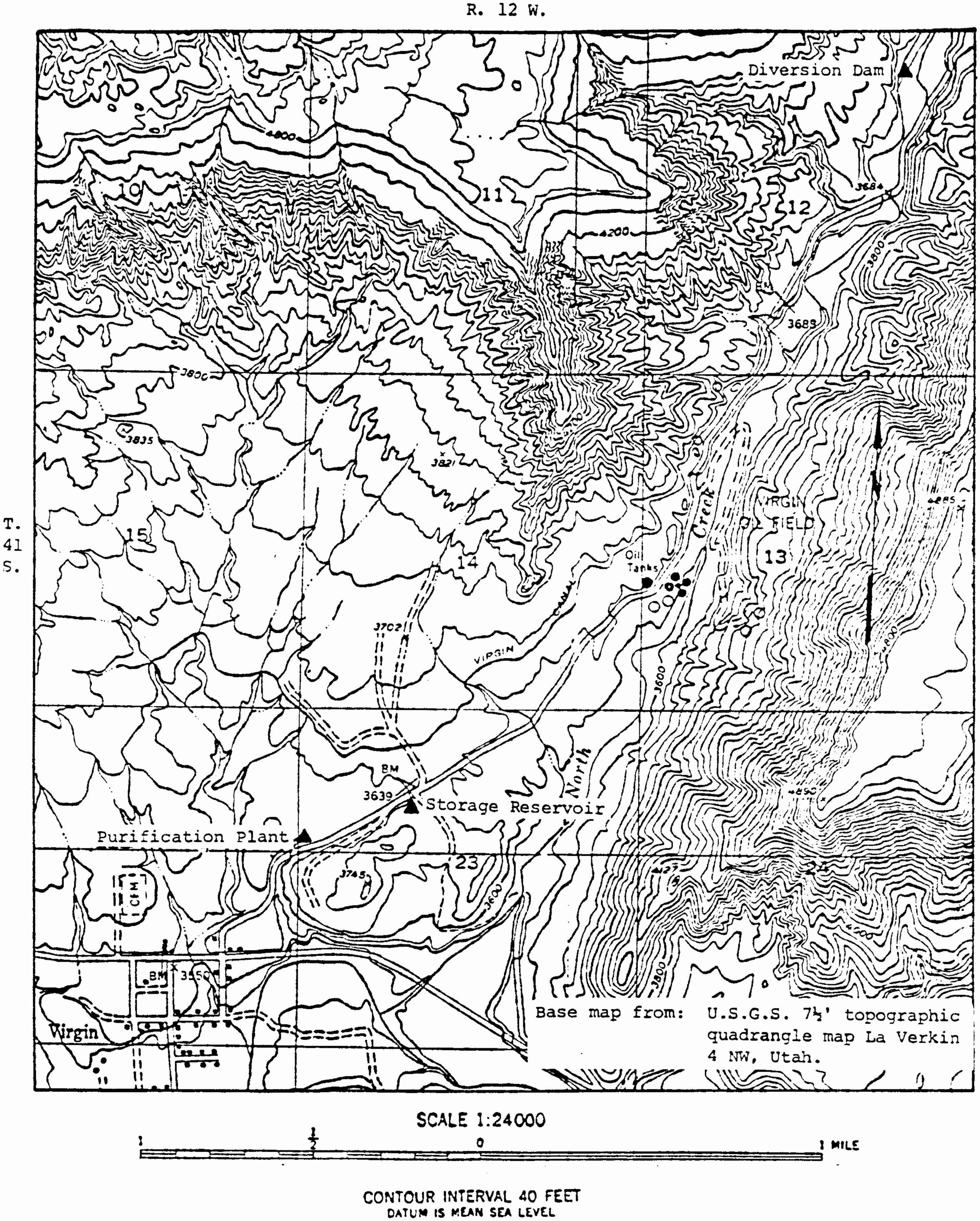
*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various size fractions are field estimates.

Table 1: Chemical analyses of spring, well, and surface waters in the Pleasant Grove area, Utah County, Utah.

		SPRING A	SPRING B	WADE SPRING	WADLEY SPRING	UNDIFFERENTIATED AQUIFER	GROVE CREEK
Temperature °C		--	--	16.00	16.00	20.00	12.00
pH		6.65	7.48	7.80	7.30	7.70	8.40
TDS	mg/l	458.00	467.00	--	--	--	--
HCO_3	mg/l	373.00	350.00	354.00	376.00	278.00	200.00
Na	mg/l	11.00	13.00	7.30	11.00	20.00	2.70
K	mg/l	0.52	0.82	0.60	0.70	1.10	0.50
Ca	mg/l	90.70	82.30	88.00	93.00	59.00	43.00
Mg	mg/l	41.00	42.80	31.00	39.00	26.00	13.00
SiO_2	mg/l	7.77	8.03	8.50	9.20	11.00	5.40
B	mg/l	0.08	0.12	0.02	0.02	0.04	--
F	mg/l	1.41	1.27	0.90	0.50	0.40	0.60
Cl	mg/l	11.90	14.80	7.50	9.30	18.00	1.70
SO_4	mg/l	54.00	90.00	90.00	81.00	59.00	18.00
Ratios by weight							
Ca/Na		9.44	6.85	13.72	9.67	3.38	17.92
Mg/Ca		0.74	0.85	0.58	0.69	0.73	0.50
K/Na		0.02	0.03	0.06	0.38	0.03	0.08
HCO_3/Cl		17.97	13.26	27.62	23.69	8.94	65.60
SO_4/Cl		3.29	4.25	8.90	6.46	2.41	7.40
F/Cl		0.22	0.16	0.23	0.10	0.04	0.63
B/Cl		0.02	0.03	0.01	0.01	0.01	--

-- Indicates analysis not provided or ratio not completed.

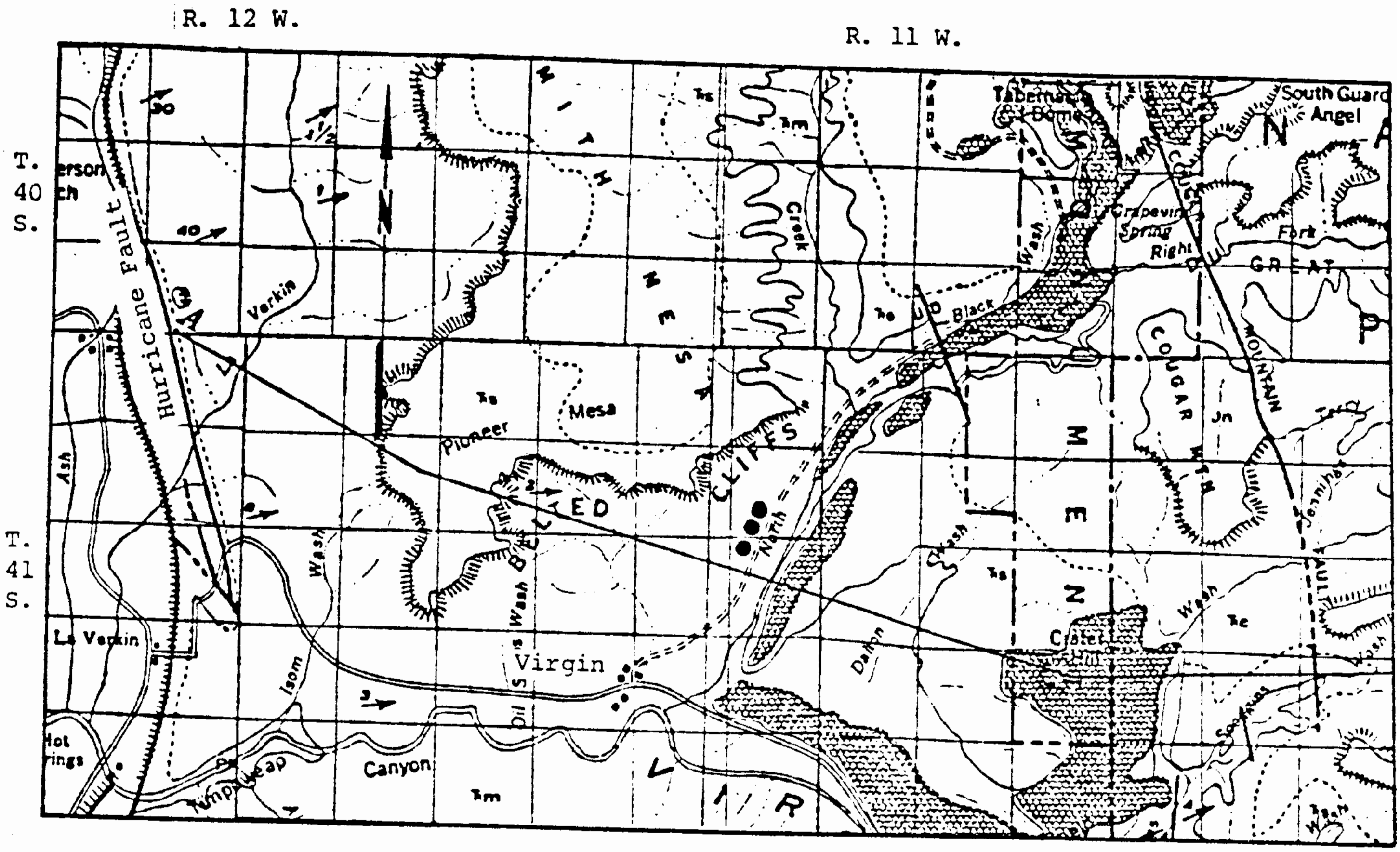
Data for springs A and B are from attachments 1 and 2.
Data for Wade Spring, Wadley Spring, the undifferentiated aquifer and Grove Creek are from Fairbanks, 1982.



Utah Geological and Mineral Survey

Location of the diversion dam, storage reservoir, and purification plant sites in Washington County, Utah.

Site Investigation Section



Scale 1:125,000

Source: Gregory, 1950.

EXPLANATION

Basalt

Jn — Navajo sandstone

Tc — Chinle formation

Ts — Shinarump conglomerate

Tm — Moenkopi formation

Contact
(Dashed where approximately located)

Regional dip

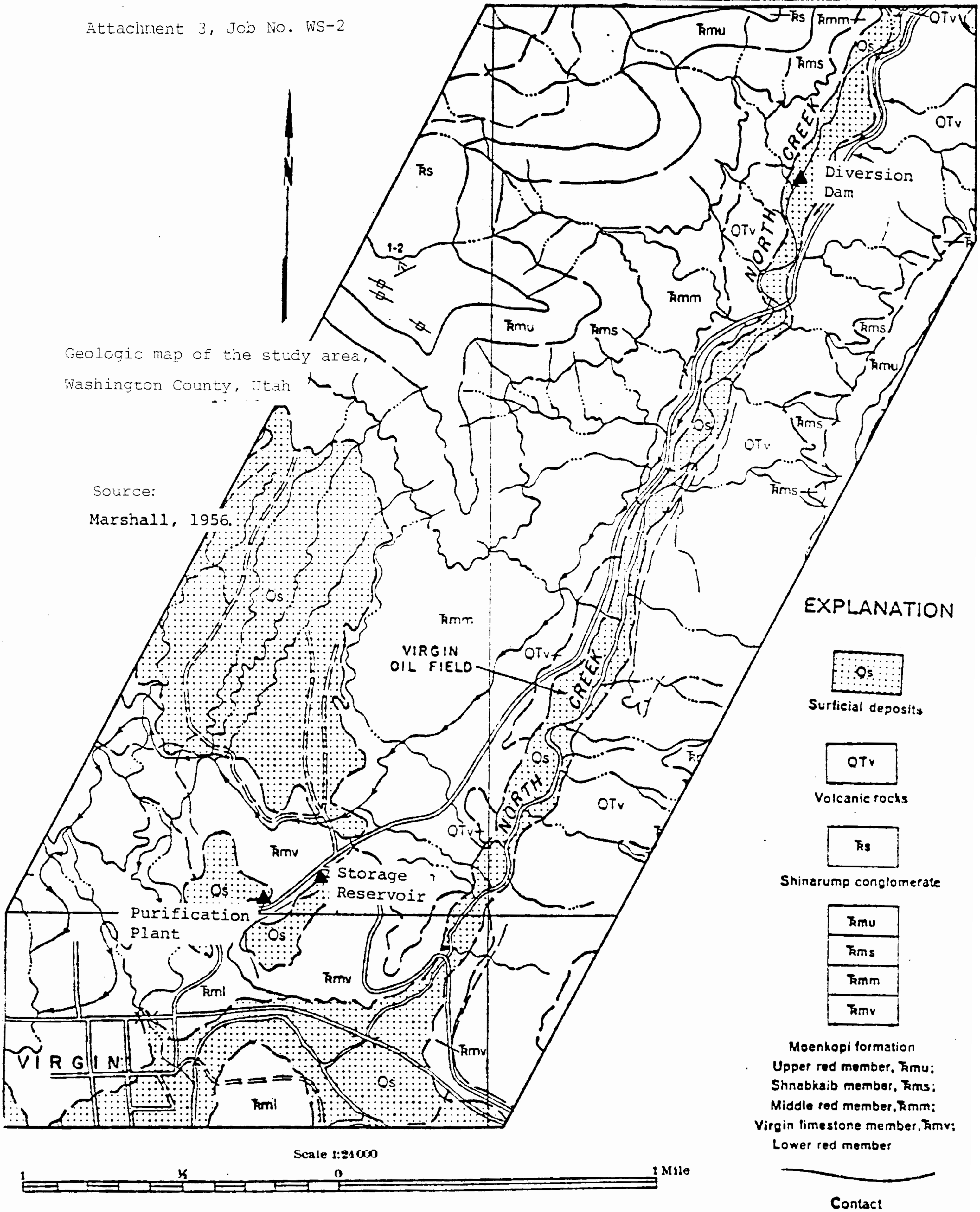
Fault
(Dashed where approximately located)

U / D — High-angle fault
(U, upthrown side; D, downthrown side)

Cliffs

Oil well

Regional geologic map of the study area in Washington County, Utah.



Geologic map of the study area, Washington County, Utah

Source:

Marshall, 1956.

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building; standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbed persons driving motor cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: Earthquake Information Bulletin; 6 (5), 1974, p. 28.

Photograph of the diversion dam on North Creek, Washington County, Utah.

LOG OF EXCAVATION

Purification Plant Site

Soil Description*

0.0 - 3.0' Silty clay (CL); tan, hard, medium to high plasticity, dry, nonindurated, 20-30 percent sand, some gravel and isolated cobbles, maximum particle size 6 inches.

NOTE: No ground water encountered.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various size fractions are field estimates.

Project:			Requesting Agency:
Evaluation of recharge area and protection zone for Buckskin Springs, Box Elder County, Utah			Utah Division of Environmental Health Bureau of Public Water Supplies
By: William Case	Date: 5/6/85	County: Box Elder	Job No.: WS-3
USGS Quadrangle: Grouse Creek (1461)			

85-017

BUCKSKIN SPRINGS EVALUATION, GROUSE CREEK COMMUNITY

The Bureau of Public Water Supplies requested an evaluation of Buckskin Springs, a source of culinary water for the community of Grouse Creek, in order to determine its recharge area and to recommend a suitable protection area. The scope of work involved a review of applicable literature and a site reconnaissance. The site was visited on April 17, 1985, by William F. Case (Utah Geological and Mineral Survey), Ursula K. Trueman (Bureau of Public Water Supplies, Utah Division of Environmental Health), and Lee Malmberg (Bear River District Health Department).

The area investigated is located in northwestern Utah approximately 20 miles south of the Idaho border and 10 miles east of the Nevada border (attachment 1). The springs are 1300 feet south and 240 feet west of the northeast corner of sec. 32, T. 12 N., R. 18 W., SLB&M at an elevation of approximately 5630 feet (attachment 2). The springs are in a boggy area near the top of a long slope below an alluvial terrace. The field in which the springs discharge is a rectangular reentrant in the terrace about 700 feet (parallel to slope) by 500 feet. The area has been disturbed by attempts to develop the springs, making the original contours and vegetation difficult to identify.

The springs issue from beneath about 5 feet of soil that is black, except for a 6-inch thick variegated light-gray to reddish-black clayey horizon about 4 feet below the surface. The clayey horizon contains many roots. Bedrock is not exposed in the area, but according to Hood and Price (1970) the geology in the spring vicinity consists of alluvium underlain by the Tertiary Salt Lake Formation. The Salt Lake Formation consists of lacustrine clastics and carbonates which generally have low permeability except for thin beds of coarse-grained material or fault zones (Hood and Price, 1970). Doelling (1980) identifies the bedrock above the alluvial terrace as the Permian Rex Chert Formation. Rex Chert float observed near the springs appears to have fracture porosity which may be related to nearby faulting. However, no faults were observed during the reconnaissance, and the only fault mapped in the area is a normal fault two miles to the north which trends toward Buckskin Springs (Doelling, 1980).

The water collection system consists of a network of pipes driven horizontally into the soil. The pipes eventually route water to a central collection box which directs water to the Grouse Creek community line. The collection pipes consist of white PVC pipe which has been inserted into older, much corroded, cast-iron pipes. Hood and Price (1970) report that the community of Grouse Creek was using Buckskin Springs water for domestic uses in 1968. Past records of Buckskin Springs as compiled by Hood and Price (1970) show a reported flow of 110 gpm. No flow estimates were made during the visit. Lee Malmberg reported a high bacterial count in the spring water which seems to be increasing with time (personnal commun., April 17, 1985). The Buckskin Springs area was fenced, but the fence was breached during the recent construction work. A local citizen indicated that the fence was temporarily removed to allow haulage of fill into the spring area. The upslope fence was about 500 feet from the springs. There was abundant evidence of grazing (1984 or earlier) just outside the upslope fence.

A small spring near the base of the Rex Chert about one-half mile northwest of Buckskin Springs was investigated. Although the spring was at least 50 feet from surface bedrock, it appeared to have a bedrock source because the alluvial recharge area is small. The spring outlet was dry, but there was a small flow issuing from the space between an old corroded cast-iron pipe and a black plastic pipe which had been inserted into the cast-iron pipe. The pipes were protruding from the alluvium about 50 feet directly downslope from the dry spring. The black plastic pipe was not traced to find its outlet. The spring had been fenced and the outlet was overgrown with vegetation.

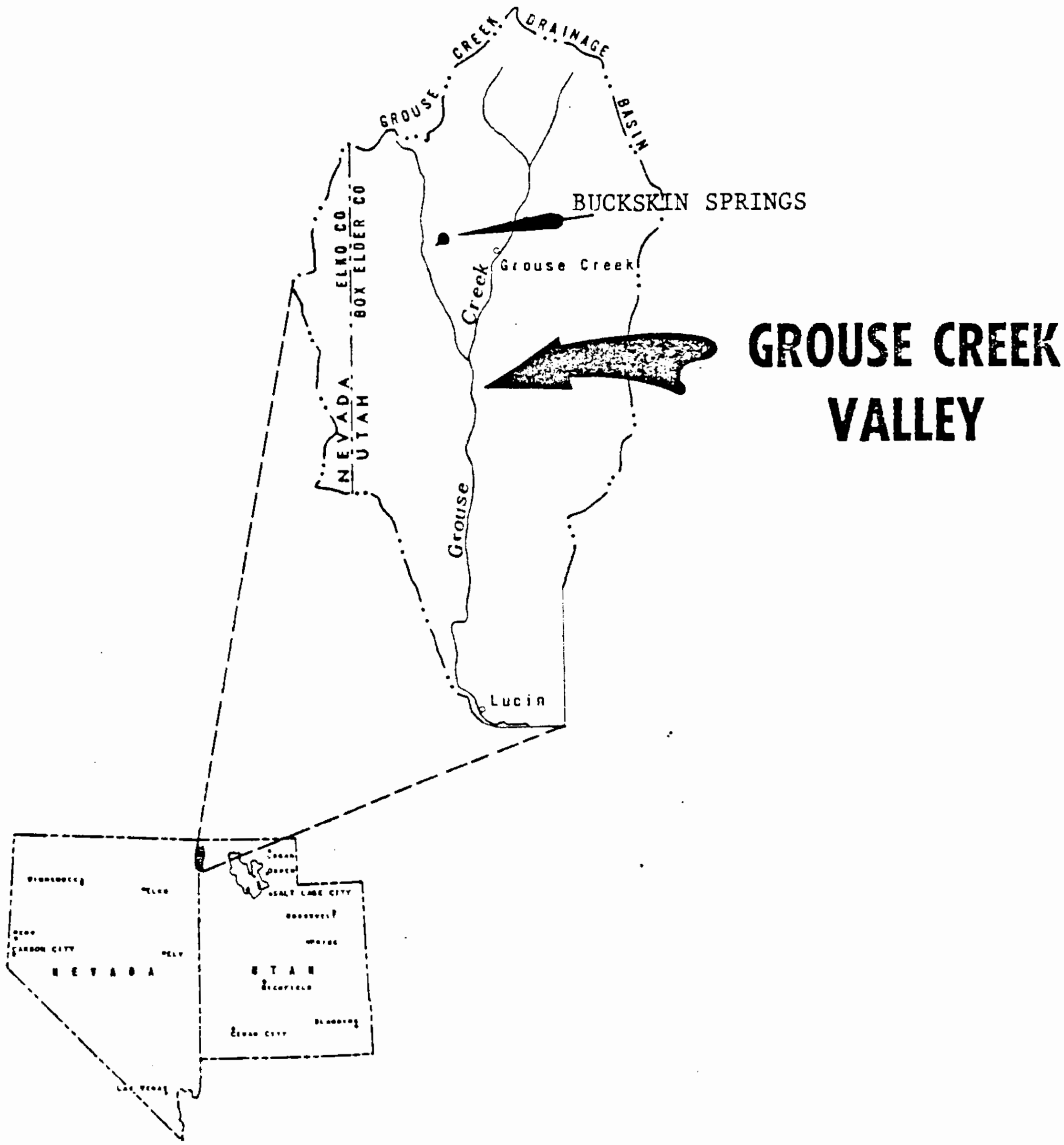
Buckskin Springs appears to have a bedrock source for the following reasons: 1) the flow rate is reported to be constant, showing little variation through the year as would be expected if the recharge area were alluvium and of small extent, and 2) a nearby spring in a simliar geologic setting appears to have a source in the Rex Chert even though it issues downslope in alluvium/Salt Lake Formation. Buckskin Springs may have a similar, albeit larger circulation system.

The recharge area for Buckskin Springs is large enough to support present water demand, as evidenced by its use as a culinary water source since 1968. The protection area should extend at least 500 feet upslope to prelude grazing in the immediate vicinity of the springs. The downslope area could be decreased to 100 feet below spring discharge points without increasing the danger of pollution.

REFERENCES

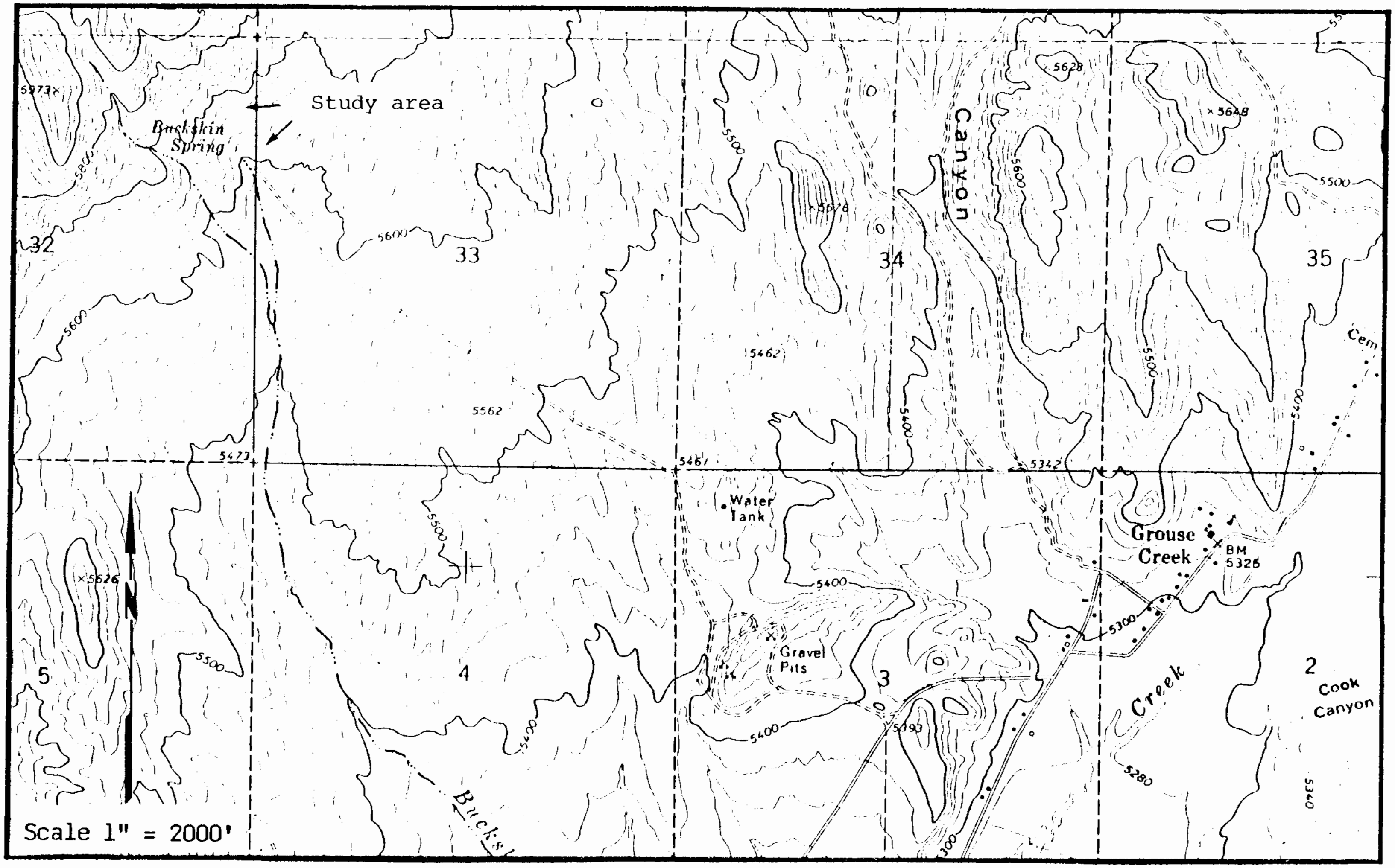
Doelling, H. H., 1980, Geology and mineral resources of Box Elder County, Utah: Utah Geological and Mineral Survey Bulletin 115, 251 p.

Hood, J.W. and Don Price, 1970, Hydrologic reconnaissance of Grouse Creek Valley, Box Elder County, Utah: Utah Department of Natural Resources Division of Water Rights Technical Publication No. 29, 54 p.



Index and location map, after Hood and Price (1970)

Base map from USGS 7½ minute topographic quadrangle, Grouse Creek, Utah.



Topographic map of Buckskin Springs and vicinity

Utah Geological and Mineral Survey

Applied Geology Group

Project:			Requesting Agency:
Evaluation of recharge for Spring I, phase I 3200 Subdivision, and geologic evaluation of phase II 3200 Subdivision.			Utah Health Department, Bureau of Public Water Supplies
By: W.R. Lund	Date: 7/9/85	County: Iron	Job No.: WS-4
USGS Quadrangle: Summit (278), Cedar Breaks, 15'			

#85-024

In response to a request from Dan Blake, Utah Division of Environmental Health (Bureau of Public Water Supplies), and Rod Cosslett, Southwestern Utah District Health Department, an investigation was made of portions of the 3200 Subdivision in Iron County, Utah. The 3200 Subdivision is a large mountain recreation subdivision that is being developed in sequential phases. The purpose of the investigation was to evaluate the recharge area of a spring being considered for culinary use on phase I, and to make a general review of geologic and soil conditions on the newly proposed phase II portion of the development (attachment 1). Considerations on phase II included wastewater disposal, source of culinary water, and slope stability. The scope of work consisted of a review of existing literature, including a UGMS memo dated November 5, 1979, on phase I; air photo analysis; and a field reconnaissance on June 18 and 19, 1985. Messrs. Blake and Cosslett were present during the field inspection as was Ralph Watson of Eckhoff, Watson, and Preator Engineering, the developer's representative.

SETTING

The 3200 Subdivision is located along the East and West Forks of Braffits Creek in rugged mountain terrain about 5 miles southwest of Summit, Utah (attachment 1). The subdivision encompasses approximately 3200 acres and is being developed in phases of about 800 acres each. Activity on phase I commenced in 1979 and work is now beginning on phase II. Both phases are characterized by steep slopes along drainages and moderate to gentle slopes on ridge tops and on the flank of Summit Mountain. Bedrock underlying the proposed subdivision includes both Tertiary and Cretaceous age sedimentary rocks and Tertiary volcanics. Rock outcrops are isolated and of limited areal extent. The East and West Fork faults, large normal faults exhibiting several hundred feet of vertical displacement, are mapped by Gregory (1950) as traversing the property from north to south along East and West Forks of Braffits Creek respectively. Elevations range from about 7400 feet in the canyon bottom at the north end of phase II to over 9000 feet on Summit Mountain. Both the East and West Forks of Braffits Creek flow to the north to Parowan Valley. Vegetative cover is moderate to heavy, with sagebrush, scrub oak, and aspen predominating. Pine trees are found at higher elevations and along creeks. A number of roads have been cut on phase I, but access to phase II is limited to a single road along the West Fork of Braffits Creek and a jeep trail along the crest of Middle Ridge. The subdivision is presently platted as a low density, recreational development with lots of 5 acres or larger. Both phases are proposed as "water hauling" subdivisions with water available from a springs developed on site.

SPRING 1 RECHARGE AREA

One of the springs being developed for culinary use on phase I is designated as Spring 1 and is located near the east property boundary in the NE1/4SW1/4 sec. 25, T. 25 S., R. 10 E., SLBM (attachment 1). Utah Public Drinking Water Regulations require a 1500-foot protection zone free of concentrated sources of pollution upslope from springs used for culinary purposes. An exception to the 1500-foot zone may be granted if it can be demonstrated that a smaller area is justified on the basis of geologic and hydrologic conditions. An exception was requested by the developer for Spring 1 and supported by a brief geologic report prepared by a consultant (Maxfield, 1981). The report states that the spring recharge area is limited to "a rather restricted area composed of soils and gravels trapped within the basin in which it is located." The report goes on to say that "Because of the low permeability of the rocks on the ridge above the spring and steep dip of the beds (volcanics) to the southeast, away from the spring area; it is not possible for the spring to receive any appreciable amount of ground water from the ridge area to the southwest." The report recommends that a variance of unspecified size be permitted in the spring protection zone.

The results of the field reconnaissance did not substantiate the consultant's conclusions. Bedrock exposures could not be reliably identified in the spring vicinity, therefore, it was not possible to verify either the dip direction or degree of fracturing of the volcanics. Thomas and Taylor (1948) and Bjorkland, Sumsion, and Sandbery (1978) state that the volcanics are generally impervious but can contain ground water in fractures which gives rise to some springs in the area. Since fracture permeability is generally independent of the strike and dip of bedrock, there is no reason to conclude from existing evidence that a southeast dip would prevent water from moving downslope to the spring. In addition, colluvial cover over a considerable area of the ridge above the spring appears sufficiently thick that it could collect ground water and transmit it to the spring above the bedrock. The colluvium is hummocky and contains a number of closed or semi-closed depressions that would hold snow, allowing it to melt slowly and infiltrate into the soil. Based on the field review, it is believed that the recharge area for Spring 1 is larger than that concluded by the consultant and should be considered to extend to the crest of Summit Mountain southeast of the spring. The 1500-foot protection zone normally required for a culinary spring appears appropriate for Spring 1.

PHASE II GEOLOGIC EVALUATION

The geologic evaluation of phase II of the 3200 subdivision was primarily concerned with suitability of site soils for individual wastewater disposal systems, the recharge area and protection zone for Pine Spring, and slope stability in areas being considered for development. Additional comments are are provided concerning erosion on phase II that might affect development.

Soils

Rugged terrain and lack of roads resulted in an uneven distribution of soil test pits across phase II. Eleven test pits were available for inspection. They were concentrated along the crest of Middle Ridge, in a topographic saddle north of Dairy Hill, and in a meadow near the north end of the property. Most test pits had sloughed and filled to varying degrees since being excavated in October 1984. However, a nearly continuous series of road cuts extending north-south across the property on the west side of West Fork Braffits Creek provided numerous good soil exposures. A total of 17 detailed soil logs were made either in test pits or in road cuts (attachment 2). Generally, the soils were found to be silty or clayey sands with gravel and containing a high percentage of cobbles and boulders. Medium to high plasticity clay was encountered in test pit 31 in the meadow near the north end of the property and in test pits 1, 4, and 5 on Middle Ridge. The meadow is in a closed topographic depression where clay has been deposited after eroding from surrounding hills. The clay on Middle Ridge is associated with shallow weathered shale bedrock. Evidence of shallow bedrock was also observed at other test pits on Middle Ridge. The piles of excavated material next to the test pits commonly contained boulder-sized pieces of weathered bedrock that had been ripped by the backhoe.

Though commonly containing some clay, most soils on the property are sandy and appear suitable for wastewater soil absorption systems. Absorption systems should not be installed in areas of shallow bedrock or high plasticity clay. Dry, desicated clay often contains cracks that readily accept water and make it appear that the soil has a moderate to high percolation rate. However, once the clay minerals absorb water they swell and close the cracks, making the soil almost impermeable. The clay soils examined during the field reconnaissance contained numerous desication cracks and exhibited moderate to high plasticity. It is recommended that absorption fields not be installed in those materials.

Pine Spring

Pine Spring is near the north boundary of phase II on the west side of West Fork Braffits Creek (attachment 1). The creek channel is deeply incised and the spring is several tens of feet above the stream. The spring discharges from colluvium over a relatively large area (approximately 1 acre) that is heavily vegetated with trees and underbrush. The thickness of the colluvium is not known, but volcanic bedrock probably occurs at shallow depth. Due to the elevation difference between the spring and creek, little if any recharge to the spring comes from infiltrating stream water. The principal recharge area is a closed topographic depression due south of the spring (attachment 1). The depression is 80 to 100 feet higher than the spring, about 30 acres in size, and occupied by a grassy meadow. Its origin is not known, but possibilities include landsliding, a collapse feature in underlying volcanics, or less likely, faulting along the West Fork fault which Gregory (1950) shows trending north-south through phase II on the east side of West Fork Braffits Creek. The west and south sides of the depression are formed by high mountain ridges that are steep and consist of volcanic bedrock overlain by colluvium. The east side of the depression is lower and less steep, but drops steeply from its crest to the incised channel of West Fork Braffits Creek more than 200 feet below. The north side faces down-canyon and is low with a gentle slope before dropping steeply to Pine Spring. The depression collects runoff from a large area and concentrates it in the meadow where it infiltrates and recharges the spring. The 1500-foot protection zone for the spring passes approximately through the middle of the meadow. Under most circumstances, a protection zone of that size would be adequate for a culinary spring. However, because runoff is concentrated in the depression, it is recommended that the entire meadow be included in the protection zone. Incorporation in the protection zone need not preclude all development, but the meadow should be kept free of concentrated sources of pollution.

Slope Stability

The geologic evaluation for phase I of the 3200 Subdivision (Lund, 1979) identified several landslides and areas of potentially unstable ground on the east side of Middle Ridge. As a result, a number of modifications were made in the development plan for that area. Phase II encompasses all of the west side, crest, and upper portion of the east side of Middle Ridge. Geologic conditions there are similiar to those encountered in phase I. An investigation performed for the developer by a geologic consultant identified five areas of unstable ground in phase II of the subdivision (Maxfield, 1985). The field review and air photo analysis indicate that the boundaries of the unstable areas mapped by the consultant are essentially correct (attachment 1). Evidence of recent movement (spring 1985) was observed in a portion of one unstable area on the west side of Middle Ridge. In addition to areas of unstable ground, erosion is active over much of phase II. Large gullies, some several feet deep and hundreds of feet long, are common on the flanks of the ridge and the banks of West Fork Braffits Creek are eroding at a number of locations. The combination of steep slopes, unstable ground, and active erosion will combine to make development on Middle Ridge very difficult. If development does proceed, it is recommended that structures and individual wastewater disposal systems not be allowed in the unstable areas or within a 100-foot buffer zone around them. Roads should avoid unstable ground to the extent possible and be permitted only where grading can be kept to a minimum and where there is evidence of long-term inactivity in the unstable areas. Drainage for roads and other facilities should direct water away from unstable or eroding areas.

Development of lots partially underlain by unstable ground should proceed with caution. The boundary of the unstable area on each lot should be determined and the 100-foot buffer zone established. The remainder of the lot should be evaluated in terms of slope, soil type, depth to bedrock, and access to determine if construction is feasible. Building sites and wastewater disposal systems should avoid actively eroding areas or potential unstable areas. The complexity of establishing the buildable area on those lots is such that it can only be done on a lot by lot basis. It is recommended that the developer prepare a report for review by county officials covering those lots where it is believed construction is possible. The report should document that sufficient buildable area is available for a cabin and wastewater disposal system, and that geologic conditions are suitable for wastewater disposal.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of this investigation, the following conclusions and recommendations are made:

1. The recharge area for Spring 1 on phase I of the 3200 Subdivision includes the area of hummocky topography underlain by colluvium east and southeast

of the spring and extending to the crest of Summit Mountain. The required 1500-foot protection zone for a culinary spring is appropriate for Spring 1.

2. Soil conditions on phase II of the subdivision are variable but generally suitable for individual wastewater disposal systems. Care should be exercised to avoid areas of shallow bedrock (chiefly ridge crests) and high plasticity clay soils.

3. The principal recharge area for Pine Spring is the closed topographic depression immediately south of the spring and the area that drains into the depression. It is recommended that the entire meadow occupying the bottom of the depression be included in the protection zone for Pine Spring.

4. Areas of unstable ground and active erosion are present on phase II of the subdivision. It is recommeded that development not be permitted in those areas or within a 100-foot buffer zone around them. Lots partially included within unstable areas should be evaluated on an individual basis to insure that sufficient buildable area is available and that site conditions are adequate for installation of individual wastewater disposal systems. Roads should avoid unstable and potentially unstable areas to the extent possible and cross them only where grading can be kept to a minimum and where there is evidence of long-term stability.

Conditions on phase II of the 3200 Subdivision are less than optimum, particularly with regard to slope stability and erosion. It is anticipated that the degree of success achieved in developing the property (as measured by the absence of geology-related problems experienced by lot owners) will depend on the extent to which geologic conditions are considered as the development proceeds.

REFERENCES

Bjorklund, L.J., Sumsion, C.T., and Sandberg, G.W., 1978, Ground-water resources of the Parowan-Cedar City drainage basin, Iron County, Utah: State of Utah Department of Natural Resources Technical Publication No. 60, 93 p.

Lund, W.R., 1979, Technical memorandum to Bruce Kaliser on 3200 Subdivision, Iron County, Utah: Utah Geological and Mineral Survey unpublished file data, 7 p.

Maxfield, E.B., 1981, 3200 Subdivision, geologic investigation of Spring 1: consultant's report to Ralph Watson of Echoff, Watson, and Preator Engineers, 1 p.

------1985, Project 3200, phase II, land stability evaluation: consultant's report to Ralph Watson of Echoff, Watson, and Preator Engineers, 2 p.

Thomas, H.E., and Taylor, G.H., 1946, Geology and ground-water resources of Cedar City and Parowan Valleys, Iron County, Utah: U.S. Geological Survey Water-Supply Paper 993, 210 p.

Logs of Test Pits and Road Cuts*
Phase II 3200 Subdivision
Iron County, Utah

Test Pit 1**

0.0 - 3.0'	Fat clay (CH); brown, stiff, high plasticity, dry; trace fine sand, well developed prismatic soil structure.

Note: Test pit sloughed below 3 feet. Varicolored shale noted in the waste pile.

Test Pit 2

0.0 - 0.9'	Silty sand with gravel (SM); yellow brown, medium dense, nonplastic to low plasticity, dry; 15 percent gravel to 1 1/2-inch diameter.
0.9' - 2.4'	Clayey, silty sand with gravel (SM-SC); yellow brown, dense, low plasticity, moist; 25 percent gravel to 2-inch diameter.
2.4' - 3.2'	Silty sand with gravel (SM); light brown to yellow brown, dense, nonplastic, dry; 20 percent gravel to 2-inch diameter.
3.2' - 6.5'	Silty gravel with sand (GM); light brown, medium dense to dense, nonplastic, dry; very coarse grained with numerous cobbles and boulders, weathered bedrock.

Note: Test pit has sloughed below 6.5 feet.

Test Pit 3

0.0 - 0.3'	Silty sand with gravel (SM); dark brown to black, medium dense, nonplastic to low plasticity, dry; 40 percent gravel to 3-inch diameter, some cobbles, root zone.
0.3' - 2.0'	Silty gravel with sand (GM); brown, medium dense, nonplastic, dry; numerous cobbles and boulders to 1 1/2-foot diameter.
2.0' - 4.3'	Silty sand with gravel (SM); yellow brown, medium dense, nonplastic, dry; medium-grained quartz sand with 20 percent gravel.

Note: Test pit have sloughed below 4.3 feet. Numerous large slab-like boulders in the waste pile.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure) and ASTM Standard D2487-83 Classification of Soils for Engineering Purposes. Percentages recorded for various size fractions are field estimates.

**Test pit designations correspond to those established by the developer.

Test Pit 4

0.0 - 0.8'	Sandy silt (ML); brown, stiff, low plasticity, dry.
0.8' - 2.7'	Lean clay with sand (CL); red brown, stiff, medium plasticity, dry; 15 percent fine to medium sand.
2.7' - 3.9'	Clayey gravel-gravelly lean clay (GC-CL); red brown, stiff to very stiff, medium plasticity, dry; weathered shale bedrock with boulders to 1-foot diameter.

Note: Test pit has sloughed below 3.9 feet.

Test Pit 5

0.0 - 0.9'	Clayey sand (SC); orown, dense, medium plasticity, dry.
0.9' - 2.4'	Fat clay (CH); gray, very stiff, medium to high plasticity, dry; well-developed prismatic soil structure.
2.4' - 4.1'	Shale bedrock; gray, highly weathered.

Note: Test pit has sloughed below 4.1 feet.

Test Pit 6

0.0' - 0.5'	Cobble and boulder layer; very coarse grained, boulders to 1-foot diameter or larger.
0.5' - 2.1'	Silty gravel with sand (GM); brown, medium dense, nonplastic to low plasticity, dry; numerous cobbles and boulders to 1 1/2-foot diameter.
2.1' - 3.7'	Silty sand-sandy silt (SM-ML); yellow brown, stiff; dense; low plasticity, dry; fine to medium sand.

Note: Test pit has sloughed below 3.7 feet. Top of waste pile contains clay.

Test Pit 7

0.0 - 3.4'	Silty sand with gravel (SM); black, medium dense, low plasticity, dry.

Note: Test pit has sloughed below 3.4 feet. Top of waste pile contains red clayey sand and boulders.

Test Pit 8

0.0 - 0.4'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 20 percent gravel to 2-inch diameter, root zone.
0.4' - 3.7'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel to 2 1/2-inch diameter.

Note: Test pit has sloughed below 3.7 feet. Numerous cobbles and boulders.

Test Pit 9

0.0 - 2.6'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel to 1 1/2-inch diameter; root zone.
2.6' - 6.8'	Silty sand with gravel (SM); red brown, dense, medium plasticity, dry; 25 percent gravel to 2-inch diameter, trace of clay.

Note: Test pit has sloughed below 6.8 feet.

Test Pit 13

0.0 - 0.9'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel to 2-inch diameter, root zone.
0.9' - 4.7'	Clayey sand with gravel (SC); brown, medium dense to dense, medium plasticity, dry; numerous cobbles and boulders to 1 1/2-foot diameter.

Note: Test pit has sloughed below 4.7 feet.

Test Pit 23

0.0 - 1.4'	Silty sand with gravel (SM); black, medium dense, low plasticity, dry; 30 percent gravel, some cobbles.
1.4' - 7.5'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel, numerous cobbles and boulders.

Note: Soil log made in a road cut.

Test Pit 24

0.0 - 1.1'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel, some cobbles.
1.1' - 4.3'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel to 2 1/2-inch diameter.
4.3' - 6.5'	Poorly graded gravel with sand (GP); dark gray, medium dense, nonplastic, dry; gravel to 3-inch diameter.

Note: Soil log made in a road cut.

Test Pit 26A

0.0 - 1.6'	Silty, clayey sand with gravel (SC-SM); black, medium dense, low to moderate plasticity, dry; 20 percent gravel, numerous cobbles and boulders.
1.6' - 4.7'	Silty sand with gravel (SM); dark brown, medium dense, slightly plastic, dry; 30 percent gravel, numerous cobbles and boulders.

Note: Soil log made in road cut adjacent to percolation test hole. The road cut identified by the developer as the location of the log for test hole 26 that was included in the feasibility study for the project is approximately 100 feet to the northeast (see below).

Test Pit 26

0.0 - 0.5'	Silty sand with gravel (SM); black, medium dense, slightly plastic, dry; 30 percent gravel, numerous cobbles and boulders.
0.5' - 7.0'	Volcanic bedrock; gray, moderately weathered, highly fractured.

Note: Soil log made in a road cut.

Test Pit 29

0.0 - 1.2'	Silty, clayey sand with gravel (SM-SC); black, medium dense, low plasticity, dry; 20 percent gravel, some cobbles.
1.2' - 8.0'	Clayey sand (SC); red brown, dense, medium plasticity, dry.

Note: Soil log made in a road cut.

Test Pit 30

0.0 - 0.8'	Silty sand with gravel (SM); black, medium dense, slightly plastic, dry; 30 percent gravel, some cobbles.
0.8' - 7.0'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 60 percent coarse sand, numerous cobbles and boulders.

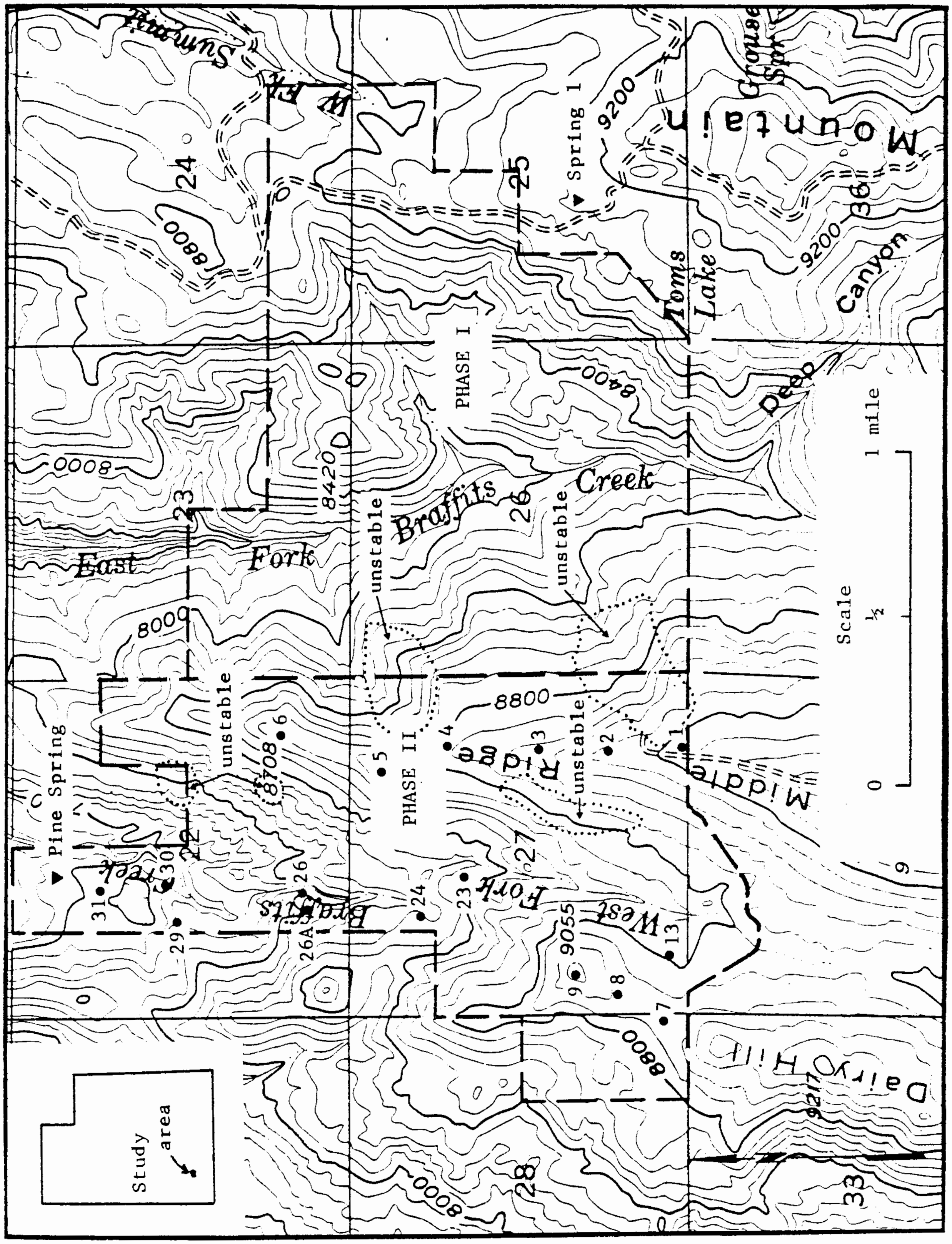
Note: Soil log made in a road cut.

Test Pit 31

0.0 - 3.4'	Silty sand (SM); black, medium dense, slightly plastic, dry; fine sand.
3.4' - 5.5'	Lean clay with sand (CL); yellow brown, very stiff, medium plasticity, dry; 30 percent medium sand, stage II caliche.

Note: Test pit is located in the meadow above Pine Spring.

Base map from enlarged USGS 15' topographic quadrangle, Cedar Breaks, Utah.



Location map showing springs (▼) and unstable areas (⁚⁚⁚) (after Maxfield,1981; 1985), and test pits (•).

Logs of Test Pits and Road Cuts*
Phase II 3200 Subdivision
Iron County, Utah

Test Pit 1**

0.0 - 3.0' Fat clay (CH); brown, stiff, high plasticity, dry; trace fine sand, well developed prismatic soil structure.

Note: Test pit sloughed below 3 feet. Varicolored shale noted in the waste pile.

Test Pit 2

0.0 - 0.9' Silty sand with gravel (SM); yellow brown, medium dense, nonplastic to low plasticity, dry; 15 percent gravel to 1 1/2-inch diameter.

0.9' - 2.4' Clayey, silty sand with gravel (SM-SC); yellow brown, dense, low plasticity, moist; 25 percent gravel to 2-inch diameter.

2.4' - 3.2' Silty sand with gravel (SM); light brown to yellow brown, dense, nonplastic, dry; 20 percent gravel to 2-inch diameter.

3.2' - 6.5' Silty gravel with sand (GM); light brown, medium dense to dense, nonplastic, dry; very coarse grained with numerous cobbles and boulders, weathered bedrock.

Note: Test pit has sloughed below 6.5 feet.

Test Pit 3

0.0 - 0.3' Silty sand with gravel (SM); dark brown to black, medium dense, nonplastic to low plasticity, dry; 40 percent gravel to 3-inch diameter, some cobbles, root zone.

0.3' - 2.0' Silty gravel with sand (GM); brown, medium dense, nonplastic, dry; numerous cobbles and boulders to 1 1/2-foot diameter.

2.0' - 4.3' Silty sand with gravel (SM); yellow brown, medium dense, nonplastic, dry; medium-grained quartz sand with 20 percent gravel.

Note: Test pit have sloughed below 4.3 feet. Numerous large slab-like boulders in the waste pile.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure) and ASTM Standard D2487-83 Classification of Soils for Engineering Purposes. Percentages recorded for various size fractions are field estimates.

**Test pit designations correspond to those established by the developer.

Test Pit 4

0.0 - 0.8' Sandy silt (ML); brown, stiff, low plasticity, dry.

0.8' - 2.7' Lean clay with sand (CL); red brown, stiff, medium plasticity, dry; 15 percent fine to medium sand.

2.7' - 3.9' Clayey gravel-gravelly lean clay (GC-CL); red brown, stiff to very stiff, medium plasticity, dry; weathered shale bedrock with boulders to 1-foot diameter.

Note: Test pit has sloughed below 3.9 feet.

Test Pit 5

0.0 - 0.9' Clayey sand (SC); brown, dense, medium plasticity, dry.

0.9' - 2.4' Fat clay (CH); gray, very stiff, medium to high plasticity, dry; well-developed prismatic soil structure.

2.4' - 4.1' Shale bedrock; gray, highly weathered.

Note: Test pit has sloughed below 4.1 feet.

Test Pit 6

0.0' - 0.5' Cobble and boulder layer; very coarse grained, boulders to 1-foot diameter or larger.

0.5' - 2.1' Silty gravel with sand (GM); brown, medium dense, nonplastic to low plasticity, dry; numerous cobbles and boulders to 1 1/2-foot diameter.

2.1' - 3.7' Silty sand-sandy silt (SM-ML); yellow brown, stiff; dense; low plasticity, dry; fine to medium sand.

Note: Test pit has sloughed below 3.7 feet. Top of waste pile contains clay.

Test Pit 7

0.0 - 3.4' Silty sand with gravel (SM); black, medium dense, low plasticity, dry.

Note: Test pit has sloughed below 3.4 feet. Top of waste pile contains red clayey sand and boulders.

Test Pit 8

0.0 - 0.4' Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 20 percent gravel to 2-inch diameter, root zone.

0.4' - 3.7' Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel to 2 1/2-inch diameter.

Note: Test pit has sloughed below 3.7 feet. Numerous cobbles and boulders.

Test Pit 9

0.0 - 2.6'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel to 1 1/2-inch diameter; root zone.
2.6' - 6.8'	Silty sand with gravel (SM); red brown, dense, medium plasticity, dry; 25 percent gravel to 2-inch diameter, trace of clay.

Note: Test pit has sloughed below 6.8 feet.

Test Pit 13

0.0 - 0.9'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel to 2-inch diameter, root zone.
0.9' - 4.7'	Clayey sand with gravel (SC); brown, medium dense to dense, medium plasticity, dry; numerous cobbles and boulders to 1 1/2-foot diameter.

Note: Test pit has sloughed below 4.7 feet.

Test Pit 23

0.0 - 1.4'	Silty sand with gravel (SM); black, medium dense, low plasticity, dry; 30 percent gravel, some cobbles.
1.4' - 7.5'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel, numerous cobbles and boulders.

Note: Soil log made in a road cut.

Test Pit 24

0.0 - 1.1'	Silty sand with gravel (SM); dark brown to black, medium dense, low plasticity, dry; 25 percent gravel, some cobbles.
1.1' - 4.3'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 30 percent gravel to 2 1/2-inch diameter.
4.3' - 6.5'	Poorly graded gravel with sand (GP); dark gray, medium dense, nonplastic, dry; gravel to 3-inch diameter.

Note: Soil log made in a road cut.

Test Pit 26A

0.0 - 1.6'	Silty, clayey sand with gravel (SC-SM); black, medium dense, low to moderate plasticity, dry; 20 percent gravel, numerous cobbles and boulders.

1.6' - 4.7'	Silty sand with gravel (SM); dark brown, medium dense, slightly plastic, dry; 30 percent gravel, numerous cobbles and boulders.

Note: Soil log made in road cut adjacent to percolation test hole. The road cut identified by the developer as the location of the log for test hole 26 that was included in the feasibility study for the project is approximately 100 feet to the northeast (see below).

Test Pit 26

0.0 - 0.5'	Silty sand with gravel (SM); black, medium dense, slightly plastic, dry; 30 percent gravel, numerous cobbles and boulders.

0.5' - 7.0'	Volcanic bedrock; gray, moderately weathered, highly fractured.

Note: Soil log made in a road cut.

Test Pit 29

0.0 - 1.2'	Silty, clayey sand with gravel (SM-SC); black, medium dense, low plasticity, dry; 20 percent gravel, some cobbles.

1.2' - 8.0'	Clayey sand (SC); red brown, dense, medium plasticity, dry.

Note: Soil log made in a road cut.

Test Pit 30

0.0 - 0.8'	Silty sand with gravel (SM); black, medium dense, slightly plastic, dry; 30 percent gravel, some cobbles.

0.8' - 7.0'	Clayey sand with gravel (SC); red brown, dense, medium plasticity, dry; 60 percent coarse sand, numerous cobbles and boulders.

Note: Soil log made in a road cut.

Test Pit 31

0.0 - 3.4'	Silty sand (SM); black, medium dense, slightly plastic, dry; fine sand.

3.4' - 5.5'	Lean clay with sand (CL); yellow brown, very stiff, medium plasticity, dry; 30 percent medium sand, stage II caliche.

Note: Test pit is located in the meadow above Pine Spring.

Project: Investigation of spring and well protective zones, Pine Meadow Ranch, Summit County			**Requesting Agency:** Bureau of Public Water Supplies Utah Dept. of Health
By: G.E. Christenson	**Date:** 8/5/85	**County:** Summit	**Job No.:** WS-5
USGS Quadrangle: Big Dutch Hollow (1251) Wanship (1250)			

#85-026

PURPOSE AND SCOPE

In response to a request from Larry Mize, Bureau of Public Water Supplies, an inspection was made of several potential culinary water sources for the Pine Meadow Ranch Subdivision in Summit County. The sources include Bobcat Spring and three wells (attachment 1). The purpose of the inspection was to: 1) determine the recharge area and protection zone for the spring and its relations to two existing homes on lots 7 and 8 of Plat A (attachment 1), and 2) evaluate whether the wells should be classified as deep or shallow under State Health Department regulations.

The scope of work for the study included a literature review, air photo analysis, and field reconnaissance. Several previous field investigations have been performed at Pine Meadow Ranch Subdivision for the Bureau of General Sanitation and experience gained from these studies was valuable in this analysis. Brent Sutherland (Pine Meadow Ranch Owner's Association), Roy Dixon (Summit City/County Health Department), and Mr. Mize accompanied me in the field on June 26, 1985.

GEOLOGY AND HYDROLOGY

Little information is available on the bedrock geology of the Pine Meadow Ranch Subdivision area. Maps that have been completed (Intermountain Association of Geologists, 1969; Mullens, 1971) were found to be in error during earlier investigations by the UGMS (Christenson, 1983) and Dames and Moore (1984). These maps show the area to be underlain by coarse-grained sedimentary rocks rather than the volcanic tuff, tuff breccia, and tuffaceous sandstone actually present over most of the subdivision. The volcanic rocks are overlain by a variable thickness of residual and transported soil ranging from rounded gravels to highly plastic clay, and are underlain by conglomerate of the Wasatch Formation. Structure in these units is not known, but from air photos the fractured volcanic rocks appear to be flat-lying to gently dipping as is the underlying Wasatch Formation. The Wasatch Formation unconformably overlies the north-dipping Cretaceous Frontier Sandstone (Mullens, 1972; Hintze, 1982).

Bobcat Spring and two of the wells studied are in an area termed the Salt Box basin (attachment 1). In this area soils are clayey, rock is highly weathered and fractured, and many springs occur. These conditions are conducive to landsliding, and geomorphic evidence of past landsliding in the area includes hummocky topography in the bottom of the basin and flat terraces on hillsides and ridges, perhaps representing tops of backtilted landslide blocks, northwest of Bobcat Spring. This evidence is not conclusive, however, and slopes in the Salt Box area appear stable at present. Drainage is well established and landslides, if present, show no evidence of modern movement. However, active landsliding is common along the road and stream to the southeast in Tollgate Canyon.

Little information is available on the hydrologic properties of the volcanic rocks underlying the Pine Meadow Ranch Subdivision, but water probably exists chiefly in fractures in rock with recharge occurring from precipitation, snowmelt, and stream flow at higher elevations. Sandstones with primary intergranular permeability are present and may transmit water, but this water moves slowly and generally does not contribute significantly to the discharge from springs or wells. Old slide planes and zones of broken rock related to ancient landsliding may also play a role in the movement of ground water.

PROTECTION ZONES FOR CULINARY WATER SOURCES

Bobcat Spring

Test pits in the vicinity of Bobcat Spring during previous investigations show weathered volcanic bedrock at depths ranging from 0.5 to 1.5 feet on hillslopes (test pit 42, Dames and Moore, 1984; test pit 1, Christenson, 1983) and unconsolidated clay, silt, sand, and gravel with cobbles to 10 feet at the base of slopes (test pits 43 and 46, Dames and Moore, 1984). The discharge area and spring collection system are buried and could not be observed, but it is likely that the water is derived from fractured volcanic bedrock beneath colluvial cover at the base of the slope. The spring has an average discharge of 35 gallons per minute (gpm) and a minimum discharge of 15-16 gpm (Brent Sutherland, oral commun., June 16, 1985). Because of the heterogeneity of rock in the area, effects of possible landsliding, and lack of outcrops, the flow paths and recharge area for the spring cannot be determined with certainty using existing information. Recharge probably occurs from snowmelt and precipitation at higher elevations to the north, including areas outside the surface drainage basin in which the spring is located. Natural springs are reported at approximately the same elevation around the north side of the Salt Box basin, indicating a possible perched water table in rock at that elevation. Individual recharge areas for each spring are unknown, but would include at least the immediate area of the spring. Thus, the protection zone for Bobcat Spring should extend the required 1500 feet upslope above the spring, but need not extend laterally beyond the next adjacent spring if it is less than 1500 feet away. Such a spring is present below the two existing homes in Plat A (attachment 1). These homes and the spring are at an elevation roughly equivalent to Bobcat Spring and are about 800 feet away. Although wastewater disposal at these homes may contaminate the local spring, it should not affect Bobcat Spring.

Well 1

Well 1 is located about 250 feet directly north of Bobcat Spring (attachment 1). It was drilled in September 1977, to a depth of 190 feet (attachment 2). The well is 60-70 feet above Bobcat Spring. The report filed with the State Engineer lists a static water table of 85 feet but does not include a lithologic log of the hole. The casing schedule, perforated intervals, and depth of surface seal are unknown. The water level is below the elevation of Bobcat Spring, indicating that the well may tap a deeper aquifer. If so, it is not known if this aquifer is under artesian pressure, although a less permeable layer would necessarily separate the two aquifers. Monitoring the effect of pumping well 1 on flow from Bobcat Spring could give an indication of whether they tap a single aquifer or two separate aquifers. If extended pumping has no effect on spring flow, the well likely taps a deeper aquifer and is sealed from the upper aquifer. However, without this aquifer test or further information on soil and rock types, depth of the perforated interval(s), and depth and type of surface seal, the source of water cannot be determined and the well should be considered shallow.

Well 2

Well 2 is about 1/4 mile east of Bobcat Spring on the east edge of the Salt Box basin at the head of Tollgate Canyon (attachment 1). The well is 233 feet deep, but was only logged from 193 to 233 feet (attachment 3). Although no record was made of the perforated interval, the well log indicates that water was encountered in a sandstone bed from 193-228 feet so this interval was likely perforated. A surface seal of unknown depth was emplaced, but the rock types and possible water sources in the upper 193 feet are unknown. Because of the lack of information, the source of water cannot be determined and the degree of protection from surface contaminants is unknown. Unless further information can be acquired, the well should be classified as shallow.

Well 3

Well 3 is southeast of well 2 about 3500 feet (attachment 1). The well driller's report indicates that it was drilled through interbedded clay (shale) and sandstone to a depth of 555 feet (attachment 4). The well is perforated at a sandstone interval from 371 to 402 feet, with a surface seal placed from 0 to 100 feet in an interval consisting chiefly of clay. This well probably derives water from beds in the Cretaceous rocks which underlie the Wasatch Formation.

The water level at the time of drilling was 20 feet, and at the time of this investigation the well was flowing under artesian pressure. The well head consists of an inner and outer casing, both extending above ground, and water was flowing from both the inner casing and the space between the two casings. This indicates that a seal is not present between the casings. Also, if the outer casing only extends downward 20 feet as indicated by Brent Sutherland (oral commun., June 26, 1985), a seal does not exist between the inner casing and the rock below the base of the outer casing. Water is apparently rising up in the annular space between the rock and inner casing and eventually up between the two casings at the top. If pumping of the well lowers water levels in both the well and outer casing, then the well is not sealed properly above the aquifer level. If pumping does not lower the water level in the outer casing, then this water is derived from a more shallow aquifer not tapped by the inner casing. More details of the well construction are needed to fully evaluate the situation, but in either case the evidence suggests that a proper surface seal is not present and the well should not be classified as deep at this time.

CONCLUSIONS AND RECOMMENDATIONS

Because of the variability and lack of detailed information about the geology of the area, the recharge area for Bobcat Spring is not precisely known. The source of water is most likely precipitation falling in higher elevations to the north. The presence of shallow bedrock in the recharge area and probable bedrock source of water to the spring indicates that flow of ground water will be through fractures. Based on present knowledge, a reduction of the 1500-foot spring protection zone upslope is not recommended. Laterally, however, the zone need not extend beyond the next adjacent spring at a similar elevation and thus would not include the two existing homes to the south.

Because of a lack of information, it is recommended that none of the wells be classified as a deep well at this point. Wells 1 and 2 lack sufficient data to evaluate the source of water and type of well construction. Both indicate that surface seals were provided, but their depth and the soil/rock types in the upper 100 feet of each well are unknown. Judging from water levels in the wells, it is possible that both may be deriving water from artesian aquifers and may qualify as deep wells, but at present the necessary information is lacking. Evaluation of the effect of pumping at well 1 on flow in Bobcat Spring may provide information on the aquifer system and well construction. Well 3 is under artesian pressure, demonstrating that the aquifer is overlain by an impermeable bed. This, in addition to the great depth from which water is obtained, indicates that well 3 may be classified as a deep well if a proper surface seal is provided. At present, the existing surface seal does not appear to be adequate.

REFERENCES

Christenson, G.E., 1983, Suitability of soils in Plats E, F, and G of Pine Meadow Ranch Subdivision, Summit County, for soil absorption fields: Utah Geological and Mineral Survey memo to William R. Lund, 7 p.

Dames and Moore, 1984, Percolation study, Pine Meadow Ranch, Summit County, Utah for Pine Meadow Ranch Owners Association: unpub. consultants report, 11 p.

Hintze, L.F., compiler, 1980, Geologic map of Utah: Utah Geological and Mineral Survey, 1:500,000.

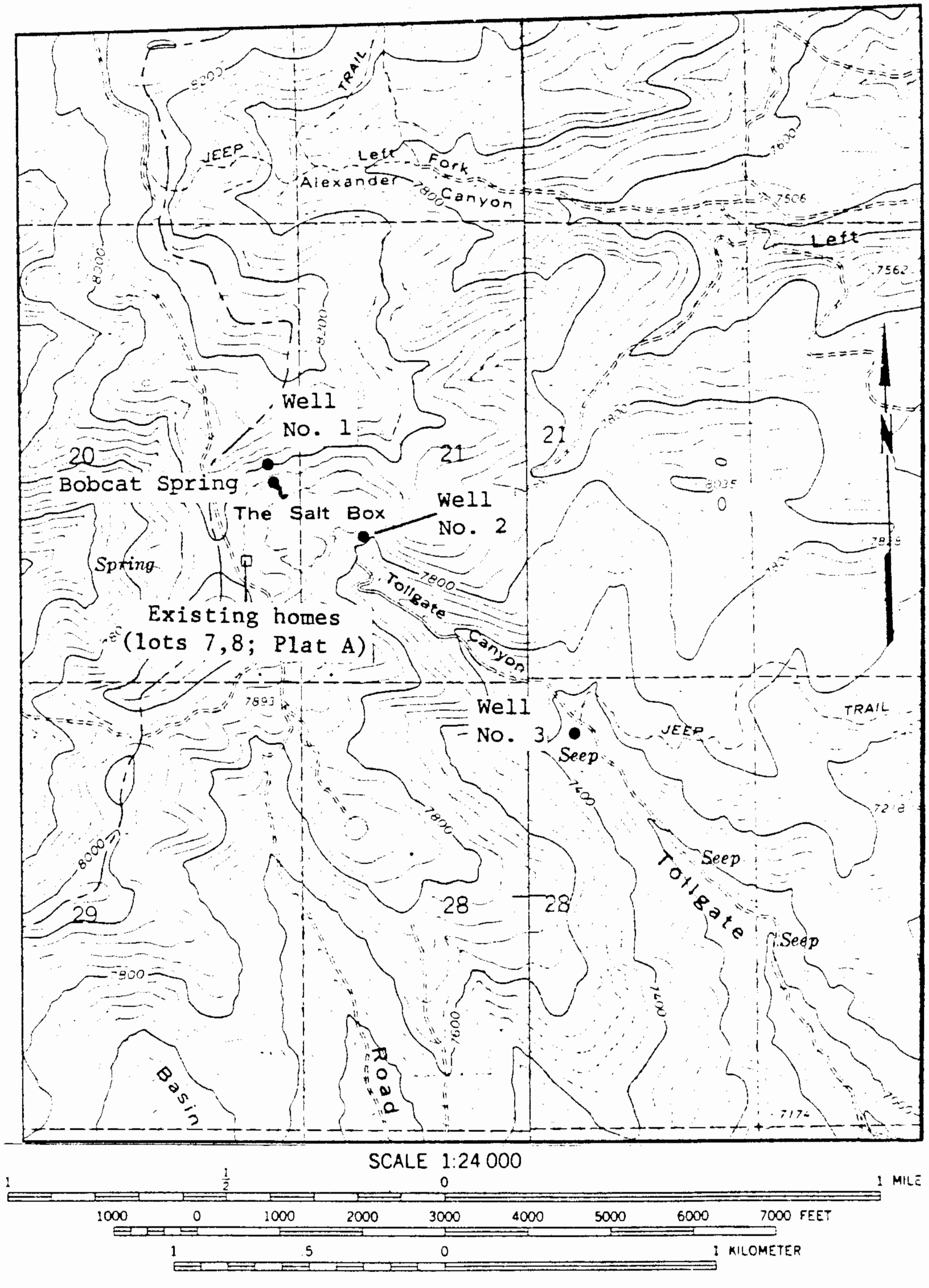
Intermountain Association of Geologists, 1969, Geologic guidebook of the Unita Mountains, Utah's maverick range: Sixteenth Annual Field Conference, 237 p.

Kaliser, B.N., 1972, Preliminary geologic reconnaissance of the Forest Meadow Ranch recreation property, Summit County: Utah Geological and Mineral Survey Report of Investigation No. 68, 3 p.

McGriffin, K., 1973, Geologic report on the Pine Meadow Ranch and Forest Meadow Ranch properties in Summit and Morgan Counties, Utah: unpub. consulting geologist's report, 4 p.

Mullens, T.E., 1971, Reconnaissance study of the Wasatch, Evanston, and Echo Canyon Formations in part of northern Utah: U.S. Geological Survey Bulletin 1311-D, 31 p.

Base map from USGS 7½ min. topo quad
Wanship, Utah
Big Dutch Hollow, Utah



Approximate location of spring and wells,
Pine Meadow Ranch, Summit County

Attachment 2, Job No. WS-5

RECEIVED OCT 18 1979 WATER RIGHTS

Well #1 Exchange #507

Form 113-514-1140

Examined OCT 2 4 1979

Recorded: B. C. ________ T. B. ________

Inspection Sheet ________

Copied OCT 2 4 1979

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. ________
Claim No. ________
Coordinate No. ________

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

N 2400 E 1600 fr SW cor Sec 21 T1N R4E

(1) WELL OWNER:
Name Discovery Recreation Inc
Address S L C Ut.

(2) LOCATION OF WELL: Salt Lake canyon 100 yds above drive
County Summit Ground Water Basin (leave blank) G. Basset Springs

North/South ______ feet, East/West ______ feet from ______ Corner of Section ______, T. ______ N/S, R. ______ E/W SLBM/USM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐

If abandonment, describe material and procedure: ________

(4) NATURE OF USE (check): Domestic ☑ Industrial ☐ Municipal ☑ Stockwater ☐ Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check): Rotary ☐ Dug ☐ Jetted ☐ Cable ☑ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑

16" Diam. from 0 feet to Unknown feet Gage ________
______" Diam. from ______ feet to ______ feet Gage ______
______" Diam. from ______ feet to ______ feet Gage ______

New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☐

Type of perforator used Unknown
Size of perforations ______ inches by ______ inches
______ perforations from ______ feet to ______ feet (×5)

(8) SCREENS: Well screen installed? Yes ☐ No ☑

Manufacturer's Name ________
Type ________ Model No. ________
Diam. ______ Slot size ______ Set from ______ ft. to ______
Diam. ______ Slot size ______ Set from ______ ft. to ______

(9) CONSTRUCTION:

Was well gravel packed? Yes ☐ No ☑ Size of gravel: ________
Gravel placed from ______ feet to ______ feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? Unknown
Material used in seal: Bentonite + Clay
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ________ Depth of strata ________
Method of sealing strata off: ________

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☐

(10) WATER LEVELS:

Static level 84 feet below land surface Date Sept 1979
Artesian pressure ______ feet above land surface Date ______

LOG RECEIVED:

(11) FLOWING WELL:

Controlled by (check) Valve ☐ Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.

Was a pump test made? Yes ☑ No ☐ If so, by whom? owner
Yield: 60 gal./min. with ______ feet drawdown after ______ hours
Unknown
Bailer test ______ gal./min. with ______ feet drawdown after ______ hours
Artesian flow ______ g.p.m. Date ______
Temperature of water 58 Was a chemical analysis made? No ☑ Yes ☐

(13) WELL LOG: Diameter of well 16" inches

Depth drilled 190 feet. Depth of completed well 190 feet.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
		Unknown										

RECEIVED MAR 6 1985 UTAH STATE DIV. OF HEALTH ENVIRONMENTAL HEALTH

Work started ______, 19__ Completed ______, 19__

(14) PUMP:

Manufacturer's Name ________
Type: ________ H. P. ______
Depth to pump or bowles ______ feet

Well Driller's Statement:

This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.

Name Int-Mt Drilling Corp SL (Person, firm, or corporation) (Type or print)
Address P.O. Box 458 Roosevelt Ut
(Signed) [signature] (Well Driller)
License No. 200 Date Sept 19, 1979

Attachment 3, Job No. WS-3

Form 113-494-11-69

Examined
Recorded: B. C. ______ T. B. ______
Inspection Sheet
Copied

REPORT OF WELL DRILLER
STATE OF UTAH

Application No.
Claim No.
Coordinate No.

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. (This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name Diversified Recreation Inc.
Address

(2) LOCATION OF WELL: Salt Lick Canyon app. 100' below + E. of Bobcat Springs
County Summit Ground Water Basin (leave blank)
North/South ______ feet, East/West ______ feet from ______ Corner
of Section ______ T. ______ N/S, R. ______ E/W SLBM/USM (strike out words not needed)

(3) NATURE OF WORK (check): New Well ☑
Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check):
Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☐
Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check):
Rotary ☐ Dug ☐ Jetted ☐
Cable ☑ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
16" Diam. from 0 feet to 143 feet Gage .250
" Diam. from ______ feet to ______ feet Gage
" Diam. from ______ feet to ______ feet Gage
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☐ No ☐
Type of perforator used Unknown
Size of perforations ______ inches by ______ inches
perforations from ______ feet to ______ feet (×5)

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name
Type ______ Model No.
Diam. ______ Slot size ______ Set from ______ ft. to
Diam. ______ Slot size ______ Set from ______ ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☐ No ☑ Size of gravel:
Gravel placed from ______ feet to ______ feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? Unknown feet
Material used in seal: Bentonite #1
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: ______ Depth of strata ______
Method of sealing strata off:

Was surface casing used? Yes ☐ No ☑
Was it cemented in place? Yes ☐ No ☑

(10) WATER LEVELS:
Static level 40 feet below land surface Date Aug 1979
Artesian pressure ______ feet above land surface Date

LOG RECEIVED:

(11) FLOWING WELL:
Controlled by (check) Valve ☐
Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☐

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☑ No ☐ If so, by whom? Int. Mt. Drilling
Yield: 20 ± gal./min. with approx 70' feet drawdown after 3 hours
Bailer test ______ gal./min. with ______ feet drawdown after ______ hours
Artesian flow ______ g.p.m. Date Aug 1979
Temperature of water 58 Was a chemical analysis made? No ☐ Yes ☐

(13) WELL LOG: Diameter of well 16" Reduced inches
Depth drilled 233' feet. Depth of completed well 233' ft.

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make any desirable notes as to occurrence of water and the color, size, nature, etc., of material encountered in each depth interval. Use additional sheet if needed.

DEPTH From	DEPTH To	Clay	Silt	Sand	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
												Unknown
193	228											H_2O Sandstone
228	233											limestone

RECEIVED MAR 6 1985 UTAH STATE DIV. OF HEALTH ENVIRONMENTAL HEALTH

MAR UTAH STATE ... ENVIRONM... HEALTH

Work started Aug 1, 1979 Completed Aug 12, 19

(14) PUMP:
Manufacturer's Name None
Type: ______ H. P.
Depth to pump or bowles ______ feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name Intermountain Drilling Corp of Ut. (Person, firm, or corporation) (Type or print)
Address Box 198 Springville Ut. 84774
(Signed) Calvin Darling Sr. (Well Driller)
License No. 200 Date Sept 19, 19

USE OTHER SIDE FOR ADDITIONAL REMARKS

Attachment 4, Job No. WS-5

REPORT OF WELL DRILLER
STATE OF UTAH

Application No. 2160
Claim No.
Coordinate No.

GENERAL STATEMENT: Report of well driller is hereby made and filed with the State Engineer, in accordance with the laws of Utah. This report shall be filed with the State Engineer within 30 days after the completion or abandonment of the well. Failure to file such reports constitutes a misdemeanor.)

(1) WELL OWNER:
Name: Pine Meadow Ranch Owners Assoc.
Address: 1104 Ashton Ave Suite 106

(2) LOCATION OF WELL:
County Summit Ground Water Basin (leave blank)
North 800 feet, West 2100 feet from NW Corner
Section 27 T. 1 N, R. 4 E SLBM

(3) NATURE OF WORK (check): New Well ☑ Replacement Well ☐ Deepening ☐ Repair ☐ Abandon ☐
If abandonment, describe material and procedure:

(4) NATURE OF USE (check): Domestic ☑ Industrial ☐ Municipal ☐ Stockwater ☐ Irrigation ☐ Mining ☐ Other ☐ Test Well ☐

(5) TYPE OF CONSTRUCTION (check): Rotary ☑ Dug ☐ Jetted ☐ Cable ☐ Driven ☐ Bored ☐

(6) CASING SCHEDULE: Threaded ☐ Welded ☑
6 5/8" Diam. from 0 feet to 555 feet Gage
" Diam. from feet to feet Gage
" Diam. from feet to feet Gage
New ☑ Reject ☐ Used ☐

(7) PERFORATIONS: Perforated? Yes ☑ No ☐
Type of perforator used: Slot
Size of perforations: 6 inches by 1 inch
perforations from 371 feet to 402 feet

(8) SCREENS: Well screen installed? Yes ☐ No ☑
Manufacturer's Name
Type / Model No.
Diam. Slot size Set from ft. to
Diam. Slot size Set from ft. to

(9) CONSTRUCTION:
Was well gravel packed? Yes ☑ No ☐ Size of gravel:
Gravel placed from 100 feet to 555 feet
Was a surface seal provided? Yes ☑ No ☐
To what depth? 100 feet
Material used in seal: 9 5/8 Casing Cement top & Bottom
Did any strata contain unusable water? Yes ☐ No ☑
Type of water: Depth of strata
Method of sealing strata off:
Was surface casing used? Yes ☑ No ☐
Was it cemented in place? Yes ☑ No ☐

(10) WATER LEVELS:
Static level 20 feet below land surface Date 12-29-82
Artesian pressure feet above land surface Date

LOG RECEIVED:

(11) FLOWING WELL:
Controlled by (check) Valve ☐ Cap ☐ Plug ☐ No Control ☐
Does well leak around casing? Yes ☐ No ☑

(12) WELL TESTS: Drawdown is the distance in feet the water level is lowered below static level.
Was a pump test made? Yes ☑ No ☐ If so, by whom? Neil Moon
Yield: gal/min. with feet drawdown after hrs.
Bailer test 75 gal/min. with feet drawdown after hrs.
Artesian flow g.p.m. Date 12-29-82
Temperature of water 57 Was a chemical analysis made? No ☑ Yes

(13) WELL LOG: Diameter of well inches
Depth drilled 555 feet. Depth of completed well 555 feet

NOTE: Place an "X" in the space or combination of spaces needed to designate the material or combination of materials encountered in each depth interval. Under REMARKS make desirable notes as to occurrence of water and the color, size, nature, etc. of material encountered in each depth interval. Use additional sheet if needed.

From	To	Clay	Silt	Sand Stone	Gravel	Cobbles	Boulders	Hardpan	Conglomerate	Bedrock	Other	REMARKS
0	17											Top Soil
17	100	✓										
100	110			✓								
110	155	✓										
155	185			✓								
185	240	✓										
240	300											Shale and Clay
300	340			✓								
340	371			✓	✓							Sand and Gravel
371	402			✓								
402	437											Sand Stone
437	494	✓										
494	555	✓										Green Clay

Work started 12/26 1982 Completed 12/29 1982

(14) PUMP:
Manufacturer's Name
Type: H. P.
Depth to pump or bowls feet

Well Driller's Statement:
This well was drilled under my supervision, and this report is true to the best of my knowledge and belief.
Name M&S Drilling Co. (Person, firm, or corporation) (Type or print)
Address Box (E) Duchesne, Utah 84021
(Signed) Owen A. Jenkins (Well Driller)
License No. 511 Date 12-

USE OTHER SIDE FOR ADDITIONAL REMARKS

Project:			Requesting Agency:
Teasdale Watertank and spring evaluation			Teasdale Special Services District
By: H. Gill	Date: 8/2/85	County: Wayne	Job No.: WS-6
USGS Quadrangle: Loa 1 SE (431) Loa 4 NE (390)			

#85-027

In response to a request from Ernest H. Jackson, Chairman Teasdale Special Service District, the Utah Geological and Mineral Survey made a geologic inspection of the proposed site for a new 200,000 gallon culinary water tank. In addition, redevelopment plans for the spring supplying culinary water to the City of Teasdale were evaluated.

WATER TANK INVESTIGATION

Purpose and Scope

The purpose of the investigation was to assess possible geologic hazards in the site area which could have an adverse affect on the water tank. The scope of the investigation included a review of available geologic information and logging of three test pits to 10 feet in depth. Mr. Gus Williams, Jones and Demille Engineering, was present during the field inspection, performed on June 27, 1985.

Location and Description

The water tank will be approximately one mile west of Teasdale, Utah in the NW1/4, SE1/4, SE1/4, sec. 17, T. 29 S., R. 4 E., Salt Lake Baseline and Meridian (attachments 1 & 2). Planned as a concrete structure 50 feet in diameter, the water tank will be on a gentle slope with a dip of six degrees to the north-northeast. Therefore, site grading will require an excavation of 10 to 12 feet on the south side of the tank. The site is disected by several shallow drainages (2 to 3 feet deep), one of which trends through the proposed water tank location. Vegetation is sparse, consisting primarily of juniper trees and sage brush with some grass and small pine trees.

Geology and Soils

There is a bedrock cliff approximately 200 feet south and southeast of the site. The lower 250 feet of the cliff is Navajo Sandstone with limestone and sandstone of the Carmel Formation capping the upper 50 feet. An outcrop of Navajo Sandstone dipping 27 degrees to the south was observed approximately 100 feet south of the site. Bedrock could be as shallow as 20 feet below the tank location.

Three test pits, each 10 feet deep, were excavated around the water tank site (attachment 3). A loose to low-density sand was observed in all test pits to their total depth. The verticle walls of the excavations were unstable, and in two of the test pits the walls collapsed. Neither ground water nor bedrock were encountered in the excavations.

The northwest-southeast trending Teasdale fault is mapped approximately 1600 feet north of the site (Smith and others, 1963; attachment 2). Latest movement on this fault is believed to have been between Late Creteaceous and early Eocene time approximately 58 to 65 million years before present (B.P.) (Smith and others, 1963). There is evidence of movement along the Thousand Lake fault zone about 2 miles west of the site, following deposition of early Wisconson terrace gravels approximately 10,000 to 55,000 years B.P. (Smith and others, 1963). In the late 1880s, prior to instrumentation, a large earthquake (epicenter unknown) shook the Teasdale area (Smith and others, 1963). An earthquake measuring 4.3 on the Richter scale occurred in September, 1963, in the Capital Reef area about 20 to 25 miles southeast of the site (Arabasz and others, 1979). The most significant recent seismic activity in the site vicinity was a swarm of earthquakes occurring from December 1978 to December 1980 in Capitol Reef National Park, approximately 50 miles southeast of Teasdale (Woodward-Clyde Consultants, 1982). The largest earthquake recorded during that period registered 3.6 on the Richter scale (Richins and others, 1981).

Large landslides (up to 3 miles long and a mile wide) occur in the site vicinity. No landslides or rock falls were observed within a mile of the proposed site.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are presented regarding the proposed water tank site.

1) The proposed site is in seismic zone 2 of the Uniform Building Code (UBC) and the Utah Seismic Safety Advisory Council state wide seismic zonation. Earthquake hazard near the site is considered to be moderate. All construction should conform to specifications listed in the UBC for structures in seismic zone 2.

2) Compaction of the loose to low-density, poorly graded sand beneath the site could be difficult. It may be necessary to add fines (silt and clay) to the soils to acheive the required compaction.

3) Vertical cuts in the sandy soils on site will be unstable and constitute a hazard to workmen during construction. It is recommended that construction cut slopes not exceed the angle of repose for the material forming the slope unless shoring is used to maintain stability.

4) There was no evidence of landslide or rock-fall hazard within a mile of the water tank site.

SPRING EVALUATION

Purpose and Scope

The purpose for the spring investigation was to evaluate redevelopment plans intended to increase the flow of water and aleviate past pollution problems. The scope of the investigation included review of avaliable geologic information, aerial photo interpretation, and a field reconnaissance on June 28, 1985. Mr. Tim Jones, Jones and Demille Engineering, was present during the field reconnaissance.

Location and Description

The spring is approximately three miles southwest of Teasdale, Utah in the SW1/4, SE1/4, NE1/4, sec. 31, T. 29 S., R. 4 E., Salt Lake Baseline and Meridian (attachments 1 & 4). As presently developed the spring has three concrete collection boxes (A, B, & C, attachment 5) built over seeps at or near the base of a slope. The water is then transported by a four-inch PVC pipe to a central collection box (D, attachment 5). Box D is open at the bottom and is designed to intercept any water missed by the other three. The water is then carried to Teasdale through several miles of four-inch cast iron pipe. Topography in the vicinity of the spring is irregular due to numerous ridges and boulders. A small drainage containing an intermittant stream passes just east of the spring. Vegetative cover is moderate, and includes large pine trees to thick grass and wild rose bushes.

Geology

The collection system is at or near the base of a small ridge (approximately 20 feet high) on a major landslide. The landslide is over three miles long and one mile wide (attachment 4). The surface of the slide is composed of irregular transverse ridges, knobs, and small undrained depressions. The general lack of stream disection, and filling of topographic depressions on the slide indicates that the landslide is relatively young. Major movement of the landslide took place during or shortly after Wisconsin glaciation (10,000 to 55,000 years B.P.) when precipitation was high and the ground saturated (Smith and others, 1963). Small failures were observed within the body of the slide in the early 1950s (Smith and others, 1963). Although some landslide movement still occurs, no rapid movement of large portions of the slide has been recorded since the area was first settled (Smith and others, 1963).

The Thousand Lake fault zone (latest movement 10,000 to 55,000 years B.P.) is approximately one mile west of the spring (attachment 4). In the 1880s an earthquake (epicenter unknown) shook the Teasdale area and the water supply became salty, cloudy, and unpalatable (Smith and others, 1963). However, at that time Bullberry Creek was utilized as the culinary water supply and not the spring.

Redevelopment Plan

There are two problems with the present spring system which redevelopment is designed to remedy. First, the present flow is inadequate for the growing community of Teasdale and second, the spring is susceptable to periodic coliform bacteria contamination (orral commun., Tim Jones, 1985). The flow from the spring remains approximately 80 to 90 gallons per minute (gpm) throughout the year, indicating that the recharge area for the spring is not localized, but includes at least the entire northwest flank of Boulder Mountain. Redevelopment plans call for excavation of a trench along the top of the slope to intercept water flowing to the spring area (attachment 5). The trench will vary in depth from approximately 20 feet above box A to eight feet above boxes B and C. During the investigation, a small amount of light grey clayey sand/sandy clay was sampled and described from boxes A and B. Mr. Jones believes this material may represent an impermeable layer acting as an aquitard that causes the water to surface at this location. The redevelopment trench would extend to this layer and subsequently intercept water flowing to the spring. Mr. Jones feels the redevelopment will increase the flow to approximately 150 gpm. However, given the jumbled nature of landslide material, any pre-existing bedding within the slide mass is probably in a highly disturbed state after the slope failure. Therefore, it is unlikely that a laterally continuous bed exists within the slide mass in the spring area.

The present system is susceptable to coliform bacteria contamination. Because the recharge area is not localized, it is felt that contamination is probably limited to the spring area. Examination of the collection boxes indicates that contamination could originate at any or all of them. Leakage around collection boxes A, B, and C makes them a ready source of water for both large and small animals. The grassy area around box D is probably a grazing area for deer, however, it is fenced to keep out livestock. Surface water from the drainage just east of box C, as well as leakage from the other collection boxes, enters the culinary system through the bottom of box D. If the redevelopment plan is adopted the trench would intercept the ground water in the subsurface and do away with the need for collection boxes.

CONCLUSIONS AND RECOMMENDATIONS

The following are conclusions and recommendation regarding the Teasdale spring redevelopment.

1) The Teasdale spring issues from a transverse ridge on a major landslide. Localized movement on the slide could disrupt the spring flow, however, no major movement has occurred since the area was settled.

2) Redevelopment of the Teasdale spring is designed to increase water flow and protect the spring from contamination. The redevelopment plan depends on the existance of a laterally continuous impermeable layer beneath the spring area. It is unlikely that an undisturbed soil lens exists for any distance in the landslide mass. Exploratory test pits are recommended at the toe of the slope to verify the existance of the impermeable horizon.

3) If the redevelopment plan is deemed infeasable and the trench is not installed, it is recommended that the collection boxes be rebuilt to protect the water from contamination. The bottom of collection box D should be sealed to keep surface water from entering the system at this location. New boxes would also decrease leakage and thereby increase flow to the water system.

Selected References

Anderson, L. W., and Miller, D. G., 1979, Quaternary fault map of Utah: Long Beach, California, Fugro Inc., scale 1:500,000.

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, p. 10.

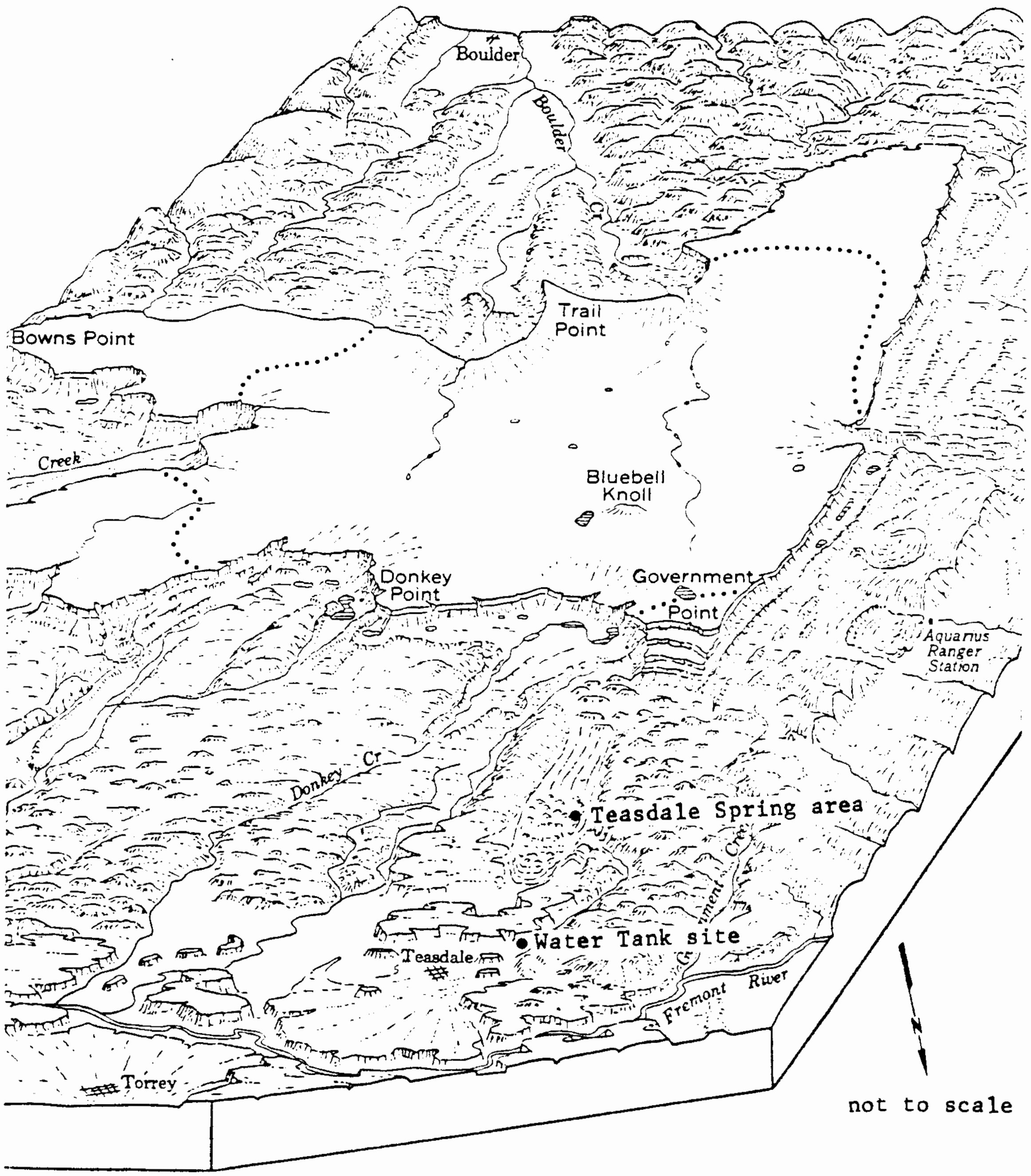
Flint, R. F., and Denny, C. S., 1958, Quaternary geology of Boulder Mountain Aquarius Plateau, Utah: U. S. Geological Survey Bulletin 1061-D, 164 p.

Richins, W. D., and others, 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, p 28.

Richins, W. D., and others, 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.

Smith, J. F. and others, 1963, Geology of the Capitol Reef area, Wayne and Garfield Counties, Utah: U. S. Geological Survey Professional Paper 363, 102 p.

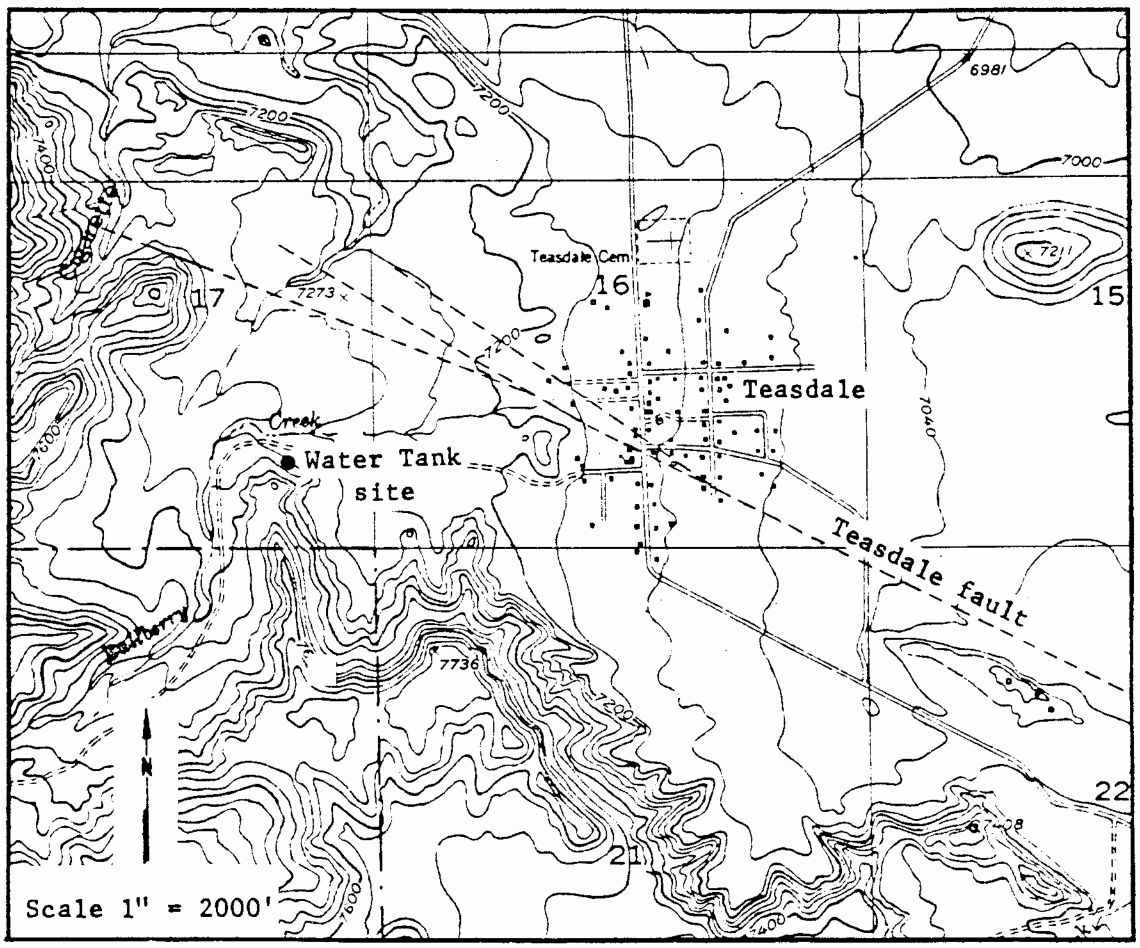
Woodward-Clyde Consultants, 1982, Geologic characterization report for the Paradox Basin study region, Utah study areas: Volume 1 regional overview: ONWI-290, p 6-1 to 6-26.



General location map - Teasdale spring area and water tank site (from Flint and Denny, 1958).

Attachment 2, Job No. WS-6

Base map from USGS preliminary 7½ minute topographic quadrangle, Notom 2 SW, Utah



Teasdale water tank site

Attachment 3, Job No. WS-6

Test Pit Logs
Teasdale Water Tank Investigation*

Test Pit 1

0.0' - 8.0'	Sand (SP); tan, low density, nonplastic, poorly graded, nonindurated, moist to dry.
8.0' - 10.0'	Sand (SP); light tan, loose, nonplastic, poorly graded, nonindurated, dry.

Test Pit 2

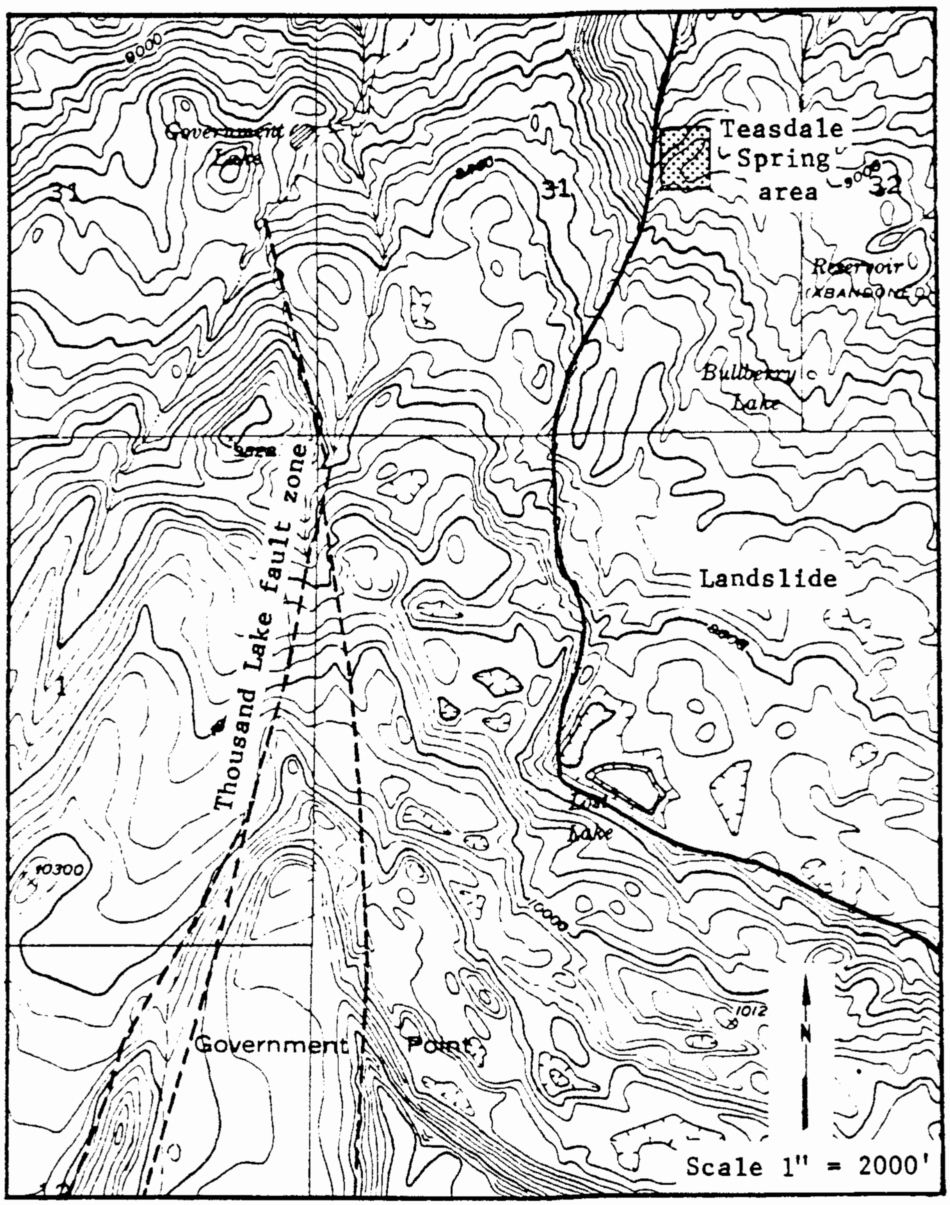
0.0' - 6.0'	Sand (SP); tan, low density, nonplastic, poorly graded, nonindurated, moist to dry.
6.0' - 10.0'	Sand (SP); light tan, loose, nonplastic, poorly graded, nonindurated, dry.

Test Pit 3

0.0' - 6.0'	Sand (SP); tan, low density, nonplastic, poorly graded, nonindurated, moist to dry.
6.0' - 10.0'	Sand (SP); light tan, loose, nonplastic, poorly graded, nonindurated, dry.

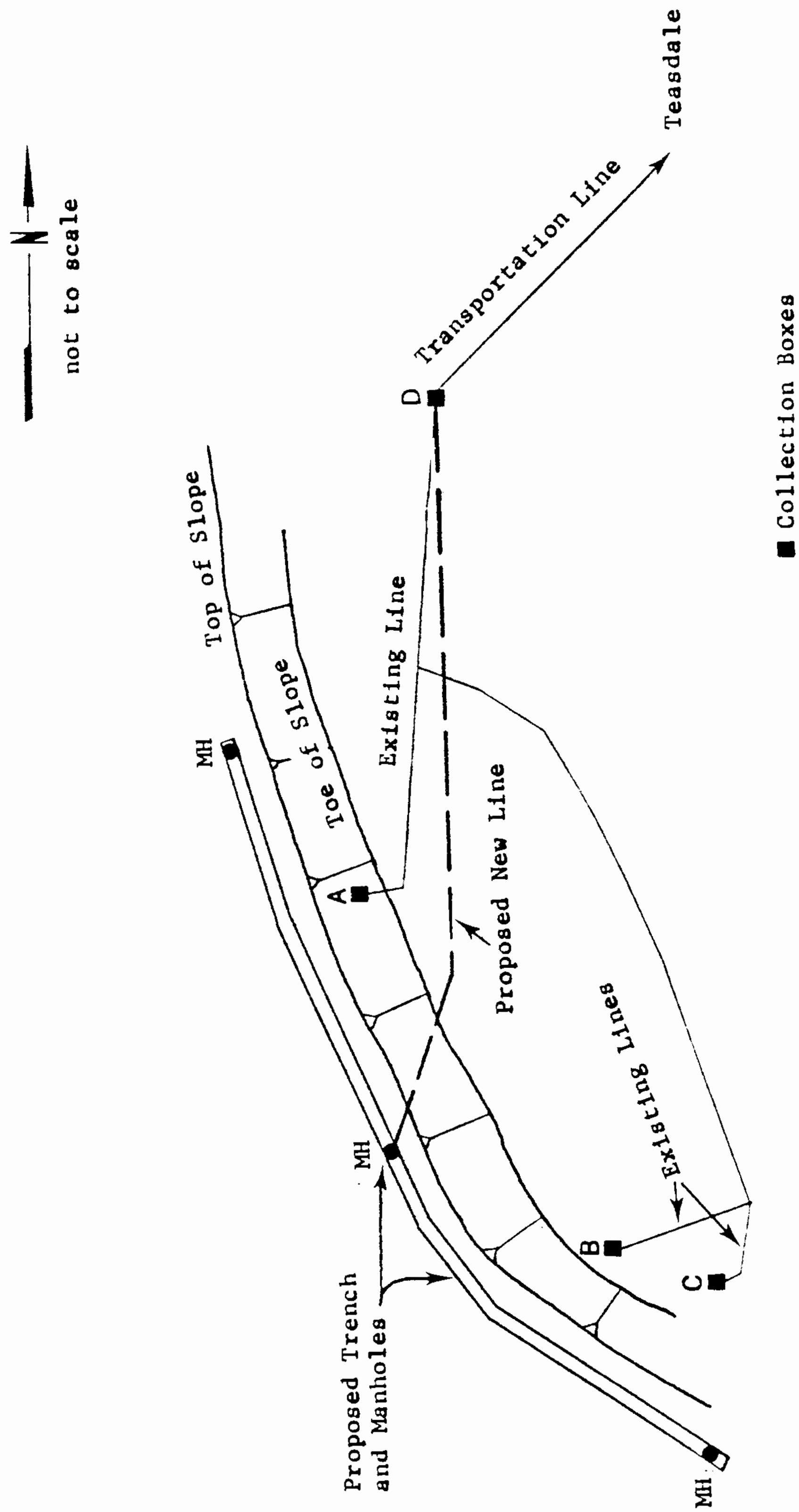
*Soils classified in accordance with procedures outlined in ASTM Standard D2489-69 (Revised 1975), Description of Soils (Visual Manual Procedure).

Base map from USGS preliminary 7½ minute topographic quadrangle, Loa 4 NE, Utah



Teasdale spring area

Attachment 5, Job No. WS-6



Teasdale Spring Redevelopment (after Jones and Demille Engineering, 1985).

Project: Review of report on pollution potential of springs at Ilangeni Estates			Requesting Agency: Bureau of Public Water Supply
By: H. Gill	Date: 8/5/85	County: Utah	Job No.: WS-7
USGS Quadrangle: Lehi (1130)			

#85-029

In response to a request from Michael Georgeson, Utah State Division of Environmental Health, the Utah Geological and Mineral Survey (UGMS) has reviewed a geologic report by James L. Baer, Ph.D., entitled "Geological Analysis of Pollution of Springs for the Ilangeni Estates Development, North of Alpine, Utah". It is our understanding that the project developers have requested that the 1500 foot protection zone required for culinary springs be waved in favor of a reduced zone. The scope of the review included evaluation of the report and pertinent geologic literature for the area, and analysis of stereoscopic aerial photographs. The springs were not visited in the field.

Dr. Baer concludes in his report, prepared for ARIX Engineering (representing Ilangeni Estates), that based on the geology of the area a reduction of the spring protection zone is justified. However, he makes no recommendation regarding the size of the reduced zone. Dr. Baer states that: 1) the springs are recharged by ground water moving through crystalline bedrock located to the north and east, 2) the recharge areas are not in danger of pollution because thay are either closed to development, or do not have a source of culinary water that would make development feasable, and 3) there is no present source of pollution within 1500 feet of the springs. We concur that recharge to the study area originates in highly fractured bedrock north and east of the site, therefore, the spring water comes from deep bedrock aquifers. However, we do not agree that the recharge area is safe from contamination. It is unlikely that the Lone Peak Wilderness Area immediately north of the springs will be developed, but Dr. Baer does not indicate in his report whether the springs would be susceptible to contamination from local pollution sources such as surface water from meadows and streams in the area. The Moyle property is located immediately east of the study area. Regarding this property Dr. Baer states "there appears to be no ready source of culinary water that could possibly be used for any development of this property. This would then preclude any potential pollution source from this area." The lack of a source of culinary water on the Moyle property is not a guarantee against future development in that area. In fact, the Utah Department of Health is presently considering at least one mountain recreation subdivision in another part of the state as a "water hauling" subdivision. It is felt that any reduction in spring protection zones should be based on valid geologic criteria and not on surmised development plans for property not controlled by the party wishing to develop the spring.

Concerning sources of pollution in the immediate vicinity of the springs, Dr. Baer's report is to general for the UGMS to make an informed decision as to the pollution potential of the springs. Detailed information is lacking on both the geology/hydrology of the springs and on the proposed method of development. Dr. Baer states at the top of page 3 "the proposed method of capturing the water and transporting it to be used on the Ilangeni Estates by ARIX Engineering is well conceived and adequate", and "the area that surrounds the springs that serves as the immediate drainage area does not pose any danger for pollution." However, no specific data was presented to support those conclusions. Figure 3, 3a, and 4 in the report, an accompanying site plan by ARIX Engineering, and aerial photos of the area were examined. All sources indicate that the springs are in or at least near a drainage channel which could direct local sources of pollution toward the springs. The following questions need to be answered before the effect of potential pollution sources can be evaluated:

1) What are the exact locations of the springs in regard to the stream channel?

2) Is the stream occupying the drainage intermittant or perennial and what is the possibility of surface-water contamination of the springs?

3) Are there other upslope streams in the vicinity of the springs, and if so, what is the potential for contamination occuring in those areas reaching the springs via the streams?

Regarding proposed development of the srings, figures 1 and 2 indicate that the springs surface in or have formed small meadows. The following questions concerning spring development should be answered:

1) Are collection lines to be buried in the meadow, and if so will a reduced protection zone be adequate to protect the meadow and adjacent slopes from local pollution sources?

2) Were the springs previously developed, and if so, will any of the existing development be used in the new system?

In conclusion, sufficient information is not presented in the report for the UGMS to make an evaluation regarding the advisability of reducing the normally required 1500 foot protection zone for these springs. It is felt that the questions raised need to be addressed before an informed decision can be made. The UGMS would be pleased to review any supplemental reports that address those questions.

SELECTED REFERENCES

Baker, A. A., and Crittenden, M. D., Jr., 1961, Geologic map of the Timpanogos Cave quadrangle, Utah: U. S. Geological Survey Geologic Quadrangle Map GQ-132, scale 1:24,000.

Bullock, R. L., 1958, The geology of Lehi Quadrangle: Brigham Young University unpublished masters thesis, 59 p.

Crittenden, M. D., Jr., 1965, Geology of the Draper quadrangle, Utah: U. S. Geological Survey Geologic Quadrangle Map GQ-377, scale 1:24,000.

Fairbanks, P. E., 1982, Chemical changes in groundwater of northern Utah Valley, Utah: Utah State University unpublished masters thesis, 82 p.

Gill, H. E., 1984, Lehi City springs evaluation, in Harty, K. M., Compiler, Technical reports for 1984 Site Investigation Section: Utah Geological and Mineral Survey Report of Investigation No. 198, p. 157-176.

Hunt, C. B., Varnes, H. D., and Thomas, H. E., 1953, Lake Bonneville: geology of northern Utah Valley, Utah: U. S. Geological Survey Professional Paper 257-A, 99 p.

Project: Effect of SR-189 highway construction on Provo City spring collection system, Provo Canyon			Requesting Agency: Utah Department of Transportation
By: G.E. Christenson	Date: 9/16/85	County: Utah	Job No.: WS-8
USGS Quadrangle: Bridal Veil Falls (1087)			

#85-030

PURPOSE AND SCOPE

At the request of Loren Rausher, Utah Department of Transportation (UDOT), an investigation was made of the Provo City spring collection system near Nunns in Provo Canyon (attachment 1). UDOT is realigning U.S. Highway 189 through the canyon, and the new alignment crosses at least one of the city's collection lines and several of their spring boxes. Both UDOT and Provo City are concerned about what effect this will have on the water system and what must be done to insure that flow and water quality are maintained at present levels. The purpose of this investigation was to evaluate these effects and list the options available to protect the water system. The scope of work included a literature review, air photo analysis, and field reconnaissance. I was accompanied in the field on August 9, 1985, by Mr. Rausher, Bob Robison (Utah County Geologist), and Joel Hall, Alan Meacham, and Jack Bytheway of the Orem UDOT office.

PROVO CITY SPRING COLLECTION SYSTEM

The spring collection system is diagrammed in attachment 2. This map is a reduction and simplification of 1:1200 scale UDOT maps. The following description of the Provo City spring collection system is based on discussions with Burdell Black of the Provo City Water Department (oral commun., August 13, 1985). The system consists of a series of concrete spring boxes connected by closed-joint clay (vitreous) pipe. Most of the system was emplaced over 50 years ago, but recent improvements have been made to spring boxes. Most boxes are located to collect water from a specific spring, but several are present only to access and clean lines. The spring boxes are generally 4-6 feet deep, except those along present Highway 189 (line 7, attachment 2) which are 10-12 feet deep, and collect water through weep holes. In some cases, a gravel blanket was emplaced below ground to collect water and direct it toward the box. Joints in pipe between boxes are closed, so no water is collected or lost along lines connecting the boxes. No record is kept of the amount of water collected at each box or from each line, and it is not known which parts of the system provide the most water.

GEOLOGY

In the vicinity of Nunns and Bridal Veil Falls, Provo Canyon is steep-sided and incised into beds of the Pennsylvanian-age Oquirrh Formation. Rocks exposed in the lower cliffs of the canyon belong to the Bridal Veil Limestone Member, consisting of dark-gray to black, thick-bedded limestone (Baker, 1972). Overlying the Bridal Veil Limestone Member in upper canyon walls above the 6200-foot contour is an unnamed member consisting of gray to tan sandstone with interbedded gray to black limestone. Rocks in the canyon are locally folded and faulted. However, in the drainage basin above the spring, dips are variable but gentle and beds are relatively undeformed.

Northwest of the Provo River above the spring area, thick alluvial-fan and debris-flow deposits have accumulated at the mouths of canyons and bases of slopes (Baker, 1972). These deposits probably interfinger with flood-plain deposits of the Provo River, but locally have been eroded by the river as it shifted across its floodplain. Most of the Provo City springs discharge near the break in slope between the eroded alluvial-fan and deris-flow deposits of Lost Creek and terraces and the flood plain of the Provo River. The alluvial-fan and debris-flow deposits of Lost Creek are very coarse-grained and consist chiefly of angular gravel, cobbles, and boulders with variable percentages of fine-grained matrix. The thickness of these deposits is unknown but locally may be many tens of feet. Provo River terrace and flood-plain deposits are likewise very coarse grained, but generally lack the high percentages of boulders and cobbles and contain greater percentages of sand and fines. All unconsolidated materials appear to be very porous and permeable.

GROUND WATER

Little subsurface information with regard to ground water is available in the area. Discharge from the springs is greatest during spring snowmelt, followed by a gradual decrease throughout the summer with some springs drying up in late summer and fall (Burdell Black, oral commun., August 13, 1985). At the time of the field inspection, most springs at the northern end of the system (lines 6 and 7, attachment 2) were producing water, but many of those in the central section (lines 4 and 5) were not flowing. The lines at the southern end (lines 1, 2, and 3) were not checked.

Springs discharge from unconsolidated deposits which are recharged from precipitation and stream flow at the surface, particularly in the Lost Creek drainage, and from subsurface flow of ground water from bedrock aquifers. The amount of contribution from each is not known. Movement of ground water along bedding planes in the bedrock is indicated by the many springs and seeps that occur at various elevations on canyon walls. The contribution from Lost Creek is indicated by its reported disappearance during low flow as water is lost to infiltration into its coarse-grained bed. Lost Creek is believed to be the major source of recharge. The contribution from possible down-valley flow of ground water along the Provo River is unknown but considered to be small because of the long distances the ground water would be required to flow under a relatively low gradient to reach the area. Also, the location of the springs with regard to the river indicate principal recharge from the northwest and not the northeast or east.

Because of the extreme permeability of gravelly soils in the area, it is believed that the water table is relatively uniform and dips gently toward the river throughout the area. An initial determination of the configuration of the water table could be obtained by plotting and contouring elevations of springs. Ground elevations at springs are shown on topographic maps, and the only additional data needed would be the depth to water in those spring boxes collecting water. Flow directions could then be determined, assuming a sufficient number of springs are flowing to provide adequate data.

POSSIBLE IMPACTS OF ROAD CONSTRUCTION ON SPRINGS

Because recharge is believed to be from the northwest, and the new highway over most of the area is downgradient to the southeast, it should have no significant impact on most of the springs. The springs which will be directly affected are those under or downgradient from the road. This includes one spring at the end of line 1 and all springs along line 7 (attachment 2). These springs could be affected in two ways: 1) flow may be reduced due to a reduction in permeability of natural soils caused by compaction and vibration during road construction and long-term compression from loading by fill, and 2) water quality may be reduced by infiltration of poor-quality water drained from the road right-of- way. The latter problem can be mitigated through proper drainage, but the former is more difficult to evaluate. Soil testing to determine compressibility is not feasible in soils as coarse grained as those in the area, although these types of soils are generally not compressible. The greatest reduction in pore space may result from vibration during construction. Either effect would presumably be greatest in surface layers, becoming less significant in deeper soils below the water table.

OPTIONS FOR PROTECTION OF THE SPRINGS

Two principal options exist for protection of the Provo City water supply in this area: 1) make no changes to the system except to strengthen and provide access to spring boxes and lines that are buried beneath the road and fill, or 2) remove lines and boxes along the right-of-way and replace the supply by extending existing collection lines, adding new lines, and/or deepening spring boxes and otherwise redeveloping existing springs. Reeds and grasses which grow in areas of shallow ground water are present east of line 5, indicating that at least locally not all water is presently being collected by the existing system. Because only a small portion of the system is likely to impacted, the contribution from these lines (particularly line 7) should be determined prior to construction in order to: 1) evaluate impacts of road construction if no change in the system is made (option 1 above), and 2) determine the amount of water to be replaced if modifications to the system are made (option 2 above).

RECOMMENDATIONS

Given the nature of soil materials from which water is being derived, it is not believed that emplacement of the fill will result in a reduction in permeability that will significantly affect flow in the springs. If access to springs and lines are provided, spring areas are not disturbed during construction, and pipes are protected against collapse from pressures generated by embankment loading, it is believed that the present system can be maintained with no reduction in water supply. Water quality should also be unchanged as long as proper surface drainage is provided. However, during construction, water quality may be reduced and lines in the areas under construction should be temporarily turned out of the system.

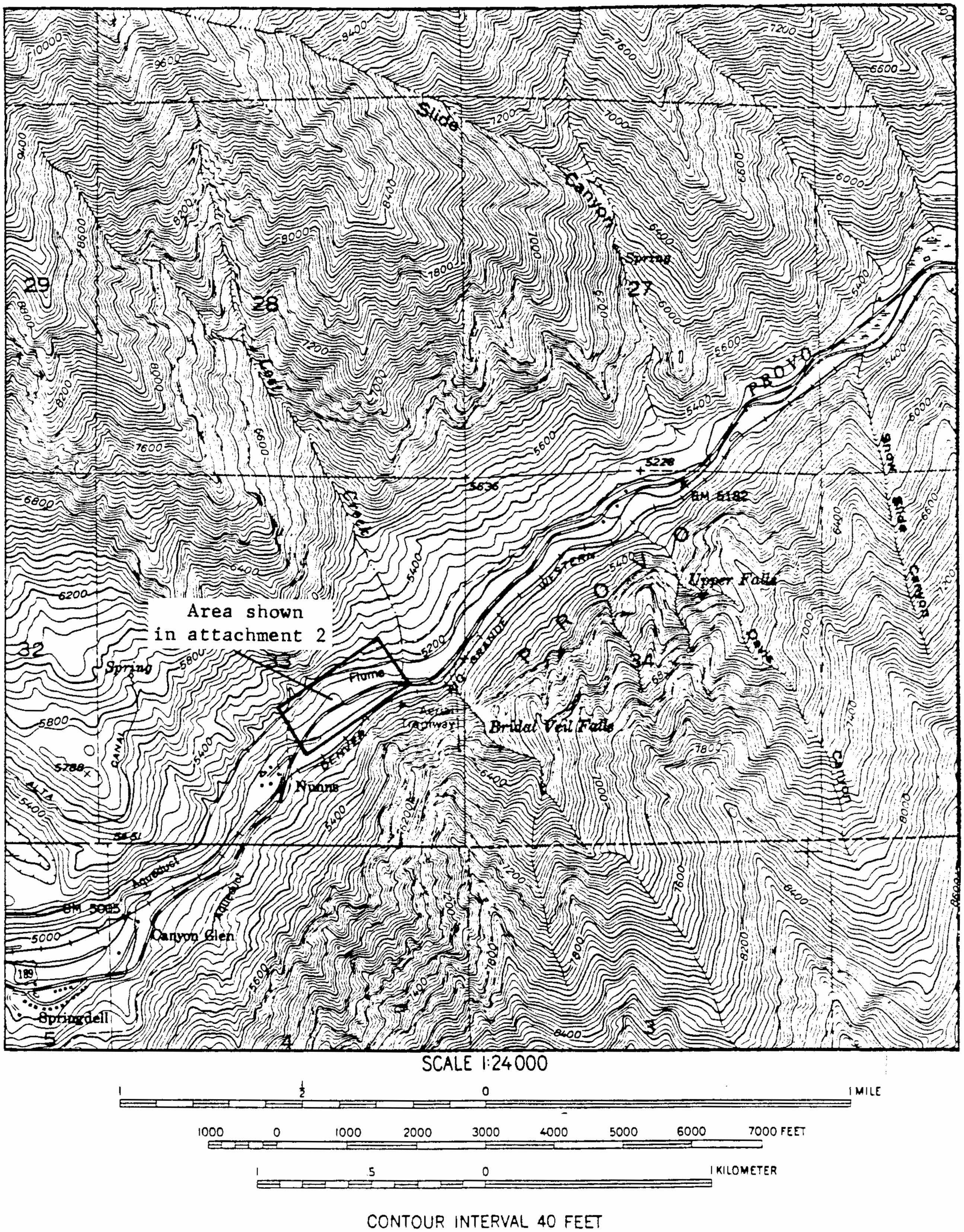
Although not considered probable, it cannot be guaranteed that the supply of water from lines within and east of the right-of-way will not be reduced by emplacement of the road fill. Should any such reduction occur, however, it is likely that it would be compensated for by an increase in flow in springs to the west as ground water becomes "dammed" by the fill. Although probable, this also cannot be guaranteed, and in order to insure that no net flow is lost and to determine the most effective means of replacing any that is, further study would be required. Initially, a contour map showing the elevation of the water table should be constructed from existing data, i.e. plotting of depths to water at springs, to determine flow directons. Following this, several piezometers should be placed to obtain additional data in critical areas into which lines may be extended as shown in attachment 2 and discussed below. Based on the present study, it appears that the most effective means of increasing discharge west of the highway would probably be to extend line 6 further in a northwest direction. This should tap the same supply that is presently being collected by line 7 east of the new alignment. It is recommended that a piezometer be installed east of the end of line 6 (attachment 2) prior to extending the line to verify that ground-water conditions are such that further development would indeed increase flow. Because ground-surface elevations increase abruptly north of the present end of line 6, it may be most practical to extend it by drilling horizontally into the hillside rather than trenching from the surface. Another option to supplement flow would be to place a line between lines 5 and 6 (attachment 2). Here again, it is advisable to determine ground-water conditions in the area prior to making modifications in order to evaluate whether the additional water would result in a net increase or simply cause a decrease in flow in adjacent lines. In this case, a piezometer should be placed between lines 5 and 6 (attachment 2) to compare water levels. Because the springs along line 5 were dry during the investigation but shallow ground water was apparently present to the east, deepening of the collection boxes or redevelopment of springs along line 5 as well as extending the line may increase supply. Whichever option is chosen, all plans must be submitted and approved by appropriate Health Department authorities prior to construction.

REFERENCES

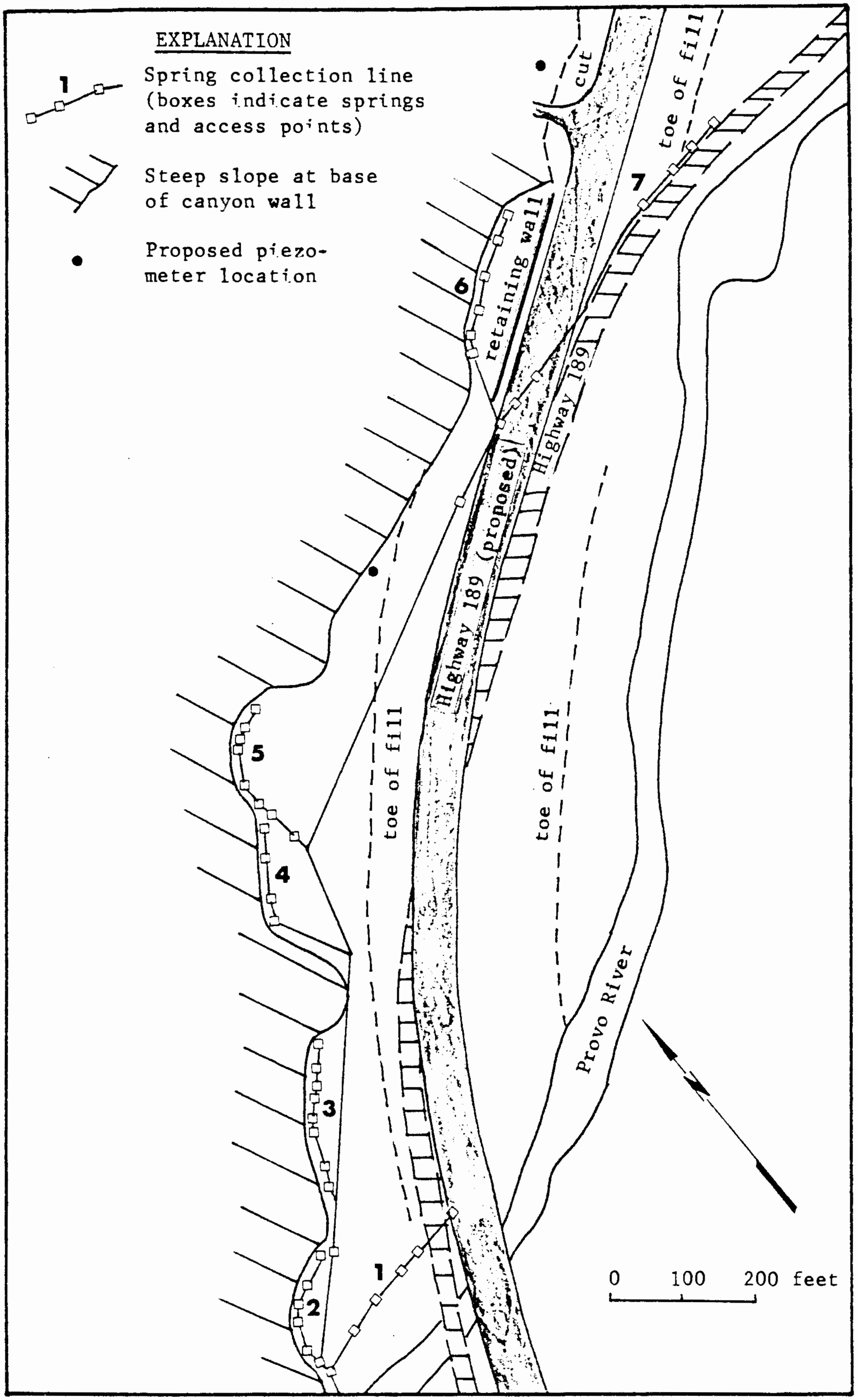
Baker, A.A., 1972, Geologic map of the Bridal Veil Falls Quadrangle, Utah: U.S. Geological Survey Map GQ-998, scale 1:24,000.

Bytheway, J.L., 1985, Preliminary geology report on US-189 in Provo Canyon from the Murdock Diversion Dam to Wildwood Junction: unpublished Utah Department of Transportation Report F-019(23), 11 p.

Base map from: USGS 7½' topo quad
Bridal Veil Falls, Utah



Location Map



Map showing Provo City spring collection system and proposed Highway 189 alignment with extent of fill.

Project: Elder Hollow Spring			Requesting Agency: Bureau of Public Water Supplies
By: R.H. Klauk	Date: 9/16/85	County: Summit	Job No.: WS-9
USGS Quadrangle: Hoyt Peak (1209)			

#85-031

PURPOSE AND SCOPE

This investigation was conducted at the request of Larry J. Mize of the State Division of Environmental Health (Bureau of Public Water Supplies) for Elder Hollow Spring located in the NW1/4, sec. 14, T. 2 S., R. 6 E., Salt Lake Baseline and Meridian, Summit County, Utah (attachment 1). Elder Hollow Spring has been removed from the City of Kamas' culinary water system because of high coliform bacteria counts. It is suspected that an unnamed spring approximately 500 feet upslope from Elder Hollow Spring is the source of the bacteria. The purpose of this study was to determine if a subsurface connection exists which allows contaminated water from the unnamed spring to mix with Elder Hollow Spring. For this report the unnamed spring will be referred to as Spring A.

The scope of work for this study included a literature review, air photo analysis, and a field reconnaissance on August 5, 1985. In attendance during the field reconnaissance were Alan Scates, Kamas City Council, Terry D. Atkinson, Kamas Water Department, and Kimm M. Harty, Utah Geological and Mineral Survey. No subsurface investigation was performed during this study.

GENERAL GEOLOGY

Elder Hollow Spring and Spring A are located in Elder Hollow at the west end of the Uinta Mountains. Bedrock in the area consists of the Upper Member of the Morgan Formation conformably overlain by the Weber Quartzite (McDougald, 1953; Woodfill, 1972; and Hintze, 1980). Both formations dip to the southwest, reflecting the west-plunging axis of the Uinta Arch anticline which strikes through this area (Crittenden, 1976). The Upper Member of the Morgan Formation consists of fine-grained sandstone, siltstone, and mudstone, interbedded with cherty, marine limestone (McDougald, 1953). The Weber Quartzite consists of quartzite and limey sandstone with some interbedded limestone and dolomite (Woodfill, 1972). Woodfill (1972) has located a fault striking through the axis of lower Elder Hollow which places Round Valley Limestone to the southeast unconformably against Weber Quartzite to the northwest. Woodfill (1972) describes Round Valley Limestone as consisting of limestone, quartzite and sandy limestone. His map does not include the springs area, ending approximately one half mile to the west. No other geologic literature reviewed identified this fault.

Soils in Elder Hollow are thin and of colluvial or alluvial origin. Where exposed, particle sizes range from boulders to clay.

SITE RECONNAISSANCE

Spring A issues from two circular depressions formed in colluvium at an elevation of about 8200 feet. The depressions, located within 10 feet of each other, are surrounded by dense foliage. No discharge was occurring at the time of the investigation. Alan Scates (oral commun., August 5, 1985) reported that water begins to flow from the depressions in early spring and stops sometime between June 1 and 15. No bedrock was observed in the spring vicinity, but geologic maps indicate Morgan Formation is present below the colluvium. The area is used for grazing and cattle waste was present around the spring.

Spring A appears to receive water from colluvium and shallow weathered bedrock from higher elevations in Elder Hollow. The limited flow period indicates a shallow recharge system of limited extent.

Elder Hollow Spring is down slope from Spring A at an elevation of approximately 8100 feet. Alan Scates (oral commn., August 5, 1985) reports flows of 100 gallons per minute (gpm) during late spring and early summer, decreasing to 35 gpm at other times of the year. He also reports discharge is from bedrock. Numerous boulders and cobbles of tan quartzite were scattered around the spring area from excavation during spring development, however, no bedrock was observed. A small area around the spring has been fenced.

It was not apparent during the site reconnaissance which bedrock formation is supplying water to Elder Hollow Spring. All maps reviewed for this area identify Morgan Formation at the spring site. Excavated boulders and cobbles at the site, however, appear to be Weber Quartzite which is the major source of water to mines in the Park City area approximately 12 miles to the west (Baker, 1970). Furthermore, if the fault mapped by Woodfill (1972) were to extend through the spring site, it could provide a conduit for deep circulating water to reach the surface. Generally, continuously flowing springs are indicative of deep circulation systems.

SOURCE OF COLIFORMS

Spring A is unprotected and may be contaminated by the cattle waste observed in the immediate area. Flowing water from spring A moves over the ground surface downslope and mixes with Elder Hollow Spring. Mr. Scates reported that coliform counts for Elder Hollow Spring in the past were high during the period when Spring A was discharging. Spring A water has never been analyzed, however, and therefore no data exists to establish it as the source of pollution.

CONCLUSIONS AND RECOMMENDATIONS

Spring A discharges from a shallow ground-water system composed of weathered bedrock and colluvium. Elder Hollow Spring discharges from bedrock, the result of deep circulation. Each system appears to be independent of the other with no subsurface hydrologic interconnection. However, to further document the presence or absence of a subsurface connection, it is recommended Spring A be analyzed for common ions, certain trace elements, and coliform bacteria. Furthermore, it is recommended Elder Hollow Spring be sampled for similar constituants before, during, and after Spring A begins discharging. Sampling Spring A will establish if it is a contaminated source and also provide data for comparison of chemical constituents with Elder Hollow

Spring. Sampling Elder Hollow Spring in the manner suggested will document chemical changes caused by a hydrologic interconnection with Spring A should one exist.

In any case, surface flow from Spring A which is likely contaminated by bacteria from animal waste in the area should be diverted away from Elder Hollow Spring. It is recommended the diversion be constructed prior to the spring snowmelt and resumption of flow from Spring A.

REFERENCES CITED

Baker, C.H., Jr., 1970, Water resources of the Heber-Kamas-Park City area north-central Utah: Utah Department of Natural Resources Technical Publication No. 27, 79 p.

Crittenden, M.D., 1976, Stratigraphic and structural setting of the Cottonwood area, Utah, in Hill, J.G., ed., Symposium on geology of the Cordilleran hingeline: Rocky Mountain Association of Geologists, p. 363-379.

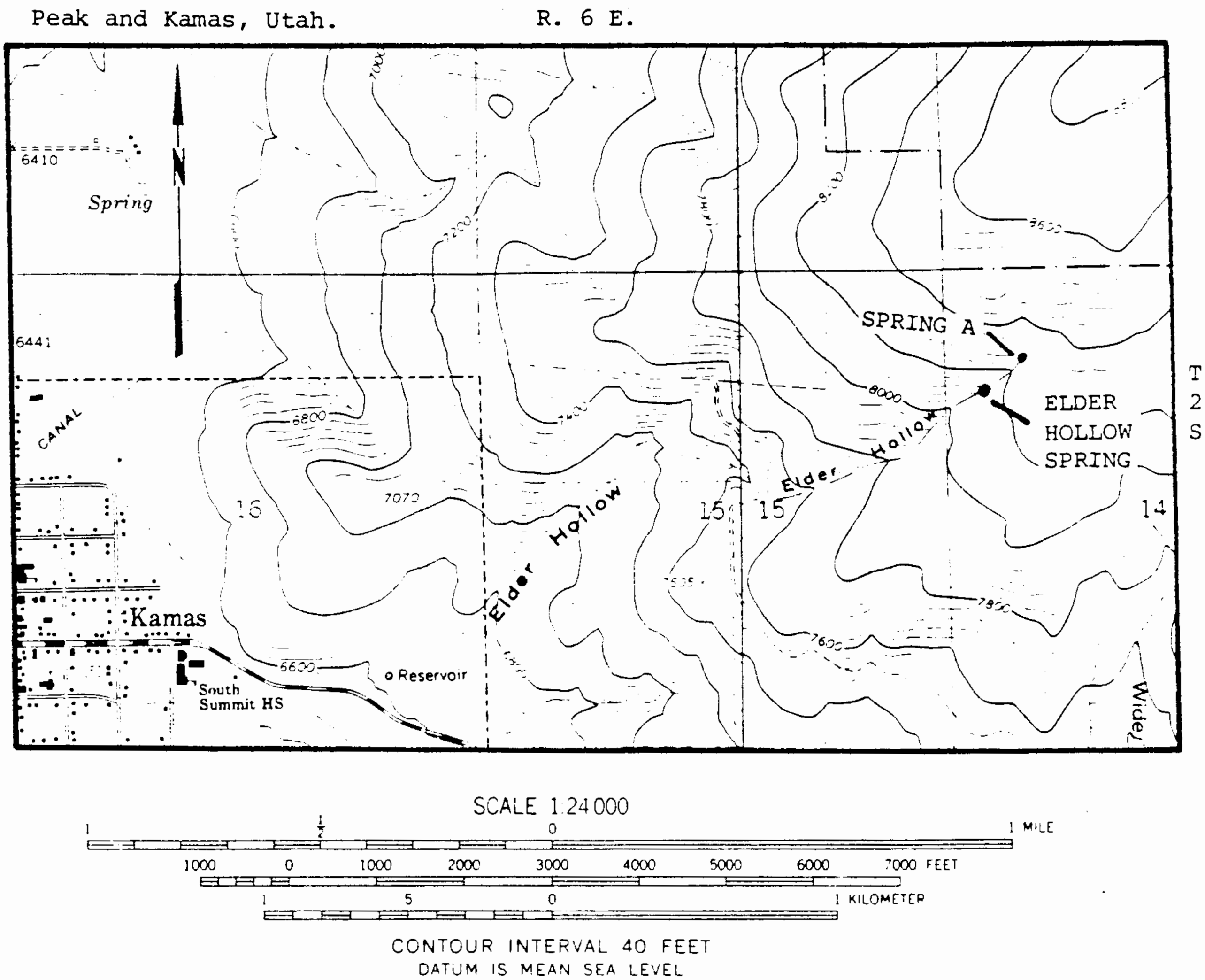
Hintze, L.F., compiler, 1980, Geologic map of Utah: Utah Geological and Mineral Survey, 1:500,000.

McDougald, W.D., 1953, Geology of Beaver Creek and adjacent areas, Utah: Salt Lake City, University of Utah, M.S. Thesis, 54 p.

Woodfill, R.D., 1972, A geologic and petrographic investigation of a northern part of the Keetley volcanic field, Summit and Wasatch counties, Utah: Lafayette, Indiana, Purdue University, Ph.D. Dissertation.

Attachment 1, Job No. WS-9

Base map from: U.S.G.S. 7½'
topographic quadrangles, Hoyt
Peak and Kamas, Utah.



Location Map

Project:			Requesting Agency:
Richfield Spring Investigation			Bureau of Public Water Supply
By: H. Gill	Date: 9/12/85	County: Sevier	Job No.: WS-10
USGS Quadrangle: Richfield (599)			

#85-032

At the request of Mr. Ken Bousfield, Utah State Division of Environmental Health, the Utah Geological and Mineral Survey (UGMS) investigated Richfield Spring to determine if construction of Interstate 70, immediately west of the spring site, would effect it's recharge area or discharge point. The spring is on the west edge of Richfield, Utah and has provided culinary water to the City for many years. The spring is on the faulted east flank of the Pavant Range and issues from the slope approximately 200 feet east of the mountain front (attachment 1). The spring has been developed by constructing a concrete sump around the discharge point and installing pumps to lift the water to a reservoir.

During the investigation a 1967 memorandum on Richfield Spring, written by Mr. Andrew Kurie previously with the Utah Department of Transportation (UDOT), was discovered (attachment 2). The report dealt with the exact subject under investigation by UGMS, and answered many of the questions raised concerning the spring and construction of I-70. In addition, the report included both borehole and seismic refraction data, the aquisition of which were beyond the scope of the UGMS investigation. The UGMS has reviewed the UDOT memorandum and generally concurs with its findings. The following conclusions and recommendations are taken from that report with additional comments and recommendations by UGMS.

WATER SOURCE

1) The source of the spring is primarily a deep artesian aquifer fed by water migrating eastward from the Pavant Range through an extensive joint system. The water migrates upward along the Elsinore fault and discharges at the spring. Evidence for this was obtained through borehole and seismic data. In addition, the water temperature is higher than normal, 74 degrees Fahrenheit as compared to a normal range of 44 to 57 degrees Fahrenheit, indicating the water has circulated to a considerable depth.

2) The existance of a shallow ground-water reservoir (in upper Flagstaff Limestone or the lower Crazy Hollow Formation) was determined from borehole data. The shallow water table was measured in boreholes at 5386 feet above sea level, the same elevation as the spring discharge point. Mr. Kurie states that the 5386 foot level remains static as long as the city does not pump the spring in excess of 3.2 cubic feet per second (cfs). He also states: "when the underground and pump house reservoirs are filled to the overflow crest, the City pumps can be operated at top efficiency (1600 gallons per minute) for 72 hours before the water level is lowered to about 5381.8 feet, then one pump must be stopped to allow recharging from the deep water sources." The shallow ground-water reservoir receives water from the Pavant Range to the west as well as from infiltration of precipitation and leakage from the Sevier Valley canal.

EFFECT OF HIGHWAY CONSTRUCTION ON AQUIFERS AND SPRING DISCHARGE POINT

1) Load tests on rock core samples indicate that the shallow reservoir rock is easily capable of withstanding the weight of the proposed highway embankment and any traffic loads placed on it. However, UDOT recommends that impact loads imposed by construction equipment, embankment loads, and traffic on I-70, must be kept at a safe distance from the spring discharge point (distance determined by UDOT to be at least 200 feet west of the spring enclosure fence). This will prevent changing the spring to a new point of outlet, or in any way effecting the natural shallow underground reservoir.

2) According to UDOT "it is not conceivable that construction of Interstate 70 could disturb the flow in the deep near vertical ground-water channels. The UGMS concurs with this statement but recommends that the safety distance for impact loads be strictly followed.

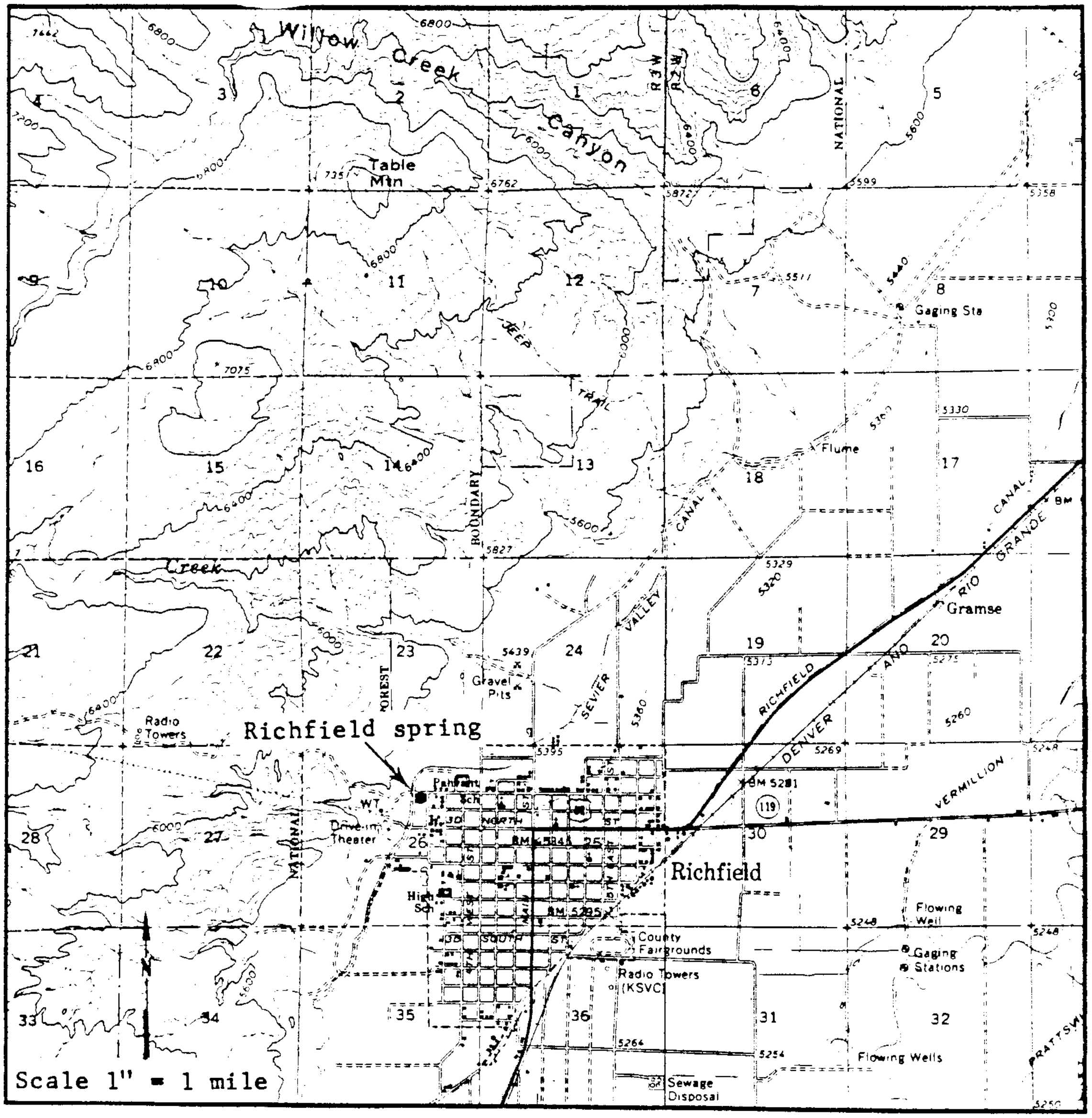
3) It was also recommended by UDOT that a minimum disturbance of the ground surface be allowed in the spring vicinity. Therefore, a minimum grade elevation of 5406 feet and no excavation within 15 vertical feet of the 5386 foot water level was recommended.

CONTAMINATION OF THE SHALLOW RESERVOIR

1) It was documented by Harold Hansen, Utah State Department of Health District Sanitarian, that muddy water from the Sevier Valley Canal has entered the shallow ground-water reservoir, temporarily contaminating the spring system. The Utah Department of Transportation states that as long as the city pumps are operated below 3.2 cfs the shallow reservoir is not tapped. However, the report is 18 years old and there is no guarantee that the peak flow from the deep aquifer has remained constant. A review of water quality test data indicates that high coliform bacteria counts were recorded during August 1981, 1984, and 1985. This may correspond with periods of increased pumping resulting in withdrawal of water from the shallow aquifer. We recommend a review of pumping records to see if high periods of pumping correspond with elevated coliform bacteria counts. In any case we recommend lining the canal where it borders the shallow aquifer.

In summary, the UGMS concurs with conclusions and recommendations contained in the UDOT report. It is felt, based upon data presented in the report and the results of our own investigation, that there should be no adverse effect on either the shallow or deep aquifers due to construction of I-70, as long as recommendations set forth in the UDOT memorandum are implemented.

Base map from USGS 15' topographic quadrangle, Richfield, Utah.



General location map, Richfield spring.

Attachment 2, Job No. WS-10

Design Recommendations Adjacent To
The Richfield Spring

Prepared By: Utah State Department of Highways

Memorandum · UTAH STATE DEPARTMENT OF HIGHWAYS

DATE: June 21, 1967

TO : D. L. Sargent, Engineer for Preconstruction

H. J. Liddle

FROM : W. J. Liddle, Chief, Materials & Tests

Andrew Kurie

SUBJECT: I-70-1(5)26 Design Recommendations Adjacent to the Richfield Spring

INTRODUCTION

The study of the Richfield spring is preliminary to the construction of Interstate 70, which will be located west of Richfield City. The elevation of the spring is 5386 ft., and it is located on the faulted east flank of the Pavant Mountains in the Sevier River valley. The Richfield spring has a discharge of 3.2 cubic feet per second[1] and constitutes a major source of culinary water for the area. The cause of the spring has been inferred as the result of subsurface and surface studies of the area, undertaken by the Utah State Department of Highways. The drilling, geophysical and geologic studies which have just been completed indicate that the primary source of the spring water is hundreds of feet below the surface outlet. The sizeable spring flow at the outlet comes from a regional artesian system. No seasonal decline of outflow has been reported[2], regardless of extended dry periods.

GEOLOGIC CONDITIONS

Early publications describe the spring as emerging near the trace of the Elsinore fault, from fractured Eocene age limestone. This limestone is most likely upper Flagstaff. The Flagstaff Limestone underlies the Crazy Hollow Formation at this locality and may in part be the age equivalents of the Colton and Green River Formations; however, for mapping purposes, they cannot be differentiated from the Flagstaff lithology.

The spring intake area is believed to be in the Pavant Mountains region about 1-9 miles west of the Elsinore fault where the spring has its outlet; fractured Flagstaff Limestone bedrock predominates in the area. The elevation at the intake area ranges from 6000-10,000 ft. above sea level and precipitation in normal years ranges from 15-30 inches. Precipitation at the spring and in the Sevier River valley is normally less than 15 inches. The Flagstaff Limestone of the intake area has a regional dip eastward toward the spring outlet. The limestone probably forms a relatively continuous reservoir for groundwater through which hydrostatic pressure is transmitted, thereby causing artesian conditions to result at the spring outlet. Water movement is thought to be near vertical along the west side of the fault

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[1]Letter from Richfield City Manager, Guy Baker, to W.J. Stephenson, dated Jan. 3, 1966 (sic.)

[2]Personal Communication from Mr. Guy Baker to A. Kurie, 1967

trace (see Figs. 1 & 3). Location of the fault trace shown on the Index Map, Figure 1, is confirmed by our drilling (Test Hole 1, see Fig. 2) and geophysical investigations (Figs. 1 & 4). The seismograph shows that bedrock lies at shallow depths on the upthrown side of the fault, while on the downthrown side, there is a deep cover of poorly consolidated material over the bedrock.

The Elsinore fault acts as an underground dam and conduit by impounding the water percolating through the deep aquifers and then conducting it from the deep source to the surface. The spring water maintains a temperature of 74°F. at its outlet. If a geothermal gradient of 1°F. per 80 ft. in the Richfield area is assumed[1]; and if no allowance is made for cooling, the water rises from a depth of 2000± ft. Although the fault, with its associated minor fractures, is the dominant factor controlling the location of the spring outlet, the place of actual outlet must be the result of many favorable conditions by which free flow is maintained. One of these factors is the system of open rock joints and fracturing which serve to conduct the water. These fissures are evident in the cores of Flagstaff Limestone taken in Test Holes 2 and 3 (see Index Map, Fig. 1). Another factor is the original spring outlet elevation which is at the lowest elevation found along the surface trace of the fault within the map area (Fig. 1).

SHALLOW GROUNDWATER RESERVOIR

A shallow groundwater reservoir which communicates with the Richfield spring is evident in the area west of the Elsinore fault. The groundwater level elevation was found to be at 5386 ft. in Test Holes 2 and 3 (Fig. 1). Further evidence of the reservoir has been indicated by three sumps which were dug below the 5386 ft. level, see Index Map, Fig. 1: first, the present Richfield city sump at the original spring outlet; second, the former Richfield city sump 250± ft. southwest of the present outlet; and third, a privately developed former sump 325± ft. north of the present outlet. The area delineated between the test holes and sumps containing the 5386 ft. groundwater level indicates a 2.5± acre groundwater reservoir. The actual reservoir is probably about 7 acres in area as shown by evidence discussed below.

An inference of the actual size of the shallow reservoir is made from the following report by Richfield City Manager Guy Baker[2]. It has been observed that the 5386 ft. groundwater level is static except for periods when the Richfield city pumps operate in excess of 3.2 cfs (1400± gallons per minute). For example, when the underground and pump house reservoirs are filled to the overflow crest, the city pumps can be operated at top efficiency (1600± gpm) for 72± hours before the water level is lowered to about 5381.8 ft., then one pump must be stopped to allow recharging from the deep water sources. If the effective reservoir porosity is assumed to be 10%, a minimum 7 acre near-surface reservoir is indicated.

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[1]Personal Communication from Dr. Ray E. Marsell to A Kurie, 1967
[2]Personal Communication to A. Kurie, 1967

Another evidence of the shallow reservoir is the fact that several years ago, dredging operations in the Sevier Valley canal, which lies 130 ft. west of the spring outlet, opened vertical channels from the bottom of the canal into the shallow reservoir. According to an eye-witness, Utah State Department of Health District Sanitarian, Harold Hansen[1], the spring water was seen "at about arm's length" through the opening in the canal floor, and muddy canal water flowed into and temporarily contaminated the spring system.

All available evidence of the shallow limestone reservoir rock indicates the effective porosity transmitting water to the spring outlet is a system of natural rock fractures and joints. Cores of the limestone in Test Holes 2 and 3 exhibit considerable open fracturing; however, no sizeable cavernous voids or extensive honeycomb structure were found either in the cores or in a thorough surface investigation of outcropping Flagstaff Limestone surrounding the city sump and I-70 alignment. No sinkhole inlets were found in the probable aquifer intake area in the Pavant Mountains; however, open vertical fracturing is commonplace. The effective porosity for intake as well as transmission can most likely be attributed to fractures. Furthermore, the presence of a relatively widespread static subsurface water level, with its elevation controlled by the overflow crest at the city pump house (c.f. Test Holes 2 & 3, and the three sumps, Fig. 1), indicates a confined system of underground porosity and permeability, rather than a system of cave-like water conduits of the nature of an underground "river".

The possible existence of water flow through sizeable subterranean channels or cave-like conduits was investigated by means of a series of geophysical tests. The purpose of these tests was to detect any sound vibrations which might be produced by turbulent flow of water in large openings. Results of these tests were negative as no underground sound source was located, other than the outflowing spring itself.

RECOMMENDATIONS

There are several characteristics of the Richfield City spring which must be safeguarded during and after construction of Interstate 70; they are:

(1) The artesian flow rate (3.2 cfs)[2]
(2) The outlet location
(3) The integrity of the shallow underground reservoir
(4) The quality of the water.

Two rock cores from the reservoir were tested for their ability to withstand load and they failed at 665 and 864.4 tons per square foot in unconfined compression tests. These tests indicate that the limestone reservoir is capable of withstanding more than the weight of highway embankment fill, pavement and traffic loads which will be placed above it; therefore, it is not conceivable that construction of Interstate 70 could disturb the flow in the deep near vertical ground water channels. However, the impact loads imposed by construction equipment, embankment loads and traffic on I-70 must be kept

[1]Personal Communication to A. Kurie, 1967

[2]To confirm a regional artesian system with a minimum flow rate fluctuation (continued)

at a safe distance from the outlet sump area to prevent changing the spring to a new point of outlet, or in any way affecting the natural shallow underground reservoir.

To safeguard the Richfield spring, the I-70 alignment should be located west of the City spring works enclosure fence with at least a 200 ft. radius from the nearest roadway shoulder to the enclosure fence (Fig. 1). Furthermore, a minimum disturbance to the natural ground surface must be assured during construction across the shallow underground reservoir. To help assure this, a minimum grade elevation of 5406 ft. is recommended and no excavation should be done nearer than 15 ft. above the 5396 ft. water level across the area of the shallow underground reservoir along the I-70 centerline from a point 400± ft. south to a point 500± ft. north of the center of the City spring works enclosure. The placement of fill required within the critical area should be controlled so as to produce minimum disturbance to the natural ground surface.

AKurie/mv

cc: W. J. Stephenson
N. R. Christensen
Foundations
Geologic Recons.
Central File
File

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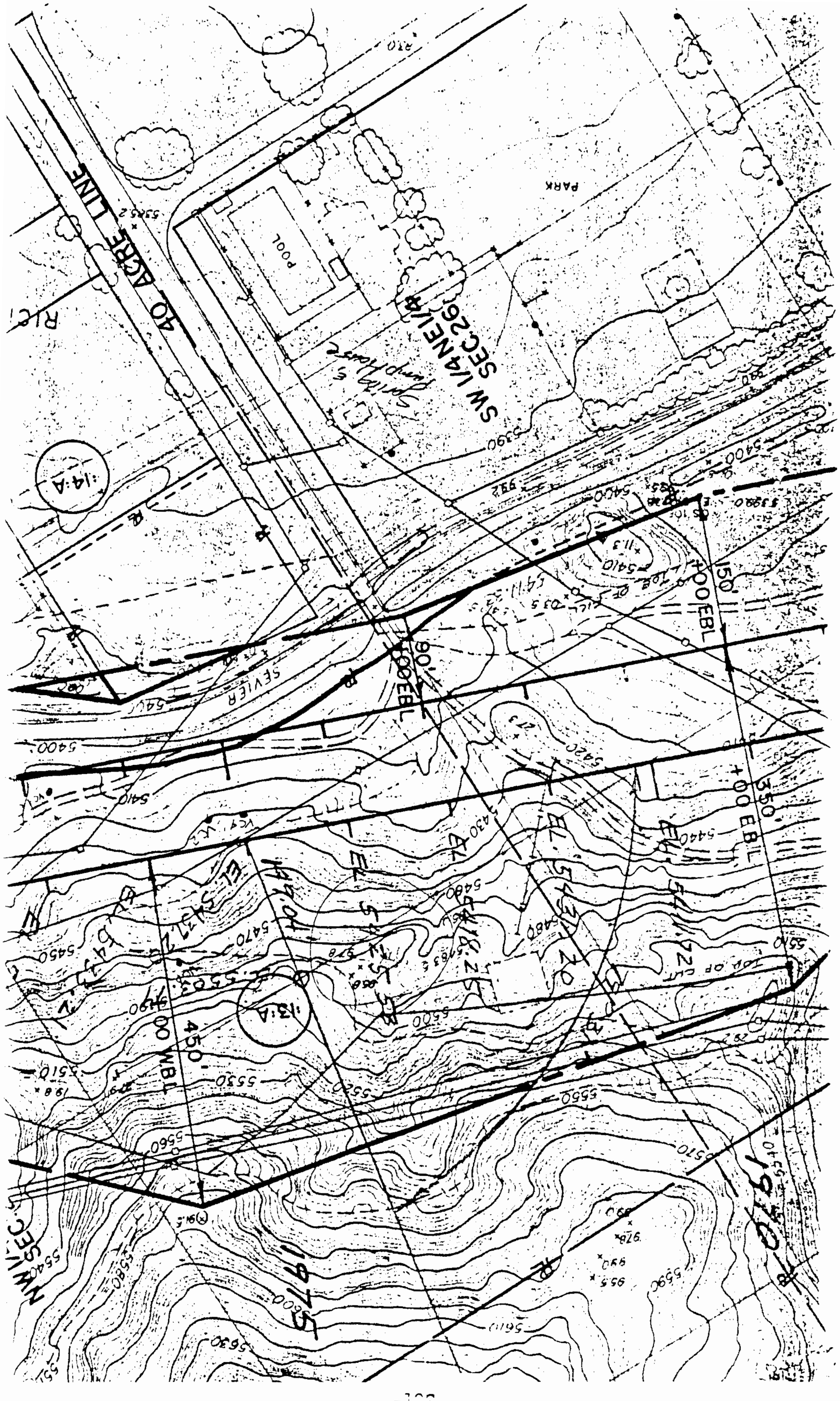
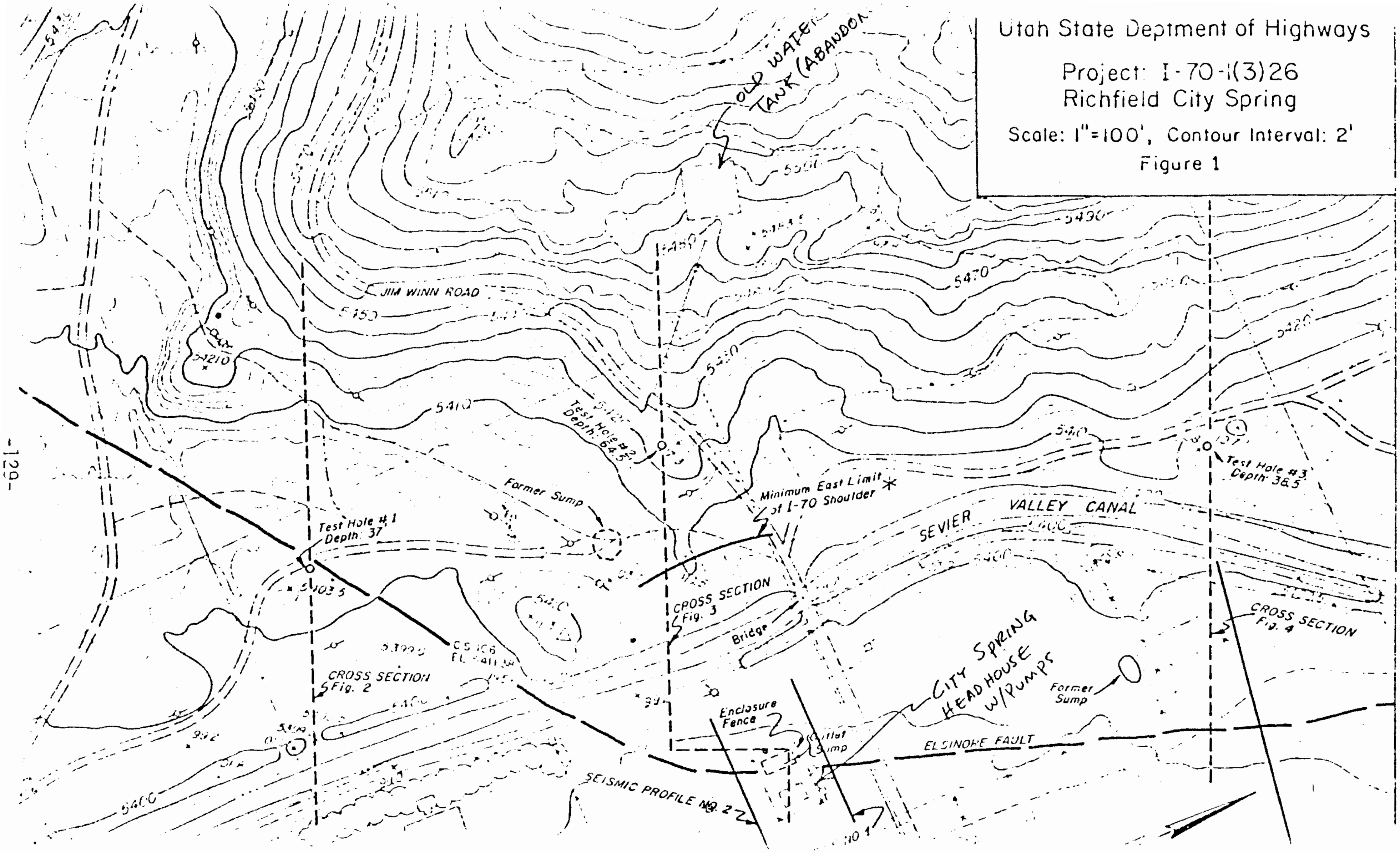
a program of spring flow gauging should be undertaken, by arrangement between the State Engineer's office and the Hydrology Branch of the U.S. Geological Survey. For the satisfaction of all concerned parties, this measurement should continue from the present time, until the constructed Interstate has been in service for a period of time. If no adverse flow characteristics are noted during this time, a year of measurements after I-70 traffic begins should be adequate to confirm the safety of the spring system.


40 ACRE LINE
SW 1/4 NE 1/4 SEC. 26
POOL
PARK
SEVIER
150+00 EBL
350+00 EBL
450+00 WBL



Utah State Deptment of Highways

Project: I-70-1(3)26
Richfield City Spring

Scale: 1"=100', Contour Interval: 2'

Figure 1

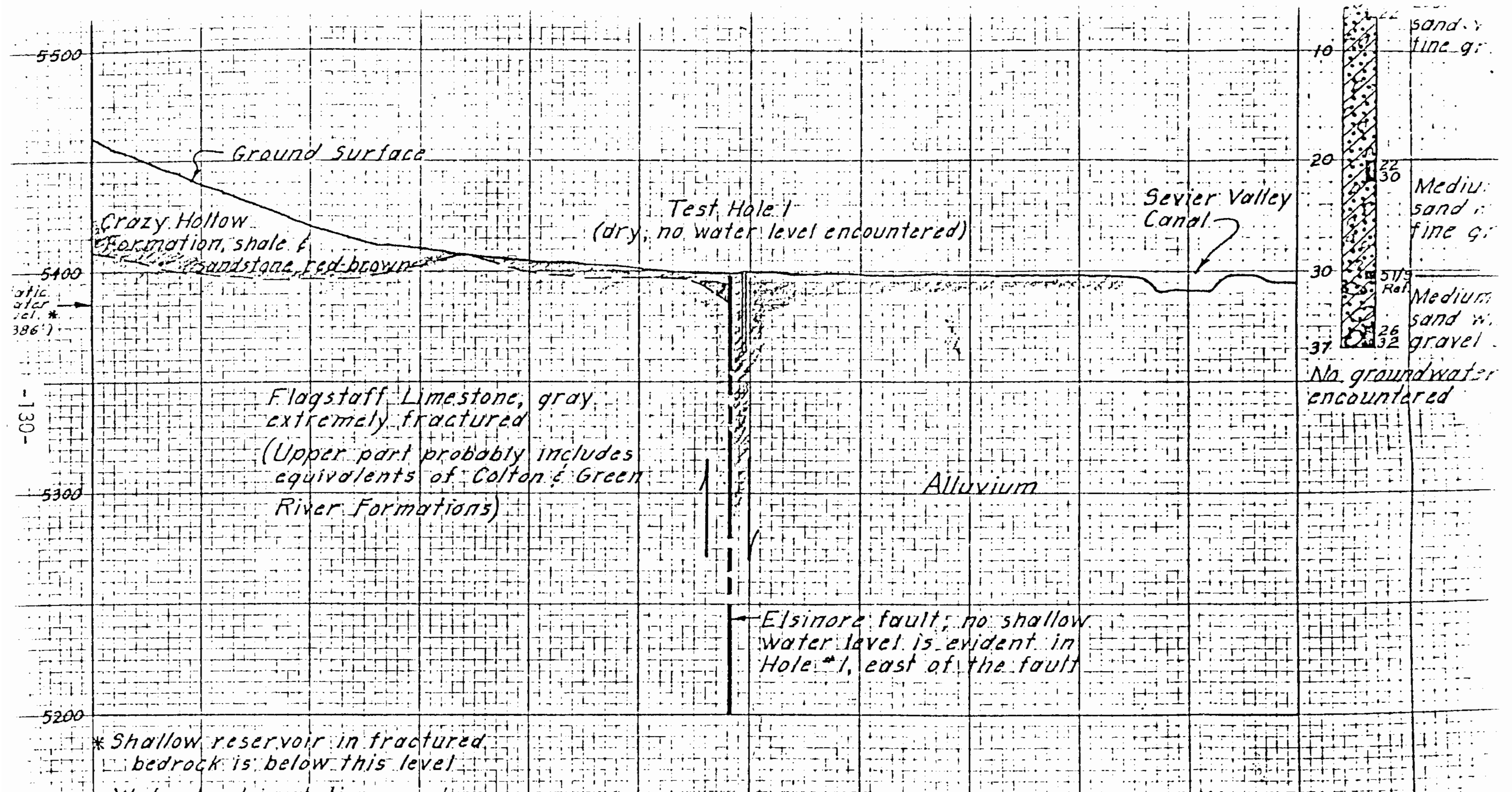


FIGURE 2
Cross Section
(location of Section is shown on Fig. 1)

Richfield Spr no I-70-1(3)26

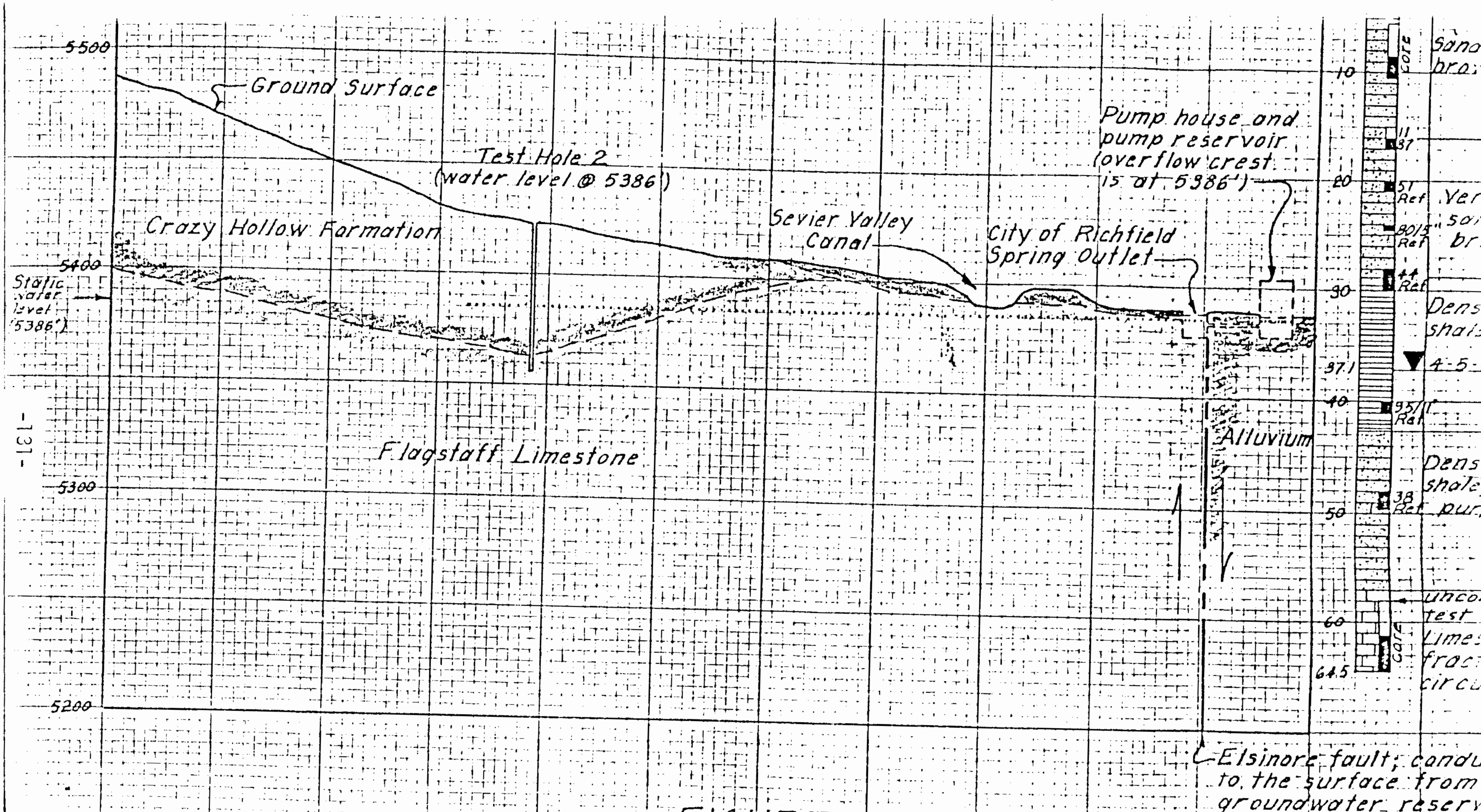


FIGURE 3
Cross Section
(location of Section is shown on Fig. 1)

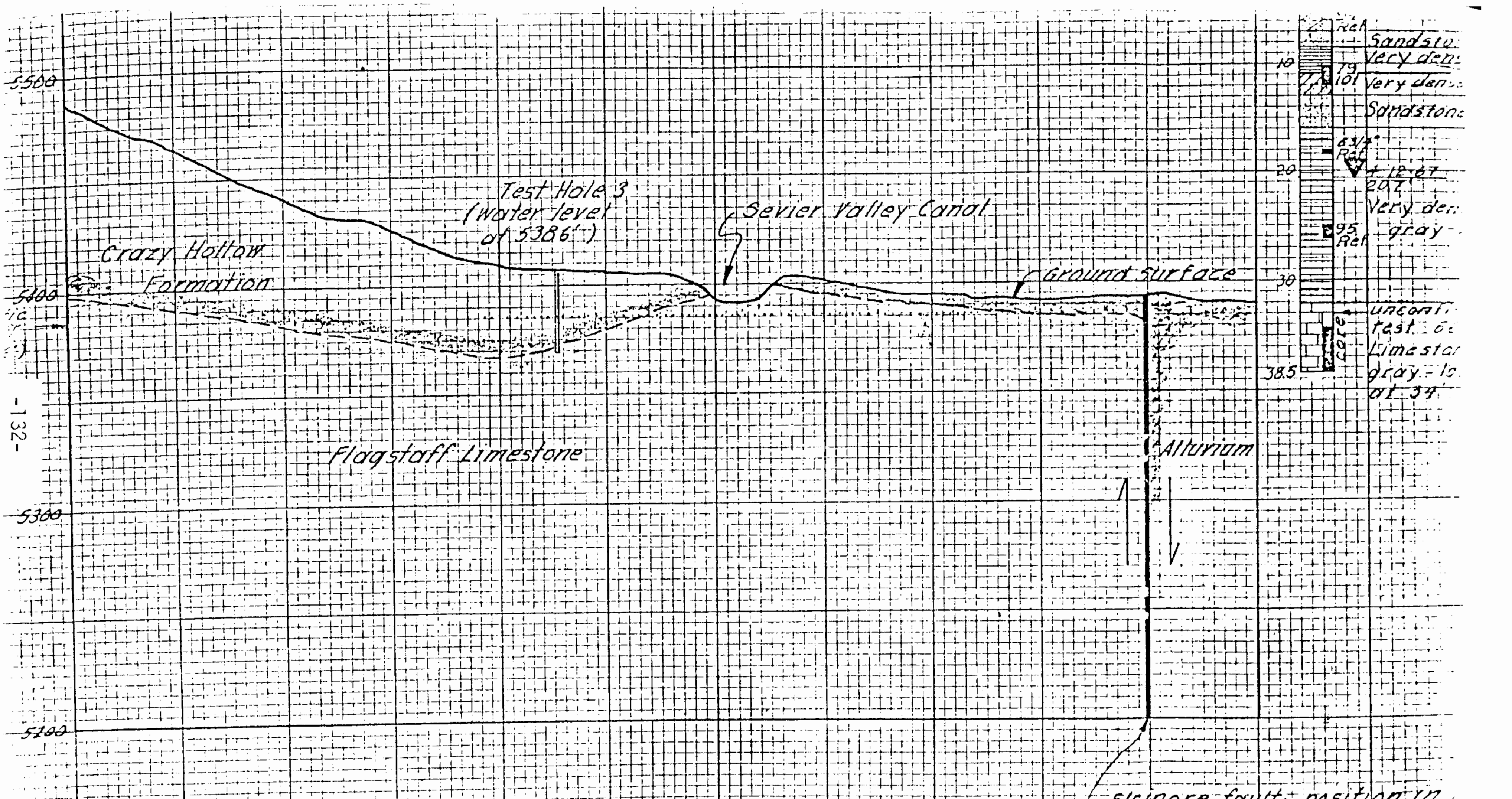


FIGURE 4
Cross Section
(location of Section is shown on Fig 1)

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Date Begun 4/6/67
Date Completed 4/6/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area
Type of Structure Centerline Investigation
Sta. of Structure
Collar Elevation 5400.5
Field Party Chandler, Eklund, Sasser

Hole No. 1
Sheet 1 of 2
Total Depth 37'

Equation: Project Line Sta. / Other Line Sta.

Hole Sta. 1962+70 ~~Rt.~~ ~~Ft.~~, Lt. 67 Ft., of ℄ I-70 NBL
Reference Highway Marker CS-106 Method Used Handlevel
Rig Mobile #15

Ground Water Table

Depth in Ft.	Dry (caved at 33')				
Time	0900				
Date	4/7/67				

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Sampling	Sample Recovery	Soil Graph	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.
Rotary				0				Hole located on an alluvial flat West of "hi-line"
Rock Bit								irrigation canal and south of U.S. Forest Service road.
↓				1				Light brown sand w/silt and trace clay
								-some adobe properties evident in material-
				2				" " " "
				3				-and some thin beds fine gravel
				4				" " " "
	↓			5				Casing to 5'
Pen		4	106	6				2/6 2/6 7/6 15/6
"		22	107					Loose to Medium- " "
"				7				
RB				8				" " " "
				9				Sand w/silt, fine gravel, and trace clay
	↓			10				casing to 10'
				11				" " " "
				12				
				13				" " " "
				14				
	↓			15				casing to 15'
								" " " "
				16				
				17				(Water in hole stands at 16.2', 1200 hrs (down 1 hour);
								at 16.2, 1230 hrs, Temp. = 63°F at 17'.)
				18				" " " "
				19				Sand w/silt, fine gravel, and some clay
↓	↓			20				casing to 20'

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Date Begun 4/6/67
Date Completed 4/6/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area

Hole No. 1
Sheet 2 of 2
Total Depth 37'

Equation: Project Line Sta. / Other Line Sta.

Type of Structure Centerline Investigation
Sta. of Structure
Hole Sta. 1962+70 Rt. Ft., Lt. 67 Ft., of ℄ I-70 NBL
Collar Elevation 5400.5
Reference Highway Marker CS-106
Method Used Handlevel
Field Party Chandler, Eklund, Sasser
Rig Mobile #15

Ground Water Table

Depth in Ft.	Dry (Caved at 33')			
Time	0900			
Date	4/7/67			

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	DESCRIPTION (Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.)
	↓			20	Sand w/silt, fine gravel, and some clay
Pen		22			
"				21	11/6 11/6 14/6 16/6
"		30			Medium to Dense - " "
"			122	22	
BB ↓					
				23	" " "
				24	
	↓			25	(Water in hole stands at 19'; 1435 (down 0.5 hr), temp. 67°F at 24'. Casing to 25')
				26	
				27	Sand w/silt, fine gravel, and clay
				28	
				29	
↓	↓				" " "
				30	
Pen		Ref			Casing to 30'
"			130.7	31	11/6 40/3 Ref. on limestone boulder, gray.
RB ↓					Medium to Very Dense - " "
				32	-Sandstone boulder, gray-white-
				33	" " "
				34	-Sandstone boulder, brown-
↓					" " "
				35	
Pen					
"		26	135.7		12/6 14/6 15/6 17/6
"		32	136.4	36	Medium to Dense - " "
"			137		
				37	Bottomed hole at 37'; 1600 hrs, 4/6/67
					-Cemented hole to surface.
				38	-(Water in hole stands at 30' [down 0.5 hr], 4/6/67.
				39	-(Hole dry, Caved at 33', 0900, 4/7/67).
				40	

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Date Begun 3/30/67
Date Completed 4/5/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area
Type of Structure Centerline Investigation
Sta. of Structure
Collar Elevation 5423.2
Field Party Chandler, Eklund, Sosser

Hole No. 2
Sheet 1 of 4
Total Depth 64.5'

Equation: Project Line Sta. / Other Line Sta.

Hole Sta. 1966+10 ~~Rt.~~ ~~Ft.~~, Lt. 167 Ft., of ℄ I-70 NBL
Reference Highway Marker CS-106 Method Used Handlevel
Rig Mobile #15

Ground Water Table

Depth in Ft.	Dry at 15', 20', 24'		Dry at 28'	37.1'	37.1'
Time		1615	1000	0900	1130
Date		3/30/67	4/4/67	4/5/67	4/5/67

DESCRIPTION
Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Sampling	Description
Rotary Rock Bit				0		Hole located on sandstone ledge near south edge of U.S. Forest Service road. *Culinary drill water used on project - see note. Shaley sandstone, very fine grained, limy, red-brown, weathered
				3		" " " "
				4–5		Sandy shale, limy, red brown, weathered, altered to silt and clay w/some thin sandstone stringers (casing to 5')
Core-BX Diamond			5.5'	5.5		
				7		" " " " (some caving)
				8–9	Core 5' (Rec. 4.5')	" " " " less weathered and altered
			10.5'	10		(casing to 10')
RB				11		" " " "
				12		" " " "
				13		" " " "
				14		weathered, altered to silt and clay (some caving)
Pen		11		15		Medium to Stiff- " "
"			216	15.5		3/6 8/6 39/6 48/6
"		87		16		Very Dense - Shaley sandstone, very fine graine[d]
"			217	17		limy, red brown, weathered
RB				18		" " " "
				19		(lost circulation) Sandy shale, limy, red brown, weathered, altered to silt and clay
				20		Casing to 20'

* Note: All drill water containers were rinsed with culinary water bef[ore]
start of proj[illegible] Drill water used in [illegible] -135- [illegible]

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Date Begun 3/30/67
Date Completed 4/5/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area
Type of Structure Centerline Investigation
Sta. of Structure
Collar Elevation 5423.2
Field Party Chandler, Eklund, Sasser

Hole No. 2
Sheet 2 of 4
Total Depth 64.5'

Equation: Project Line Sta. / Other Line Sta.
Hole Sta. 1966+10 Rt. Ft., Lt. 167 Ft., of ℄ I-70 NBL.
Reference Highway Marker CS-106 Method Used Handlevel
Rig Mobile #15

Ground Water Table

Depth in Ft.	Hole cased to 20'	Dry at 28'
Time	0900	1600
Date	4/4/67	4/4/67

DESCRIPTION: Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Description
				20	Weathered sandy Shale
Pen		51	220.3		
"			221.1		16/6 35/6 30/1 Ref. in dense material
RB		Ref.		21	Very Dense- Shaley sandstone, very fine grained, limy, red-brown, Weathered.
				22	(Circulation varies from "lost" to "high loss of drill water")
				23	W/some <0.3' layers weathered sandy shale
Pen		Ref.	224.5	24	80/5 Ref. in dense material 3/30/67
RB				25	Very Dense- " " " 4/4/67
				26	" " " "
				27	
Pen				28	Very Dense- " " "
"		44	228.7		23/6 21/6 30/6 50/5 Ref.
"		Ref.	229.4	29	Very Dense - Shale, limy, red brown, weathered, partly altered to Clay
"			230	30	
RB					Casing to 30'
				31	(Sample from 30' dry - full recovery of circulation below 30')
				32	
				33	" " " "
				34	
				35	" " " "
					(Water stands static at top of casing during rod change at 35')
				36	" " " "
				37	-cuttings and drilling rate indicates Shale is altered to clay
				38	" " " "
				39	% very fine sand increases - W/very fine sand
				40	

Date Begun 3/30/67
Date Completed 4/5/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Hole No. 2
Sheet 3 of 4
Total Depth 64.5'

Equation: Project Line Sta. / Other Line Sta.

Type of Structure Centerline Investigation
Sta. of Structure
Hole Sta. 1966+10 ~~Rt. Ft.~~, Lt. 167 Ft., of ℄ I-70 N.B.
Collar Elevation 5423.2
Reference Highway Marker CS-106
Method Used Hand level
Field Party Chandler, Eklund, Sosser
Rig Mobile #15

Ground Water Table

Depth in Ft.	37.1'				
Time	0900				
Date	4/5/67				

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Sampling	Sample Recovery	Soil Graph	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.
				40				Shale w/ very fine sand, weathered, altered
Pen			240.5					and partly altered to clay
"		Ref.	241					33/6 62/5 Ref.
RB				41				Dense to Very Dense - " "
↓								(Water in hole stands at 9.13', 1150 hrs; at 9.38', 1320 hrs
				42				at hole depth of 41')
				43				Shaley sandstone, limy, weathered w/some thin
								resistant layers, light purple gray
				44				(At 1345 hrs, 43' hole depth and below, circulation
								varies from "high loss" of drill water to "some loss"
				45				-some caving in hole)
								W/some thin brown shale layers
				46				
				47				" " " "
				48				
Pen		38	248.6					
"								15/6 23/6 26/6 50/3 Ref.
"			249.3	49				Dense to Very Dense - " "
"		Ref	249.7					(Water in hole stands at 37.0', 1500 hrs) 4/4/67
RB				50				(Water in hole stands at 37.1', 0900 hrs, Temp = 69.5°F at 48')
↓								4/5/67
				51				" " " "
				52				(Some loss drill water, some caving)
				53				
				54				" " " "
				55				" " " "
				56				
								" " " "
				57				Limestone breccia, highly fractured, gray white,
								alternating ±1' layers with decomposed limestone and clay
Core NX			58.0	58	↑			fracture fill material, tan to brown.
Diamond			↑					(Circulation lost with pumps set for coreing
				59		4.6		operation)
				60				

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Date Begun 3/30/67
Date Completed 4/5/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area
Type of Structure Centerline Investigation
Sta. of Structure
Collar Elevation 5423.2
Field Party Chandler, Eklund, Sasser

Equation: Project Line Sta. / Other Line Sta.
Hole Sta. 1966+10 ~~Rt.~~ ~~Ft.~~, Lt. 167 Ft., of ℄ I-70 NBL.
Reference Highway Marker CS-10b
Method Used Handlevel
Rig Mobile #15

Hole No. 2
Sheet 4 of 4
Total Depth 64.5'

Ground Water Table

Depth in Ft.	37.1'				
Time	1130				
Date	4/5/67				

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Sampling	Sample Recovery	Soil Graph	DESCRIPTION Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.
Core NX ↓			↓	60	Core 6.5'	(3.1')		Limestone
				61				"
				62				"
				63				(Circulation lost)
				64				"
			64.5'				X	(Limestone porosity due to fracturing)
				65				Bottomed hole at 64.5' 1130 hrs, 4/5/67
								(Water in hole stands at 37.1'; Temp. = 69.2°F at 48
				6				-Set packer at 37', cemented to surface.
								-Since 1345 hrs, 43' hole depth, have pumped ± 700
				7				gal. Clorine solution (+100 parts per million available
								clorine) into subsurface porous zones; as of 0900,
				8				4/6/66, no trace of this clorine had been detected
								at the spring.
				9				
				0				
				1				
				2				
				3				
				4				
				5				
				6				
				7				
				8				
				9				
				0				

Date Begun 4/11/67
Date Completed 4/12/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Hole No. 3
Sheet 1 of 2
Total Depth 38.5'

Equation — Project Line Sta. / Other Line Sta.
Type of Structure Centerline Investigation
Sta. of Structure
Hole Sta. 1971+30 Lt. 165 Ft. of ℄ I-70 NBL.
Collar Elevation 5406.7 Reference Highway Marker-CS 10b Method Used Handlevel
Field Party Chandler, Eklund, Sasser Rig Mobile #15

Ground Water Table

Depth in Ft.	Dry at 5', 10'	21.1'			
Time	1030	0900			
Date	4/11/67	4/12/67			

DESCRIPTION: Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Description
Rotary Rock Bit				0	Hole located near west edge of alluvial flat, and west of "hi-line" irrigation canal and north of U.S. Forest Service road
				1	Topsoil-bedrock fragments, sand, silt, and clay w/ trace hu[mus]
				2	Siltstone, sandy, shaley, partly weathered, light purple gray, brown, and tan, limy.
				3	
				4	" " " "
				5	Casing to 5'
Pen		Ref.			44/6 50/6 Ref. in dense material
"			305.8	6	Very Dense- " " "
RB					" " " "
				7	Sandstone, limy, fine, gray white and tan
				8	" " " "
				9	Shale, sandy, weathered, altered to clay, brown w/some thin, sandy, resistant layers, limy
				10	Casing to 10'
Pen					Very Dense- " " "
"		79	310.7		27/6 52/6 48/6 53/6
"		101	311.4	11	Very Dense- Siltstone, shaley, sandy, limy, partly
"			312	12	Weathered, brown, tan, and light purple gray
RB					" " " "
				13	Sandstone and siltstone, limy, very fine, ligh[t] gray
				14	" " " "
				15	" " " "
				16	Shale, sandy, limy, partly weathered, partly altered to clay, light gray and gray br[own] w/ hard thin, sandy resistent zones.
				17	
Pen		Ref	318.3	18	63/4 Ref. in dense material
RB				19	Very Dense- " " "
				20	" " " "

Date Begun 4/11/67
Date Completed 4/12/67
Hole Diameter 3 3/4"
Project No. I-70-1(3)26
Project Name Near Joseph to Salina
Richfield Spring Area

UTAH STATE DEPARTMENT OF HIGHWAYS
MATERIALS & RESEARCH DIVISION
DRILLING LOG

Hole No. 3
Sheet 2 of 2
Total Depth 38.5'

Type of Structure Centerline Investigation — Equation — Project Line Sta. — Other Line Sta.
Sta. of Structure — Hole Sta. 1971+30 — Lt. 165 Ft., of ℄ I-70NBL
Collar Elevation 5406.7 — Reference Highway Marker CS 106 — Method Used Handlevel
Field Party Chandler, Eklund, Sasser — Rig Mobile #15

Ground Water Table

Depth in Ft.	21.1'				
Time	0900				
Date	4/12/67				

Drilling Method	Casing Depth	Blows per Foot	Sample Number	Depth in Feet	Sampling	Sample Recovery	Soil Graph	DESCRIPTION — Soil type, color, texture, consistency, sampler driving notes, blows per foot on casing, depths circulation lost, observed fluctuations in water level, notes on drilling ease, bits used, etc.
RB				20				Shale, sandy, limy
				21				" "
				22				
				23				" "
				24				
Pen		95	325.7	25				(Water in hole stands at 19.9' 1215 hrs. [down 0.3 hrs] - at 1430 hrs. [down 2.5 hrs.] water stands at 20.5' Temp = 68 at 27')
"								45/6 50/6 50/3 Ref
"		Ref.	326.3	26				Very Dense - "
RB				27				
								" "
				28				-Weathered, shale altered to clay
				29				
				30				(some loss of drill water)
				31				" "
				32				Limestone breccia, fractured, gray white and gray w/ decomposed limestone and clayey fracture fill material. 4/11/67
Core-NX			33.0'	33		Core 5.5' (2.1')		4/12/67 (Water stands at 21.1', hole depth at 33', 0900, Temp. 67°F at 26', rig down overnight)
				34				
				35				(Lost circulation at 34' with pumps set for coreing operation)
				36				" " " "
				37				(limestone porosity due to fracturing)
			38.5	38				" " " "
				39				Bottomed hole at 38.5', 1030 hrs, 4/12/67 (Water stands at 20.7' 1130 hrs [down 1 hr.] Temp = 64
				40				Temp. readings on this project may not be accurate - indicator on therometer may be jarred to a lower reading coming out of hole)

-Set packer at 22', cemented to surface. - Since 0900 hrs, 33' hole depth, have pumped +300 gal. [illegible]

SOLID WASTE DISPOSAL

Project:			Requesting Agency:
Review of Construction and background documents for the Vitro tailing remedial action project.			Attorney General's Office
By: W.R. Lund	Date: 12/23/85	County: Salt Lake	Job No.: SW-1
USGS Quadrangle:			

#85-039

INTRODUCTION

In response to a request from Leland D. Ford, Assistant Attorney General, a review was made of the following documents:

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

2. "UMTRAP Uranium Mill Tailings Remedial Action Project Construction Drawings, Salt Lake City, Utah" (RACD),

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" (RAP), and

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

The purpose of the review was to determine if those documents provided sufficient information on soil and ground-water conditions to allow contractors to accurately bid the Vitro uranium mill tailings remedial action project. The remedial action involves excavating the tailings and contaminated soils at the Vitro site in South Salt Lake City and transporting them to a disposal facility near Clive in Tooele County. The tailings will be placed in a clay-lined excavation, compacted, and covered with several feet of non-contaminated material. The ARGEE Corporation was the successful bidder for the remedial action ($37,000,000 plus), but has submitted a claim for changed conditions totaling more than an $6,000,000. The funds are requested for additional costs incurred in handling, transporting, and compacting the Vitro tailings and excavating and compacting the clay soils at the Clive site. ARGEE contends that the increased costs resulted from greater than expected moisture content in both the Vitro tailings and Clive clays.

The VPM and RACD were official bid documents for the Vitro remedial project, and the RAP was brought to the attention of contractors as a source of additional information at the project pre-bid conference. The VFEIS is a public document available for inspection at libraries throughout the state.

REVIEW COMMENTS

The following comments concerning soil and ground-water conditions at the Vitro and Clive sites are based on a review of the above referenced documents. Neither site was visited and no independent field testing or investigations were performed. Where appropriate, the statements below are supported by reference to one or more of the documents.

The VPM does not present specific information on soil or ground-water conditions at either the Vitro or Clive sites. It does state that ground-water problems are expected at Vitro (p. V-13, par. 3) and indicates that the tailings and contaminated soils may be wet (p. V-13, par. 5). The compaction requirement for the tailings is specified (p. V-15, par. 2) as 90 percent of dry density determined by standard Proctor method (ASTM D698). The Proctor method establishes the range of moisture content over which the tailings can be most effectively compacted (optimum moisture). The method implies that if the tailings are not within the optimum moisture range, either drying or wetting would be required to achieve the desired moisture content.

The RACD construction drawings include logs of test holes drilled at the Vitro site (sheet 4). The logs show soil types, natural ground surface where buried by tailings, depth to ground water, and moisture content of soil samples both above and below the water table. Ground water is shown extending into the tailings in several of the test holes. Tailings and soil below the ground-water table are saturated. In situ soil moisture ranged from 8.6 to 79.9 percent with the average for all samples being 34.6 percent. The average for tailings only was 39.2 percent. RACD sheet 5 is a tabulation of Vitro tailings soil tests. One parameter reported is optimum moisture content as determined by standard Proctor method (ASTM D698). The range of optimum moisture varies from 11.4 to 30.5 percent. The average for all samples was 16.0 percent. Comparison of sheets 4 and 5 shows a considerable portion of the soil and tailings tested at the Vitro site are above optimum moisture, and in fact, average more than twice optimum. The material above optimum would require drying (beyond initial dewatering for excavation) prior to compaction to meet the specified moisture content. The RACD drawings do not contain information on the Clive site.

The RAP contains a chapter on site characterization (chapter 3), and Appendix B (Calculation Summaries and Design Drawings) includes sections on Material Properties, Site Drainage, Waste-Water Treatment (Dewatering), and Geohydrology/Water Balance. Review of that information provides a summary of soil and ground-water conditions at both the Vitro and Clive sites. In addition, references are made in the document to other reports (Processing Site Characterization Report, Disposal Site Characterization Report, Final Environmental Impact Statement) that contain supplementary detailed information on site conditions. The agency and address where the reports can be obtained are included in the RAP (p. 3, par. 4).

Information in the RAP regarding soil and ground-water conditions at the Vitro site includes: the average moisture content of tailings and contaminated soil (p. 14, par. 5); the range of moisture content for both sand and slime tailings, their degree of in situ saturation, and their range of optimum moisture content (p. B-12, table 2.1); the need to dry tailings below in situ moisture levels for excavation and transport, and the possible need for additional spreading, digging, and mixing to achieve optimum moisture for compaction (p. 8-10, par 2); and the necessity of excavating below the water table to remove contaminated soil (B-51, par 3). The RAP also specifies that tailings be blended to eliminate slime pockets and the material be placed at 90 percent of standard Proctor method (ASTM D698) at minus 0 to 3 percent below optimum moisture content (p. B-67, par. 6). That requirement, combined with the information in Table 2.1 (in situ soil moisture 9 to 79 percent, degree of saturation 29 to 100 percent, and optimum moisture 12.4 to 27.0 percent) indicates that much of the material removed from Vitro would require drying to achieve optimum moisture prior to compaction.

Moisture content information is presented in the RAP for the upper 7 to 9 feet of soil at the Clive site (p. B-12, Table 2.3). The data are used to characterize the radon barrier cover material which consists of site soil removed from the disposal excavation and stockpiled for later use (p. B-5, par. 6). Both the soil for the radon barrier and the in-place material compacted to form the impermeable liner in the disposal excavation come from the same stratigraphic horizon (p. B-8, Table 2.4). Therefore, the moisture data in Table 2.3 are representative of all the Clive soils involved in the remedial action. In situ soil moisture ranges from 23 to 45 percent and optimum moisture values are between 25.2 and 28.0 percent. Indicating soils at Clive are generally at or above optimum moisture and would require some conditioning to achieve the required moisture level.

The VFEIS includes a chapter on the affected environment at Vitro and Clive (chapter 4) and appendicies (A and D) contain design and hydrologic information of significance to both sites. The document indicates that ground water at the Vitro site is at or near the ground surface and extends into the tailings (p. 11, par. 5; p. D-31, par. 3). Dewatering would be required to facilitate handling of the tailings and contaminated soil (p. A-35, par. 1). The water table at the South Clive site is reported to be 25 to 35 feet below the ground surface (p. D-91, par. 3). U.S. Soil Conservation Service data indicates that Clive soils generally lack moisture for plant growth, but are periodically saturated at some subhorizon within 1 meter of the surface (p. 86, par. 3). That observation is confirmed in Table 4-2 (p. 87) which shows the degree of saturation of soils at South Clive. Percent saturation ranges from 37.2 to 97.5 indicating a wide range of moisture content. Although specific soil moisture data is not presented for the Vitro site, the impresson left by the VFEIS is one of high ground water and wet soil conditions. Moist to wet soils are documented at Clive (p. 87, Table 4-2), but section 4.3 on Climate (p. 60) portrays the site as a desert location receiving low precipitation and minimal runoff and infiltration. No mention is made of above normal precipitation and ponding of water that occurred in the West Desert during the two years preceding the disposal project.

CONCLUSIONS

Considered as a whole, the four documents examined for this review provide sufficient information on soil and ground-water conditions at the Vitro and Clive sites to alert contractors to the possibility of wet conditons. Appreciably more information is available for Vitro than for Clive, and careful reading combined with some interpretation is required to identify the Clive data (radon barrier cover material vs. site soils). However, both the

RAP and VFEIS reference other reports that contain detailed site information and give the address of the agency from which they may be obtained.

By specifying standard Proctor method (ASTM D698) it is clear that the owner (State of Utah) intended that the tailings and contaminated soils be placed and compacted at their optimum moisture content. It is unusual for any earthwork project to have soils that are naturally at optimum moisture, and wetting or drying of the material to reach the desired moisture content is common practice. The ARGEE Corporation appears to have confused dewatering to lower the water table for excavation purposes, with conditioning soils (reducing the water content) to obtain optimum moisture for compaction. An experienced contractor should have been aware that dewatered material (ie. material coming from below the water table) would have a moisture content above optimum and require further drying.

When only the VPM and RACD (the official bid documents given to the contractors) are considered, adequate information is still available to identify wet conditions at the Vitro site. However, neither document contains data on the Clive site and might be considered deficient in that regard. The VPM does indicate that soil investigations were conducted at both sites for design purposes (p. I-20, par. 3 and 4) but specific references are not provided.

Project:			Requesting Agency:
North Davis Refuse District disposal site study			Davis County Health Dept.
By: H. Gill	Date: 5/29/85	County: Davis	Job No.: SW-2
USGS Quadrangle: Kaysville (1320)			

85-016

In response to a request from Mr. Louis K. Cooper, Davis County Health Department, the Utah Geological and Mineral Survey (UGMS) performed an engineering geologic evaluation of the North Davis Refuse District landfill (NDRD). The purpose of the evaluation was to identify well locations from which water samples can be obtained to monitor possible ground-water contamination by the landfill. The scope of work for the study included review of a waste management study for the NDRD prepared by EMCON Associates of San Jose, California; evaluation of available published and unpublished reports, maps, and well logs pertinent to the study area; and a field reconnaissance on April 11, 1985. Drilling of test borings was beyond the scope of this investigation, therefore, the report by EMCON Associates was relied on as the primary source of soil and ground-water information.

SITE LOCATION AND DESCRIPTION

The NDRD has been in operation since the late 1950s, and is about 2 miles east of Hill Air Force Base (attachment 1). It encompasses approximately 170 acres, but only 25 to 30 acres in the northwest corner of the property are being used for the landfill. The remainder of the site is relatively undisturbed and consists of an irregular surface of low relief underlain by wind-blown sand. The landfill is on top of a steep bluff formed by down-cutting of the Weber River. The bluff forms the northern site boundary, while fields and vineyards border the property on the remaining three sides. The climate is moist-subhumid with an average annual precipitation of about 20 inches (U.S. Soil Conservation Service, 1968).

GEOLOGY AND SOILS

The property is on the Weber River delta which extends fan-like from the mouth of Weber Canyon. The delta was deposited in Lake Bonneville during the Pleistocene Epoch and consists of fine to coarse sand with lesser amounts of gravel, silt, and silty clay (Feth and others, 1966). The delta deposits are greater than 800 feet thick at some locations and cover an area of about 140 square miles (EMCON Associates, 1982). The Wasatch fault is approximately one mile east of the site at the base of the Wasatch Range. There are no other faults mapped in the site vicinity. The nearest bedrock outcrops are also located at the mountain front and consist of folded and faulted Paleozoic rock. Small slope failures have occurred east and west of the site along the bluff that borders the property. No evidence of slope failure was observed on or near the site.

EMCON Associates drilled 7 exploratory borings from 40 to 100 feet deep on the property. The subsurface sediments were found to be predominantly fine- to medium-grained sand and silty sand, with minor interbeds of silt and clay.

An exception occurs along the west side of the site where a horizon of silty clay and sandy silt about 30 feet thick was encountered at shallow depths. Excavations to obtain cover material for the landfill revealed that the horizon pinches out before reaching the north site boundary and thins significantly to the south and east (EMCON Associates, 1982).

HYDROLOGY

The site is within the Weber Delta ground-water district as defined by Feth and others (1966). Ground water beneath the site is known to occur in local bodies of perched water and in a deep confined (artesian) aquifer. It is probable that a deep unconfined (water table) aquifer is also present above the confining bed for the artesian aquifer, but direct evidence for its existence is lacking. The main sources of recharge to ground water are subsurface flow from the Wasatch Range, seepage from streams, rivers, and irrigation canals, and infiltration of precipitation (Feth and others, 1966).

Two regional artesian aquifers occur over most of the Weber Delta ground-water district (Feth and others, 1966). The Sunset aquifer has been encountered in wells as shallow as 200 feet, but in most places is between 250 and 400 feet below the ground surface. The Delta aquifer has been identified at depths of 500 to 700 feet. A contour map of the top of the Sunset aquifer indicates that it is not present beneath the site (Feth and others, 1966). Its absence is substantiated by an on-site water well that has a static water level of 418 feet and draws water from an interval between 526 and 544 feet. The depth to the water-bearing horizon corresponds to that expected for the Delta aquifer, and no mention is made in the log of artesian conditions in the interval between 250 and 400 feet, where the Sunset aquifer should occur. The major source of recharge to the deep artesian aquifer is believed to be under flow from bedrock aquifers in the Wasatch Range. To a lesser extent, infiltration of water from the Weber River near the mountain front where confining beds are absent also provides some recharge (Feth and other, 1966).

Although shallow (10 feet or less) unconfined aquifers are noted elsewhere in the Weber Delta ground-water district (Feth and others, 1966), available data indicate that a continuous shallow aquifer is not present beneath the NDRD site. Ground water was encountered in four of the seven borings (1, 3, 4, and 5; attachment 2) drilled by EMCON Associates. Depth to water ranged from 16 to 59 feet and in all cases was perched on discontinuous lenses of silt or silty clay. The EMCON report states that the primary source of recharge to the perched water horizons is infiltration of precipitation and irrigation water from vineyards to the south. It also concludes that the perched water migrates to the northwest. However, ground-water flow in that direction would be moving both up dip and away from the Great Salt Lake. Feth and others (1966) state that ground-water flow in the Weber Delta district is to the west, from recharge areas in the Wasatch Range toward the Great Salt Lake. It seems likely that the water in the perched aquifers is also moving to the west.

In addition to the near surface perched aquifers, the existence of a deep unconfined aquifer is suspected. Site soils consist of relatively clean, permeable sands through which water can percolate rapidly. In the study area, it can be expected that water which is not intercepted by shallow, discontinuous lenses of silt and clay to form perched ground water will migrate downward to the confining bed over the Delta aquifer. A saturated zone would form there, the thickness of which would depend on the flow rate in the aquifer and on the amount of recharge received. Recharge may also come from upward leakage from the artesian aquifer. The seven EMCON Associates wells were too shallow to encounter a deep unconfined water table and the log for the water well on site is of poor quality and provides little information on subsurface geologic and hydrologic conditions.

POTENTIAL FOR GROUND-WATER CONTAMINATION

The NDRD landfill has been in operation for approximately 30 years, and over that period has accepted a wide variety of waste. In addition to refuse generated by surrounding municipalities, the Davis County Health Department has been informed by Hill Air Force Base that steel drums containing wastes from the base have also been placed in the landfill. The contents of the drums are unknown, but are believed to include both organic and inorganic chemicals.

Water moving through a landfill can produce leachate that may leave the site in one of two ways, either as seepage at the ground surface or by downward percolation. Depending on soil and leachate characteristics, leachate moving through the subsurface may be renovated by ion exchange, absorption, filtration, and biodegradation. Once the leachate reaches a body of water (either surface or ground water), dilution and dispersion also become factors in renovation. However, ground-water flow is usually laminar and limits the role of dilution and dispersion in the subsurface.

The soil at the NDRD is primarily clean sand with local lenses of silt and clay. The sand is permeable and would permit rapid movement of leachate. Clean sands are chemically inert and rely on filtration to remove contaminants. Filtration has little or no effect on chemical contaminants which have been shown to move as far as 1200 feet in sand and gravel with little or no attenuation (Brunner and Keller, 1972). The potential for leachate reaching the perched aquifers beneath the NDRD is considered high, as is the possibility of contaminating any deep unconfined aquifer that may be present.

CONCLUSIONS AND RECOMMENDATIONS

Ground-water conditions at the NDRD landfill are complex. A system of multiple perched aquifers exists, the extent and number of which are unknown. An artesian aquifer used for culinary purposes is present and is tapped by at least one well for which little information is available concerning water-bearing horizons encountered or its method of construction. A deep unconfined aquifer may exist on top of the confining bed for the artesian aquifer. Both the perched ground-water horizons and the deep unconfined aquifer (if present) may be subject to contamination from leachate percolating downward from the landfill. The artesian aquifer may also be subject to contamination if the well is improperly constructed and permits water from upper saturated horizons to move downward along the outside of the well casing. In addition, high rates of pumping in the future may reverse the potentiometric head in the vicinity of the well allowing contaminants to reach the artesian aquifer.

Based on the ground-water information presently available, the UGMS cannot recommend monitoring well locations with confidence that all areas/aquifers subject to contamination would be adequately identified and monitored. Before an adequate ground-water monitoring system can be designed, the following information must be obtained:

1. The number and extent of perched aquifers beneath the landfill, the direction of ground-water flow in these aquifers, and their potential for carrying contaminants off site.

2. Confirmation of the presence or absence of a deep unconfined aquifer beneath the landfill, and if present, its characteristics and the location of its recharge and discharge areas.

3. The characteristics of the confining bed for the Delta artesian aquifer, and an evaluation of its ability to protect the aquifer from contamination.

4. Details of construction for the existing water well on site, and an evaluation of its potential as a pathway for contaminants to the artesian aquifer.

To obtain the above information, an exploratory drilling program is recommended to further investigate the subsurface geology and hydrology at the NDRD site. The drilling should extend down to and through the confining bed for the Delta artesian aquifer. Soil samples should be collected for laboratory testing (gradation and permeability) and all water-bearing horizons should be identified and sampled as drilling proceeds. East-west and north-south cross sections should be prepared for the site showing stratigraphic relationships, perched ground-water horizons, the deep unconfined aquifer if present, and the confining bed for the artesian aquifer. Observation wells can then be located to determine the direction of flow in each water-bearing horizon. Once flow directions are determined, one or more of the observation wells in each horizon can be converted to monitoring wells for sampling purposes. Depending on the direction of ground-water flow and the configuration of the water-bearing horizons, it may be necessary to locate some of the observation and monitoring wells outside the site boundaries. To prevent contamination, borings not used in the monitoring program should be plugged and abandoned in an appropriate manner.

SELECTED REFERENCES

Brunner, D. R., and Keller, D. J., 1972, Sanitary landfill design and operation: U.S. Environmental Protection Agency Solid Waste Mangement Series SW 65ts, 59 p.

Cartwright, Keros, and Sherman, F. B., 1969, Evaluating sanitary landfill sites in Illinois: Illinois State Geological Survey Environmental Geology Notes, August 1969, no. 27, 15 p.

Curry, D. R., 1980, Coastal geomorphology of Great Salt Lake and vicinity, in Gwynn, J. W., ed., Great Salt Lake, a scientific, historical, and economic overview: Utah Geological and Mineral Survey Bulletin 116, p. 69-82.

EMCON Associates, 1982, Geotechnical investigation and waste management studies NORD disposal site Davis County, Utah, project 558-02.01: San Jose, California, 36 p.

Erickson, A. J., and Wilson, Lemoyne, 1968, Soil survey of Davis-Weber area, Utah: U.S. Department of Agriculture Soil Conservation Service and Utah Agricultural Experiment Station, 149 p.

Feth, J. H., and others, 1966, Lake Bonneville: geology and hydrology of the Weber Delta district, including Ogden, Utah: U.S. Gelogical Survey Professional Paper 518, 76 p.

Heath, R. C., 2d ed., 1984, Basic ground-water hydrology: U.S. Geological Survey Water-Supply Paper 2220, 84 p.

Hughes, G. M., 1972, Hydrologeologic considerations in the siting and design of landfills: Illinois State Geological Survey Environmental Geology Notes, April 1972, no. 51, 22 p.

Johnson, T. M., and Cartwright, Keros, 1980, Monitoring of leachate migration in the unsaturated zone in the vicinity of sanitary landfills: Illinois Institute of Natural Resources State Geological Survey Division, Circular 514, 82 p.

Kehew, A. E., Schwindt, F. J., and Brown, D. J., 1983, Effect of seepage from unlined municipal waste stabilization lagoons on chemical quality of ground water in shallow aquifers: North Dakota Geological Survey Report of Investigation no. 80, 140 p.

Lindorff, D. E., and Cartwright, Keros, Ground-water contamination: problems and remedial actions: Illinois State Geological Survey Environmental Geology Notes, May 1977, no. 81, 59 p.

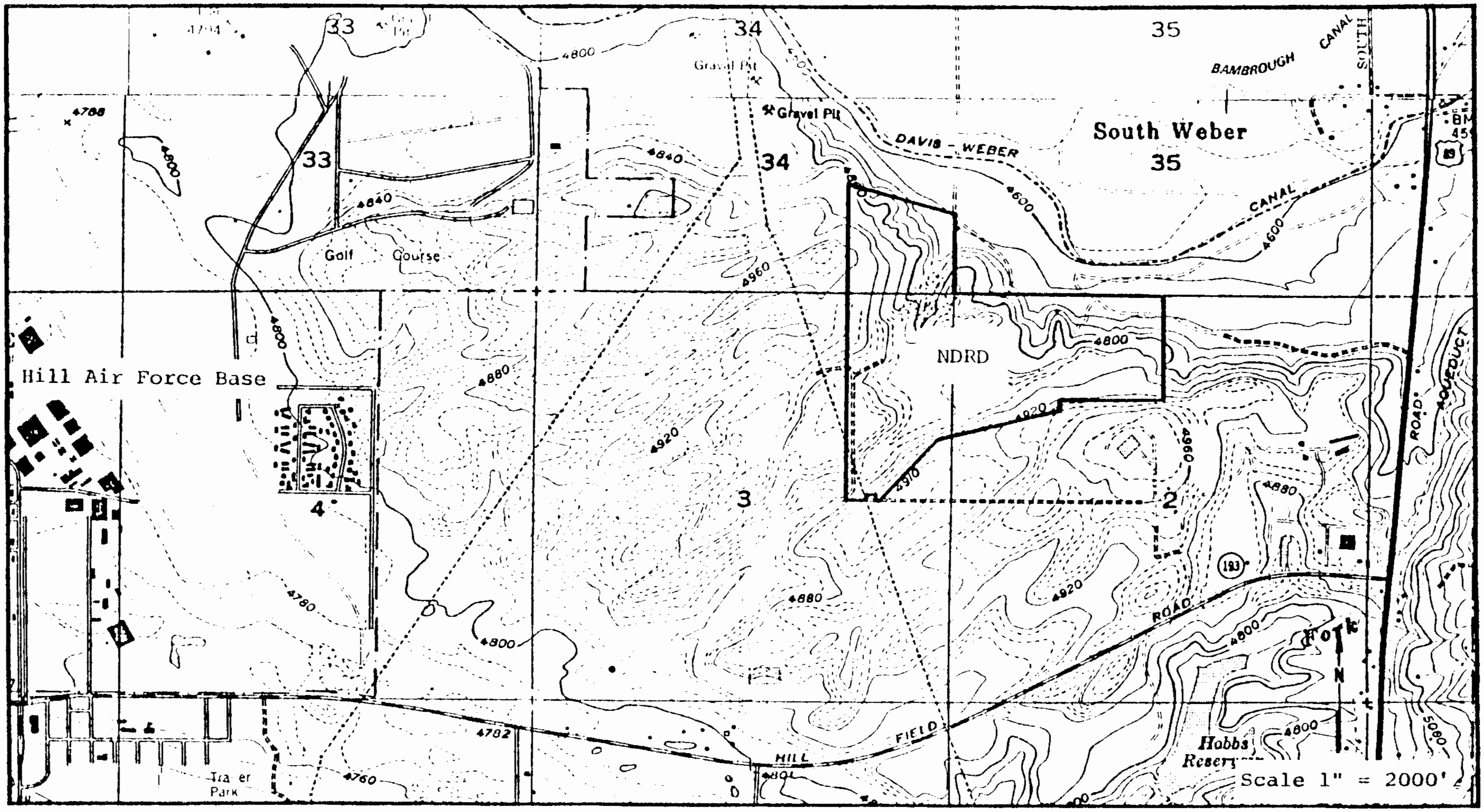
Miller, R. D., 1980, Surficial geologic map along part of the Wasatch Front, Salt Lake Valley, Utah: U.S. Geological Survey Micellaneous Field Studies Map MF-1198, scale 1:100,000.

U.S. Department of the Interior, rev. 1981, Ground water manual: A Water Resources Technical Publication: Denver, U.S. Government Printing Office, 480 p.

U.S. Environmental Protection Agency, 1980, Design manual onsite wastewater treatment and disposal systems: Washington D. C., U.S. Government Printing Office, p. 367-391.

Attachment 1, Job No. SW-2

Base map from USGS topographic quadrangle, Kaysville, Utah

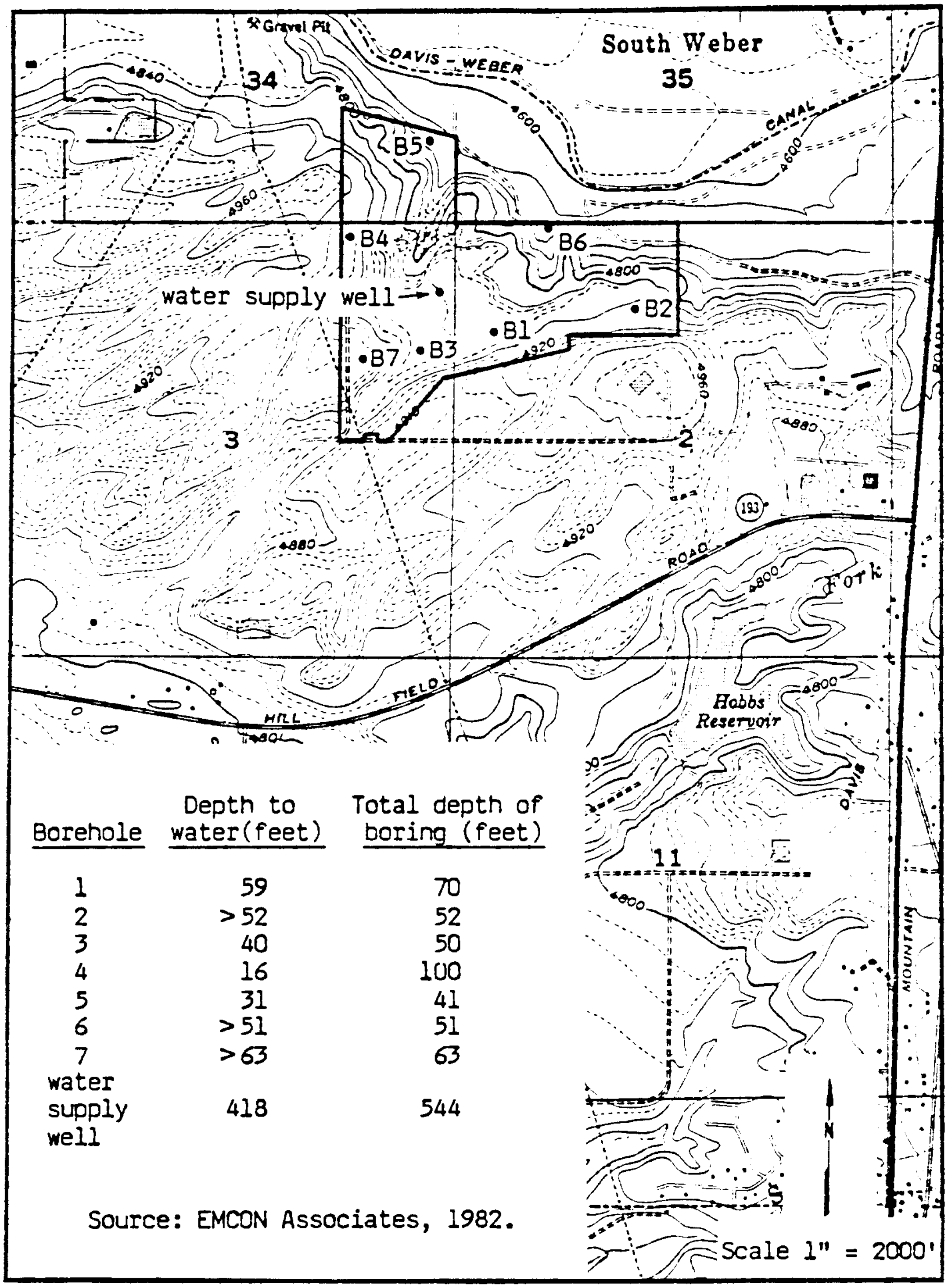


General Location Map

North Davis Refuse District Landfill

Utah Geological and Mineral Survey

Site Investigation Section



Borehole	Depth to water(feet)	Total depth of boring (feet)
1	59	70
2	>52	52
3	40	50
4	16	100
5	31	41
6	>51	51
7	>63	63
water supply well	418	544

Source: EMCON Associates, 1982.

Borehole locations and ground water depths.

LIQUID WASTE DISPOSAL

Project: Clay Basin Disposal Pit, Duchesne County			Requesting Agency: Duchesne County Planning Dept.
By: R.H. Klauk	Date: 2/27/85	County: Duchesne	Job No.: LW-1
USGS Quadrangle: Neola NW, Utah (1117)			

85-003

This report presents the results of a geologic review of a site for an oil field disposal pit located in the NE1/4, sec. 16, T. 1 S., R. 3 W. Uinta Base Line and Meridian, Duchesne County, Utah (attachment 1). The scope of work consisted of the following:

1. Evaluation of a geological report prepared for the site titled "Geological Site Report for Clay Basin Disposal Pit" by Jerry R. Riding and Sons, consultants;

2. a review of permeability data from American Testing Laboratories;

3. a review of geologic and hydrologic literature pertinent to the site;

4. discussions with Loren E. Morton, geologist with the Utah Division of Environmental Health, Bureau of Water Pollution Control; and

5. a reconnaissance of the site on February 11, 1985.

The following concerns were identified as a result of the site reconnaissance:

1. Cobbles were noted in the embankment material indicating that the "conglomerate layer" referred to in the report, may have been incorporated into the embankment. How these cobbles affect permeability needs to be determined.

2. The location and effect of the undisturbed portion of this permeable "conglomerate layer" on the clay liner needs to be determined.

3. Topsoil and vegetation may also have been included in the embankments. Deterioration of the organic material could cause leakage.

4. The east embankment has been constructed around a wooden power pole; poor compaction around this pole could provide a conduit for leakage.

5. The east embankment of the ponds is immediately adjacent to Water Hollow. Failure of what appears to be an unengineered dam adjacent to the site could cause undercutting and eventual embankment failure.

A geologic report should provide all the information necessary to evaluate the geologic acceptability of a site for the intended purpose. The report prepared by Jerry R. Riding and Sons is limited in scope and poorly written, and does not provide the data needed to fully assess the site. The following additional information should have been included in the report for this site:

1. A site location map; this map should include the exact boundaries of the site as well as other features or structures referenced in the text.

2. Geological maps of the site and site vicinity; these maps should be at minimum scales of 1:2,400 and 1:62,500, respectively.

3. A discussion of site seismicity; late Quaternary (potentially active) faults have beem mapped within 11 miles of the site (Hansen, 1969). Seismicity should be evaluated relative to the potential for and magnitude of earthquakes and their possible effect at the site.

4. Soil stratigraphy to a depth of at least 30 feet; descriptions should conform to the Uniform Soil Classification System (attachment 2) with representative samples of the different soils laboratory tested.

5. Exact locations of borings or test pits; should be shown on the site location map.

6. East-west and north-south soil profiles through the center lines of the pits; to identify potential travel paths for leakage through the unsaturated soils beneath the ponds.

7. Source and physical characteristics of materials used in the clay liner.

8. A potentiometric surface map to determine the regional direction of ground-water flow in the shallowest aquifer system.

9. Monitoring information: location, depth, and methods of construction of all monitoring wells.

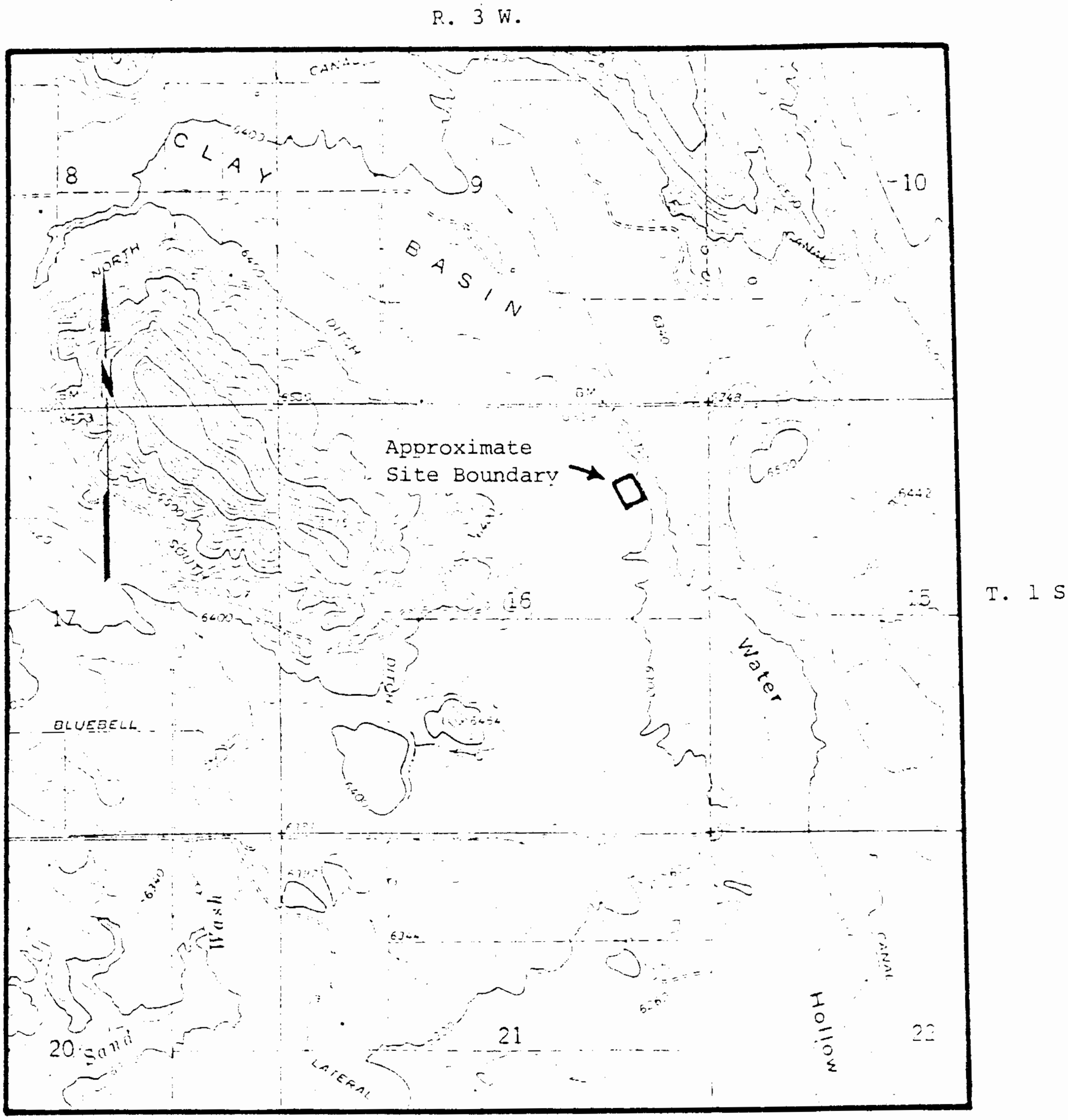
10. A list of references.

Reports of this type should be prepared by a person with at least one degree in geology and experience in engineering geology or a closely related speciality. There are indications this report may not have been prepared by a geologist.

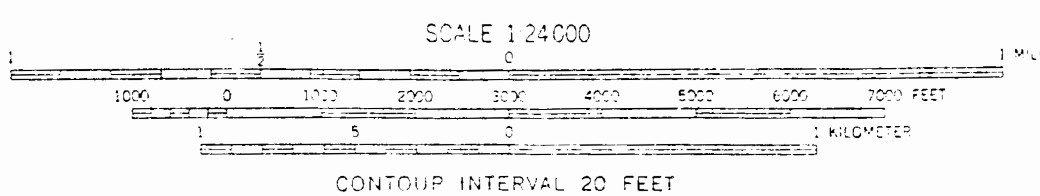
REFERENCES CITED

Hansen, W.R., 1969, The geologic story of the Uinta Mountains: U. S. Geological Survey Bulletin 1291, 144 p.

Attachment 1, Job No. LW-1



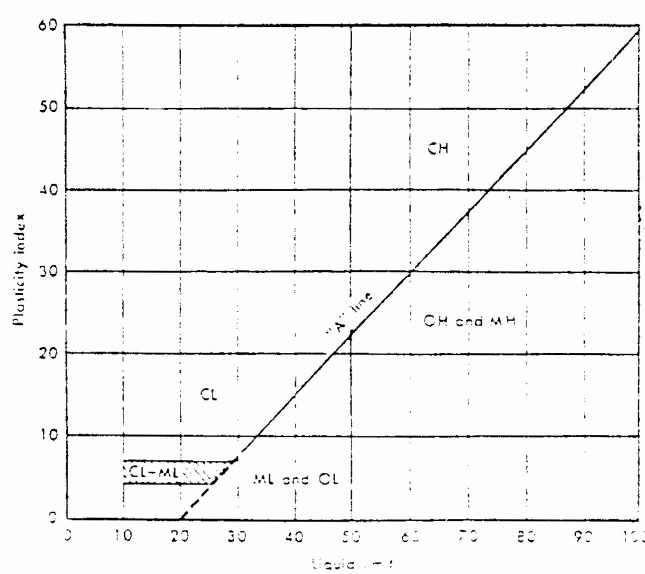
Base map from: U.S.G.S. 7½' topographic quadrangle map
Neola NW, Utah.



Location map of the Clay Basin Disposal Pit Site

UNIFIED SOIL CLASSIFICATION SYSTEM

Major divisions			Group symbols		Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent: GW, GP, SW, SP; More than 12 per cent: GM, GC, SM, SC; 5 to 12 per cent: Borderline cases requiring dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM*	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM*	d	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with P.I. greater than 7	
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			



Plasticity Chart

*Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u used when L.L. is greater than 28.

**Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

WASTEWATER DISPOSAL

Project:			Requesting Agency:
Evaluation of geologic conditions with regard to suitability for individual wastewater disposal systems at Winchester Hills Phase II subdivision.			Southwestern Utah District Health Dept.
By: W.R. Lund	Date: 3/22/85	County: Washington	Job No.: WW-1
USGS Quadrangle: St. George 15; St. George NW 7½' (79)			

85-006

This report presents the results of a study by the Utah Geological and Mineral Survey (UGMS) of Winchester Hills Phase II, a subdivision in Washington County. The investigation was requested by the Southwestern Utah District Health Department (SWUDHD) to evaluate site soil and geologic conditions with respect to suitability for individual wastewater disposal systems utilizing septic tanks and soil absorption fields. The subdivision is approximately 7 miles northwest of St. George, and consists of 209 lots on 250 acres in sections 22 and 23 T. 42 S., R. 15 W., SLB&M (attachment 1). Phase I of the Winchester Hills development was evaluated by the UGMS in 1980 (Lund, 1980). The investigation reported here included a review of the phase I information; analysis of geologic, hydrologic, and soil data for the area; a field reconnaissance on March 5 and 6, 1985; and logging of 41 test pits. Mr. Steven Labrum, SWUDHD sanitarian, was present during the field investigation.

Setting

Winchester Hills Phase II is located on Big Sand flat, a structural bench between Snow Canyon on the west and Lava Ridge on the east. Surface drainage is to the south, with numerous small ephemeral streams creating a series of low north-south ridges that give the surface of the bench a rolling appearance. Four such ridges and three intervening dry washes cross the subdivision. The difference in elevation between the ridge tops and adjacent stream channels is as much as 45 feet at the east end of the property, but is generally less than 30 feet elsewhere. Vegetation on site is sparse to moderate and consists of sand sage, creosotebush, blackbrush, cactus, and a few juniper. Average annual precipitation is less than 12 inches per year.

Geology

Big Sand flat is underlain by the Navajo Sandstone of Jurassic age. It consists of fine- to medium-grained, rounded, quartz sand cemented by iron oxide and lime. In Washington County, the Navajo Sandstone is between 1,800 and 2,200 feet thick (Cook; 1960). Large scale crossbedding is the principal structural feature of the formation and well-developed throughgoing joints are common in many areas. The sandstone is exposed in the walls of Snow Canyon and on Lava Ridge, but only one small outcrop was observed on site.

Quaternary and Tertiary basalt flows and cinder cones are common in the vicinity of the subdivision. Lava Ridge is capped by a basalt flow that cascaded over the ridge and either crossed or came very near the subdivision. Basalt does not crop out on the property but may be present at depth, even thought it was not encountered in the test pits.

The subdivision is covered by a layer of fine-grained, well rounded, eolian (wind-blown), quartz sand derived from the Navajo Sandstone (attachment

2). The thickness of the sand horizon is variable, reflecting erosion along streams and irregularities in the underlying bedrock surface. Several test pits encountered coarse-grained sandy gravel and gravelly sand at depth. These materials were almost always found in the test pits excavated on the low ridges crossing the site. The well rounded gravel, cobbles, and boulders in these horizons indicate that they were deposited in former stream channels. In each case, the coarse-grained units are associated with strongly developed stage III or IV caliche. It appears that the coarse-grained horizons and the caliche developed in them serve to protect the ridges from erosion and thereby influence present day drainage patterns. Caliche was observed in a number of other test pits across the site (attachment 2), but seldom exhibited the strongly indurated, nearly impenetrable, layered stage IV structure seen in the coarse-grained horizons. Fine particles of clay and silt carried downward by percolating soil water have been trapped above the impermeable, plugged caliche zones forming thin (usually 2 feet or less) clayey sand horizons. Alluvium deposited along ephemeral streams crossing the site consists of volcanic gravel, cobbles, and boulders in a matrix of fine quartz sand (attachment 2, test pit 39).

Faults and folds are absent in the vicinity (3-mile radius) of the subdivision (Cook, 1960). The Navajo Sandstone dips at a low angle (less than 10 degrees) to the north-northwest. Accurate determination of the dip angle was difficult due to strong crossbedding in the formation. Jointing is present but not well developed in sandstone outcrops near the site. A closely spaced set of throughgoing, northeast-southwest joints was observed in outcrops about a mile north of the subdivision along State Highway 18. Prominent joint sets are also present in Snow Canyon a mile west of the site.

There is no evidence to suggest that shallow ground water is present beneath the site. Water was not encountered in any of the test pits excavated for phases I or II of the subdivision. Drillers logs on file with the Utah Division of Water Rights indicate that the regional water table is approximately 700 feet below the ground surface in the study area. The depth to water corresponds closely with the difference in elevation between the subdivision and Snow Spring near the mouth of Snow Canyon. Snow Spring discharges from the Navajo Sandstone which is a major aquifer in southwestern Utah, supplying culinary water to St. George and other communities (Cordova, Sandberg, and McConkie, 1972).

Suitability for Individual Wastewater Disposal Systems

Geologic factors affecting the performance of individual wastewater disposal systems include: 1) soil permeability, 2) slope, 3) depth to ground water, 4) depth to bedrock or other impermeable horizon, and 5) susceptability to geologic hazards. Site conditions with respect to soil permeability, slope, and depth to ground water meet State Health Department regulations for individual wastewater disposal systems. Shallow bedrock was encountered in two test pits (28 and 35) at depths between 5 and 6 feet and may be present in other areas. The widespread occurrance of caliche (stage III and IV) throughout the subdivision has created a number of plugged, impermeable soil profiles (attachment 2). These plugged zones must be considered in the design of soil absorption fields. Where the caliche is thin enough, it may be possible to install absorption fields either above or below the plugged zone and still comply with regulations governing separation from impermeable horizons. If disposal systems are placed below caliche horizons it will be necessary to conduct percolation tests to confirm that the deeper soils are adequately permeable. In several test pits, the caliche plugged zones were so thick that a conventional soil absorption field could not be installed. These thick caliche profiles are particularly prevelent at the west end of the subdivision (test pits 36, 38, 40). Shallow bedrock was also encountered in one test pit (35) in that area.

The principal geologic hazard which may affect wastewater disposal systems in the subidivision is periodic flooding along the ephemeral streams that cross the property. All three stream channels show evidence of seasonal flow, and systems installed in them should expect to be flooded. This is of particular concern, because at least one test pit (39) was excavated in the bottom of a wash indicating that the developer may be considering placing systems in those areas.

Conclusions and Recommendations

Although geologic conditions are often less than optimum, most of Winchester Hills Phase II meets current Utah Department of Health regulations for installation of individual wastewater disposal systems. Local occurrances of shallow bedrock and soil profiles plugged by caliche must be considered when siting and designing individual wastewater disposal systems. It is possible in many cases that limitations imposed by shallow bedrock or caliche can be overcome by using either shallow or deep placement systems. Unsuitable sites would occur where depth to bedrock is less than about 5 feet and where caliche plugged profiles (stage III or IV) are too thick to allow installation of conventional absorption fields. Based on the test pits, these conditions appear to be common at the west end of the subdivision, and lots there may not have sufficient suitable area for conventional wastewater disposal systems. Additional percolation tests should be run for any deep disposal system to insure that the deep soils are adequately permeable.

An additional concern is that disposal systems may be installed along or in the ephemeral stream channels that cross the site. These areas are subject to periodic flooding and systems placed there would be susceptible to damage. Ponding of water over absorption fields can be a particular problem with the fine-grained sand soils typical at this site. As the water percolates into the ground it carries along silt and very fine sand which enters and plugs absorption field distribution lines. The layer of straw commonly placed over the gravel pack surrounding the distribution lines is not adequate to control the movement of sand and silt. A woven fabric filter material is recommended for that purpose.

References

Birkeland, P.W., 1984, Soils and geomorphology: New York, Oxford University Press, 372 p.

Cook, E.F., 1960, Geologic atlas of Utah, Washington County: Utah Geological and Mineral Survey Bulletin 70, 124 p.

Cordova, R.M., Sandberg, G.W., and McConkie, Wilson, 1972, Ground-water conditions in the central Virgin River Basin, Utah: U.S. Geological Survey in cooperation with the Utah Department of Natural Resources Division of Water Rights, 64 p.

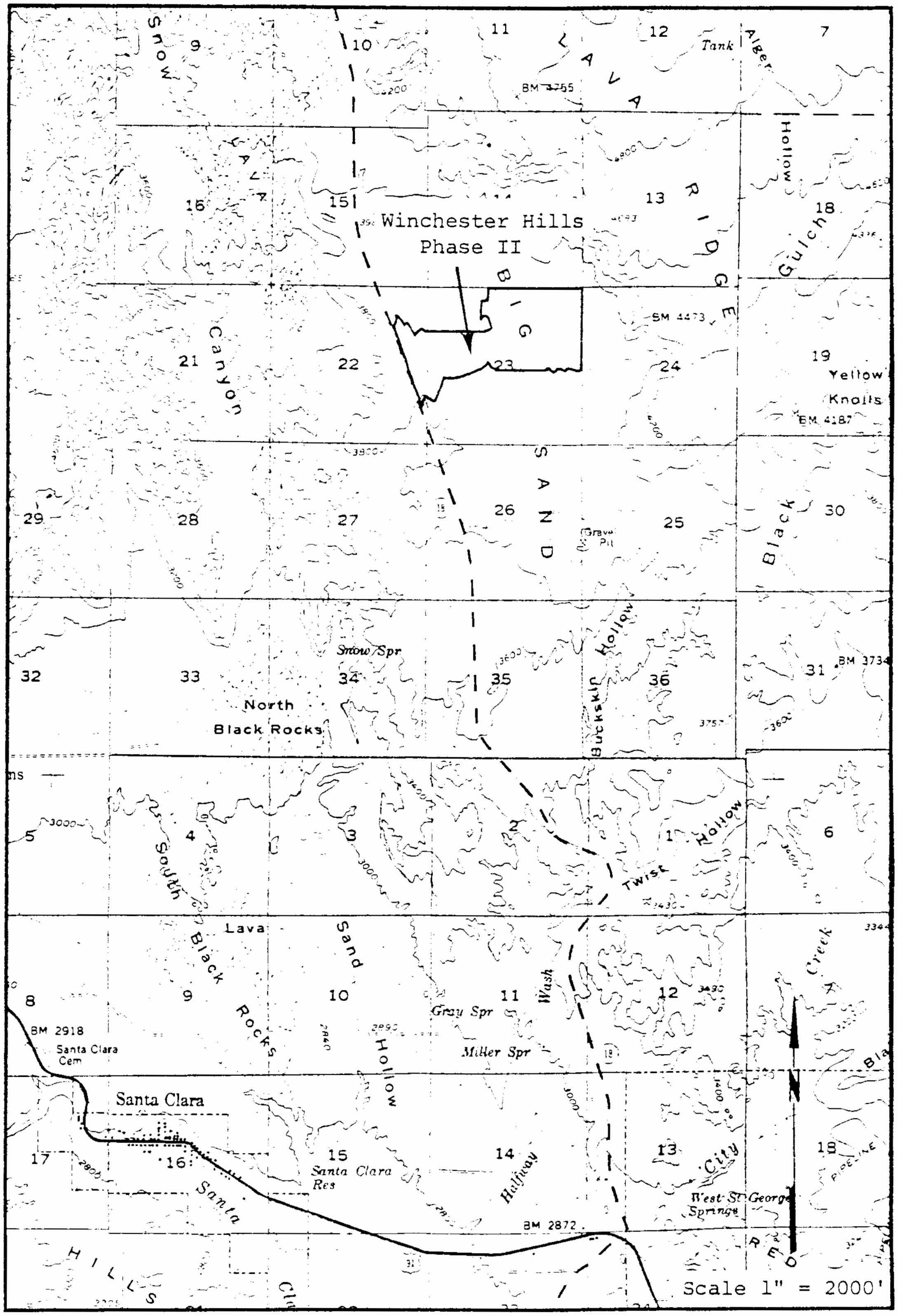
Gile, L.H., Peterson, F.F., and Grossman, R.B., 1966, Morphological and genetic sequences of carbonate accumulation in desert soils: Soil Science, v. 101, no. 5, p. 347-360.

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

Reeves, C.C., Jr., 1976, Caliche: Lubbock, Texas, Estacado Books, p. 233.

Attachment 1, Job No. WW-1

Base map taken from St. George, Utah 15 minute series topographic quadrangle map.



Location map.

Attachment 2, Job No. WW-1

TEST PIT LOGS*
Winchester Hills Phase II Subdivision
Washington County, Utah

Test Pit 1

0.0 - 3.1'	Sand/silty sand (SP/SM); red brown, low density, non-plastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
3.1' - 6.5'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
6.5' - 9.7'	Sand (SP); light brown, low density, nonplastic, slightly indurated, dry; stringers and nodules of caliche (stage II).

Test Pit 2

0.0 - 8.2'	Sand (SP); red brown, low to medium dense, nonplastic, slightly indurated, dry; poorly graded, fine-grained, rounded, quartz sand.
8.2' - 9.1'	Clayey sand (SC); dark red brown, medium dense, low plasticity, slightly indurated, dry; 20 percent fines.

Test Pit 3

0.0 - 3.3'	Sand (SP); red, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
3.3' - 4.1'	Clayey sand/sandy clay (SC/CL); dark red, medium dense, medium plasticity, slightly indurated, moist; 50 percent fines.
4.1' - 6.1'	Caliche (state IV); white, strongly indurated, soil profile plugged.
6.1' - 7.9 '	Sand (SP); white to light brown, medium dense, nonplastic, moderate to strongly indurated, dry; stage III caliche.
7.9' - 10.2'	Sand (SP); light tan, medium dense, nonplastic, moderately indurated, dry; stage II caliche.

Test Pit 4

0.0 - 4.1'	Sand with silt (SP); red brown, medium dense, nonplastic, slightly indurated, dry.

Note: Test pit either caved extensively or was not excavated the recommended 10 feet.

Test Pit 5

0.0 - 8.5'	Sand (SP); brown to yellow brown, medium dense, nonplastic, nonindurated, dry; poorly graded, fine- to medium-grained, rounded, quartz sand.

Test Pit 6

0.0 - 7.0'	Sand with silt (SP); red brown, medium dense, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Test Pit 7

0.0 - 4.9'	Sand (SP); red brown, medium dense, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
4.9' - 5.2'	Sand (SP); white, medium dense to dense, nonplastic, moderately indurated, dry; stage II caliche.

Note: Test pit walls had caved.

Test Pit 8

0.0. - 2.4'	Silty sand/sand (SM/SP); red, mediun dense, slightly plastic, slightly indurated, dry; 15 percent fines.
2.4' - 3.6'	Clayey sand (SC); dark red, medium dense, low to moderate plasticity, weakly indurated, dry.
3.6' - 5.2'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
5.2' - 9.3'	Silty sand (SM); white to light brown, medium dense, slighty plastic, moderately indurated, dry; stage III caliche.

Test Pit 9

0.0. - 0.7'	Silty sand (SM); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
0.7' - 3.2'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
3.2' - 5.0'	Sandy gravel (GP); red brown, medium dense, nonplastic, weak to moderately indurated, dry; stage II caliche, gravel to 3/4-inch diameter.
5.0' - 9.9'	Sand/silty sand (SP/SM); red brown, medium dense, nonplastic, weak to moerately indurated, dry; stage II caliche, gravel to 2-inch diameter.

Test Pit 10

0.0 - 1.4'	Silty sand (SM); red brown, low density, nonplastic, non- to weakly indurated, dry; poorly graded, fine-grained, rounded, quartz sand.
1.4' - 5.1'	Caliche (stage IV); white, strongly indurated, soil profile plugged; cobbles to 6-inch diameter.
5.1' - 6.0'	Sandy gravel (GP); red brown, medium dense, nonplastic, moderately indurated, dry.
6.0' - 7.7'	Sand (SP); red brown, medium dense, nonplastic, moderately indurated, dry; stage II caliche.
7.7' - 10.2'	Silty, sandy, gravel with cobbles (GM); white, medium dense to dense, nonplastic, moderately to strongly indurated, dry; stage III caliche.

Test Pit 11

0.0 - 5.0'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
5.0' - 9.1'	Caliche (stage IV); white, strongly indurated, soil profile plugged.

Test Pit 12

0.0 - 7.5'	Sand (SP); brown, loose to low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
7.5' - 10.5'	Caliche (stage IV); white, strongly indurated, soil profile plugged.

Test Pit 13

0.0 - 4.5'	Sand (SP); light brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
4.5' - 10.5'	Cobbley, sandy gravel (GP); brown, medium dense, nonplastic, nonindurated, dry; boulders to 1-foot diameter.

Test Pit 14

0.0 - 7.6'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
7.6' - 8.9'	Sandy gravel with cobbles (GP); brown, medium dense, nonplastic, weakly indurated, dry; stage I caliche.

8.9' - 10.0'	Sand (SP), light brown, low to medium density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Test Pit 15

0.0 - 8.5'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
8.5' - 9.0'	Clayey sand with cobbles (SC); red brown, medium dense, low plasticity, weakly indurated, dry; volcanic cobbles to 4-inch diameter.

Test Pit 16

0.0 - 10.1'	Sand (SP); light brown, low to medium density, nonplastic, noninudrated, dry; poorly graded, fine-grained, rounded, quartz sand.
10.1' - 10.6'	Sandy gravel (GP); brown, medium dense, nonplastic, nonindurated, dry; gravel to 2-inch diameter.

Test Pit 17

0.0 - 6.7'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 18

0.0 - 1.0'	Silty sand (SM); brown, low density, nonplastic, nonindurated, dry; 20 percent fines.
1.0' - 5.0'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
5.0' - 7.0'	Cobbley, sandy, gravel with boulders (GP); white, dense, nonplastic, strongly indurated, dry; boulders to 2-feet in diameter.
7.0' - 10.0'	Sand (SP); light brown to white, medium dense, nonplastic, moderately indurated, dry; stage II caliche.

Test Pit 19

0.0 - 9.2'	Sand (SP); brown, low density, nonplastic, non- to weakly indurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Test Pit 20

0.0 - 7.2'	Sand (SP); light brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 21

0.0 - 5.7'	Sand (SP), red brown, low to medium density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
5.7' - 6.9'	Clayey sand (SC); dark red brown, medium dense, low to medium plasticity, weakly indurated, dry; 20 percent fines.
6.9 '- 9.9'	Silty sand/clayey sand (SM/SC); red brown to white, medium dense, low plasticity, moderately indurated, dry; stage II caliche.
9.9' - 10.5'	Sandy gravel (GP); white, medium dense, nonplastic, moderately indurated, dry; stage II to III caliche.

Test Pit 22

0.0 - 1.1'	Silty sand with clay (SM); red brown, medium dense, non- to slightly plastic, nonindurated, dry; 25 percent fines.
1.1' - 4.2'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
4.2' - 8.3'	Sand (SP); white, medium dense, nonplastic, moderately indurated, dry; stage III caliche.
8.3' - 10.2'	Sand (SP); light brown, low to medium density, nonplastic, weakly indurated, dry; stage II caliche.

Test Pit 23

0.0 - 5.1'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
5.1' - 6.3'	Clayey sand (SC); red brown, medium dense, low to medium plasticity, weakly indurated, dry; 25 percent fines.
6.3' - 8.0'	Caliche (stage IV); white, strongly indurated, soil profile plugged.

8.0' - 9.4'	Sandy gravel (GP); brown, medium dense, nonplastic, moderately indurated, dry; stage III caliche.

Test Pit 24

0.0 - 6.5'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; porrly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 25

0.0 - 6.9'	Sand (SP); red brown, low density, nonplasitc, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 26

0.0 - 7.4'	Sand (SP); red brown, low to medium density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 27

0.0 - 3.1'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
3.1' - 4.0'	Clayey sand (SC); dark red brown, medium dense to dense, low plasticity, weak to moderately indurated, dry; stage II caliche.
4.9' - 8.5'	Sand (SP); red brown to white, medium dense to dense, non- to slightly plastic, moderately to strongly indurated, dry; stage II caliche.
8.5' - 10.8'	Sand (SP); white, medium dense, non- to slightly plastic, strongly indurated, dry; stage III caliche, soil profile plugged.

Test Pit 28

0.0 - 3.6'	Sand (SP); red brown, medium dense, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
3.6' - 5.7'	Clayey sand (SC); dark red, medium dense, low plasticity, weakly indurated, dry; 15 percent fines.

5.7' - 7.3'	Sandstone; red brown, moderately weathered bedrock.

Test Pit 29

0.0 - 6.4'	Sand (SP); tan to yellow brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit wells had caved.

Test Pit 30

0.0 - 4.8'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
4.8' - 8.8'	Caliche (stage IV); white, strongly indurated, soil profile plugged.

Test Pit 31

0.0 - 9.5'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Test Pit 32

0.0 - 8.9'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 33

0.0 - 4.4'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
4.4' - 10.6'	Sand (SP); white to red brown, low to medium density, nonplastic, weakly to moderately indurated, dry; stage II caliche.

Test Pit 34

0.0 - 6.0'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test pit 35

0.0 - 1.2'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; thin gravel stringers.
1.2' - 2.6'	Sandy gravel (GP); gray brown, low density, nonplastic, nonindurated, dry; gravel to 1-inch diameter.
2.6' - 3.6'	Gravelly sand (SP); brown, low density, nonplastic, nonindurated, dry; 30 percent gravel to 1-inch diameter.
3.6' - 4.7'	Sandy gravel (GP); brown, low density, nonplastic, nonindurated, dry; gravel to 1-inch diameter.
4.7' - 5.6'	Clayey, sandy gravel (GC); dark red brown, medium dense, low plasticity, weakly indurated, dry; cobbles to 6-inch diameter.
5.6' - 7.5'	Sandstone, red, moderately weathered bedrock.

Test Pit 36

0.0 - 1.8'	Gravelly, silty sand (SM); brown, medium dense, nonplastic, weakly indurated, dry; 15 percent gravel to 1/2-inch diameter.
1.8' - 3.9'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
3.9' - 10.8'	Cobbley, sandy, gravel with boulders (GP); white to brown, medium dense, nonplastic, moderately to strongly indurated, dry; stage III caliche in upper 2 feet.

Test Pit 37

0.0 - 5.5'	Sand (SP); brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit walls had caved.

Test Pit 38

0.0 - 2.6'	Silty sand (SM); red brown, medium dense, nonplastic, nonindurated, dry; 20 percent fines.
2.6' - 5.1'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
5.1' - 11.0'	Cobbley, sandy, gravel with boulders (GP); white, dense, nonplastic, strongly indurated, dry; stage III caliche.

Test Pit 39

0.0 - 6.4'	Sandy, cobbley, gravel with boulders (GP); red brown, medium dense, nonplastic, weakly indurated, dry; boulders to 2.5-feet in diameter, recent stream alluvium.
6.4' - 11.1'	Sand with silt (SP); red brown, medium dense, nonplastic, weakly indurated, dry; poorly graded, fine-grained, rounded, quartz sand.

Note: Test pit is in an active stream channel. An absorption field located here would be periodically flooded.

Test Pit 40

0.0 - 1.6'	Silty sand (SM); dark red brown, medium dense, non- to low plasticity, nonindurated, dry; 20 percent fines.
1.6' - 4.9'	Caliche (stage IV); white, strongly indurated, soil profile plugged.
4.9' - 11.5'	Sandy, cobbley, gravel with boulders (GP); white, medium dense, nonplastic, strongly indurated, dry; stage III caliche.

Test Pit 41

0.0 - 5.9'	Sand (SP); red brown, low density, nonplastic, nonindurated, dry; poorly graded, fine-grained, rounded, quartz sand.
5.9' - 6.9'	Clayey sand (SC); dark red brown, medium dense, low to medium plasticity, weakly indurated, dry; 20 percent fines.
6.9' - 8.5'	Caliche (stage IV); white, strongly indurated, soil profile plugged.

Ground water was not encountered in any of the test pits excavated in the Winchester Hills Phase II subdivision.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various soil-size fractions are field estimates.

Project:			Requesting Agency:
Review of Dames and Moore Report, Pine Meadow Ranch			Bureau of General Sanitation, Utah State Health Dept.
By: G.E. Christenson	Date: 3/18/85	County: Summit	Job No.: WS-2
USGS Quadrangle: Big Dutch Hollow (1251); Wanship (1250)			

85-007

Big Dutch Hollow (1251) Wanship (1250)

This report contains the results of the UGMS review of a Dames and Moore report (March 2, 1984) on the Pine Meadow Ranch Subdivision in Summit County. The purpose of the Dames and Moore study was to perform percolation tests and delineate areas suitable for individual wastewater disposal using soil absorption systems. The UGMS has previously conducted an engineering geologic investigation at Pine Meadow Ranch (memo of July 29, 1983 from Gary E. Christenson to William R. Lund) and has performed a field review of test pit logs made by Dames and Moore during their investigation (letter of November 22, 1983, from Gary E. Christenson to Mervin Reid).

The principal geologic factors to be considered when evaluating site conditions for soil absorption systems are: 1) depth to ground water; 2) depth to bedrock or other impermeable layer; 3) soil percolation rate, and 4) slope. The Dames and Moore report addresses factors one and two in the text and on plate 2. Factor three is addressed through measurements of soil percolation rates, but a map showing the distribution of soil types and percolation rates was not presented. A detailed slope map showing areas where slopes are too steep for soil absorption systems (factor four) was also not included. The UGMS has the following comments with regard to the methodology and conclusions in the Dames and Moore report:

1. The conclusion that shallow ground water does not generally occur over the site is supported by the evidence. The probable areal extent of shallow ground water encountered in three of the test pits (numbers 17, 29, 47) was not delineated on plate 2. However, as stated in the Dames and Moore report, it is likely that such occurrances are local, usually seasonal, and difficult to predict.

2. Areas where depth to bedrock (thickness of soil cover) regulations probably cannot be satisfied are shown in plate 2. Our field review of the Dames and Moore test pit logs found that the top of their "residual soil" unit generally corresponds to the uppermost zone of weathered bedrock. In most cases, this "residual soil" is sufficiently weathered to be considered soil and performs adequately in soil absorption fields. As stated by Dames and Moore, the areas outlined showing the extent of shallow bedrock are approximate and subject to interpretation. Because the "residual soil" indicates shallow bedrock, and "residual soil" or bedrock was reported in at least 41 of the 61 test pit logs included in the report, the UGMS believes that the extent of shallow bedrock is probably greater than is shown in plate 2.

3. Soil percolation rates were measured in 42 test pits. Twenty of those, or 48 percent, were slower than 60 minutes/inch, the minimum percolation rate permitted for conventional soil absorption systems. In addition, our field review of test pit logs found that site soils contain more clay than

is indicated in field soil classifications done by Dames and Moore. This discrepency is supported by laboratory test data (table 2, Dames and Moore report) which shows that nearly all fine-grained soils tested were predominately clay. In most Dames and Moore field classifications, however, the fines were identified as silt. Although no map was prepared, percolation rate tests indicate that as much as half of the subdivision may be underlain by soils with inadequate permeability. To increase the area suitable for soil absorption systems and to address soil variability, Dames and Moore recommends allowing systems to be installed in soils with permeabilities between 60 and 100 minutes/inch. We do not agree, and believe that soil variability should be addressed by a program of soil exploration (test pits) and multiple percolation tests on individual lots until sufficient suitable area is found. If an adequate area cannot be found, the lot should be considered unsuitable for wastewater disposal using conventional systems.

4. Dames and Moore does not address the influence of slope on soil absorption systems. Surface seepage commonly results when soil absorption systems are placed on steep slopes, particularly in areas of shallow bedrock or low permeability soils such as are prevalent at Pine Meadow Ranch. We believe that consideration of slope effects would show large parts of the remainder of the subdivision to be poorly suited for soil absorption systems.

Dames and Moore concludes by stating that Plats E, F, and G of Pine Meadow Ranch are generally feasible for soil absorption systems except in areas shown on plate 2 as unsuitable due to shallow ground water or rock. They state that delineations of areas are approximate and subject to engineering judgment. The latter statement is important because we believe that when soil percolation rate data and slope considerations are included in the assessment of soil absorption system suitability, a much larger area than that shown in plate 2 will be found unsuitable. In our judgment, the conclusion to be drawn from the study is that it is likely that many lots at Pine Meadow Ranch may be without sufficient suitable area for a conventional soil absorption system.

Project: Investigation of 3 sites in Weber County for experimental individual wastewater disposal systems.			Requesting Agency: Bureau of General Sanitation, Utah Dept. of Health
By: G.E. Christenson	Date: 6/25/85	County: Weber	Job No.: WW-3
USGS Quadrangle: North Ogden (1370); Ogden Bay (1347); Roy (1346)			

85-015

PURPOSE AND SCOPE

At the request of Steven Thiriot of the Bureau of General Sanitation (Utah State Department of Health), the Utah Geological and Mineral Survey (UGMS) investigated three sites being considered for experimental individual wastewater disposal systems in Weber County. The purpose of the investigations was to describe geologic conditions at the sites to help Utah Department of Health personnel evaluate their feasibility for installation of either low-pressure pipe (LPP) or Wisconsin mound systems. Site 1 is in North Ogden (NE1/4 sec. 33, T. 7 N., R. 1 W., attachment 1), site 2 is in the Kanesville-Hooper area (NW1/4 sec. 8, T. 5 N., R. 2 W., attachment 2), and site 3 is in Hooper (SW1/4 sec. 23, T. 5 N., R. 3 W., attachment 3). The scope of work included a literature review, field reconnaissance (April 24, 1985), and logging and/or observation of test pits and percolation test holes at the sites. Present during the field reconnaissance were Mr. Thiriot and Richard Schwartz and William Kessler of the Weber County Health Department.

SITE DESCRIPTIONS

Site 1

Site 1 is southeast of North Ogden on a south-sloping lot bordered on the north and east by canals and on the south by the drainage from Coldwater Canyon. Although Miller (1980) shows soils at the site to consist of Lake Bonneville sand and gravel, mapping by the U.S. Soil Conservation Service (1968) and observations made during the field investigation indicate that fine-grained soils, chiefly clay, predominate at the site. One test pit 6 feet deep near the center of the lot and five shallow test pits 2 to 2.5 feet deep in the northeast quarter of the site exposed soil profiles consisting of 1-2 feet of dark brown lean clay with sand overlaying lake-bottom bedded clay with minor sand beds (attachment 4). The bedding in the clay dips to the south and locally exhibits vertical fracturing.

Percolation rates at two localities in the southwest corner of the property at a depth of 4 feet were measured at 120 and 240 minutes/inch. Because of these low permeabilities at depth, infiltrating water applied to the site may percolate laterally southward through upper soil layers rather than vertically downward. This is evidenced by reports of seepage, apparently derived from infiltrating snowmelt, at various levels on the north (uphill) wall of the deepest test pit. This seepage initially filled the test pit, although it had drained away and the pit was dry at the time of the field reconnaissance, indicating that a permanent high water table (less than 6 feet below ground surface) does not exist in the area. Springs are present at the base of the slope at the south property line, providing evidence that an unconfined water table is probably present a few feet below the test pits.

A well tapping a deep artesian aquifer is present about midway along the western edge of the site. The well was flowing at the time of the investigation, and the log from the Utah Division of Water Rights indicates it is 120 feet deep, penetrating clay to 110 feet and gravel from 110-120 feet. It is cased with perforations from 110-120 feet. The well was not gravel packed. Although no surface seal was noted in the log, the artesian pressure in the aquifer and presence of a natural clay seal in the upper 110 feet satisfies Utah Department of Health criteria for a deep well.

Because of low permeability soils and possible shallow ground water, an LPP or Wisconsin mound system is being considered for this property. The area available for such a system is limited, however, because of required setback distances from property lines, open and unlined canals (north and east sides), springs (south side), and culinary wells (west side). Steep slopes are also present in the southern half of the site. If the canals are lined or abandoned eliminating the need for setbacks, a suitable area of limited size would be available in the northeast corner of the property. Preliminary soil percolation rates of 120 minutes/inch have been obtained there by the landowner. The minimum allowable percolation rate for LPP and Wisconsin mound systems is 120 minutes/inch and the size of the system is in part based on percolation rate. It is unlikely that sufficient area exists for the size of system required (Steven Thiriot, oral commun., April 29, 1985).

Site 2

Site 2 is about one mile east of Kanesville along the West Hooper Branch Canal and is 5-10 feet lower than nearby lots on the south side of 4000 South Street (attachment 2). The site is in a topographically low area along the west edge of Hooper Slough. The landowner intends to import fill to raise the lot, and proposes to place an individual wastewater disposal system in the fill. Under health department regulations, only experimental systems such as the LPP or Wisconsin mound system are allowed in such material.

Soils at the site are chiefly Lake Bonneville silt and clay and the intended fill material is silty sand. A percolation rate test hole at the site exposed gray silty clay with a water table 1.2 feet below the ground surface. The seasonal high stand of the water table is not known, but judging from present levels, may be less than 1 foot. No evidence that the surface has been flooded by rising ground water in the recent past was observed.

Site 3

Site 3 is on cultivated land about 3/4 mile east of the shore of the Great Salt Lake in Hooper near the Weber-Davis County line (attachment 3). The site is at an approximate elevation of 4222 feet, about 12 feet above the present level of the Great Salt Lake. One test pit and several percolation test holes were present at the site. Leveling of the site for cultivation appears to have removed upper soil horizons. Lake deposits of white to gray, bedded sand, silty sand, and clayey sand are exposed in the test pit. An LPP or Wisconsin mound system is contemplated at the site, and a question exists regarding the need to import fill and raise the lot elevation to accomodate shallow ground water. Ground water was measured at 31 inches below the ground surface in the test pit and several of the percolation test holes. A ditch along the east side of the property had recently been deepened, and water standing in the bottom of the trench was roughly equivalent in elevation to that in the test holes. Ground water at the site is probably influenced by the level of the Great Salt Lake, by irrigation and other surface water, and by drainage ditches. Estimation of the probable seasonal high ground-water table is difficult, but it is likely that it may rise above present levels, particularly if the Great Salt Lake continues to rise.

CONCLUSIONS AND RECOMMENDATIONS

Conditions at all three sites are prohibitive for conventional wastewater disposal systems, either because of slow soil permeability or shallow ground water. Use of experimental low-pressure pipe or Wisconsin mound systems may be feasible provided proper precautions are taken. At site 1, the area remaining after satisfying setback requirements from springs, canals, and the well may be insufficient for the size of system needed to accomodate the low permeability soils. Adequate area appears present at sites 2 and 3. The thickness of fill proposed at site 2 is unknown, but may be sufficiently thick that existing site conditions are of lesser significance and properties of the fill will determine system size and design. At site 3, ground water may naturally rise to less than 2 feet below the surface and fill will be required to use either an LPP or mound system unless the water table can be stabilized artifically.

REFERENCES

Bolke, E.L., and Waddell, K.M., 1972, Ground-water conditions in the east shore area, Box Elder, Davis, and Weber Counties, Utah 1960-1969: Utah Department of Natural Resources Technical Publication No. 35, p. 59.

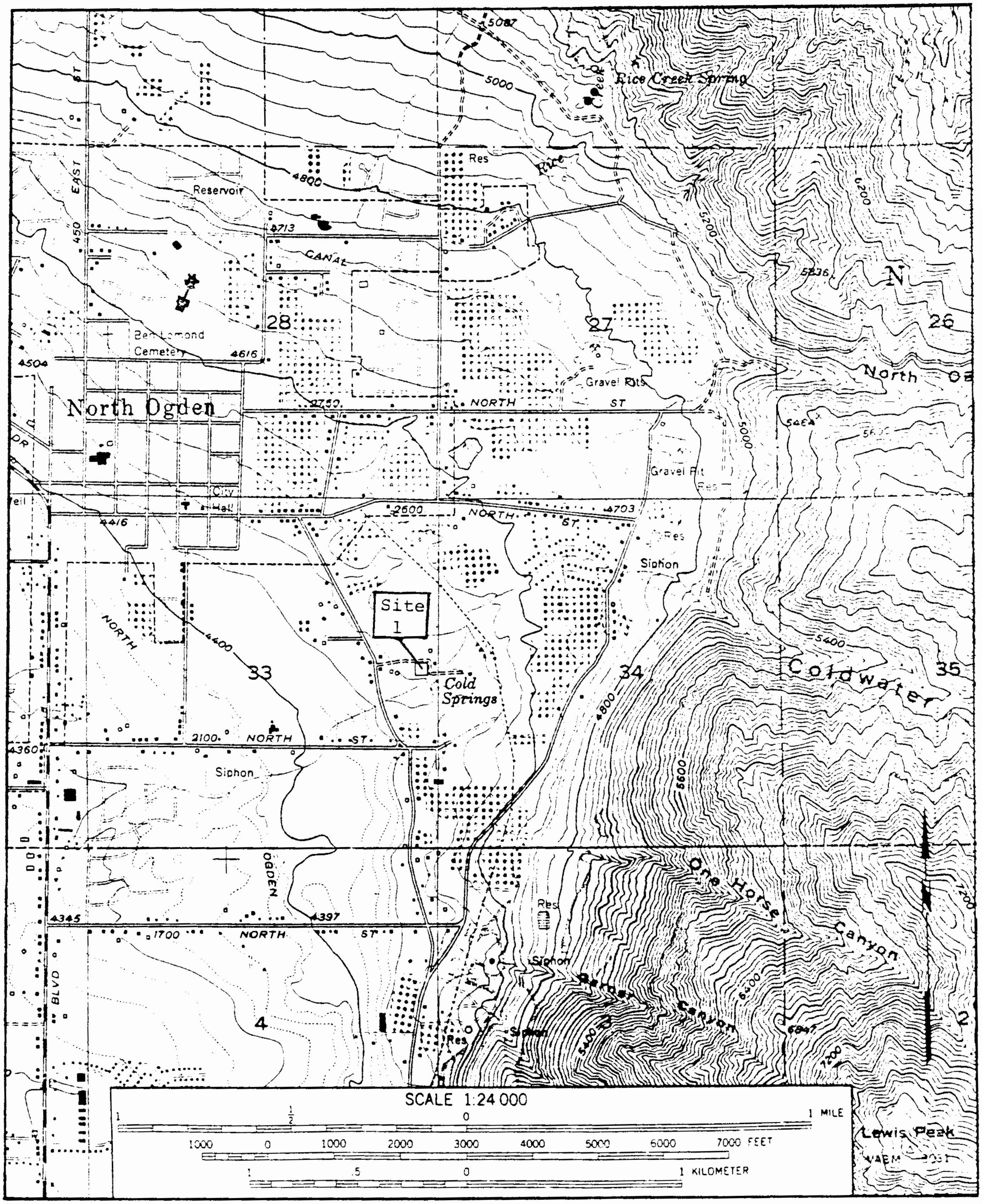
Miller, R.D., compiler, 1980, Surficial geologic map along part of the Wasatch Front, Salt Lake Valley, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1198, scale 1:100,000.

Sorensen, M.L., and Crittenden, M.D., 1972, Preliminary geologic map of part of the Wasatch Range near North Ogden, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-428, scale 1:24,000.

U.S. Soil Conservation Service, 1968, Soil Survey, Davis-Weber area, Utah: U.S. Department of Agriculture in cooperation with Utah Agricultural Experiment Station, 149 p.

Attachment 1, Job No. WW-3

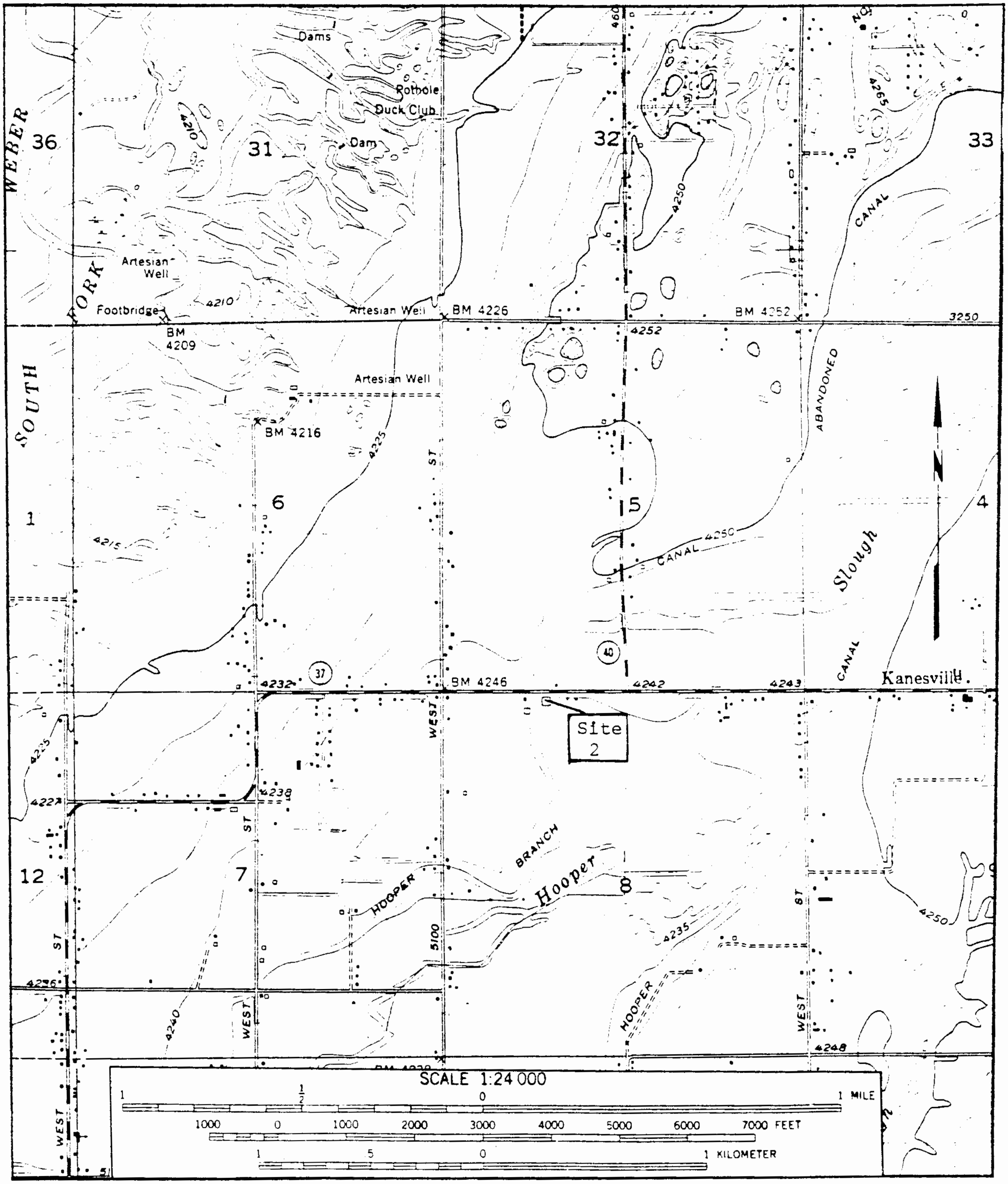
Base map from: U.S.G.S. 7½' topo quad
North Ogden, Utah



Location Map

Base map from: U.S.G.S. 7½ topo quad
Roy, Utah

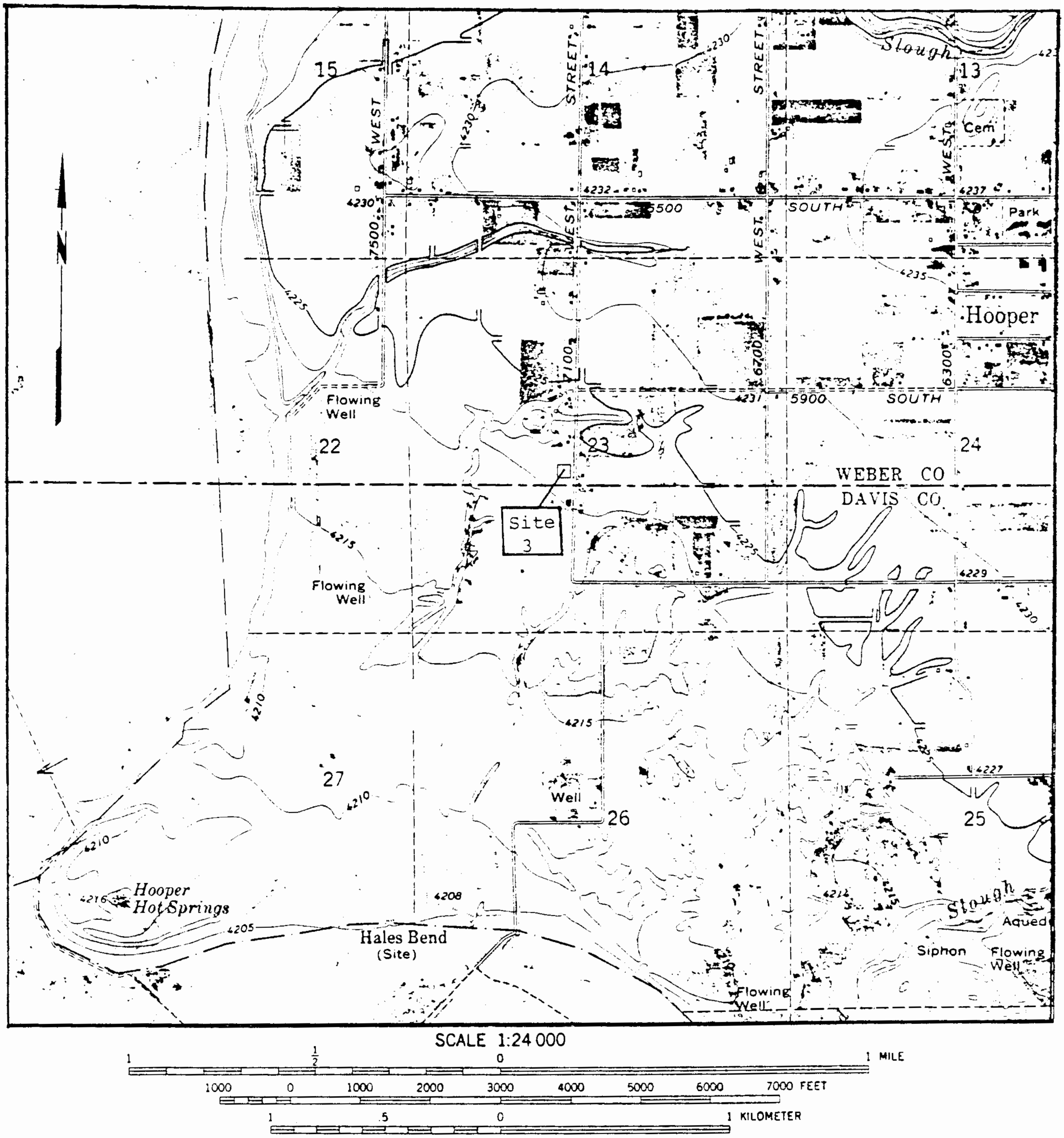
Attachment 2, Job No. WW-3



Location Map

Attachment 3, Job No. WW-3

Base map from: U.S.G.S. 7½ topo quad Ogden Bay, Utah



Location Map

Site 1 - North Ogden
Soil Description*

Test Pit near lot center	
0 - 0.4'	Lean clay (CL); red-brown, firm, medium plasticity, nonindurated, moist; disturbed upper layer, probably includes fill.
0.4' - 2.0'	Lean clay with sand (CL); black, stiff, medium plasticity, nonindurated, dry to moist; prismatic to blocky soil structure, organic.
2.0' - 6.0'	Lean clay (CL); red-brown, firm to stiff, medium plasticity, nonindurated, moist; bedded (beds less than 1/4 inch thick), local interbeds of yellow-green poorly-graded sand (SP) up to 1 inch thick.

Generalized log of test pits in NE1/4 of lot	
0 - 1.0'	Lean clay with sand (CL); black, stiff to very stiff, medium plasticity, nonindurated, dry; thickness of layer varies from 6 inches to 1 foot.
1.0' - 2.5'	Lean clay (CL); red-brown, firm to stiff, medium plasticity, nonindurated, moist; bedded (beds less than 1/4 inch-thick), calcium carbonate nodules 1/4 - 1/2 inch in diameter common.

*Soils classified according to procedures in ASTM Standard D2488-69 (revised 1975), description of soils (Visual Manual Procedure) and D2487-83, Classification of Soils for Engineering Purposes.

Project:			Requesting Agency:
Jordan Ranch Mobile Home Park septic tank suitability evaluation			Wasatch County Dept. of Health
By: H. Gill	Date: 6/6/85	County: Wasatch	Job No.: WW-4
USGS Quadrangle: Heber City (1168)			

#85-019

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 the Jordan Ranch Mobile Home Park in Wasatch County. The subdivision is in the W1/2 sec. 6, T. 3 S., R. 5 E., Salt Lake Baseline and Meridian (attachment 1). The purpose of the inspection was to evaluate the geologic suitability of the site for a community soil absorption system that could receive up to 30,000 gallons of wastewater per day. The mobile home and RV park will be east of Highway 40, just south of Jordanelle, Utah. The proposed absorption field is west of the highway immediately across from the mobile home park (attachment 1).

The scope of the investigation included a review of available geologic and soils information and logging of 16 test pits. Visits were made to the site on May 10 and May 30, 1985. Nine test pits were logged during the first visit (1 through 9), and 7 test pits on the second (10 through 16). Fifteen test pits were excavated at the proposed absorption field site; the sixteenth was on the east side of the highway (attachment 2). The test pits logged during the first reconnaissance were all approximately four feet deep or less, their depth being limited by high ground-water conditions. The test pits logged on the second visit were from 3.5 to 7.5 feet deep. Mr. Wright was present during the field inspections.

GEOLOGY AND HYDROLOGY

The study area is located adjacent to the Provo River just south of the proposed site for the Jordanelle Dam. It is underlain by Quaternary age (0 - 1.8 million years before present) Provo River flood-plain deposits. Site soils consist of a variable thickness (0.5 to 2.8 feet) of silty clay topsoil (soil logs represent location within test pit with thickest section of top soil) over coarse sandy and silty gravel deposits containing numerous cobbles and boulders. The gravel and cobbles are well rounded, and include approximately 10 percent fines (silt and clay) (attachment 3). Bedrock exposed in the hillside west of the site is variable, but consists principally of east-dipping volcanic breccia and rhyodacite porphyry of the Keetley volcanics (Bromfield and others, 1970).

The U.S. Soil Conservation Service soil survey for the Heber Valley (Woodward and others, 1976) considers the area susceptible to flooding for short periods during most years, with a water table that fluctuates in response to flow in the Provo River. Ground water was encountered in test pits 1 through 9 from 0.4 to 4.0 feet below the surface, and in test pits 14, 15, and 16 at 6.5, 3.6, and 3.0 feet respectively (attachment 3). The water table beneath the site is flat and the variable depth to ground water corresponds to changes in ground-surface elevation across the property. Because the inspection was made during the late spring, the water levels recorded probably are at or near the seasonal high stand of the shallow unconfined aquifer beneath the site. There are three Bureau of Land Management surface drains on the southern portion of the property (attachment 2). They were designed to drain the surface soils for agriculture, and are only effective to a depth of 3 or 4 feet. Their influence is evident in test pits 15 and 16 where the ground water is at 3.6 and 3.0 feet deep respectively. The developer indicated that beaver dams had caused the northern portion of the property to flood prior to the first visit on May 10. The beaver dams were removed before the second reconnaissance; however, most of the first nine test pits had been back filled so it was not possible to evaluate completely the effect that removing the dams had on ground water. Ground water was observed in test pit 8 at 6.7 feet below ground surface during the second visit, a drop of 3.5 feet from the previous recording of 3.2 feet made on the first visit (attachment 3).

SUITABILITY FOR SOIL ABSORPTION FIELD

Soil and hydrologic conditions at the site generally present severe limitations for the use of conventional soil absorption systems. Percolation rates in the gravel deposits would be very high, and the soils lack fines which assist in renovating the wastewater. The upper soil layer (silty clay) may be suitable for an absorption field, but is of variable thickness and is in general too thin and discontinuous to be of practical use. Shallow ground-water conditions at the site make it unlikely that a conventional system can be installed that maintains the required separation from the water table. A direct hydrologic connection likely exists between the ground water beneath the site and the Provo River, so contaminants entering the ground water may eventually reach the river.

In addition to poor soil conditions and shallow ground-water the site may also be subject to flooding. The southern portion of the property is on the outside of a river meander and past flooding in that area is indicated by debris observed in bushes and trees on the flood plain.

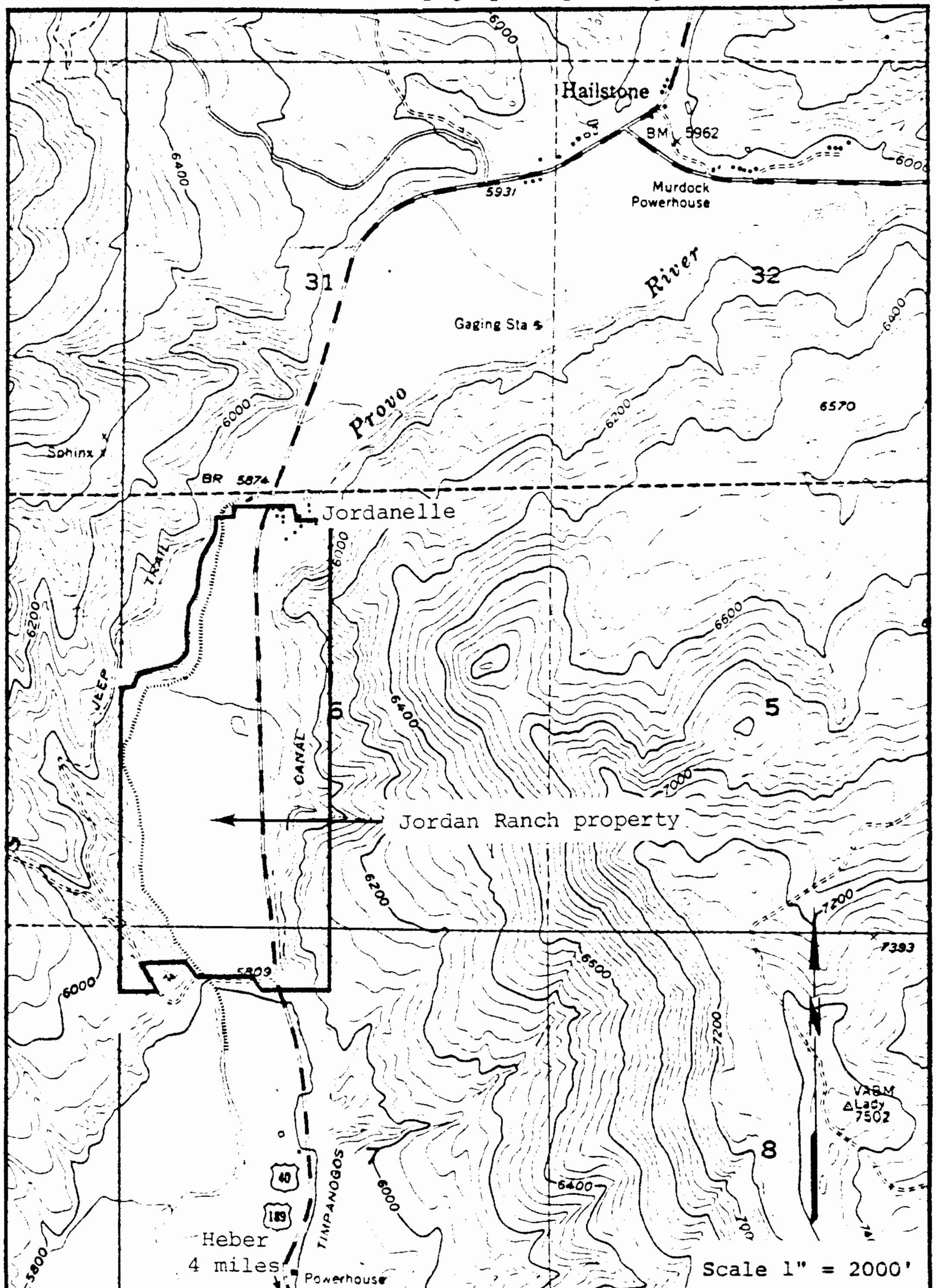
REFERENCES

Bromfield, C. S., Baker, A. A., and Crittenden, M. D., 1970, Geologic map of the Heber Quadrangle, Wasatch and Summit Counties, Utah: U. S. Geological Survey Geologic Quadrangle Map GQ-864, scale 1:24,000.

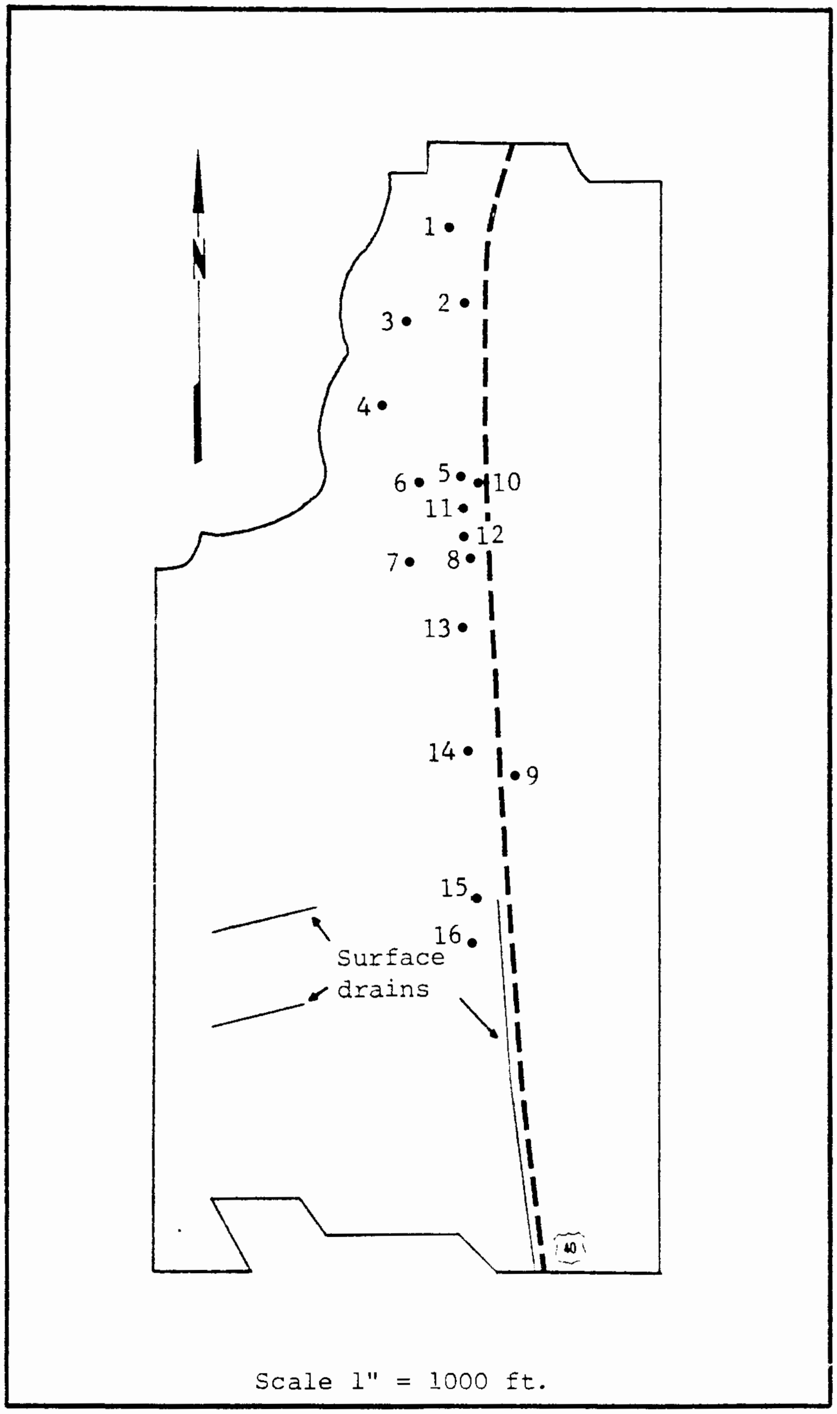
Woodward, Lowell, Jensen, E. H., and Harvey, J. S., 1978, Soil survey of the Heber Valley area, Utah: U. S. Department of Agriculture Soil Conservation Service, Forest Service, and Utah Agricultural Experiment Station, 124 p.

Attachment 1, Job No. WW-4

Base map from USGS 7½ minute topographic quadrangle, Heber City, Utah



Location map, Jordan Ranch Mobile Home Park



Test pit and surface drain locations

Attachment 3, Job No. WW-4

Test Pit Logs*

Test Pit 1

0.0' - 2.0' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

2.0' - 2.4' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Ground water encountered at 2.4 feet below the ground surface. Unable to log to total depth.

Test Pit 2

0.0' - 1.4' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

NOTE: Ground water encountered at 1.4 feet below the ground surface. Unable to log to total depth.

Test Pit 3

0.0' - 2.8' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

2.8' - 4.0' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Ground water encountered at 4.0 feet below the ground surface. Unable to log to total depth.

Test Pit 4

0.0' - 0.5' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

0.5' - 1.4' Sand (SP); light brown, low density, nonplastic, nonindurated, wet to saturated.

NOTE: Ground water encountered at 1.4 feet below the ground surface. Unable to log to total depth.

*Soils classified in accordance with procedures outlined in ASTM Standard D2489-69 (Revised 1975), Description of Soils (Visual Manual Procedure).

Test Pit 5

0.0' - 0.5' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

0.5' - 4.5' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Small amount of water observed in bottom of test pit. Believed to be ground water rather than precipitation.

Test Pit 6

0.0' - 0.5' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

0.5' - 2.8' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Small amount of water observed in bottom of test pit. Believed to be ground water rather than precipitation.

Test Pit 7

0.0' - 1.7' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

1.7' - 3.2' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Ground water encountered at 3.2 feet below the ground surface. Unable to log to total depth.

Test Pit 8

0.0' - 1.2' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

1.2' - 3.5' Sandy gravel with cobbles/silty gravel with cobbles (GP/GM); brown, low density, nonplastic, nonindurated, saturated; 20 percent cobbles.

NOTE: Small amount of water observed in bottom of test pit. Believed to be ground water rather than precipitation.

Test Pit 9

0.0' - 0.4' Silty clay (CL); topsoil, black, firm, medium plasticity, nonindurated, wet.

NOTE: Ground water encountered at 0.4 feet below the ground surface. Unable to log to total depth.

Test Pit 10

0.0' - 1.5'	Silty clay with sand (CL); brown, stiff, low plasticity, nonindurated, dry.
1.5' - 7.5'	Sandy gravel with cobbles (GP); light brown, low to medium dense, nonplastic, nonindurated, dry.

Test Pit 11

0.0' - 0.4'	Silty sand (SM); brown, low density, nonplastic, nonindurated, dry.
0.4' - 1.4'	Sand (SP); light brown, low density, nonplastic, nonindurated, dry.
1.4' - 7.5'	Sandy gravel with cobbles (GP); light brown, low density, nonplastic, nonindurated dry.

Note: Bottom moist, ground water probably close to bottom of test pit.

Test Pit 12

0.0' - 1.0'	Silty clay with sand (CL); brown, firm, low placticity, nonindurated, dry.
1.0' - 2.7'	Silty gravel with cobbles (GM); light brown, low density, nonplastic, nonindurated, dry.
2.7' - 3.7'	Clay (CH); dark brown, very stiff, high plasticity, nonindurated, dry.
3.7' - 3.8'	Sandy gravel with cobbles (GP); light brown, low density, nonplastic, nonindurated, dry.

Test Pit 13

0.0' - 0.5'	Silty clay with sand (CL); brown, stiff, low plasticity, nonindurated, dry.
0.5' - 3.5'	Sandy gravel with cobbles (GP); light brown, low density, nonplastic, nonindurated, dry.

Test Pit 14

0.0' - 1.5'	Silty clay with sand (CL); brown, firm, low plasticity, nonindurated, dry.
1.5' - 6.5'	Silty gravel with cobbles (GM); light brown, low density, nonplastic, nonindurated, dry.

Note: Ground water at 6.5 feet.

Test Pit 15

0.0' - 2.8' Silty clay (CL); dark brown, stiff, medium plasticity, nonindurated, dry.

2.8' - 4.0' Silty gravel with cobbles (GM); light brown, low density, nonplastic, nonindurated, saturated.

Note: Ground water at 3.6 feet.

Test Pit 16

0.0' - 3.0' Silty clay (CL); dark brown, stiff, medium plasticity, nonindurated, dry.

3.0' - 4.0' Silty gravel with cobbles (GM); light brown, low density, nonplastic, nonindurated, saturated.

Note: Ground water at 3.0 feet.

Project: Sewage lagoon site for Escalante, Utah			Requesting Agency: Town of Escalante
By: R.H. Klauk	Date: 11/4/85	County: Garfield	Job No.: WW-5
USGS Quadrangle: Escalante (267)			

85-034

PURPOSE AND SCOPE

This report presents the results of an investigation by the Utah. Geological and Mineral Survey (UGMS) to assess the geologic suitability of a sewage lagoon site for the town of Escalante, Utah. The investigation was performed at the request of Mayor Christensen and the Escalante Town Council. The site is located in the SW 1/4 sec. 9, T. 35 S., R. 3 E., Salt Lake Baseline and Meridian (attachment 1).

The scope of work for the study included a review of existing geological literature, interpretation of stereoscopic aerial photographs, and a field investigation on October 16 and 17, 1985. The field investigation included the excavation of three test pits with a tractor mounted backhoe.

GENERAL GEOLOGY

The town of Escalante is on alluvial deposits overlying undifferentiated Upper Jurassic Carmel Formation and Entrada Sandstone of the San Rafael Group (Gregory and Moore, 1931). At Escalante, the San Rafael Group forms the slightly west dipping, west limb of the Escalante monocline. One mile east of town the monocline consists of steeply upturned Entrada Sandstone in contact with gypsum and shale of the Carmel Formation (Gregory and Moore, 1931; and McFall and Peterson, 1971). The alluvium overlying the San Rafael Group at Escalante is terrace and flood-plain deposits associated with the Escalante River and Alvey Wash a possible abandoned channel of the Escalante River (attachment 1).

Escalante is in Uniform Building Code (UBC) seismic zone 2 and Utah Seismic Safety Advisory Council (USSAC) seismic zones 1 and 2. This indicates the site is in an area where an earthquake of modified Mercalli intensity VII may be expected. See attachment 2 for an explanation of the intensity scale. No earthquakes have been recorded within a 10 mile radius of Escalante (Arabasz and others, 1979; Richins and others, 1981; and Richins and others, 1984). The nearest suspected Quaternary fault is more than 15 miles to the northwest (Anderson and Miller, 1979). No other young faults are known in the area.

SITE CONDITIONS

The wastewater lagoon site is located less than 1/2 mile east of Escalante on a terrace 10 to 20 feet above the flood plain of the Escalante River (attachment 1). A second, higher terrace (20 feet) borders the site to the south. Presently, the property is utilized as a pasture with a small cultivated area in the northwest corner. An unnamed intermittant drainage crosses the southeast corner of the site. Perennial springs that emanate from the slope between the terraces results in ponded water over more than half the site. A small ditch has been excavated across the property to drain some of the ponded water into the Escalante River. The site is adjacent to but not included in the 100 year flood zone for the Escalante River delineated on the U.S. Department of Housing and Urban Development Federal Insurance Administration flood map (1978).

Soils on site range from silty or clayey, poorly graded fine sand (SM/SC) to fine sand (SP) (appendix 3). These soils extend to a depth of at least 5 feet and possibly much deeper. Severe sloughing of the test pits and high ground water ranging from 2.5 to 4.0 feet in depth precluded deeper excavation. Numerous roots and a portion of a 4-inch diameter tree were found in the upper parts of the test pits. No gypsum was observed.

CONCLUSIONS AND RECOMMENDATIONS

The Escalante sewage lagoon site is located in UBC seismic zone 2 and USSAC seismic zones 1 and 2. No earthquakes have occurred in historic time and no Quaternary faults are known within 10 miles of the site. Flood hazard from the Escalante River is low, but localized runoff in an unnamed drainage crossing the site may be a problem. Discharge from springs produces standing water over much of the site. High ground water and organic rich and possibly low-bearing strength soils may provide foundation problems. Based on these conditions, the following recommendations are made:

1. The lagoon should be designed and constructed, at a minimum, in accordance with UBC seismic requirements for zone 2, including design review and field inspection to insure compliance for USSAC seismic zones 1 and 2.

2. Spring discharge should be diverted and ponding of water prevented on the site.

3. Construction should not block the unnamed drainage.

4. A foundation investigation should be conducted to evaluate soil and shallow ground-water characteristics pertinent to the design of the facility.

REFERENCES CITED

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Fugro, Inc., Long Beach, California, 35 p., scale 1:500,000.

Arabasz, W.J., Smith, R.B., and Richins, W.D., (editors), 1979, Earthquake studies in Utah, 1850 to 1979: University of Utah, Department of Geology and Geophysics, 548 p.

Gregory, H.E., and Moore, R.C., 1931, The Kaiparowits region: U.S. Geological Survey Professional Paper 164, 161 p.

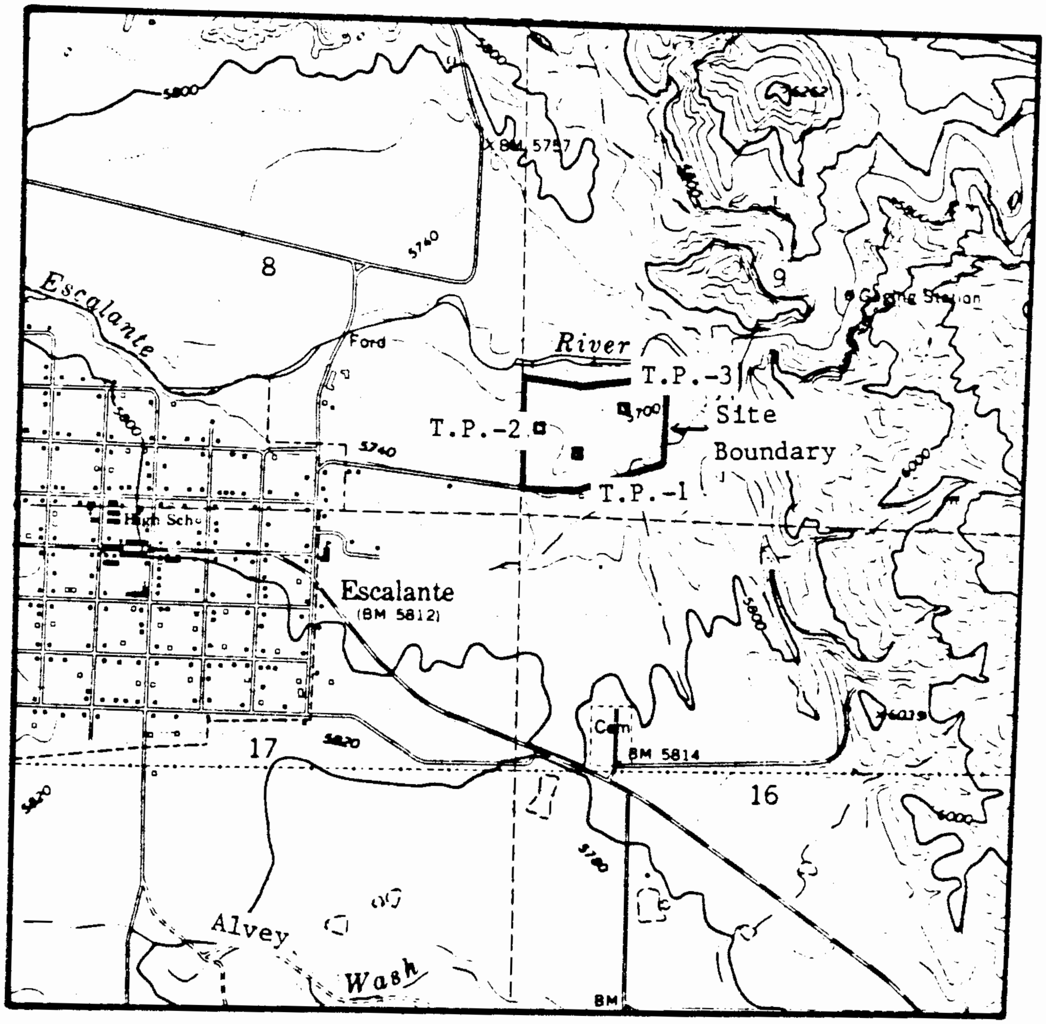
McFall, C.C., and Peterson, P.R., 1971, Geology of the Escalante - Boulder area Garfield County, Utah: Utah Geological and Mineralogical Survey Map 31, scale 1:65,545.

Richins W.D., and others, 1984, Earthquake data for the Utah region January 1, 1981 to December 31, 1983: University of Utah, Department of Geology and Geophysics, 111p.

Richins W.D., and others, 1981, Earthquake data for the Utah region July 1, 1978 to December 31, 1980: University of Utah, Department of Geology and Geophysics, 127p.

U.S. Department of Housing and Urban Development Federal Insurance Administration, 1978, Flood hazard boundary map - unincorporated area, Garfield County, Utah: Community - Panel No. 490065 0030A, scale 1:24,000.

R. 3 E.



T. 35 S.

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

Scale 1:24,000

0 — 1 mile

Contour Interval 40 feet

Location Map

MODIFIED MERCALLI INTENSITY SCALE OF 1931
(Abridged)

I. Not felt except by a very few under especially favorable circumstances.

II. Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls made cracking sound. Sensation like heavy truck striking building; standing motor cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.

VI. Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbed persons driving motor cars.

IX. Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.

XI. Few, if any (masonry), structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

Source: Earthquake Information Bulletin: 6 (5), 1974, p. 28.

Logs of Test Pits*

Test Pit 1

0.0' - 0.5' Peat, (PT)- dark brown, odor, thick grass and roots.

0.5' - 1.5' Poorly Graded Silty Sand or Clayey Sand (SM/SC)- About 70 percent fine, subangular to subrounded sand; about 30 percent fines with low plasticity; light brown, homogeneous; wet; strong organic odor, numerous roots throughout, buried tree trunk from 1.0 to 3.0 feet in depth, overbank flood-plain deposits.

1.5' - 5.0' Poorly Graded Clayey Sand (SC)- About 60 percent fine, subangular to subrounded sand; about 40 percent fines with medium plasticity; dark brown, homogeneous, wet to saturated; strong organic odor, overbank flood plain-deposits, some roots, severe sloughing of trench walls.

Note: Water table at 2.5 feet.

Test Pit 2

0.0' - 0.5' Peat (PT)- brown, odor, thick grass and roots.

0.5' - 5.0' Poorly Graded Sand (SP)- About 75 percent fine, subrounded to rounded sand; about 5 percent medium to coarse subrounded to rounded sand, brown, organic odor, moist to wet, no reaction with HCl, homogeneous, no cementation, overbank flood-plain deposits, some roots in upper part of trench, severe sloughing of pit walls.

Note: Water table at 4.0 feet.

Test Pit 3

Due to sloughing it was not possible to log this test pit. However, observations and bucket material indicate soils are similar to those in test pits 1 and 2. The water table was estimated to be from 2 to 3 feet in depth.

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

Project:			Requesting Agency:
Timberlakes Plat 18			Wasatch County Health Dept.
By: H. Gill	Date: 10/17/85	County: Wasatch	Job No.: WW-6
USGS Quadrangle: Heber Mountain (425)			

#85-035

PURPOSE AND SCOPE

In response to a request from Phillip Wright, Wasatch County Health Department, the Utah Geological and Mineral Survey (UGMS) performed a geologic investigation of Timberlakes Subdivision Plat 18 in the E1/2, NW1/4, Sec. 23, T. 4 S., R. 6 E., Salt Lake Baseline and Meridian, Wasatch County, Utah (attachment 1). The purpose of the inspection was to determine if subsurface soil and water conditions are suitable for installation of individual wastewater disposal systems on the subdivision lots.

The scope of the investigation included a review of available geologic and soils information and logging of 13 test pits. The test pits ranged in depth from 3.9 to 10.4 feet below ground surface. Present during the investigation, performed on September 25, 1985, were Phillip Wright, William Lund (UGMS), and William Burkes and Dan Blake both with the Utah State Bureau of Public Water Supplies.

GEOLOGY AND HYDROLOGY

The entire subdivision is underlain by hummocky Quaternary glacial deposits (Baker, 1976). Although only one geologic unit, glacial till, is present on the property, a number of soil types were encountered in the test pits. Glacial till is characteristically heterogeneous, consisting of material from rock units and soil types encountered and eroded by the glacier. When melting begins, the rock and soil materials contained in the ice are deposited as one unit. Numerous melt water streams mix and scour the deposits even more. During a period of retreat, a glacier may leave behind isolated blocks of ice, which after melting create depressions or kettles. This, as well as the typical hummocky glacial terrain which tends to form closed depressions and trap surface runoff, is a likely origin for the numerous small lakes and ponds in the area.

Annual precipitation is approximately 25 to 35 inches, mostly falling as snow between October and March (Woodward and others, 1976). Long months of snow cover and subsequent snowmelt create marshy areas as well as keep small lakes and ponds full. Beaver dams along Lake Creek create additional ponds, and cause a shallow water table. Shallow ground water was encountered in test pits 2, 9, and 10 at 9.0, 3.9, and 7.6 feet respectively (attachment 2). The 1984-1985 water year was drier than in the recent past (1982-1984) when precipitation amounts were well above normal, therefore, ground-water depths are probably lower. In addition, the inspection took place in late September when the water table is at or near its lowest level.

Culinary water for the subdivision will be supplied by a spring approximately 1000 feet southwest of the nearest property line (attachment 2). The recharge area for the spring is southwest of and higher in elevation than the subdivision and a major drainage separates the spring from the site. As a result, there is no danger of contamination to the spring from individual soil absorption systems in Plat 18.

SOILS

Soils observed during the field reconnaissance were generally consistant between the test pits (attachment 3). A generalized description would include: 1 to 4 feet of dark gray-black, soft to firm, silty clay topsoil over 5 to 9 feet of brown, very stiff to hard, clay with gravel and cobbles. This soil horizon has a high plasticity and a moderate shrink/swell potential (Woodward and others, 1976). In test pit 11, from 4.7 to 9.4 feet beneath the ground surface, late stage II to early stage III caliche development was observed (attachment 3). This indicates the gravelly clay soils were moderately indurated and the soil horizon is partially plugged with secondary calcium carbonate.

SUITABILITY FOR SEPTIC TANK DRAINFIELDS

According to the U. S. Soil Conservation Service (SCS) soil survey for the Heber Valley, soil conditions at the site generally present severe limitations for septic tank absorbtion fields (Woodward and others, 1976). Limitations are primarily due to slow permeability. Based on the test pit inspections and field reconnaissance (no lab tests were run), the soil conditions in the subdivision were found to range from poor to unacceptable for septic tank drainfields. The major soil type at depth across the site is a fat clay with gravel and cobbles. The fines fraction (-200 sieve size) was estimated to be from 50 to 90 percent (with high plasticity and moderate shrink/swell potential, SCS, 1976) and therefore a poor soil for soil absorption systems. However, the gravel and cobble fraction ranged from 25 to 50 percent and may allow for a greater degree of percolation than would normally be expected in soils containing so many fines. Percolation tests would be required to confirm the soils suitability.

Test pit number 2 (lot 1863) contained a silty sand and silty clay horizon from the surface to 9.0 feet. Because of the greater permeability of these soils, they would be well suited for use in a soil absorbtion field. However, the ground-water level was 9 feet below ground surface. The water level can be expected to be higher during the spring and summer, and the possibility of saturation and failure of an absorption system in this area is moderate to high. Shallow ground water was observed in other areas on the property (lots 9 and 10), and soil in these locations may remain saturated most of the year. Therefore, these soils would be unacceptable for absorbtion fields.

Test pit 11 (lot 1814) contains a moderately indurated (stage II/stage III) caliche horizon developed in clay with gravel and cobbles. Caliche decreases the permeability of the soil. In addition, the northern portion of the lot drops off rapidly to the north. The caliche horizon will act as an impermeable barrier to the septic tank effluent creating a perched water table which may migrate laterally and eventually result in surface seepage on the steep slope to the north.

SUMMARY

Glacial deposits can vary considerably over short horizontal and vertical distances. For that reason, each lot should be carefully evaluated prior to installation of a wastewater disposal system. The majority of the soils observed on site were high plasticity clays that contained a high percentage of gravel and cobbles. Although normally possessing low permeability, the gravel and cobbles may make these soils suitable for installation of individual wastewater disposal systems. Soil suitability should be confirmed by percolation tests on a lot by lot basis, and it should be noted that the soils on some lots may be unacceptable. In addition to soil permeability the presence of seasonally high ground water near streams and ponds must be considered in siting disposal systems. Ground-water conditions during the inspection were probably at the lowest level for the year and will be higher in the spring. Particular care should be taken when installing systems on lots adjacent to areas of known high ground water (lots 1820, 1825, 1863). Lots near lot 1814 should be inspected for layers of impermeable caliche. The caliche development in the area is not particularly thick, and it may be possible to install systems below the plugged layer.

SELECTED REFERENCES

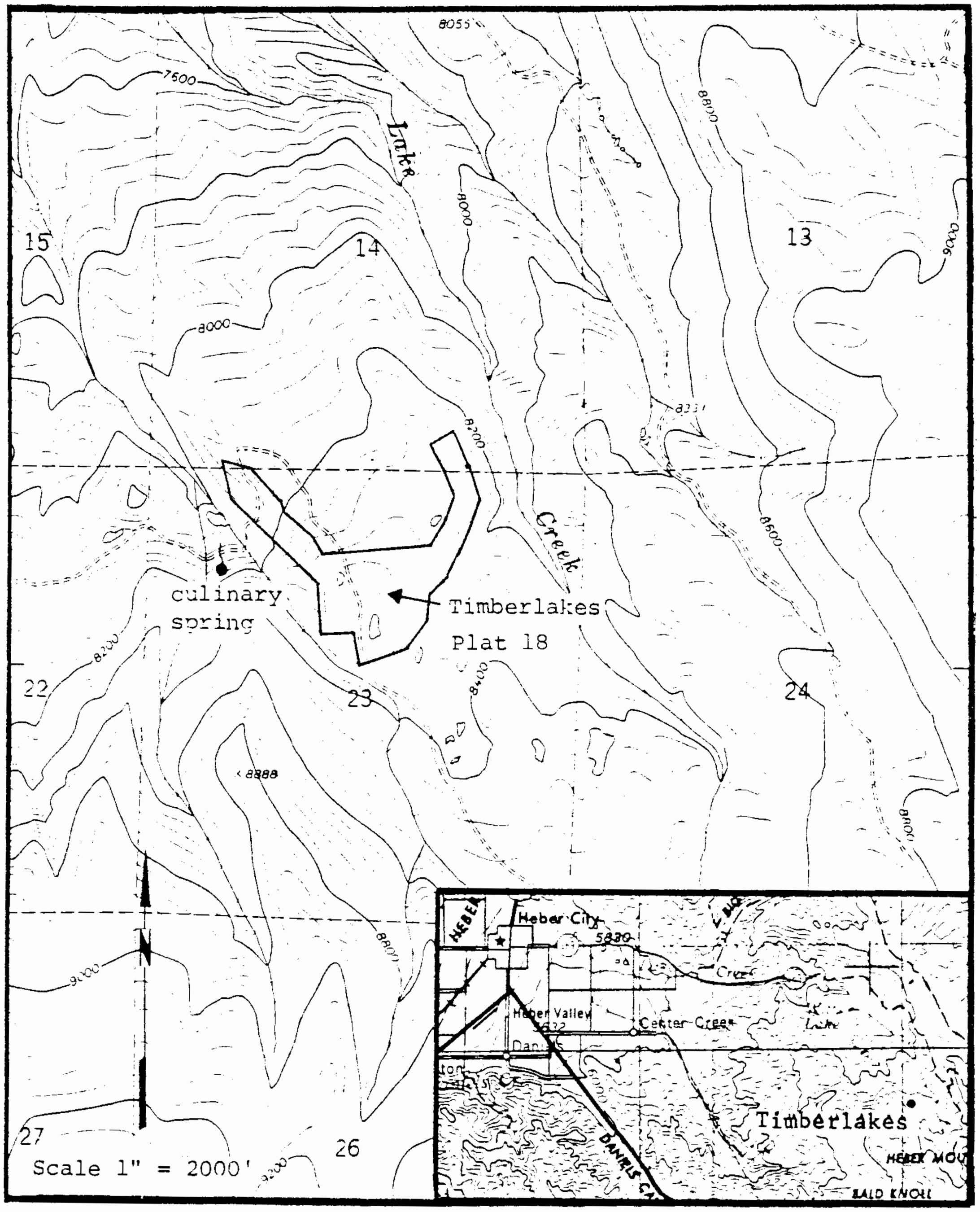
Atwood, W. W., 1909, Glaciation of the Uinta and Wasatch Mountains: U.S. Geological Survey Professional Paper no. 61, 96 p.

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, 1:63,360.

Bissell, H. J., 1952, Stratigraphy and structure of northeast Strawberry

Attachment 1, Job No. WW-6

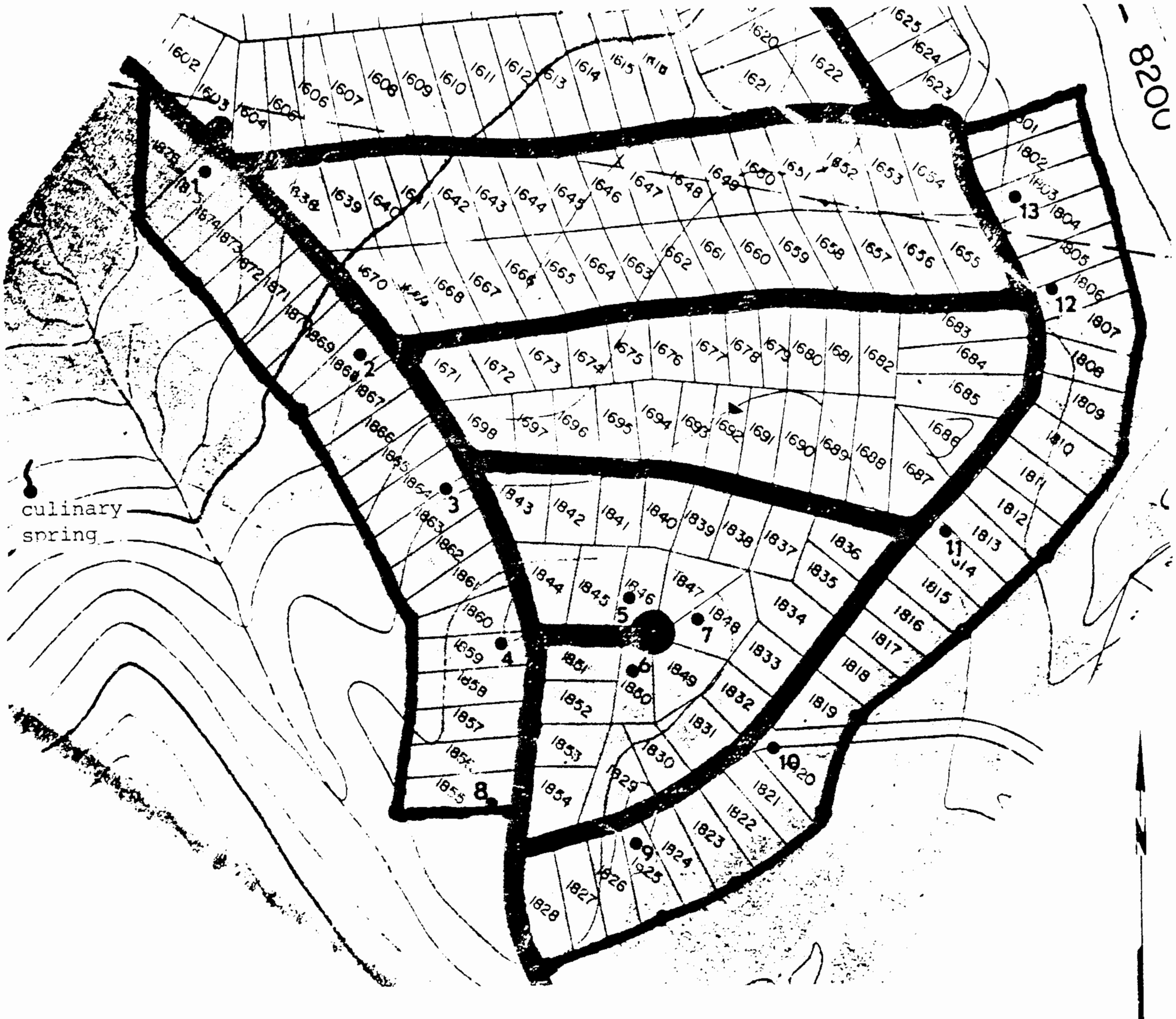
Base map from USGS 7½ minute topographic quadrangle, Heber Mountain, Utah and from Salt Lake City, Utah; Wyoming 2° USGS map



General location map Timberlakes, Plat 18

Attachment 2, Job No. WW-6

Base map from Timberlakes Plat 18



Shaded area is plat 18

Scale 1" ≈ 400'

Culinary spring, lots, and test pit locations

Attachment 3, Job No. WW-6

Test Pit Logs*

Test Pit 1

0.0' - 1.2' Fill material, coarse sandy gravel.

1.2' - 2.7' Gravelly lean clay (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 25 percent gravel, 5-10 percent sand.

2.7' - 10.4' Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, nonindurated, moist; 25 percent gravel, 20 percent cobbles.

Test Pit 2

0.0' - 1.0' Lean clay with sand (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 15 percent sand.

1.0' - 2.5' Sandy lean clay with gravel (CL); red brown-light brown, very stiff, medium plasticity, nonindurated, dry; 25 percent sand, 25 percent gravel.

2.5' - 6.2' Silty sand (SM); light brown, medium dense, nonplastic, nonindurated, dry; 25 percent fines.

6.2' - 9.0' Fat clay (CH); brown-red brown, very stiff, medium plasticity, nonindurated, dry; 10 percent sand.

Note: Ground water encountered at 9.0 feet below ground surface.

Test Pit 3

0.0' - 2.3' Lean clay with sand (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 15 percent sand.

2.3' - 9.8' Fat clay with gravel (CH); yellow brown, hard, highly plastic, nonindurated, dry to moist; 15 percent gravel.

Test Pit 4

0.0' - 3.8' Sandy lean clay with gravel (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 20 percent sand, 20 percent gravel.

3.8' - 9.8' Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, nonindurated, dry; 20 percent gravel, 15 percent cobbles.

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

Test Pit 10

0.0' - 2.7'	Fill material, coarse sand and gravel.
2.7' - 4.1'	Sandy lean clay (CL); topsoil, dark gray-black, firm, low to no plasticity, nonindurated, moist; 20 percent sand.
4.1' - 7.6'	Gravelly fat clay (CH); dark gray-black, very stiff, highly plastic, nonindurated, moist to wet; 25 percent gravel.

Note: Ground water encountered at 7.6 feet below the ground surface. Subtract thickness of fill material for actual depth to water.

Test Pit 11

0.0' - 2.0'	Gravelly lean clay with sand (CL); topsoil, dark gray-black, firm, low to no plasticity, nonindurated, moist; 15 percent sand, 20 percent gravel.
2.0' - 4.7'	Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, induration increases with depth (from stage I to stage II caliche), dry to moist; 30 percent gravel, 20 percent cobbles.
4.7' - 9.4'	Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, moderately indurated (stage II/stage III caliche), dry to moist; 30 percent gravel, 20 percent cobbles.

Test Pit 12

0.0' - 1.7'	Gravelly lean clay with sand (CL); topsoil, dark gray-black, soft, low plasticity, nonindurated, dry; 15 percent sand, 20 percent gravel.
1.7' - 4.5'	Lean clay with gravel (CL); dark gray-dark brown, firm, low to medium plasticity, nonindurated, dry; 15 percent gravel.
4.5' - 9.7'	Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, nonindurated, dry; 30 percent gravel, 20 percent cobbles.

Test Pit 13

0.0' - 1.4'	Gravelly lean clay with sand (CL); topsoil, dark gray-black, soft, low plasticity, nonindurated, dry; 15 percent sand, 20 percent gravel.
1.4' - 8.8'	Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, nonindurated, dry; 30 percent gravel, 20 percent cobbles, minor caliche coatings on cobbles and gravel at depth.

Test Pit 5

0.0' - 1.8'	Lean clay with gravel (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 15 percent gravel.
1.8' - 7.6'	Sandy fat clay with gravel (CH); brown, hard, highly plastic, nonindurated, dry; 20 percent sand, 20 percent gravel.

Test pit 6

0.0' - 1.0'	Lean clay with gravel (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry; 15 percent gravel.
1.0' - 9.2'	Gravelly fat clay with cobbles (CH); brown, hard, highly plastic, nonindurated, dry; 30 percent gravel, 15 percent cobbles.

Test Pit 7

0.0' - 1.0'	Lean clay with sand (CL); topsoil, dark brown-black, soft, low plasticity, nonindurated, dry.
1.0' - 2.3'	Gravelly lean clay (CL); dark gray, stiff, low to medium plasticity, nonindurated, dry; 15 percent gravel.
2.3' - 7.4'	Sandy fat clay with gravel and cobbles (CH); brown, hard, highly plastic, nonindurated, dry; 20 percent sand, 15 percent gravel, 15 percent cobbles.

Test Pit 8

0.0' - 1.0'	Sandy lean clay with gravel (CL); topsoil, dark gray-black, soft, low plasticity, nonindurated, dry; 25 percent sand, 15 percent gravel.
1.0' - 3.8'	Gravelly fat clay (CH); brown, hard, highly plastic, nonindurated, dry; 35 percent gravel.
3.8' - 4.6'	Sand/silt (SM/ML); tan, medium dense/stiff, low to no plasticity, nonindurated, dry; 50 percent very fine sand, 50 percent silt.
4.6' - 8.9'	Clayey gravel with sand (GC); brown, high density, medium to high plasticity, nonindurated, dry; 25 percent sand, 40 percent gravel, 25 percent fines

Test Pit 9

0.0' - 1.9'	Lean clay with sand (CL); topsoil, dark gray-black, firm, low plasticity, nonindurated, dry.
1.9' - 3.9'	Fat clay with gravel and cobbles (CH); brown, very stiff, highly plastic, nonindurated, moist; 20 percent gravel, 15 percent cobbles.

Note: Ground water encountered at 3.9 feet below the ground surface.

Project:			Requesting Agency:
Geologic evaluation of three subdivisions in Duchesne County for installation of septic tank and soil absorption field wastewater disposal systems.			Utah Division of Environmental Health and Uintah Basin Health Dept.
By: W.R. Lund	Date: 11/13/85	County: Duchesne	Job No.: WW-7
USGS Quadrangle: Hancock Cove (1075); Roosevelt (1074)			

#85-036

In response to a request from Mr. Steven Thiriot, Utah Division of Environmental Health, and Mr. Lowell Card, Uintah Basin Health District, an investigation was made of the Crescent Heights, Black Powder Ranchetts, and Pleasant View Acres Subdivisions in Duchesne County. The purpose of the investigation was to evaluate site soil and geologic conditions with regard to suitability for individual wastewater disposal systems using septic tank and soil absorption fields. The scope of work consisted of a review of both published and unpublished information, including test pit logs and percolation test results provided by the developer; a field reconnaissance on October 22, 1985; and examination of test pits at all three subdivisions. Messers. Thiriot and Card were present during the field inspections, as were members of Mr. Card's staff. Jerry Allred, the developer's engineer, was present during the field visit to the Crescent Heights Subdivision.

Crescent Heights Subdivision

The Crescent Heights Subdivision is located about 2.5 miles north of Roosevelt, Utah in sec. 4, T. 2 S., R. 1 W. of the Uintah Special Base and Meridian. It consists of six lots ranging in size from 2.5 to 5 acres. The subdivision is on a pediment at the base of Harmston Bench west of Pickup Wash (attachment 1). The pediment surface is gently undulating with a slope of 1 to 3 degrees to the east. The Roosevelt Lateral, a deeply incised unlined irrigation canal, borders the property on the west. Vegetation is sparse and consists chiefly of low brush and grass. A residence approximately 0.5 miles north of the subdivision was observed to have a failing soil absorption system at the time of the field reconnaissance.

Harmston Bench is comprised of the Eocene- to possibly Oligocene-age Dry Gulch Creek Member of the Duchesne River Formation (Rowley and others, 1985). The Dry Gulch Creek Member is about 490 feet thick and consists of soft to moderately resistant, light- to medium-gray, medium-red, purplish-gray, and yellow mudstone, shale, sandstone, and conglomerate. As the formation weathers and erodes, the front of the bench recedes and alluvium and colluvium are deposited on the pediment forming at the base of the bench.

Three test pits were excavated at the subdivision (attachment 1). Detailed soil logs are presented in attachment 2. Test pits 1 and 2 showed high plasticity, very stiff to hard clays through most of their depth. The upper soil layers appeared sandy, but the sand consisted of soft gypsum crystals that quickly dissolved when water was added to the soil. Veinlets of gypsum up to 0.1 feet thick were present, and it is estimated that some soil horizons were more than 30 percent gypsum. The clay in test pit 2 had such high dry strength that the backhoe could only proceed with great difficulty, and the excavation was terminated at 5.9 feet. Test pit 3 showed nearly 2 feet of sandy (gypsiferous) lean clay over more than 1.5 feet of high plasticity fat clay believed to have formed inplace by weathering of the

Duchesne River Formation. Weathered purple shale bedrock was encountered at a depth of 3.4 feet immediately below the residual clay soil. Examination of the sides of the Roosevelt Lateral at the west end of the subdivision showed a similar profile. There, about one foot of gypsum rich clay containing abundant plant roots overlays approximately 4 feet of residual fat clay that grades downward to a purple shale containing abundant gypsum veinlets. Ground water was not encountered in any of the test pits and is estimated to be at least 15 feet below the ground surface and possibly much deeper.

The soils at Crescent View Subdivision are predominately high plasticity CH clays (ASTM 2488-84) containing a large percentage of soluble gypsum. They can be expected to exhibit low to very low permeability and moderate to high shrink-swell capacity. Percolation tests may give anomalously fast results due to the interconnecting system of cracks associated with the columnar and blocky secondary soil structure developed in the clay. Upon continuous wetting, the clay would swell and close the cracks. Bedrock beneath the subdivision is chiefly low permeability shale and mudstone and is present at shallow depth (3-5 feet) at the west end of the property. A potential also exists for drainfield leachate to dissolve gypsum in the surrounding soil and alter or even reverse the grade along drainfield distribution lines. For the above reasons, installation of septic tank and soil absorption field wastewater disposal systems is not recommended at this subdivision.

Black Powder Ranchetts Subdivision

Black Powder Ranchetts Subdivision is about 3.5 miles northwest of Roosevelt, Utah in sec. 5, T. 2 S., R. 1 W. of the Uintah Special Base and Meridian. The subdivision consists of 10 lots ranging in size from 5 to 8 acres. The property is bounded on the west by State Highway 121 and extends eastward to the top of Harmston Bench (attachment 1). An intermittant drainage crosses the subdivision at the base of the bench in a north-south direction. Slopes over most of the property are gentle (2 to 3 degrees) to the southeast, but are steep (20 degrees plus) to the west on the side of the bench. Vegetative cover is heavy along the drainage, but moderate elsewhere, consisting mostly of low brush and grass.

Harmston Bench is comprised of shale, mudstone, and siltstone of the Dry Gulch Creek Member of the Duchesne River Formation. Outcrops are not common due to the soft, easily eroded nature of the rock. The bench is capped by a layer of cemented river terrace gravel that appears to be 4 to 10 feet thick. Colluvium predominates on the side of the bench, and a combination of colluvium and alluvium covers the remainder of the subdivision.

Four test pits previously excavated by the developer were examined during the field reconnaissance. Test pits 1, 7, and 9 (test pit numbers reflect the lot on which they were excavated) encountered shale or mudstone bedrock at depths ranging from 3.8 to 7.6 feet (attachment 2). Shale and siltstone in the spoil pile for test pit 3 indicate that bedrock is also present there, but ground water standing in the excavation obscured the contact. Generally, the soils overlying bedrock consisted of CL and CH clays with abundant gypsum. In some cases, gypsum crystals made the clay sandy, but quickly dissolved when water was added to the soil. However, test pit 3, which was close to the drainage, exposed 2.7 feet of high plasticity clay over 3.4 feet of green, low plasticity clayey silt. Total thickness of the silt unit is not known due to the presence of ground water in the test pit, but if bedrock was also encountered in the excavation as indicated by the spoil pile, total thickness of the silt unit probably does not exceed 4.5 feet. Abundant phreatophytic vegetation along the drainage defines a zone of shallow ground water across the site. Depth to water in test pit 3 was 6.1 feet, but is expected to be higher in the spring and during the irrigation season. The area of the subdivision affected by high ground water includes portions of lots 3, 4, 7, and 8.

Conditions at this subdivision are not well suited for installation of septic tank and soil absorption field systems. Most soils are medium to high plasticity clays that would exhibit low to very low permeability and moderate to high shrink-swell capacity. Bedrock is shallow across much of the subdivision and high ground water is present along the drainage. Since test pits were not excavated on top of Harmston Bench, the potential for installing systems there is unknown. Factors that would affect siting of systems on the bench include: the thickness of the gravel horizon, the extent to which the gravel is cemented by caliche, and the amount of room on the lots to accomodate required setback distances from bench side-slopes. The clayey silt horizon in test pit 3 was the only soil observed that appears to be usable in a soil absorption field, and then only in areas not affected by shallow bedrock or high ground water. The silty unit is probably a residual soil developed on siltstone in the underlying Duchesne River Formation. Observation of bedrock in the test pits and in limited outcrops near the subdivision indicates that siltstone is not a common rock type in the area. Therefore, it is likely that the clayey silt unit is not widespread. Lot by lot investigation would be required to determine if soil absorption systems can be successfully installed, but given the overall geologic and soil conditions at the subdivision, the likelihood of finding more than one or two acceptable sites is considered low.

Pleasant View Acres Subdivision

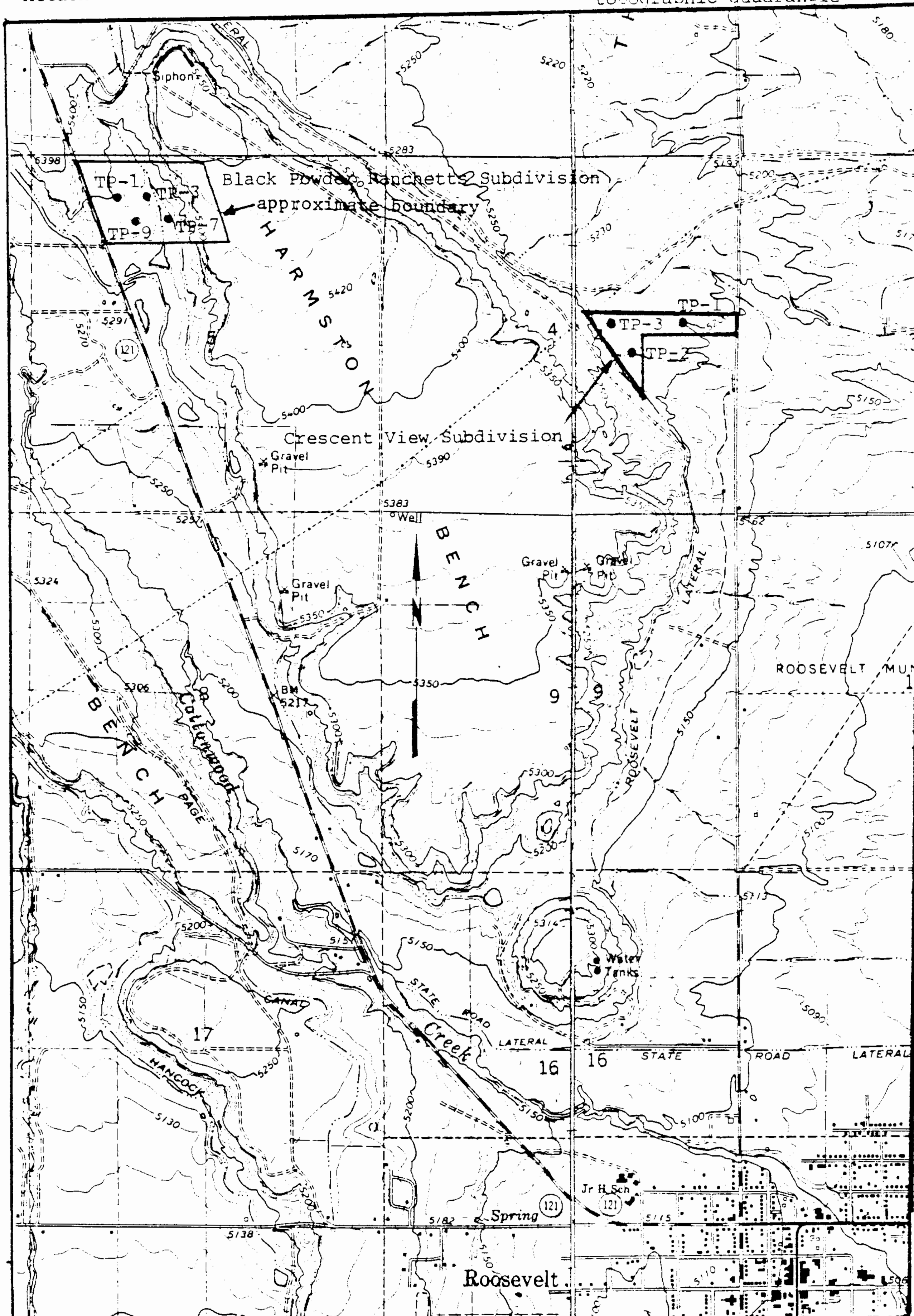
Pleasant View Acres Subdivision is located approximately 7.5 miles northwest of Roosevelt, Utah in sec. 35, T. 1 S., R. 2 W. of the Uintah Special Base and Meridian (attachment 3). It includes 18 lots ranging in size from 5 to about 10 acres. The subdivision is on a pediment that grades to the east from uplands separating Dry Gulch and Cottonwood Creeks. The surface of the pediment is undulatory, with an overall gentle slope (3 to 5 degrees) to the east. Vegetation is sparse, consisting chiefly of low brush ad grass. One lot is occupied by a residence, the remainder of the subdivision is vacant.

The pediment surface is underlain at shallow depth by the Duchesne River Formation (Stokes and Madsen, 1961). Small, isolated outcrops of sandstone were observed in the subdivision, and surface soils consist of poorly graded sand and silty sand. The sand layer is thin, ranging from 0.5 to 3.8 feet thick in the 5 test pits previously excavated on the property by the developer (attachnent 2). Beneath the sand all of the test pits encountered high plasticity CH clay. In addition, test pits 5, 7, and 7a (test pit numbers reflect the lot on which they were excavated) exposed shale bedrock. Pieces of shale in the spoil pile for test pit 2 indicate that bedrock was also encountered there, but the contact was obscured by ground water standing in the excavation. Depth to water in test pit 2 was 8.7 feet. It is anticipated that the water table beneath the subdivision fluctuates with the seasons and will be highest in the spring. Due to the multicolored nature of the clay in test pit 2, soil mottling could not be positively identified and the extent of water-table rise is not known. The area of the subdivision that appears to be susceptible to high ground water includes the northern portions of lots 1, 2, 3, 4, 5 and 6.

The sandy surface soils at the subdivision are derived from the weathering of the sandstone that crops out on-site. The sandstone strata is thin, has been entirely removed by erosion in many areas, and rests on shale and mudstone. The sand horizon would be adequate for installation of septic tanks and soil absorption fields provided a sufficient thickness were present to meet State Health Code regulations. However, based on existing test pits, the sand layer is too thin to meet current requirements and is underlain by low permeability, high plasticity clays not considered suitable for soil absorption systems. In addition, depth to bedrock is shallow across much of the site and high ground water occurs locally. Therefore, septic tank and soil absorption systems are not recommended in this subdivision.

Attachment 1, Job No. WW-7

Base map USGS Roosevelt, Utah topographic quadrangle



Map showing the location of Cresent View and Black Powder Ranchetts Subdivisions

Scale 1:24,000

Attachment 2, Job No. WW-7

Crescent Heights Subdivision
Test Pit Logs*

Test Pit 1

0.0' - 2.7' Sandy fat clay; (CH), brown, about 30 percent angular fine sand, soft consistency, high plasticity, dry, weak cementation; sand consists of gypsum crystals that dissolve when water is added, plant roots.

2.7' - 4.7' Sandy fat clay; (CH), brown, about 30 percent angular fine sand, hard consistency, high plasticity, dry, weak cementation; sand consists of gypsum crystals.

4.7' - 7.8' Fat clay; (CH), red-brown, very hard consistency, high plasticity, dry, weak cementation; blocky secondary soil structure, gypsum veinlets, very high percentage of fine-grained gypsum disseminated through the soil.

Test Pit 2

0.0' - 1.6' Fat clay with sand; (CH), brown, about 15 percnt angular fine sand, firm consistency, high plasticity, dry, weak cementation; sand consists of gypsum crystals that dissolve when water is added, plant roots.

1.6' - 5.9' Fat clay; (CH), brown, very hard consistency, high plasticity, dry, weak cementation; high percentae of fine-grained gypsum disseminated through soil.

Note. The lower clay unit in this test pit had such high dry strenth and was so hard that excavation was terminated due to the very slow progress being made by the backhoe.

Test Pit 3

0.0' - 1.8' Sandy lean clay; (CL), medium brown, about 35 percent angular coarse sand, firm consitency, low to medium plasticity, dry weak cementation; sand consists of gypsum crystals that dissolve when water is added, plant roots.

2.8' - 3.4' Fat clay with gravel; (CH), purple, about 25 percent gravel, hard consistency, medium plasticity, dry, residual soil developed on shale bedrock.

Black Powder Ranchetts Subdivision

Test Pit 1

0.0' - 4.7' Fat clay; (CH), brown, hard consistency, high plasticity, dry, weak to moderate cementation; early stage II caliche development, well developed columnar/blocky secondary soil structure, abundent fine gypsum.

4.7' - 6.5' Gypsum; light brown, fine grained, moderately indurated layer of compact gypsum crystals in a clay matrix.

6.5' - 7.6' Fat clay; (CH), brown, hard consitency, high plasticity, dry, weak to moderate cementation; stage I caliche development.

7.6' - 9.7' Shale; bedrock, variegated red-purple-green, highly weathered.

Test Pit 3

0.0' - 2.7' Lean to fat clay; (CL/CH), brown, hard consistency, medium to high plasticity, dry, weak to moderate cementation; stage I caliche development, blocky secondary soil structure.

2.7' - 6.1' Clayey silt; (ML), green, soft to stiff consistency, low to medium plasticity, dry to wet with depth; residual soil developed on shale bedrock.

Note: Ground water encountered at 6.1 feet. Pieces of shale on the spoil pile indicate that bedrock was encountered, but ground water obscures the contact.

Test Pit 7

0.0' - 1.8' Lean clay with sand; (CL), brown, about 15 percent medium sand, stiff to hard consistency, medium plasticity, dry, weakly cemented; sand consists of gypsum crystals that dissolve when water is added, blocky secondary soil structure.

1.8' - 3.8' Interbedded shale and sandy mudstone; bedrock, gray to olive-gray, highly to moderately weathered with depth.

Test Pit 9

0.0' - 2.8' Sandy lean clay; (CL), brown, stiff consistency, low plasticity, dry, moderately cemented; sand consists mostly of gypsum crystals that dissolve when water is added, blocky secondary soil structure.

2.8' - 5.3' Gypsum; light-brown, moderately indurated layer of compact gypsum crystals in clay matrix.

5.3' - 9.2' Mudstone; bedrock, brown to yellow-brown, moderately weathered, abundant gypsum.

Pleasant View Acres Subdivision

Test Pit 2

0.0' - 1.8' Silty sand; (SM), brown, about 70 percent fine sand and 30 percent silty fines with low plasticity, dry.

1.8' - 8.7' Fat clay; (CH), variegated purple-yellow-brown, hard consistency, high plasticity, dry to wet with depth, weakly cemented.

Note: Ground water encountered at 8.7 feet. Pieces of shale on the spoil pile indicate that bedrock was encountered, but ground water obscures the contact.

Test Pit 5

0.0' - 0.5' Silty sand; (SM), brown, about 70 percent medium sand and 30 percent silty fines with low plasticity, dry.

0.5' - 2.9' Fat clay; (CH), variegated purple-green, hard consistency, high plasticity, dry, weakly cemented; residual soil developed on shale.

2.9' - 6.3' Shale with interbedded sandstone; bedrock, purple, moderately weathered.

Test Pit 7

0.0' - 2.3' Silty sand; (SM), brown, about 60 percent medium sand and 40 percent silty fines with low plasticity, dry.

2.3' - 3.9' Fat clay; (CH), olive-green, stiff consistency, high plasticity, dry, weakly cemented; residual soil developed on shale.

3.9' - 8.5' Shale; bedrock, variegated purple-green, highly to moderately weathered with depth.

Note: Test pit 7a showed approximately the same profile as that exposed in test pit 7.

Test Pit 18

0.0' - 3.8' Poorly graded sand; (SP), red-brown, 90 percent fine, subrounded to rounded sand, dry, weakly cemented; discontinuous layer of stage II caliche.

3.8' - 6.0' Fat clay, (CH), green, very hard consistency, high plasticity, dry, weakly cemented; caliche stringers, well developed columnar secondary soil structure.

6.0' - 9.1' Lean to fat clay; (CL/CH), purple, stiff consistency, low to medium plasticity, dry, weakly cemented.

*Soils classified in accordnace with procedures outlines in ASTM Standard D 2488-84. Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

Selected References

American Society for Testing Materials, 1984, Standard practice for description and identification of soils (visual-manual procedure): Designation: D 2488-84, 15 p.

Corrara, P.E., 1980, Surficial geologic map of Vernal 1° X 2° Quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Investigation Series Map I-1204, scale 1:250,000.

Hood, J.W., 1976, Characteristics of aquifers in the northern Uinta Basin area, Utah and Colorado: State of Utah Department of Natural Resources Technical Publication No. 53, prepared in cooperation with the U.S. Geological Survey, 71 p.

Hood, J.W., and Fields, F.K., 1978, Water resources of the northern Uinta Basin area, Utah and Colorado, with special emphasis on ground-water supply: State of Utah Department of Natural Resources Technical Publication No. 62, prepared in cooperation with the U.S. Geological Survey, 73 p.

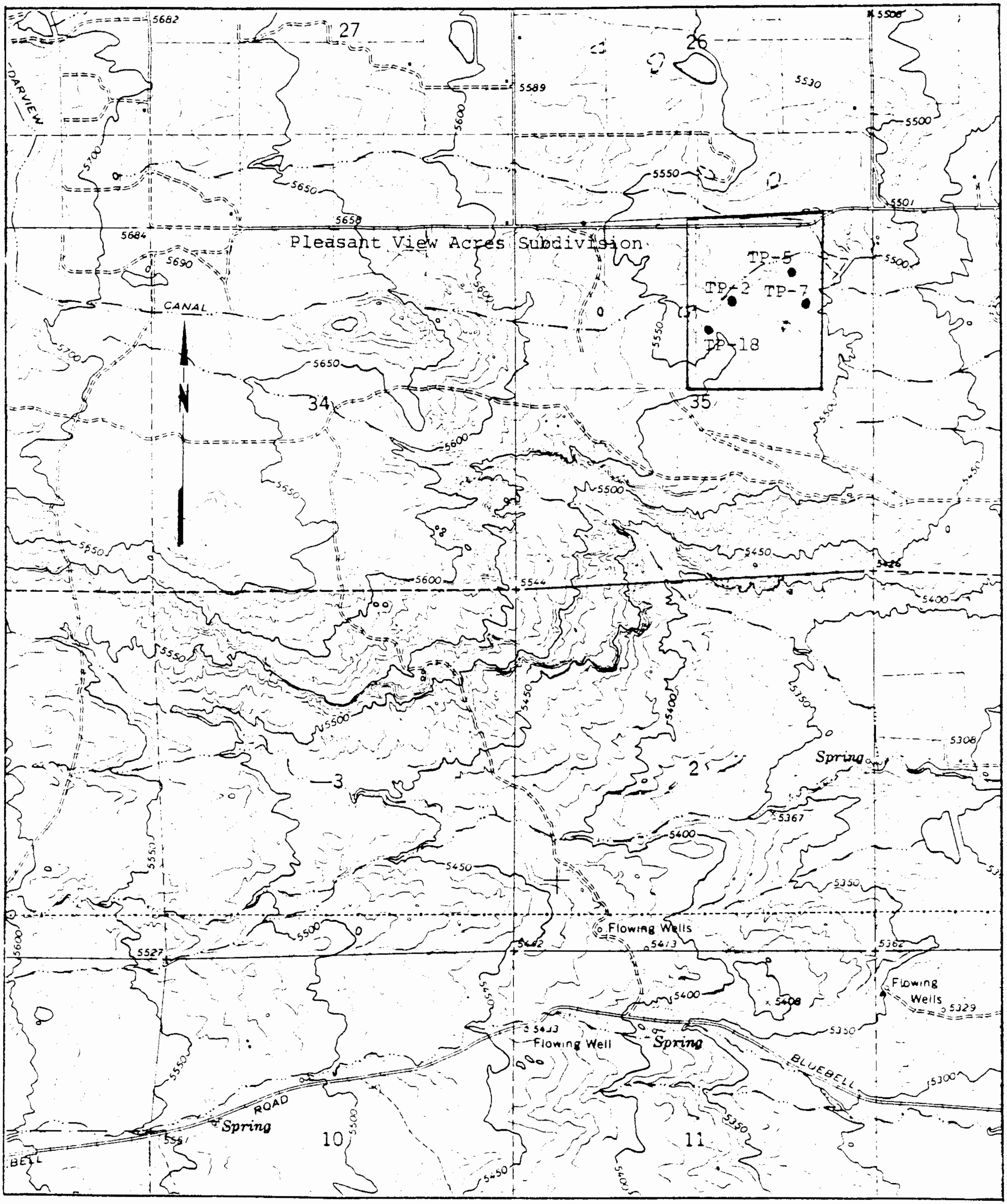
Rowley, P.D., and others, 1985, Geologic map of the Vernal 1° X 2° Quadrangle, Colorado, Utah, and Wyoming: U.S. Geological Survey Miscellaneous Investigation Series Map I-1526, scale 1:250,000.

Stokes, W.L., and Madsen, J.H., Jr., 1961, Geologic map of Utah, northeast quarter: College of Mines and Mineral Industries, University of Utan, scale 1:250,000.

Wilson, Le Moyne, and others, 1959, Soil survey of Roosevelt-Duchesne area, Utah: U.S. Soil Conservation Service in cooperation with the Utah Agricultural Experiment Station, 61 p.

Attachment 3, Job No. WW-7

Base map USGS 7½' Hancock Cove, Utah topographic quadrangle



Map showing the location of Pleasant View Acres Subdivision. Scale 1:24,000

Utah Geological and Mineral Survey

Site Investigation Section

Project:			Requesting Agency:
Suitability of calcium carbonate deposits near Midway, Utah for installation of individual wastewater disposal systems.			Wasatch County Health
By: H. Gill	Date: 12/4/85	County: Wasatch	Job No.: WW-8
USGS Quadrangle: Heber City (1168)			

#85-037

PURPOSE AND SCOPE OF WORK

In response to a request from Mr. Phillip Wright, Wasatch County Health Department, the Utah Geological and Mineral Survey has performed a geologic inspection of an area of extensive calcium carbonate deposits near Midway, Utah. The purpose of the inspection was to evaluate geologic conditions in the area and assess their suitability for installation of individual wastewater disposal systems (septic tanks and soil absorption fields).

The scope of the investigation included a review of available geologic, soil, and hydrologic information for the area, examination of stereo aerial photographs, and review of 26 water/exploration well logs on file with the Utah Division of Water Rights. Two days were spent in the field mapping and checking geologic relationships, inspecting road cuts, and logging an excavation for a home and adjacent septic tank. Excavation of test pits and borings was beyond the scope of the project.

LOCATION AND GENERAL DESCRIPTION

The Midway Hot Springs are located in and around the town of Midway, Utah, in the northwest corner of Heber Valley (attachment 1). Two types of thermal springs occur in the area: 1) pools that occupy craters in conical or hemispherical mounds of calcium carbonate (known locally as "hot pots"), and 2) springs that flow from cracks or openings in the calcium carbonate (Kohler, 1979). The springs are surrounded by extensive deposits of calcium carbonate that form a low terrace underlain by alluvium. The deposits, which cover an area of approximately 4.5 square miles, are locally more than 100 feet thick (Kohler, 1979). Although the hot pots are not very active at present, they are by no means extinct. Calcium carbonate is still being deposited around the orifice of the flowing springs.

GEOLOGY AND SOILS

The generalized geology of the area is shown in attachment 1 (Kohler, 1979). Midway Hot Springs are on the east flank of the Wasatch Mountains, south of the east-west trending Uintah arch, and on the axis of the Park City anticline. The Charleston thrust fault is the major structural feature to the south. Folded and faulted Paleozoic and Mesozoic sedimentary rocks are found in the Wasatch Range to the west, Tertiary intrusive stocks to the north, and Tertiary volcanic rocks to the northeast (Konler, 1979).

Baker (1968) feels that meteoric water is heated at depth and returns to the surface through fractures in the rocks. When rising mineralized waters near the surface, a drop in confining pressure causes a loss of dissolved carbon dioxide and results in deposition of calcium carbonate. There are two types of calcium carbonate deposits: tufa, which is typically soft, spongy, and porous; and travertine which is dense, crystalline, and laminar. Both types are found in the study area. The tufa observed during the investigation was soft, vesicular, buff to tan, and weathered to a dirty gray. Although tufa is primarily found on or near the surface it has been described throughout the total thickness of the calcium carbonate deposit (Kohler, 1979). The travertine was moderate to very hard, massive, and tan to white. Travertine is often found at depth but also occurs on or near the surface. The carbonate deposits in the study area exhibit a complete range of densities. Permeability is generally reflected by the density of the deposit. Vesicular tufa may have moderate to high permeability, while laminar travertine can be impermeable. Baker (1968) states that well logs in the area show an older deposit of calcium carbonate at depth overlain by alluvium, and suggests that the hot pots have gone through at least two cycles of activity. Five of the 26 well logs reviewed showed possible deeper deposits of calcium carbonate and alluvium. However, the quality of the logs is poor and the validity of interpretations made from them questionable. The principal problem is determining if the alluvial deposits described are gravel deposits or pieces of broken travertine. In any case, the deeper alluvial deposits are well below the level at which individual wastewater disposal systems would be installed.

The U. S. Soil Conservation Service (SCS) has described the major soil types found in association with calcium carbonate as follows: 1) Cudahay Variant; poorly drained soils formed on beaches and terraces in mixed alluvium over travertine (the SCS does not make a distinction between travertine and tufa). The travertine is encountered at a depth of about 26 inches below moderately permeable soils. 2) Rock Land, travertine; exposed travertine and areas mantled with up to 5 inches of soil. 3) Spaa Series; well-drained soils formed on terraces in alluvium and residuum from travertine deposits. Travertine is found in irregular masses at about 17 inches below moderately permeable soils. These soil types, and others mapped by the SCS have been used to develop a map delineating depth to calcium carbonate (attachment 2). Depth catagories include 5 to 20 inches, 20 to 36 inches, and greater than 36 inches. Data from wells showing thickness of calcium carbonate deposits (Kohler, 1979) have also been included on this map. Contacts between SCS soil units are generally irregular and gradational and represent zones of transition rather than distinct contacts. The soil/calcium carbonate contacts shown on attachment 2 are primarily those of the SCS, therefore, the same cautions concerning the accuracy of these contacts apply to this map.

HYDROLOGY

It is proposed by Baker (1968), that the source of the water for the hot pots and thermal springs is meteoric water that has descended along fractures and solution openings to great depths, where it is heated and, under artesian conditions, returns to the surface through fractures in the rock. Kohler (1979) believes that the source is not so deep but that the meteoric water enters the system to the north of Midway where it is heated by shallow, young, igneous intrusives. The heated water then moves laterally along the Dutch Hollow and Pine Creek faults and in fractures in the Weber Quartzite and underlying carbonate rocks until it comes to the surface under artesian pressure along minor faults at the north edge of the area and through fractures along the crest of the Park City anticline. In either case, the meteoric water returns to the surface under artesian pressure. Well logs and SCS data show that shallow unconfined ground water is also present in portions of the study area. Mixing of the shallow ground water and the artesian water has been documented by both Baker and Kohler. Although the shallow ground water cannot migrate downward against the artesian pressure, once the pressure has stabalized at or near the surface, mixing can occur.

Using SCS data and field observations, a map has been prepared showing depth to shallow ground water (attachment 3). The map shows shallow ground water at depths of 10 to 20 inches, 20 to 40 inches, 40 to 60 inches, and greater than 60 inches below ground surface.

SUITABILITY FOR WASTEWATER DISPOSAL SYSTEMS

According to the SCS soil survey for the Heber Valley (Woodward and others, 1976), soil conditions in the study area generally present severe limitations for individual wastewater disposal systems. Limitations are primarily due to shallow ground water, near surface calcium carbonate deposits, or both. It is evident from drill logs, road cuts, and other excavations that calcium carbonate can be encountered at shallow depth throughout the study area (attachment 2). The following soil log was made in a septic tank excavation near Warm Ditch Spring in the northern portion of the study area (located where the calcium carbonate deposit is 45' thick, attachment 2).

0.0' - 0.5' Tufa; yellow brown, loose, nonplastic, dry; able to excavate with hand pick and shovel.

0.5' - 2.2' Sand with silt (SM); tan, low density, nonplastic, dry.

2.2' - 3.0' Tufa; light gray, medium dense, nonplastic, dry; low permeability, excavated with backhoe, however, drill holes were evident (possibly a jack hammer to break up tufa).

3.0' - 3.9' Lean clay with sand (CL); light brown, firm, low plasticity, moist; some tufa in horizon.

3.9' - 5.5' Travertine; white, high density, nonplastic, dry; laminated, impermeable; excavated with backhoe, however, drill holes were evident (possibly a jack hammer to break up travertine), excavation terminated at 5.5 feet.

The Utah Department of Health (UDH) regulations for individual wastewater disposal systems require at least four feet of "suitable soil" above bedrock or other impervious strata. The UDH defines "suitable soil" as one that: 1) adequately disperses the desired effluent loading, 2) does not exhibit swelling or collapsing characteristics, 3) does not exhibit a fractured pattern of underlying bedrock, 4) is not consolidated, cemented, indurated, or plugged by a buildup of secondary calcium carbonate, and 5) acts as an effective effluent filter. The travertine in the last two feet of the excavation is impermeable and for purposes of the UDH regulations would be considered bedrock or an impervious strata. The soil profile presented above is typical of many exposures observed in the Midway Hot Springs area. Dense impermeable travertine may be encountered at any depth, and often four feet of "suitable soil" is not present. While vesicular tufa may be moderately permeable (Baker, 1968) and capable of being included with soils suitable for soil absorption systems, the more dense travertine serves as an impermeable barrier to effluent movement which could result in failure of the soil absorption system.

It is evident from examination of existing excavations and road cuts that the soil horizons interbedded with the calcium carbonate deposits may not be laterally continuous over large areas. Siting of individual wastewater disposal systems would require a sufficient number of test pits to confirm the presence of suitable soils across the proposed drain field site.

Areas of shallow ground water have been identified in the study area (attachment 3). Effluent from wastewater disposal systems installed in these locations may reach the shallow water table by verticle migration through permeable tufa deposits, or by lateral migration along dense, laminar travertine deposits. There has been documented mixing of the shallow ground water and meteoric waters in the area by Baker (1968) and Kohler (1979). Although there should be no danger of pollution entering the deep meteoric system that supplies the hot springs (due to upward artesian pressure), pollution of the individual hot pots and thermal springs is possible.

RECOMMENDATIONS

The variable conditions found in the study area make it necessary to assess wastewater disposal systems on a site by site basis. The following recommendations are made to assist in that evaluation.

1) Very dense deposits of travertine are present in the study area and should be treated as bedrock when characterizing a site for individual wastewater disposal systems. More permeable deposits of tufa are also present and where interbedded with other suitable soil units should prove acceptable for use in soil absorption systems. A complete range of densities exists between the tufa and travertine and the following characteristics should be noted for identification.

    a) Loose to low density, friable tufa is easily broken with a hand pick, exhibits moderate to high permeability, has visable pore spaces, and is light weight. These deposits should be acceptable for use in individual absorption systems.

    b) Medium dense, laminar tufa exhibits a complete range of hardness; from difficult to excavate with a hand pick to requiring a backhoe for excavation. These deposits also have a wide range of permeabilities and may require a percolation test to qualify them as "suitable soil".

    c) Very dense, laminar travertine deposits are too difficult for a backhoe to excavate and are impermeable. For purposes of the UDH regulations these deposits should be considered bedrock. In some instances, these dense deposits are not thick and may be broken through. If this is the case, and there is adequate "suitable soil" beneath the horizon the site may be acceptable for individual absorption systems.

2) Suitable soils may be interbedded with deposits of tufa. However, it has been observed that the lateral continuity of the soil can seldom be demonstrated over a large area. Test pits or drill holes should be excavated to ensure that there is adequate area and volume of suitable soil available for the size of the absorption field required. It is recommended that at least three test pits or drill holes be made at each site, and more when the size of the drain field requires it.

3) Both deep meteoric ground water and shallow ground water are present in the study area. Baker (1968) and Kohler (1979) documented a direct hydrologic connection between shallow ground water and meteoric water in the hot pots and thermal springs. The less dense vesicular tufa deposits have moderate to high permeability and may allow effluent to percolate vertically to the shallow water table. Effluent may also migrate laterally along impervious travertine deposits and reach the shallow water table if an area of higher permeability is intercepted. Therefore, areas of high ground water should be avoided whenever possible, and at a minimum Wasatch County regulations requiring a 4-foot separation from ground water should be followed rather than the 2-foot separation in UHD regulations.

SELECTED REFERENCES

Baker, C. H., Jr., 1968, Thermal springs near Midway, Utah, in Geological Survey Research 1968, chapter D: U. S. Geological Survey Professional Paper 600-D, p. D63-D70.

Bromfield, C. S., Baker, A. A., and Crittenden, M. D., Jr., 1970, Geologic map of the Heber Quadrangle, Wasatch and Summit Counties, Utah: U. S. Geological Survey Geologic Quadrangle Map GQ-864, scale 1:24,000.

Bryan, Kirk, 1919, Classification of springs: Journal of Geology, v. 27, p. 522-561.

Collinson, J. D., and Thompson, D. B., 1982, Sedimentary structures: Boston, George Allen & Unwin, 194 p.

Franks, A. L., 1972, Geology for individual sewage disposal systems: California Geology, September 1972, p. 195 - 203.

Goode, H. D., 1978, Thermal waters of Utah: Utah Geological and Mineral Survey Report of Investigation No. 129, 183 p.

Hem, J. D., Study and interpretation of the chemical characteristics of natural water: U. S. Geological Survey Water-Supply Paper 1473, 363 p.

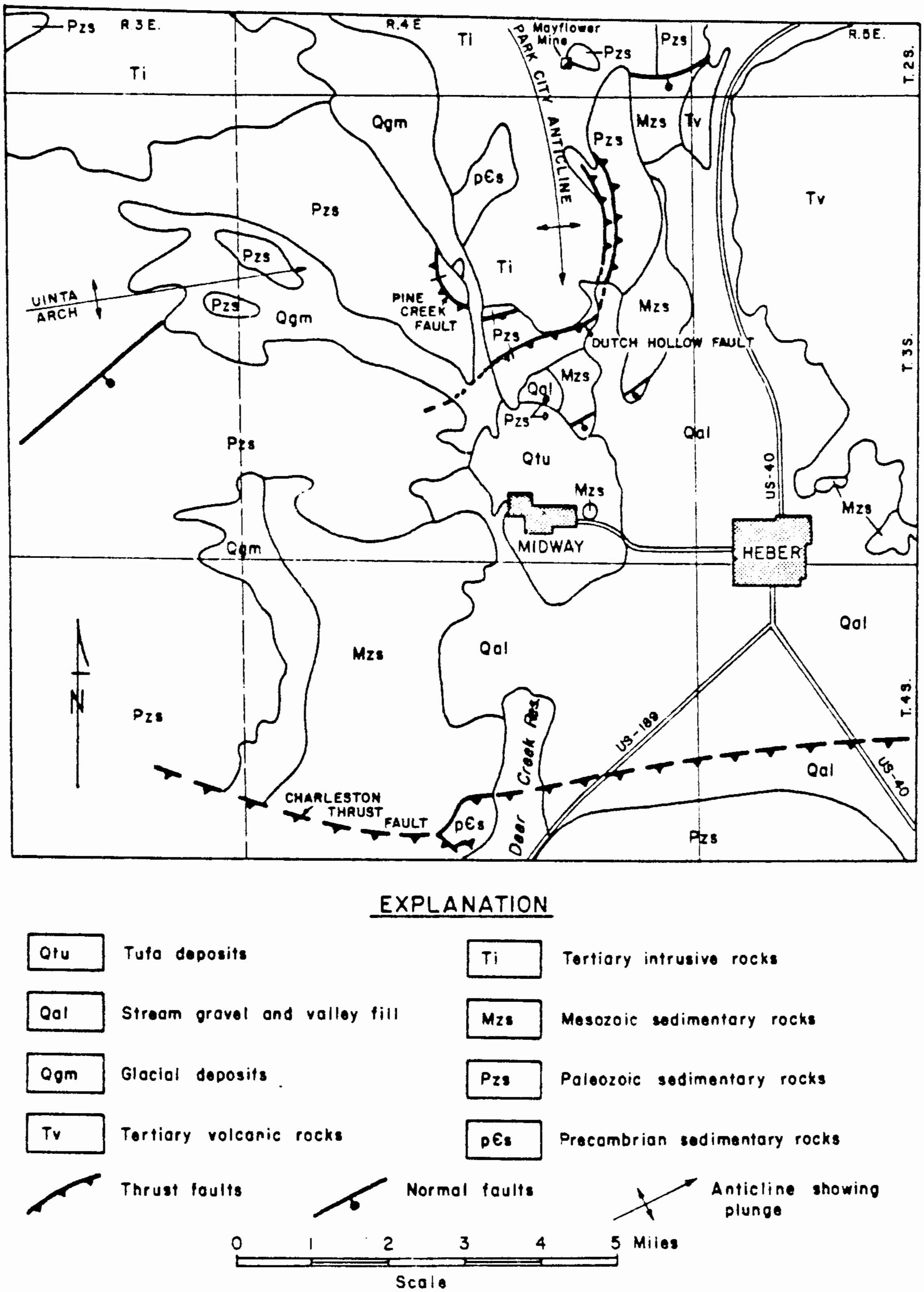
Meinzer, O. E., 1924, Origin of the thermal springs of Nevada, Utah, and Southern Idaho: Journal of Geology, v. 32, p. 295-303.

Kohler, J. F., 1979, Geology, characteristics, and resource potential of the low-temperature geothermal system near Midway, Wasatch County, Utah: Utah Geological and Mineral Survey Report of Investigation No. 142, 45 p.

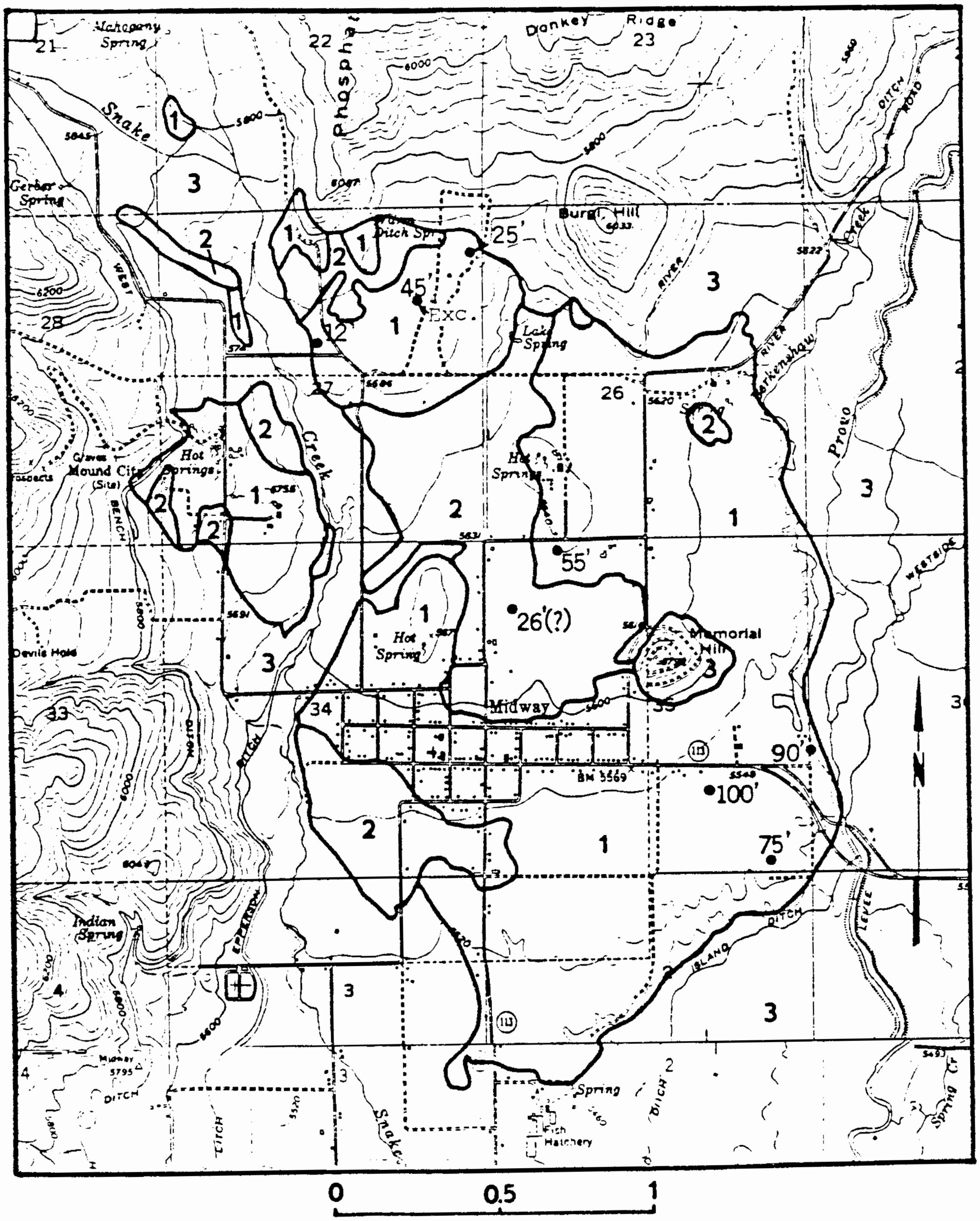
Milligan, J. H., Marsell, R. E., and Bagley, J. M., 1966, Mineralized springs in Utah and their effect on manageable water supplies: Utah Water Research Laboratory in cooperation with the Utah Water and Power Board Report WG 23-6, p. 36.

Mundorff, J. C., 1970, Major thermal springs of Utah: Utah Geological and Mineral Survey Water-Resources Bulletin 13, 59 p.

Woodward, Lowell, Jensen, E. H., and Harvey, J. S., 1978, Soil survey of the Heber Valley area, Utah: U. S. Department of Agriculture Soil Conservation Service, Forest Service, and Utah Agricultural Experiment Station, 124 p.



Generalized geology and location map Midway Hot Springs area (after Kohler, 1979)

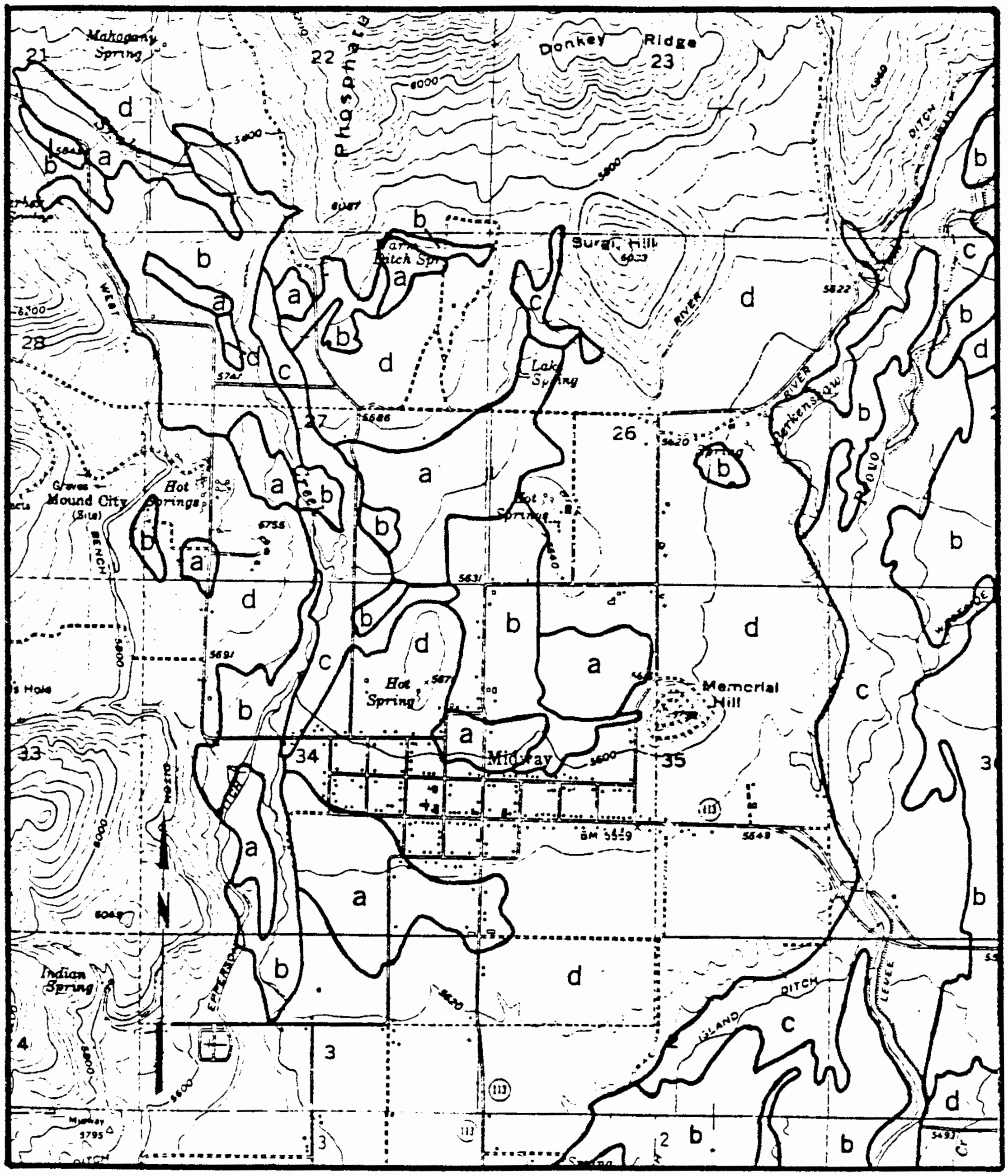


Scale

Depth to top of calcium carbonate deposit (after Woodward and others, 1976)

1. from 5 to 20 inches below ground surface
2. from 20 to 36 inches below ground surface
3. greater than 36 inches below ground surface

•12' Thickness of calcium carbonate deposit



0 0.5 1

Scale

Depth to shallow ground water (after Woodward and others, 1976)

1. from 10 to 20 inches
2. from 20 to 40 inches
3. from 40 to 60 inches
4. greater than 60 inches

GROUND WATER

Project:			Requesting Agency:
Investigation of basement flooding at the Volner residence 8806 South 1220 West, West Jordan, Utah			Dept. of Business Regulation
By: H. Gill	Date: 3/29/85	County: Salt Lake	Job No.: GW-1
USGS Quadrangle: Midvale (1172)			

85-008

In response to a request from Mr. Dave Fairhurst, Lead Investigator for the Department of Business Regulation, Division of Contractors, the Utah Geological and Mineral Survey made an inspection at the home of Mr. Steven Volner to determine if basement flooding there was caused by shallow ground water or by a broken water line. The investigation included a site reconnaissance, a conversation with Mrs. Volner, and hand augering four test holes around the home. Mr. Fairhurst was present during the field investigation.

SITE LOCATION AND DESCRIPTION

The Volner residence is at 8806 South and 1220 West in West Jordan, Utah (attachment 1). The house is in a relatively new subdivision with homes immediately to the north and south, and an elementary school across the street to the east. A horse ranch borders the property to the west. The area is nearly flat with a very gentle 0.5 degree slope to the east. The home has a half basement, with a finished grade about 18 inches below the ground surface.

BASEMENT FLOODING

According to Mrs. Volner, the basement flooding is seasonal and occurs in February or March. There is a possibility that flooding has occurred in other months, but Mrs. Volner could not be certain. Water has also been observed in the basement after rain and snow storms. The maximum duration of the flooding not associated with individual storms was approximately four days, and the depth of water was about 4 inches.

Neighbors have told Mrs. Volner that there was standing water observed in a basement excavation on their property. The water remained for quite some time and complaints were made to the contractor by people concerned about their children's safety. The Volners were also told that the first owner of the property traded lots when he observed the water in the excavation. According to Mrs. Volner, people in the area with full basements have had flooding problems. The closest of these is approximately 300 feet southwest of the Volner property. As far as she knows, however, their residence is the only home with a half basement that has experienced flooding.

During the investigation it was determined that the water main, sewer, and storm drain are in the street in front and downslope (east) of the house. In addition, the horse ranch immediately west and upgradient from the residence has no underground water lines, nor was evidence of irrigation noted on the property. The closest underground water lines to the west are approximately 500 feet away at 1300 West Street.

An unpublished UGMS map titled "Depth to Wet Season Water Table Jordan Valley" shows the home is in an area where ground water varies from 0 to 5 feet below the ground surface. Four hand augered test holes were dug to determine the depth to shallow ground water in the vicinity of the home (attachment 1). Ground water was encountered in all four holes at the following depths (from hole 1 through 4, attachment 1): 2.4, 2.5, 2.8, and 2.3 feet. The slight variation in the surface elevation of the water table between holes reflects differences in ground elevation where the holes were dug.

CONCLUSION

It is the opinion of the UGMS that the basement flooding at the Volner home is caused by shallow ground water. Evidence supporting that conclusion includes the following:

1) The basement flooding is reoccurring and seasonal.

2) The nearest subsurface water lines on the upgradient (west) side of the home are about 500 feet from the basement.

3) An unpublished UGMS map showing the depth to shallow ground water in the Jordon Valley indicates that the home is is an area where depth to water varies from 0 to 5 feet below the ground surface.

4) Shallow ground water, ranging from 2.3 to 2.8 feet below the ground surface, was encountered in four test holes augered at various points around the home during the field reconnaissance for this study.

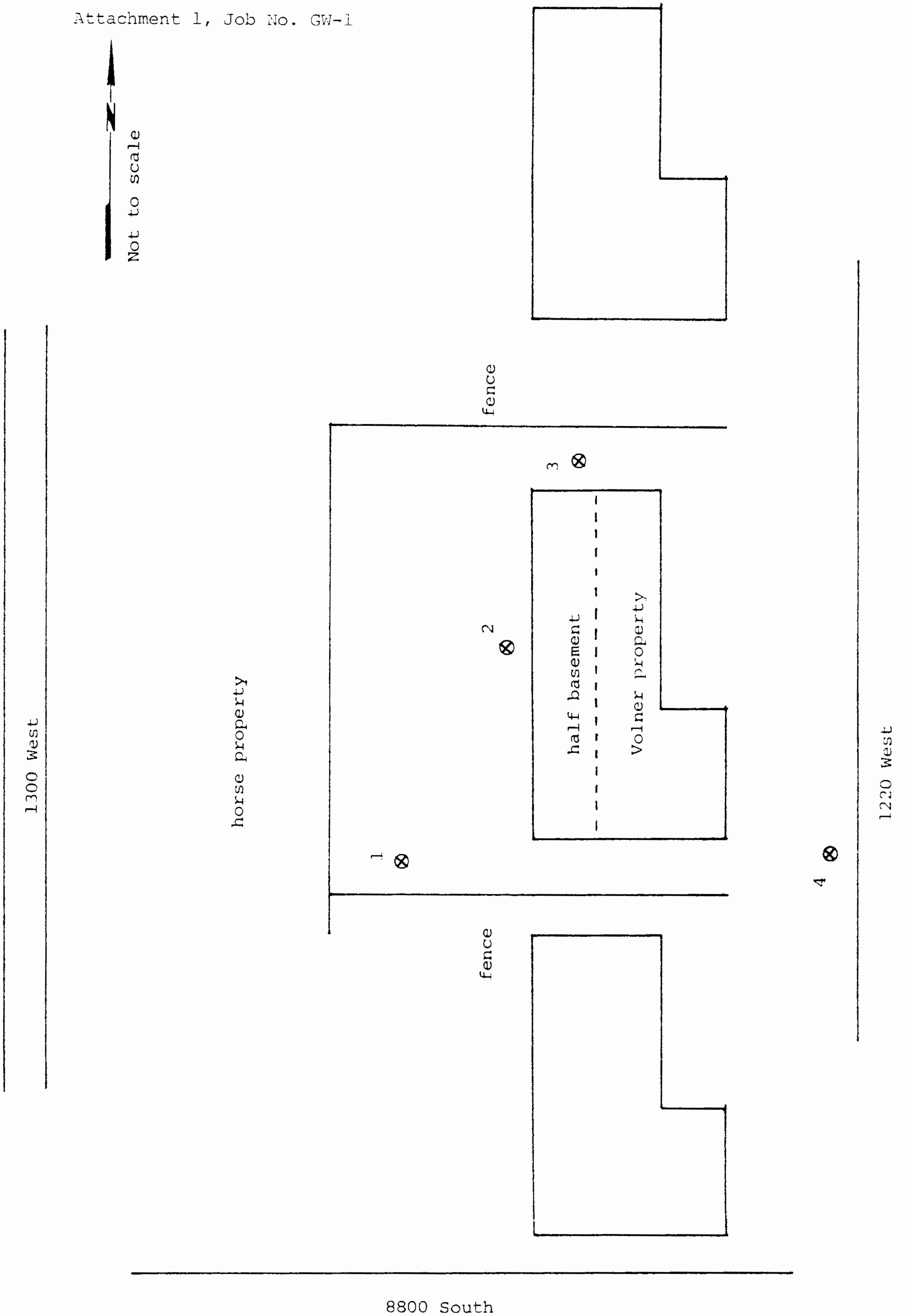
In addition, information obtained from neighbors and transmitted to Mrs. Volner indicates that shallow ground water was observed in excavations on site prior to construction of the home.

References

Everitt, B. L., 1980, Depth to wet season water table Jordan Valley, Utah: Utah Geological and Mineral Survey unpublished map, scale 1:60,000.

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

Attachment 1, Job No. GW-1



General Location Map Volner Property

Project:			Requesting Agency:
Preliminary evaluation of high ground-water conditions in Erda, Tooele County, Utah			Tooele County Health Dept.
By: W.R. Lund	Date: 4/16/85	County: Tooele	Job No.: GW-2
USGS Quadrangle: Tooele (1175); Mills Junction (1216)			

85-011

This report presents the results of a preliminary investigation by the Utah Geological and Mineral Survey into the occurrence of high ground water in Erda, Tooele County, Utah (attachment 1). A large number of basements in Erda have been flooded this spring by shallow ground water. The investigation was requested by the Tooele County Health Department because of concerns that discharge from the Tooele City wastewater treatment plant may be contributing to the flooding problem. The investigation was done at a reconnaissance level and consisted of a review of available geologic and hydrologic literature, a field visit to the treatment plant and area affected by flooding, and discussions with county officials, local residents, and U.S. Geological Survey personnel. Mr. Myron Bateman, Tooele County Environmental Health Supervisor, and Mr. Reid Russell, Tooele County Commissioner, were present during the field visit.

SETTING

Erda is about 4 miles north of Tooele near the north end of Tooele Valley. The valley is bounded by Great Salt Lake on the north, the Oquirrh Mountains on the east, and the Stansbury Mountains on the west (attachment 1). South Mountain, a low transverse divide, and Stockton Bar, a large sand bar deposited in Pleistocene Lake Bonneville, separate Tooele Valley from Rush Valley to the south. The valley encompasses approximately 250 square miles, but the total watershed, including the mountains that drain into the valley is about 400 square miles. Ephemeral and perennial streams discharge approximately 17,000 acre-feet per year from the mountains bordering Tooele Valley (Razem and Steiger, 1981). Perennial streams are in Middle and Settlement Canyons in the Oquirrh Mountains, and in Davenport, North and South Willow, and Box Elder Canyons in the Stansbury Mountains. The streams in Middle and Settlement Canyons are diverted and/or stored for irrigation, and flow in their lower reaches only in response to periods of heavy runoff.

Most of the homes with basement flooding in Erda are located along the Grantsville-Erda road. The elevation at Erda is approximately 4350 feet and Tooele is at about 5000 feet. The wastewater treatment plant is at the northwest edge of Tooele at an elevation of 4980 feet. The ground surface between Tooele and Erda slopes to the northwest at a gentle 1 to 2 percent grade. The Great Salt Lake is 5 miles north of Erda at an elevation of approximately 4210 feet.

GEOLOGY

The Oquirrh Mountains and South Mountain are comprised chiefly of the Oquirrh Formation of Mississippian age. This unit consists primarily of alternating quartzite and limestone beds. Several formations crop out in the Stansbury Mountains, the most prominent being the Oquirrh Formation and the Tintic Quartzite of Cambrian age. The rocks in all three mountain ranges have been extensively folded and faulted.

Tooele Valley is underlain by a thick sequence (greater than 1000 feet in some areas) of unconsolidated and semiconsolidated sediments of Quaternary and Tertiary age. The fill consists of interbedded clay, sand, and gravel deposited in a complex sedimentary pattern (Razem and Steiger, 1981). This complexity is reflected in the surface geology of the valley which includes alluvial fans along the valley margins, coarse-grained near-shore Lake Bonneville deposits, fine-grained lake bottom silt and clay with lesser deposits of sand and gravel at temporary lake shorelines, and stream alluvium (Tooker, 1980). The U.S. Geological Survey was not able to trace individual horizons for long distances in the subsurface, however, the valley fill is generally finer-grained below a depth of 800 to 900 feet. This change may mark the top of sediments of Tertiary age (Razem and Steiger, 1981).

HYDROLOGY

Ground water in Tooele Valley occurs in consolidated rocks in the mountains and in the unconsolidated valley fill. Little is known about the bedrock aquifers because most ground water is withdrawn from the valley-fill deposits. The consolidated rocks are important to the valley's hydrologic system, however, because they serve as a source of recharge to the fill. Although few wells obtain water from bedrock, discharge from mine tunnels shows that large quantities of water exist in the mountains. Most of this water probably finds its way into the valley fill, either through subsurface flow along the valley margin or by upward leakage in the valley (Razem and Steiger, 1981).

Ground water occurs under unconfined (water table) and confined (artesian) conditions in the unconsolidated valley fill. Water-table conditions exist where ground water has free access to the atmosphere though interconected voids in the sediment. Artesian conditions develop where relatively impermeable layers, usually clay or silt, separate the aquifer from access to the atmosphere. More than one artesian aquifer probably exists in the Erda area. These aquifers are mostly comprised of thick deposits of coarse well-sorted gravel (Razem and Steiger, 1981). Recharge to the artesian aquifers is principally by subsurface flow from consolidated rocks in the mountains and by lateral movement from adjoining water-table aquifers near the mountains. Subsurface flow from rock aquifers in the Oquirrh Mountains probably accounts for the largest percentage of total recharge to artesian aquifers in the Erda area. A recently released report by the U.S. Geological Survey (Arnow, 1985) shows that the maximum measured water-level rise in Utah from March 1984 to March 1985 (standard recording year) was 45.95 feet in the artesian aquifer northeast of Erda. Other wells in the vicinity of Erda showed rises greater than 15 feet, continuing a pattern of generally increasing artesian water levels in the area extending back to 1980 (Steiger, 1981).

Ground water occurs under water-table conditions in the unconsolidated valley fill near the mountains and in the northern part of Tooele Valley (Razem and Steiger, 1981). The water-table aquifers adjacent to the mountains are hundreds of feet deep, and merge baisnward with artesian aquifers toward the center of the valley. The water-table aquifer in the northern part of the valley occupies about the upper 50 feet of the valley fill, and water levels range from the land surface down to several tens of feet. A principle source of recharge to the shallow water table is upward leakage from the underlying artesian aquifers (Razem and Steiger, 1981). Other sources include infiltration of precipitation that falls directly on the shallow aquifer, seepage of water discharging from springs, and infiltration of excess irrigation and runoff water.

The following table shows annual precipitation at Tooele from 1978 through March 1985, and the cumulative departure from the 30-year norm.

Year	Annual Precipitation (inches)	Departure from Normal (inches)	Percent Normal
1978	19.99	+ 3.68	122
1979	11.10	- 5.21	68
1980	19.79	+ 3.48	121
1981	19.13	+ 2.82	117
1982	25.37	+ 9.06	156
1983	28.32	+12.08	174
1984	27.44	+11.13	168
1985	6.25*	+ 2.17	153

*Based on 1/4-year record

Since 1978, the total departure from normal has been +39.3 inches or 2.4 times the 1941 to 1970 thirty-year average of 16.31 inches. The 1982-1985 departure is 34.53 inches, more than twice the thirty-year norm. This indicates that in the 3 1/4-years since January 1982 the Tooele/Erda area has experienced the equivalent of five years of "normal precipitation." The result has been a dramatic increase in both the hydrostatic head of the artesian aquifer and the level of the shallow water table. An increase in the hydrostatic pressure of the artesian system would produce a corresponding increase in upward leakage to the shallow aquifer. In addition, greater than normal recharge would result from direct infiltration of precipitation and the excess runoff directed toward and through Erda from upslope areas during the last three years. Additional sources of water that contribute to the shallow water table, but which are believed to have remained relatively constant over time and are now a proportionately smaller percentage of total recharge, include discharge from septic tank and soil absorption systems, infiltration of irrigation water, and infiltration of water discharged from the Tooele City wastewater treatment plant. These sources represent a more or less constant background level of recharge and the actual amount of water contributed by each is thought to be small when compared to the increased recharge resulting from excess precipitation.

CONCLUSIONS AND RECOMMENDATIONS

The results of this preliminary study indicate the following regarding ground water in the Erda area:

1. Ground water occurs under both artesian and water-table conditions.

2. Water levels in the artesian aquifer have risen steadily since 1980, and between March 1984 and March 1985 increases in hydrostatic head of between 15 and 45 feet were recorded.

3. Recharge to the shallow unconfined aquifer comes chiefly from upward leakage from deeper artesian systems, direct precipitation on the shallow aquifer, and infiltration of surface water.

4. During six of the last seven years the Tooele/Erda area has recorded greater than normal precipitation, and the past three years have produced the equivalent of more than two years extra precipitation.

5. Erda is at a low elevation relative to the rest of Tooele Valley and greater than normal amounts of surface runoff have been directed toward and through the town during the previous two years.

6. Other sources of recharge to the shallow unconfined aquifer include septic tank and soil absorption systems, infiltration of irrigation water, and discharge from Tooele City's wastewater treatment plant. These sources are believed to have remained relatively constant or decreased (sprinkler irrigation replacing flood irrigation) over time.

Based on the above information, it is concluded that high ground-water conditions in Erda are a response to a sustained pattern of greater than normal precipitation for the previous six years and particularly the last three years. The contribution from the wastewater treatment plant is believed to be small and, because of increased recharged from heavy precipitation, to actually represent a proportionately smaller amount of the total recharge than in the past. It should be expected that even if "normal" precipitation patterns return, it may take some time (two to three seasons) for the shallow water table to drop significantly.

Determining the amount of water contributed to the shallow aquifer in Erda from all potential sources of recharge would require a detailed and costly study beyond the scope of this reconnaissance investigation. Evaluation of the contribution from the wastewater treatment plant alone would be difficult and conclusive results may not be obtainable. If the parties involved (city, county, and local residents) determine that further investigation is justified, the following are recommended:

1. Accurately map the wastewater drainage channel including all possible diversion pathways. Monitor which pathways are used and for how long on a daily basis. Simultaneously monitor pumping rates from selected flooded basements to determine if a correlation exists between use of the various pathways and rate of pumping. Care must be taken to identify other sources of short-term recharge or changes in the ground-water regime (i.e. precipitation or installation of a drain) that could effect pumping rates during the monitoring period.

2. Monitor wastewater discharge at the treatment plant, at the culvert beneath State Route 112, and near the termini of the other diversion pathways. Differences in flow rates between the treatment plant and the other monitoring points will give an indication of the volume of water lost to infiltration along the drainage channel.

3. Compare the chemistry of the wastewater as discharged from the treatment plant with that of the ground water flooding the basements to see if diagnostic similarities exist between them.

4. Dye the wastewater discharge and monitor for the appearance of the dye in the flooded basements. The prospect for a successful test is considered low because of the distances involved (2-4 miles), the probable length of time required for the dye to reach the shallow water table and migrate to the basements, and the limited life expectancy of the dye once in the subsurface. Under such circumstances, the appearance of the dye would represent a positive test, but an absence of dye would not prove the absence of recharge.

5. Installation of monitoring well strings (3 to 5 wells each) across the wastewater drainage channel at several locations. The shallow water table could then be profiled to determine if infiltration has created a ground-water mound along the channel. If sites are carefully selected, the wells could also be used to monitor increases or decreases in the shallow water table downslope from the drainage channel as water is turned into or out of various diversion pathways.

6. Installation of shallow monitoring wells on widely spaced centers (1/4 to 1/2 mile) between the wastewater treatment plant and Erda to determine the precise direction of ground-water flow in the shallow aquifer. In conjunction with the monitoring-well program, aquifer tests should be run to determine the permeability coefficient and transmissivity of the water-table aquifer. Those values would give an indication of how fast the ground water is moving and the time required for wastewater to reach Erda.

The data obtained from the program outlined above should give a reasonable estimate of recharge to the shallow unconfined aquifer from infiltration of wastewater. Since recharge from that source is thought to be small, the following immediate steps are recommended to reduce basement flooding in Erda.

1. Divert surface runoff away from Erda. The large volume of surface water channeled toward Erda during the previous two years represents a major source of recharge to the shallow water table which should be kept away from town. Wastewater from the treatment plant should be routed through the drainage channel configuration that keeps it as far from Erda as possible.

2. Surface drainage should be improved in Erda to prevent ponding and to carry surface runoff away from town as quickly as possible.

3. Sources of water in Erda that may be contributing to recharge (flowing artesian wells, springs, leaking irrigation systems, etc.) should be identified and controlled.

Although it is expected that the above measures will help control shallow ground water, they will not affect upward leakage from artesian aquifers. For that reason, consideration should be given to installing subsurface drains or a series of shallow high-volume pump wells to remove ground water from areas subject to basement flooding. Gravity drains are considered superior to pump wells because, when designed properly, they are relatively maintenance free and do not require a source of electricity, making them less costly and more reliable over the long term.

SELECTED REFERENCES

Arnow, Ted, 1985, Ground-water levels rise throughout most of Utah for third consecutive year: U.S. Geological Survey in cooperation with the Utah Department of Natural Resouces Division of Water Rights, Water-level-change report and maps, 20 p.

Gates, J.S., 1963, Hydrology of Middle Canyon, Oquirrh Mountains, Tooele County, Utah: U.S. Geological Survey Water-Supply Paper 1619-K, 40 p.

Gates, J.S., and Keller, O.A., 1970, Ground water in Tooele Valley, Utah: Utah Department of Natural Resources Division of Water Rights Water Circular No. 2, 15 p.

Guttormson, Kevin, 1983, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1983: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 23 p. 27-31.

------1984, Tooele Valley, in Developing a state water plan, ground-water condition in Utah, spring of 1984: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 24, p. 25-28.

Lund, W.R., 1984, Geologic evaluation of five culinary water facilities and Settlement Canyon Dam for Tooele City, Tooele County, Utah: Utan Geological and Mineral Survey Report of Investigation No. 187, 32 p.

Moore, W.J., and Sorensen, M.L., 1979, Geologic map of the Tooele 1° by 2° Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigation Series Map I-1132, scale 1:250,000.

Price, Don, 1981, Surface-water resources in the Tooele 2° Quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigation Series Map I-1245, scale 1:250,000.

Razem, A.C., 1978, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1978: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 17, p. 8.

------1979, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1979: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 18, p. 7.

Razem, A.C., and Steiger, J.I., 1981, Ground-water conditions in Tooele Valley, Utah, 1976-1978: Utah Department of Natural Resources Division of Water Rights Technical Publication No. 69, 95 p.

Steiger, J.I., 1980, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1980: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 19, p 8.

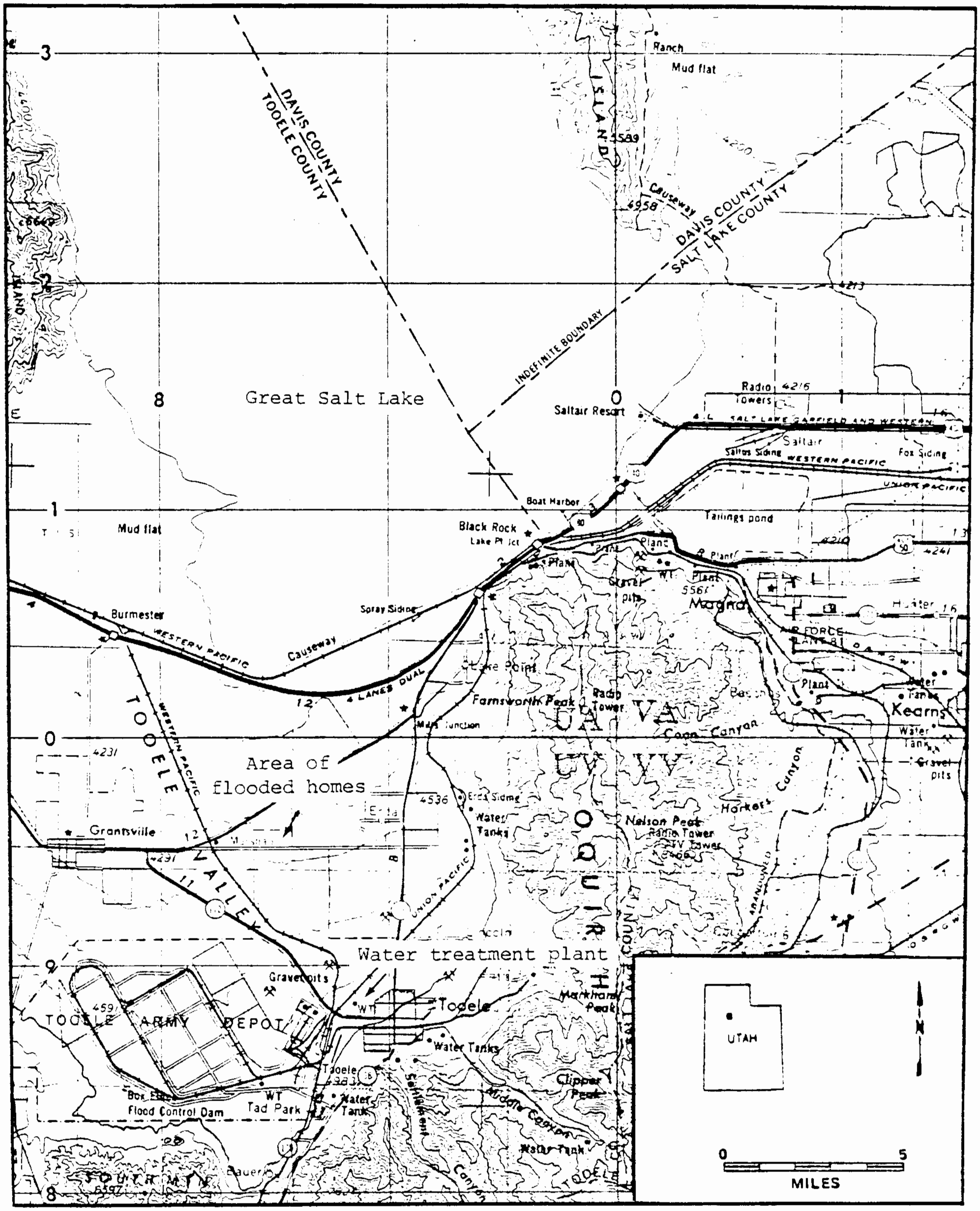
------1981, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1981: Utah Division of Water Resources and U.S. Geological Survey Cooperative Investigations Report Number 21, 9 p.

------1982, Tooele Valley, in Developing a state water plan, ground-water conditions in Utah, spring of 1982: Utah Division of Water Rights and U.S. Geological Survey Cooperative Investigations Report Number 22, p. 24-25.

Tooker, E.W., 1980, Preliminary geologic map of the Tooele Quadrangle (7 1/2 minute), Tooele County, Utah: U.S. Geological Survey Open-File Report 80-623, scale 1:24,000.

Tooker, E.W., and Roberts, R.J., 1971, Geologic map of the Mills Junction Quadrangle, Tooele County, Utah: U.S. Geological Survey Geologic Quandrangle Map GQ-924, scale 1:24,000.

Attachment 1, Job No. GW-2

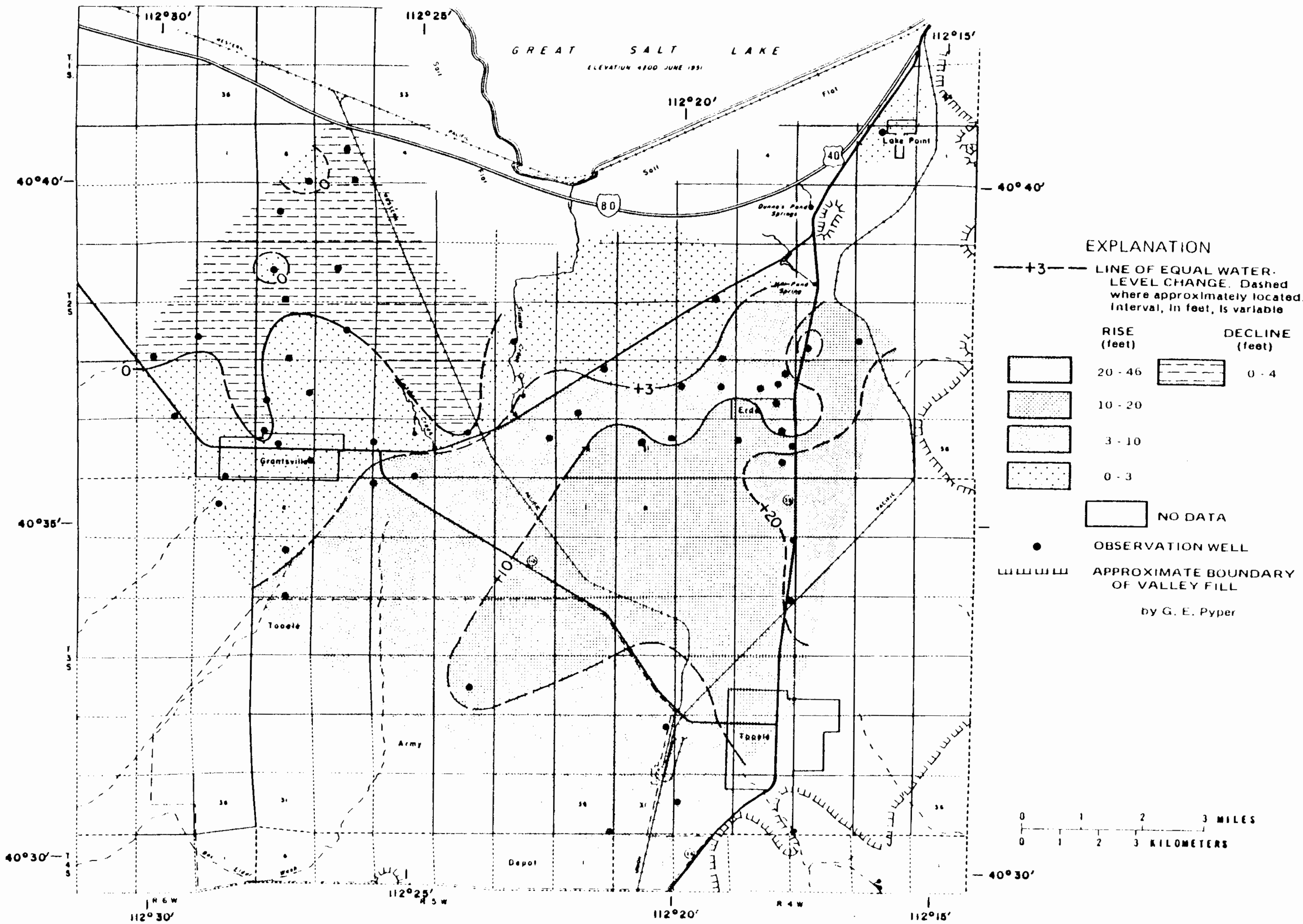


Location map

U. S. Geological Survey
in cooperation with the
Utah Department of Natural Resources,
Division of Water Rights

Attachment 2, Job No. GH-2

Water-level-change Map
Number 413



Map of Tooele County, Utah, showing change of ground water levels in artesian aquifers, March 1984 to March 1985.

Project:			Requesting Agency:
Altamont Water Well			Bureau of Public Water Supplies
By: R.H. Klauk	Date: 1/16/85	County: Duchesne	Job No.: GW-3
USGS Quadrangle: Altamont (1077)			

#85-038

PURPOSE AND SCOPE

This investigation was conducted at the request of Mike Georgeson, Utah Health Department, Bureau of Public Water Supplies, for a culinary water well owned by the Town of Altamont in Duchesne County, Utah. The purpose of the study was to determine if two oil wells being drilled within 3,000 feet of the water well had adversely affected the aquifer from which water was being withdrawn, causing the well to dry up.

The scope of work for this investigation included a literature review and a field reconnaissance on November 15, 1985. No subsurface exploration was performed. This report, one of three to be completed, is concerned with geology and how it pertains to aquifer characteristics. The remaining reports are being prepared by the Bureau of Public Water Supplies and the Division of Oil, Gas, and Mining. They will cover engineering and oil well drilling aspects of the investigation.

BACKGROUND

In October, 1981 a culinary water well was completed for Altamont, Utah. The well is located in the NW 1/4 NW 1/4 sec. 36, T. 1 S., R. 4 W., Uinta Baseline and Meridian (attachment 1). The well is one of four owned by Altamont and was completed in a deep, confined, bedrock aquifer. The other three wells tap a shallow unconfined, unconsolidated aquifer. The well in question is one of two used regularly to meet water system demands.

On September 12, 1985 the well failed because the water level dropped below the submersible pump (460 feet). As of November 15, 1985, the water level had not risen above the pump. Records indicate the last time the pump operated was September 11, 1985, 13 hours prior to failure. Records also show the well had been pumping almost continuously during the previous week because the primary well in the system had inadvertently been shut off.

GENERAL GEOLOGY AND HYDROLOGY

The Town of Altamont is in the northern Uinta Basin in the Colorado Plateau physiographic province. The town is situated on Pleistocene glacial outwash deposits consisting of unconsolidated sand, gravel, cobbles, and boulders (Stokes and Madsen, 1961). The glacial deposits overlie the Tertiary Duchesne River Formation which crops out less than a half mile north of town and also in cliffs formed by downcutting of the Lake Fork River a mile west of town. The Duchesne River Formation consists of interbedded sandstone and shale that is slightly to strongly jointed (Hood, 1976). Underlying the Duchesne River Formation is the Tertiary Uinta Formation consisting of calcareous shale with some limestone, claystone, siltstone, and sandstone (Hood, 1976). The Uinta Formation is not exposed in the immediate Altamont area, but does crop out approximately six miles to the southeast, along the Lake Fork River.

Aquifers in the northern Uinta Basin are unconfined, perched, or confined (Hood and Fields, 1978). Pleistocene unconsolidated glacial outwash and alluvium contain unconfined ground water that comprises the most prolific aquifer in the northern basin (Hood, 1978; and Hood and Fields, 1978). The unconfined aquifer was the sole source of ground water to Altamont prior to drilling the deep well in 1981. The Tertiary Duchesne River and Uinta Formations, in which the deep well was completed, combine to form one bedrock aquifer because of shared hydrologic and lithologic charcteristics (Hood, 1976). Sandstones in these two formations have low permeabilities, with much of the water yield coming from joints (Hood, 1976). This aquifer is confined in the vicinity of Altamomt.

Recharge to both the unconfined Pleistocene and confined Tertiary aquifers comes from the northwest (Hood and Fields, 1978). Most recharge occurs during spring snowmelt; additional recharge occurs along stream valleys, from unlined canals, and from irrigation in the summer (Hood and Fields, 1978).

WELL CHARACTERISTICS

Altamont's deep well was drilled into the Duchesne River Formation to a depth of 625 feet. The 16-inch well was lined with 10-inch well casing perforated from 140 to 500 feet. The upper 120 feet was grouted to seal off the unconfined aquifer, which extends to a depth of 85 feet. The water level in the well after completion rose to 91 feet, indicating the bedrock aquifer is artesian. A pump test produced 369 feet of drawdown at a pumping rate of 230 gallons per minute (gpm).

DISCUSSION

Two oil wells were drilled in the vicinity of Altamont during the summer and fall of 1985. Well number 1 (attachment 1) is approximately 1,500 feet south of Altamont's deep culinary well and was cased to a depth of 5,000 feet. This well began producing oil in October, 1985. Well number 2 (attachment 1) is less than 3,000 feet northwest of the water well, was cased to 3,000 feet, and was still being drilled on November 15, 1985. Both wells were rotary drilled. The oil reservoir is thousands of feet below the surface and drilling and pumping operations, if done properly, should not affect ground water in shallower aquifers. Alan Nelson of the Utah Division of Water Rights (personal comm., November 15, 1985) reported he was informed by both drilling companies that formation water was not returned to the surface during drilling and completion of well number 1, and none had returned to date during drilling of well number 2. Neither oil well had been completed at the time of the Altamont well failure and, therefore, lowering of the potentiometric surface of the Tertiary aquifer would have had to occur during drilling. If Alan Nelson's information is correct, no additional water was discharged to the surface during drilling, and therefore, water could only have drained to a lower aquifer. This is doubtful because increased artesian pressures and saturated conditions would prevent the downward flow of water. According to

Hood (1976), the permeability of the Tertiary aquifer is such that uncontrolled flow from wells creates large declines in the potentiometric surface and prolonged pumping of large-yield wells can cause drawdown the effects of which extend for miles. Therefore, if one or both of the oil wells had returned substantial quantities of formation water to the surface, it is conceivable that the potentiometric surface for the Tertiary aquifer could have been lowered over a distance that would include the Altamont well, causing it to go dry.

A second possibility suggests that the prolonged pumping of the Altamont well at substantial rates (180 to 200 gpm) the week prior to failure lowered the potentiometric head significantly or dewatered the aquifer in the vicinity of the well. Where the Tertiary aquifer is dewatered by pumping, the sandstones only have an estimated specific yield of about 1 percent (Hood, 1976). If prolonged pumping caused dewatering, collapse of aquifer fractures may have occurred, slowing or precluding recharge.

CONCLUSIONS AND RECOMMENDATIONS

The cause of the Altamont culinary well failure is not known. It has been suggested that one or both of the oil wells recently drilled within a 3,000 foot radius of the well may be the cause; however, there is no geologic evidence to suppoort this conclusion, and it appears unlikely. A second theory suggests excessive pumping the week prior to failure may have dewatered and reduced the permeability of the aquifer in the vicinity of the well. No other water wells have been drilled in this aquifer in the vicinity of Altamont. Therefore, the data or the conditions necessary to collect the data to test or confirm this theory is not available. A study to determine the cause of the failure would involve drilling piezometer holes and conducting aquifer tests. Such a study would be expensive and probably exceed the cost of developing an alternate water source. Deepening or fracing the dry well may be a possibility, but additional information on the aquifer is required before specific recommendations can be made. It is understood that Altamont is pursuing an alternate source of water. If this is the case, it is recommended that any new wells be completed in the shallow, unconfined aquifer. Furthermore, it is recommended that the present deep well be monitored at regular intervals to determine if recovery, especially during the optimum recharge period, is occurring.

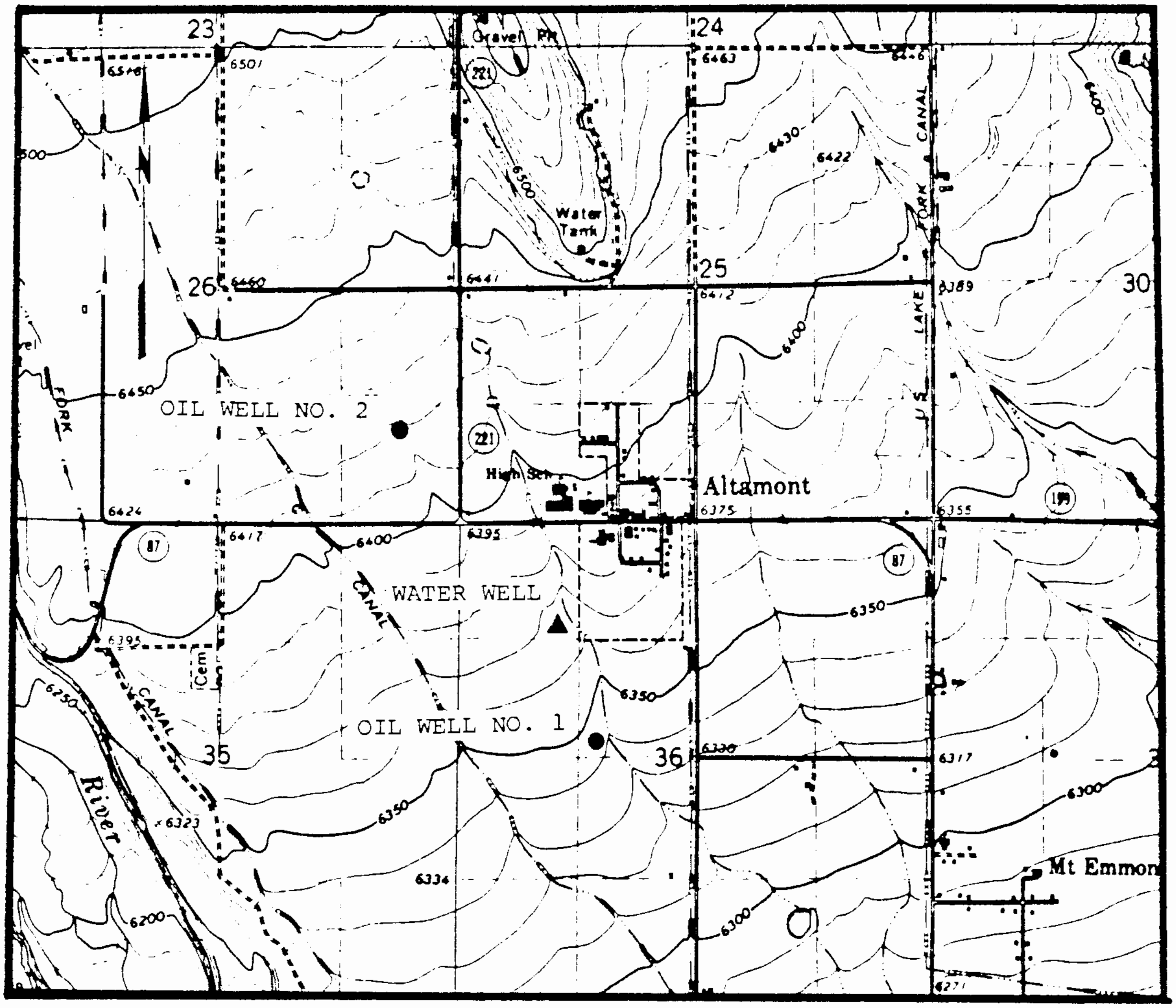
REFERENCES CITED

Hood, J.W., 1976, Characteristics of aquifers in the northern Uinta Basin area, Utah and Colorado: Utah Department of Natural Resources Technical Publication No. 53, 71 p.

Hood, J.W., and Fields, F.K., 1978, Water resouces of the northern Uinta Basin area, Utah and Colorado, with special emphasis on ground-water supply: Utah Department of Natural Resources Technical Publication No. 62, 75 p.

Stokes, W.L., and Madsen, J.H., compilers, 1961, Geologic map of Utah northeast quarter: University of Utah Department of Mines and Mineral Industries, scale 1: 250,000.

R. 4 W.



T. 1 S.

Base map from: U.S.G.S.
topographic quadrangle map
Altamont, Utah. Scale 1:24,000

0 1 Mile

Contour Interval 10 Feet

Location Map

GEOLOGIC HAZARDS

Project:			Requesting Agency:
Clastic dikes, Smith and Moorehouse Dam, Summit County			Division of Water Resources
By: G.E. Christenson	Date: 3/8/85	County: Summit	Job No.: GH-1
USGS Quadrangle: Slader Basin (1247)			

85-002

PURPOSE AND SCOPE

At the request of Ben Everitt, chief geologist for the Utah Division of Water Resources (DWR), an investigation of numerous clastic dikes and a lenticular sand body in the spillway cut for the Smith and Morehouse Dam was performed. The purpose of this investigation was to determine the origin of these features. The dam is under construction by the DWR and will replace and enlarge an old dam near the mouth of Smith and Morehouse Canyon, a southern tributary to the Weber River in Summit County about 12 miles east of Oakley (attachment 1). The spillway excavation is at the right abutment which has been identified as a possible landslide consisting chiefly of Mississippian-age limestone. The site was visited on November 30 and December 7, 1984, and January 15, 1985, as the spillway was being excavated. One dike was observed on November 30, but none were exposed on subsequent visits. The lenticular sand body was observed on January 15, 1985. Samples of dike material supplied by Ben Everitt were also studied. During all site visits, the ground surface was covered with snow and the only exposure was on the east face of the spillway excavation.

DESCRIPTION

Many bedrock joints in the excavation exhibit thin (less than 1/16 inch) fillings of red clay and silt. These are easily recognized because of the color contrast with the gray limestone bedrock. In addition to these thin coatings, clastic dikes commonly several inches thick filled with bedded sand, silt, and clay are present. A lenticular sand body about 2 feet thick, 5-6 feet wide and of unknown extent (perpendicular to the cut) is also present within the limestone. Material in the dikes and sand body is chiefly non-indurated sand and is similar in color to the most recent glacial deposits in the area. Field observations, descriptions of the phenomena by Ben Everitt, and study of samples have revealed the following pertinent data. The dikes: 1) range up to several inches thick and appear to fill open joints, 2) are variable in attitude, width, and trend, 3) are composed of water-washed sediment which exhibits bedding parallel to joint walls with graded bedding both inward and outward from the center to the walls, 4) range in composition from red clay and silt to red, well-rounded, fine-to coarse-grained sand with angular limestone clasts, probably derived from joint walls, 5) locally exhibit polish on joint walls indicative of movement, 6) exhibit bedding irregularities and are "brecciated" with angular inclusions of clay beds in sand beds, and 7) extend to a depth of about 20-30 feet below the top of the cut. The actual depth below the surface is not known because the spillway excavation is being made into a pre-existing slope and the thickness of material removed is unknown.

The lenticular sand body contains fine-to coarse-grained sand with a basal coarse sand-fine gravel bed. Grain size decreases upward, and upper beds consist of fine-grained sand. The body is not connected to any observed clastic dike. Shearing is evident along the up-valley contact of the sand body, and beds are also truncated at the down-valley contact. Apparent "cross bedding" in the sand body shows inverse truncation (overlying beds truncated by underlying beds), indicating that the contact between "cross beds" may also be a shear plane.

ORIGIN

Possible origins of the clastic dikes include: 1) injection of sediment and water during liquefaction, landsliding, or glacial loading, 2) incorporation of unconsolidated surficial deposits into a slide mass during movement, 3) weathering of primary sandstone layers interbedded with the limestone, and 4) washing of sediment from above into joints opened through landsliding, solution, weathering, stress relief in rock following valley erosion, glacial action, and/or frost-wedging (Selby, 1982; Eyles, 1983; Dyke, 1984).

Liquefiable sands have been exposed in the keyway excavation for the dam, and a possible buried sand boil was uncovered in a trench near the left abutment (B. Everitt, oral commun., November 30, 1984). In at least one case, sand deposits underlie rock. A drill hole through a limestone outcrop containing a clastic dike in the valley bottom along the west side of the spillway encountered sand beneath limestone, indicating a probable slide block that had overridden valley-bottom deposits (Palmer Wilding Consulting Engineers, 1982, 1983). However, no sand has been encountered beneath limestone in drill holes in the right abutment (east side of the spillway), and clastic dikes do not appear to extend below depths of 20-30 feet. Injection of these dikes through liquefaction of underlying material is thus unlikely. Injection laterally or from above during glacial loading is possible. However, the stratification and sorting in dikes is not typical of that expected when till is injected into a crack. Thus, it is considered unlikely that many of these dikes are the result of injection.

Another possible origin of the dikes is through incorporation of surficial deposits along slide planes and within a slide mass during landsliding. Polished surfaces along joints filled with sand indicate that movement of bedrock has occurred, although the polish probably predates deposition of the sand. Some deformation of sediment in joints has occurred following deposition, as indicated by shear planes and truncation of beds in the lenticular sand body and disruption of bedding and "brecciation" in some dikes. However, bedding in many dikes is not affected and primary depositional features such as graded bedding cannot be explained by landsliding. Sliding may have occurred before, during, and after deposition of the sand, but it was not a primary mode of emplacement.

The possibility that the dikes and sand body are weathered sandstone interbeds within the limestone is not likely. Sandstone is present in the stratigraphic sequence exposed in the spillway cut, but is yellow and strongly indurated. In contrast, the material in the dikes and in the lenticular sand body is red, includes clay and rounded limestone clasts, and is loose to weakly indurated. The dikes are also found cross cutting bedding in the limestone bedrock.

Probably the most likely origin of the clastic dikes is washing of materials into open joints, solution cavities, or landslide cracks in bedrock. Similar dikes in unconsolidated materials in eastern Washington have been extensively studied and attributed by most authors to downward flow of water and sediment into open cracks (Carson and others, 1978). Lupher (1944, p. 1447, 1451) noted that bedding parallel to fissure walls was common in dikes with dips of 20 to 30 degrees or less. Some of the dikes observed with this type of bedding at the Smith and Morehouse site dip less than 30 degrees, and may be of similar origin. In the eastern Washington study, bedding in steeply dipping dikes was generally inclined at near the angle of repose, dipping from the footwall toward the hanging wall (Lupher, 1944). Although near vertical dikes occur at the Smith and Morehouse site, this type of bedding has not been observed (B. Everitt, oral commun., January, 1985). However, bedding parallel to fissure walls has been found in steeply dipping dikes in eastern Washington and is attributed to fissures which opened and filled periodically or opened continuously and filled periodically. A similar process may account for bedding in vertical dikes at the Smith and Morehouse site.

Although clastic dikes could not be traced to the surface, the sand is similar to nearby Quaternary glacial and fluvial deposits. Sands show evidence of fluvial transport in the degree of sorting and size and roundness of grains. During the last glaciation, ice filled the valley to a level above the highest dike (Montgomery, 1977), and flow in subglacial or ice-marginal channels could have provided the infiltrating water and sediment. Some washing of sediment into hillside cracks may have continued in post-glacial times. The red silt and clay fillings found in many joints in the excavation also indicate deposition of suspended sediment from infiltrating ground water. The lenticular sand body probably represents deposition in a void or solution cavity, although the conduit for sediment and water is not exposed. It may be removed, still buried, or truncated by post-depositional movement.

AGE AND DEFORMATION

Age relationships between clastic dikes, glacial deposits, and possible landsliding are not clear. The location of the dikes in rock above the valley floor, the similarity of dike material to glacial deposits in the canyon, and the likely source of sediment and water during times when glacial ice buried the hillslope indicate that the dikes probably date at least to the last glaciation. However, no datable material has been found in the dikes.

The dikes and sand body exhibit internal deformation, bedding irregularity, and in one case, shearing which appears to extend into surrounding rock. Internal deformation in the form of "brecciation" of clay beds, resulting in angular blocks of bedded clay being immersed in sand, and shearing tranverse to joint walls and bedding is evident in some dikes. This may be in part caused by excavation activities, because most dikes were observed on the floor of the cut following blasting and scraping (B. Everitt, oral commun., January, 1985). Many dikes locally exhibit irregular bedding, however, and this may be due in part to turbulent flow in cracks, deposition in irregular cracks, and/or erosional cut and fill during deposition. Compressional deformation may also account for some of the irregularity. Evidence for compressional deformation in clastic dikes elsewhere is common

(Jenkins, 1925; Lupher, 1944), particularly in cracks which may open and close in response to landsliding, frost-wedging, or loading and unloading by glacial ice.

However, some of the post-depositional deformation, particularly shearing of the sand body, appears related to larger-scale movements. Although highly fractured, the material in the right abutment is not extensively brecciated. In places, the rock exhibits bedding consistent with local and the regional structure (B. Everitt, oral commun., January, 1985). Blasting is required to loosen the material for excavation, and if this material is landslide debris, it appears relatively intact. Discrete offsets in bedrock layers are apparent in many places where bedding is visible, although it is unclear whether these are primary tectonic features or are landslide-related. Similarly, the shears in the sand body which extend into the rock may be tectonic, landslide-related, or may represent renewed movement along old tectonic shears during slope movement.

CONCLUSION

The clastic dikes exposed in the spillway excavation at Smith and Morehouse Dam are most likely the result of washing of sediment into open joints in underlying rock. Joints may have opened continuously or incrementally by landsliding, solution, weathering, stress relief in rock following valley erosion, glacial action, and/or frost-wedging. Such a mechanism may account for bedding parallel to joint walls in vertical dikes. Bedding that has developed parallel to joint walls in near horizontal dikes probably represents a primary depositional feature. Irregularities in bedding may be caused by turbulent flow in cracks, irregular joint walls, piping and erosion following deposition, or deformation from continued movement (opening or closing) of the joint. The lenticular sand body is probably the result of deposition in a solution channel or cavity within the limestone. It is probable that these features date back to at least the last glaciation, although their age and the age and cause of post-depositional deformation are not certain.

REFERENCES

Carson, R.J., McKhann, C.F., and Pizey, M.H., 1978, The Touchet Beds of the Walla Walla Valley, in Baker, V.R. and Nummedal, Dag, eds., The channeled scabland: Guide for the Comparative Planetary Geology Field Conference, Columbia Basin, Washington, p. 173-177.

Dyke, L.D., 1984, Frost heaving of bedrock in permafrost regions: Bulletin of the Association of Engineering Geologists, V. XXI, p. 389-406.

Eyles, N., 1983, Glacial geology an introduction for engineers and earth scientists: Oxford, Pergamon Press, 409 p.

Jenkins, O.P., 1925, Clastic dikes of eastern Washington and their geological significance: American Journal of Science, 5th Series, v. 10, p. 234-246.

Lupher, R.L., 1944, Clastic dikes of the Columbia Basin region, Washington and Idaho: Bulletin of the Geological Society of America, v.55, p. 1431-1462.

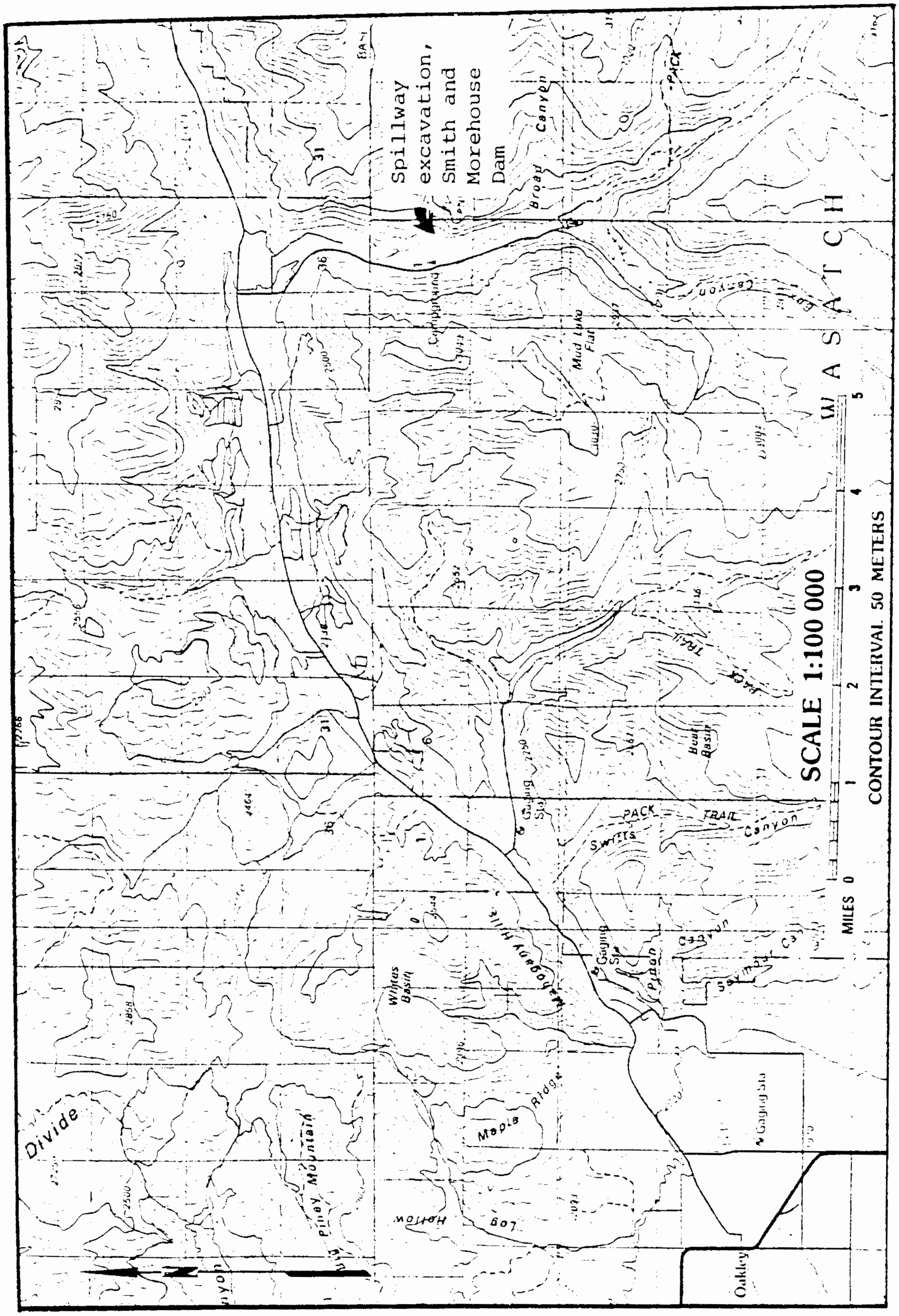
Montgomery, S.B., 1977, Geologic map of Smith-Morehouse dam site: unpub. Utah Division of Water Resources map, scale 1:4800.

Palmer Wilding Consulting Engineers, 1982, Smith and Morehouse project, design report: Report for Utah State Division of Water Resources, 59 p.

------1983, Smith and Morehouse project, addendum design report: Report for Utah State Division of Water Resources, 43 p.

Selby, M. J., 1982, Hillslope materials and processes: Oxford, Oxford University Press, 264 p.

Attachment 1, Job No. GH-1



Base map from: USGS 30'x 60' topo quad
Salt Lake City, UT-WYO

Location Map

Project:			Requesting Agency:
Richfield, Utah Earthquake Information for a proposed disaster response scenario			Sevier Valley Hospital
By: W. Case	Date: 2/22/85	County: Sevier	Job No.: GH-2
USGS Quadrangle: Richfield SE (599)			

85-004

RICHFIELD EARTHQUAKE INFORMATION

INTRODUCTION

The following memorandum was prepared in response to a request for information by Carlos Madsen, Hospital Administrator Sevier Valley Hospital, Richfield, Utah. Mr. Madsen requested information concerning the earthquake hazards of the Richfield area for emergency response planning.

BACKGROUND

Richfield is located in the transition zone between the Basin and Range and Colorado Plateau physiographic provinces. The Colorado Plateau consists of mesas and plateaus that were uplifted relative to the area to the west and valleys formed by erosion as the landmass rose. The seismicity of the Colorado Plateau is relatively low, although there are a few surface faults which have been active within the last two million years (Quaternary time). The Canyonlands area of southeastern Utah exhibits typical Colorado Plateau topography. Basin and Range topography is characterized by numerous, short, north-south trending mountain ranges separated by discontinuous basins many of which have internal drainage. The western Utah desert is typical of Basin and Range terrain. Most ranges have faults that have experienced movement within the last 2 million years. The faults exhibit mainly vertical displacement, the valleys being downthrown relative to the mountains. The valleys exist due to faulting, not erosion and may contain several thousand feet of accumulated sediment. Grabens are fault controlled valleys formed when a block of the earth's crust is downdropped between two parallel faults. The Sevier River Valley may be a graben; some investigators have inferred the existence of faults along its west and east boundaries. The faults of the Basin and Range area are believed to be listric, that is, near vertical at the surface but becoming flatter with depth. At a depth of about 10 miles the faults are thought to be almost horizontal. The origin or focus of earthquakes tend to be several miles below the surface, and the epicenters (surface location directly above the earthquake focus) tend to be located in the valley rather than along the surface expression of the fault near the range front. The significance of this fact is best appreciated when it is realized that the maximum surface displacement occurs along the faults at the mountain front but the maximum shaking takes place near the epicenter.

Seismicity in the Basin and Range is generally higher than in the Colorado Plateau. The highest earthquake activity is centered along the Intermountain Seismic Belt (ISB), a diffuse zone of increased earthquake activity which, in the Richfield area, follows the Basin and Range/Colorado Plateau transition zone (fig. 1). The seismicity of the ISB is as high as some areas along the San Andreas Fault in California. The ISB has generated several earthquakes with magnitudes greater than 7. Examples include the Hebgen Lake, Montana earthquake which resulted in twenty-eight lives lost in 1959 and the Borah Peak, Idaho earthquake in 1983 which took the lives of two children. The Richter magnitude of an earthquake is a relative estimate of the energy released during fault rupture (table 1). The length of many fault scarps (fault induced surface brakes) in the Basin and Range indicate that they were formed by large magnitude earthquakes. The Borah Peak earthquake (magnitude 7.3) produced a fault break on the surface that extended for more than twenty miles. The maximum vertical displacement during a single earthquake event in the ISB is on the order of 15 feet. Historical records in Utah are too short for a reliable determination of past earthquake activity, however, the geologic record gives ample evidence of past seismic events. The recurrence interval of active faults in the ISB is greater than 100 years, and may approach several hundred years, for an earthquake with a magnitude of 7.

The intensity of an earthquake represents the extent and type of damage resulting from the event. Many investigators use the Modified Mercalli intensity scale (table 2). The intensity of an earthquake is determined by many factors including nearness of the area to the epicenter or fault, magnitude of the earthquake, duration of the event, ground conditions (soil type, depth of water table, depth to bedrock).

RICHFIELD AREA

Figure 2 shows the surface faults in the Sevier River Valley as reported by Anderson and Miller (1979). Figure 3 (Arabasz and others, 1979) shows epicenters in the Richfield area greater than magnitude 1. The Elsinore Fault is inferred to be along the west edge of the Sevier River Valley. A second inferred fault along the east edge of the valley may also be an extension of the Sevier Fault. According to the University of Utah Seismograph Station a magnitude 7.0 earthquake occurred near Richfield on November 14, 1901, at approximately 4:40 a.m. and was followed by several aftershocks of magnitude 2. The Intensity is recorded as 8 to 9. This was Utah's largest historic earthquake. A 1921 event centered near Elsinore had a magnitude of about 5 with a minimum Intensity of 5. Four aftershocks ranging in magnitude from 2.3 to 4.3 were recorded over a period of two days. Earthquakes in Utah were not instrumented before 1962, therefore, magnitudes of pre-1962 events have been estimated from the intensity of the earthquakes using a arithmetic relationship. Figure 4 is a computer plot of south central Utah earthquake epicenters of magnitude greater than 1 that occurred between 1850 and 1983 (data courtesy of University of Utah Seismograph Station).

A realistic scenario for a seismic event in the Sevier River Valley could be as follows:

A. Earthquake magnitude 7 to 7.5.
B. Aftershocks felt for several days following the main event, magnitude of the aftershocks on the order of 2 to 5; others may occur for a period of 12 or more months
C. Maximum expected bedrock acceleration of 0.15g (Algermission, 1976) near the epicenter.
D. Length of surface fault rupture of 10-20 miles with a maximum vertical displacement of up to 15 feet.
E. Earthquake Intensity between 8 and 9.

Older stone buildings, particularly those not on a concrete foundation will suffer cracking at the windows and doors. Homes with heavy, stiff walls such as brick or stone may also be cracked, some brick may separate from the frames. Brick chimneys will be damaged, may fall, and lose bricks. Many chimneys may pull away from the building. Stone veneers will tend to separate from their frames. Cornices and parapets, common on older buildings will fall. Signs overhanging sidewalks or streets also pose a hazard. Wood frame buildings tend to withstand shaking because they are flexible and all structural units (walls, floors, ceilings) are tied together and move as a unit. Buildings may slide off foundations if they are not tied down. Similar damage would occur in multistory buildings, walls can separate from the roof and floor, and heavy veneers may fall. Steel fabricated buildings tend to withstand shaking because floors, ceilings, and walls are tied together. However, stone or brick added to the walls reduces their flexibility. Wings added to buildings after initial construction may separate. During the 1971 Sylmar, California earthquake (mag. 6.4) the elevator/stair attachment to a hospital separated intact from the main building. The ambulance bay (a carport) was not designed to withstand seismic forces, the columns failed and the roof collapsed crushing the ambulances. An inventory of building types in Richfield could be made to estimate the extent of probable damage and to determine which buildings could serve as refuge centers. Figure 5 shows a model building code as recommended by the Utah Seismic Safety Advisory Council in 1980.

Geologic conditions also influence earthquake intensity. For example, low density soil such as that found in some areas of Sevier River Valley (Kaliser, 1976; Lund, 1982) may be subject to collapse during shaking causing stress to building foundations. Sandstone outcrops west of Richfield may constitute a rockfall hazard (Grant Willis, UGMS geologist, personal commun., 1985). Rockfalls can be quite dangerous, two people were killed by falling rock during the Hebgen Lake earthquake. Property was damaged and roads were blocked due to rockfalls during the Borah Peak earthquake. The Green River Formation and other geologic units that are often involved in landslides occur in areas adjacent to the valley. Therefore, a potential may exist in those areas for landslides which could disrupt lifelines (transportation corridors, communication links, water, power, sewer) and cause extensive damage or loss of life (28 people were buried by a landslide during the Hebgen Lake earthquake). Sinkholes or ground cracks may develop during an earthquake if water is forceably injected into shallow horizons. The shallow water table in the valley may increase the hazards related to ground shaking.

Almost all lifelines will be affected by a large earthquake in the Sevier River Valley. Roads and railroads could be blocked by landslides or structural failures. Communication lines may be inoperable or taxed to their limit. Gas and electrical lines may be severed and could start fires. Broken water lines may limit water available for fighting fires. Culinary water may become contaminated from sewage or dead animals. Springs used for culinary water may change in flow, turbidity, or color, and wells may suffer pump and casing damage. Sewer lines tend to be brittle and because they are low pressure, breaks may not be noticed until considerable sewage has escaped.

Critical facilities should be inventoried with regard to risk from geologic hazards. Such facilities include hospitals; police, fire, telephone, and radio stations; power substations; nursing homes; clinics, drugstores, and blood banks; refuge centers (schools?); gasoline storage areas for emergency vehicles; and water supply and treatment facilities.

REFERENCES

Algermissen, S.T., and Perkins, D.M., 1976, A probabilistic estimte of maximum acceleration in rock in the contiguous United States: U.S. Geological Survey Open-File Report 76-416, 45 p.

Anderson, L.W., and Miller, D.G., 1979, Quaternary fault map of Utah: Fugro, Inc., Long Beach, California, 35 p.

Kaliser, B.N., 1976, Geological reconnaissance of the site for the Sevier Valley Technical College with notes of archeological significance: Utah Geological and Mineral Survey Report of Investigation RI-107, 5 p.

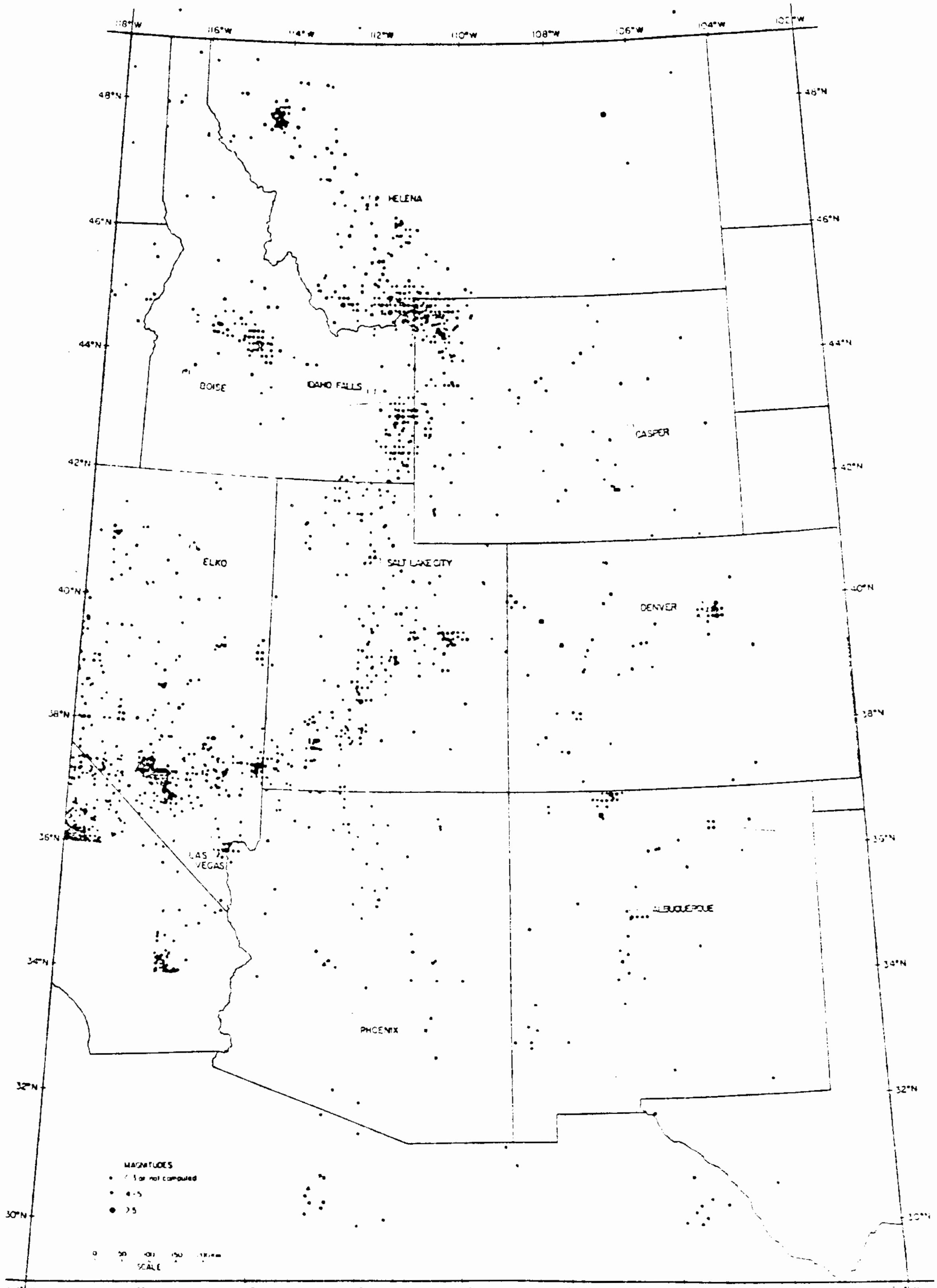
Lund, W.R., 1982, Letter to Richfield City manager giving results of investigation of subsurface soil conditions at a swimming pool site: Utah Geological and Mineral Survey technical memo, 4 p.

Seismic Safety Advisory Council of Utah, 1980, Seismic zones for construction in Utah: 13 p.

Attachment 1, Job No. GH-2

INTERMOUNTAIN SEISMIC BELT

~1850-1974



Compiled by R. B. Smith

Figure 1. Epicenter map of Intermountain Seismic Belt. (Arabasz, W., et al,1979, Earthquake Studies in Utah)

'able 1. RICHTER SCALE OF EARTHQUAKE MAGNITUDE (ESCP Vol. I, pg. 50, table 1-3)

Magnitude	Equivalent energy by mass of TNT	Remarks
0	600g	enough to blast a stump
1	20kg	small construction blast
2	600kg	average quarry blast
3	20,000kg, 20 Ton	large quarry blast
4	600,000kg, 600 Ton	small atom bomb
5	20 Kiloton	standard atom bomb
6	600 Kiloton	small hydrogen bomb
7	20 Megaton	energy enough to heat New York City for one year
8	600 Megaton	energy enough to heat New York City for 30 years
9	20,000 Megaton	energy equal to world's coal and oil production for 5 years

The maximum magnitude recorded is 8.9 for the Columbia-Ecuador earthquake in 1906 and Sanriku, Japan earthquake in 1933. (AGI data sheet 47b)

Table 2. Modified MERCALLI EARTHQUAKE INTENSITY SCALE
(AGI data sheet 47a)

Because the performance of masonry is such an important criterion for evaluating intensity, this version specifies four qualities of masonry, brick or otherwise, as follows:

<u>Masonry A</u>: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together using steel, concrete, etc.; designed to resist lateral forces.

<u>Masonry B</u>: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

<u>Masonry C</u>: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

<u>Masonry D</u>: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

<u>INTENSITY</u>

I Not felt. Marginal and long-period effects of large earthquakes.

II Felt by persons at rest, on upper floors, or favorably places.

III Felt indoors. Hanging object swings. Vibration like passing of light truck. Duration estimated. May not be recognized as an earthquake.

IV Hanging objects swing. Vibration like passing of heavy trucks, or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.

V Felt outdoors, direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI Felt by all. Many frightened and run outdoors. People walk unsteadily. Windows, dishes, glassware broken. Knicknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken visible, or heard to rustle.

Mercalli Intensity Scale (cont.)

VII Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices, unbraced parapets and architectural ornaments. Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving-in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B, none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed pining broken off. Branches broken from trees. Changes in flow or temperature of springs and well. Cracks in wet ground and on steep slopes.

IX General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. General damage to foundations. Frame structures, if not bolted, shifted off foundations. Frame cracked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.

X Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent sightly.

XI Rails bent greatly. Underground pipelines completely out of service.

XII Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into air.

Attachment 2, Job No. GH-2

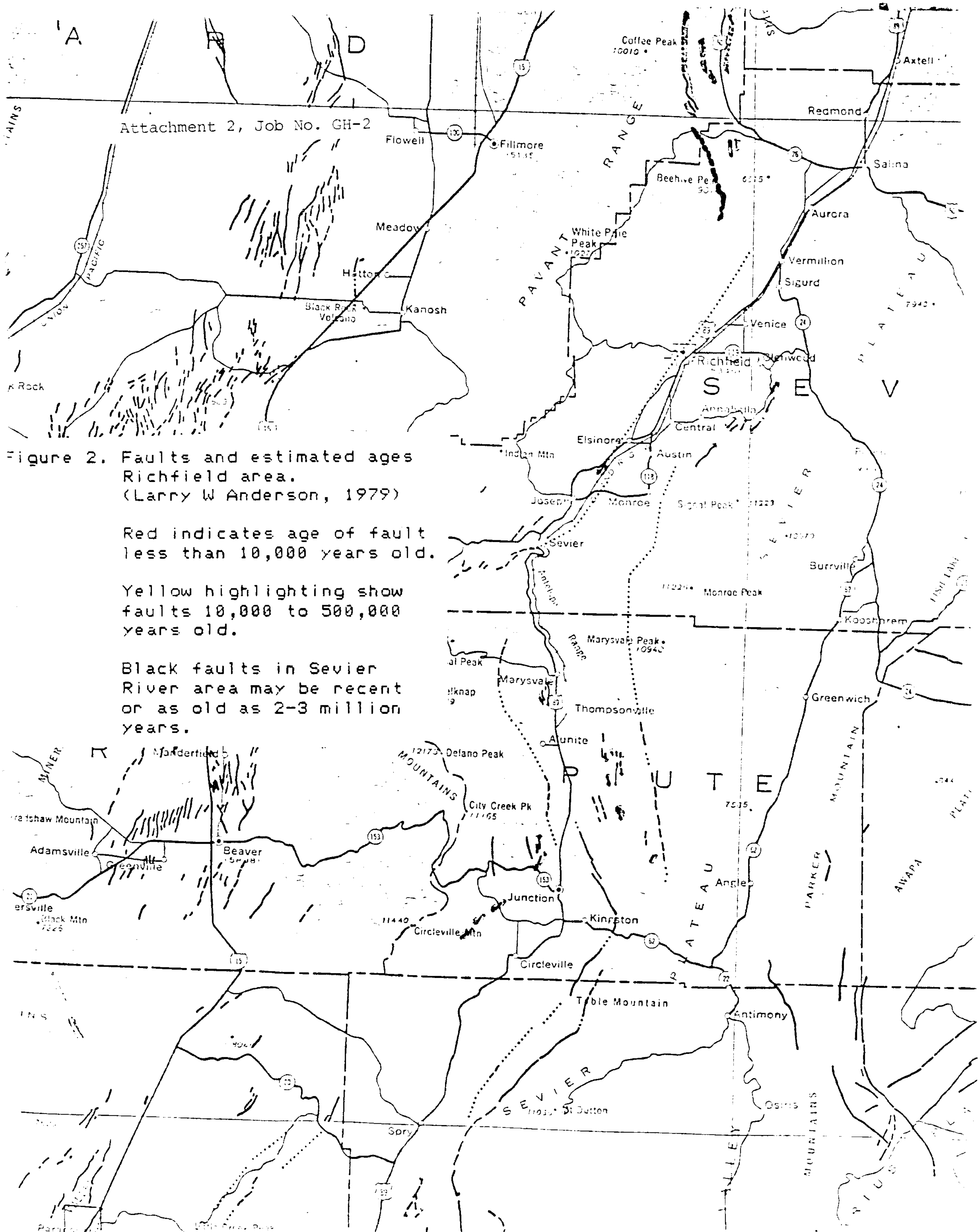


Figure 2. Faults and estimated ages Richfield area. (Larry W Anderson, 1979)

Red indicates age of fault less than 10,000 years old.

Yellow highlighting show faults 10,000 to 500,000 years old.

Black faults in Sevier River area may be recent or as old as 2-3 million years.

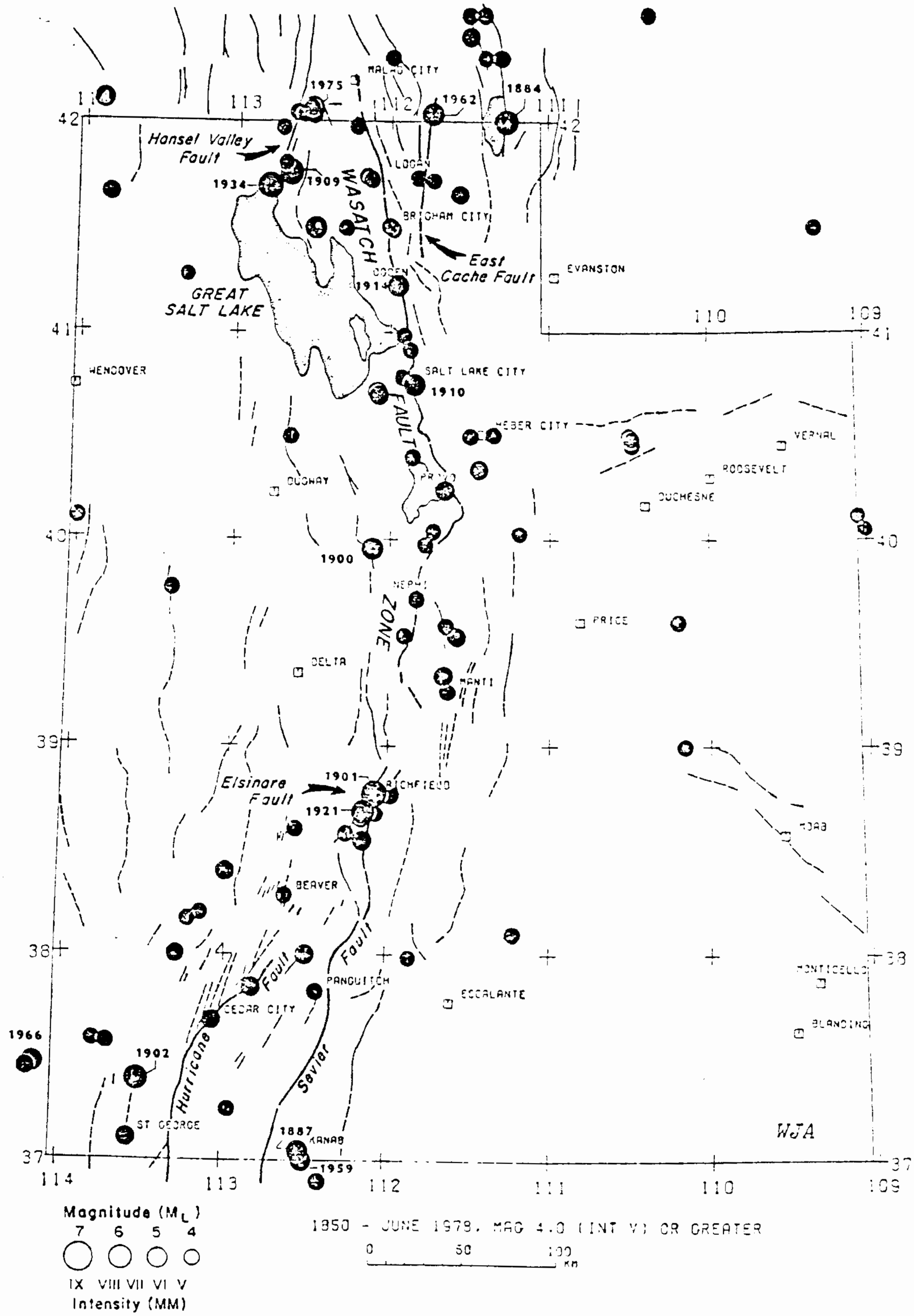


Figure 3. Epicenters of Utah earthquakes larger than 5 1/2 magnitude, 1850-1978. (W Arabasz, et al 1979 Earthquake Studies in Utah)

Attachment 4, Job No. GH-2

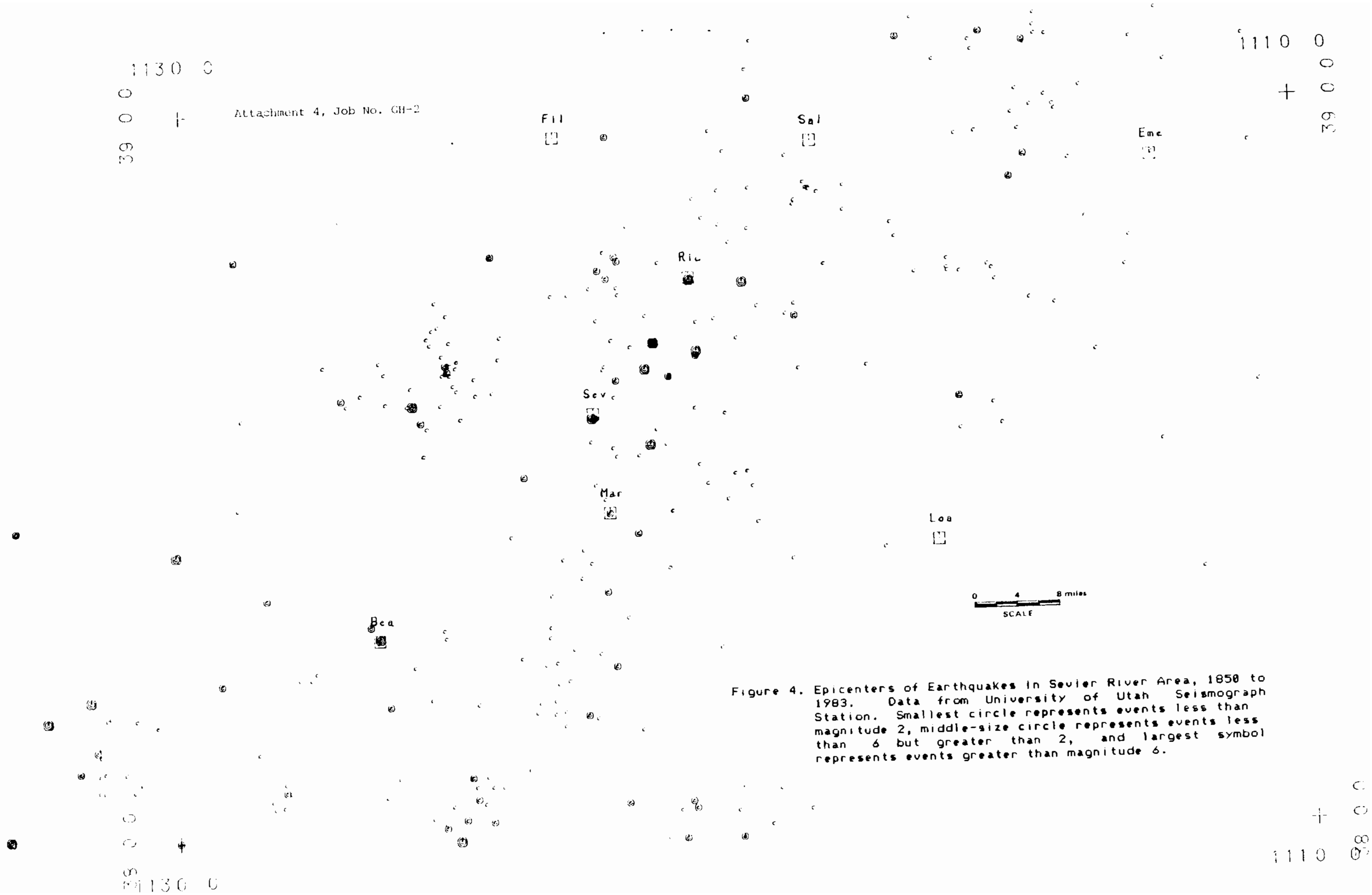


Figure 4. Epicenters of Earthquakes in Sevier River Area, 1850 to 1983. Data from University of Utah Seismograph Station. Smallest circle represents events less than magnitude 2, middle-size circle represents events less than 6 but greater than 2, and largest symbol represents events greater than magnitude 6.

Attachment 5, Job No. GH-2

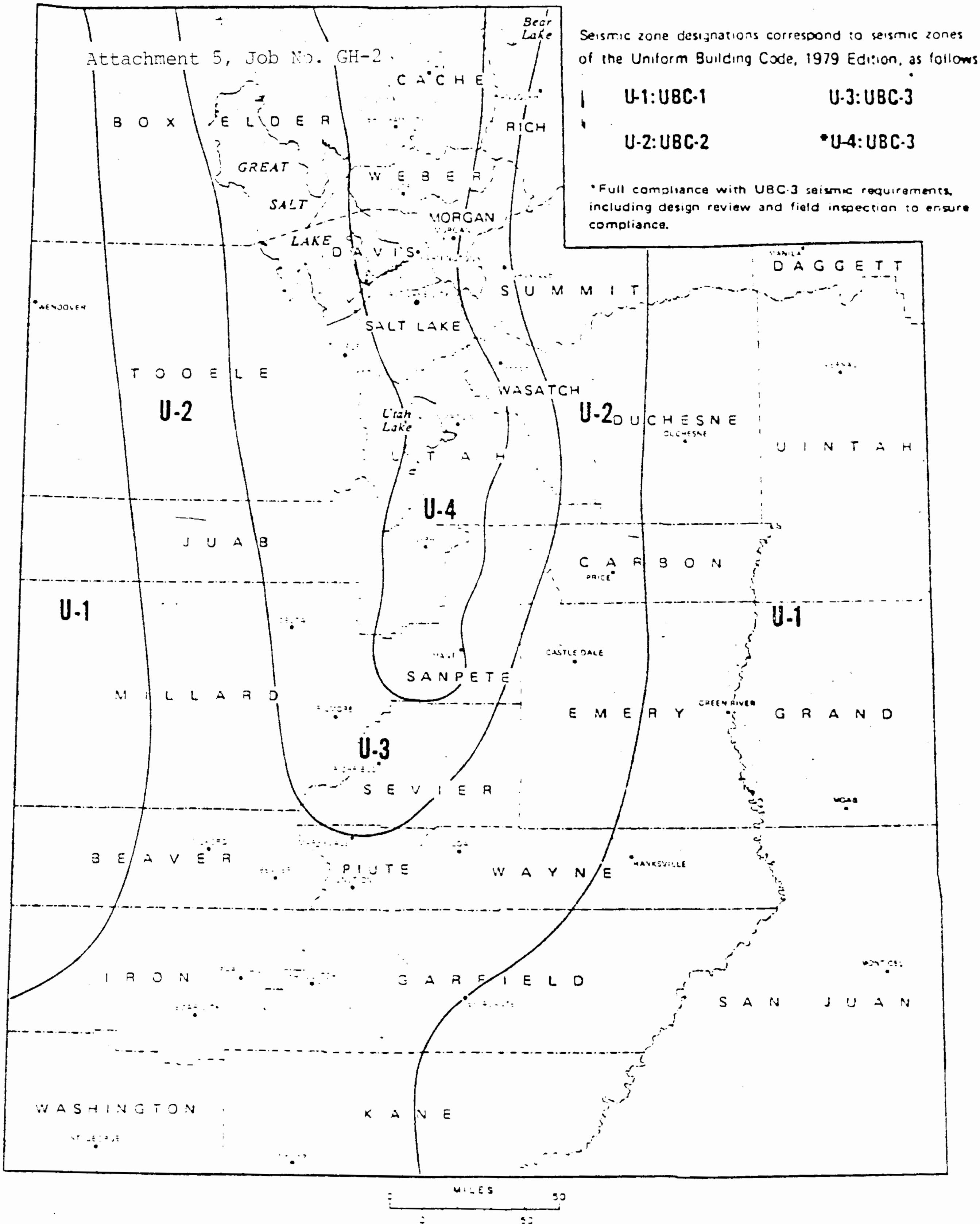


Figure 5

SEISMIC ZONES

January 1980

(Recommended by the Utah Seismic Safety Advisory Council)

EARTHQUAKE SAFETY RULES (from U.S. Dept. Commerce bull.)

During the shaking:

1. Don't panic. The motion is frightening but, unless it shakes something down on top of you, it is harmless. The earth does not yawn open, gulp down a neighborhood, and slam shut. Keep calm and ride.

2. If it catches you indoors, stay indoors. Take cover under a desk, table, bench, or in doorways, halls, and against inside walls. Stay away from glass.

3. Don't use candles, matches, or other open flames, either during or after the tremor. Douse all fires.

4. If the earthquake catches you outside, move away from buildings and utility wires. Once in the open, stay there until the shaking stops.

5. Don't run through or near buildings. The greatest danger from falling debris is just outside doorways and close to outer walls.

6. If you are in a moving car, stop as quickly as safety permits, but stay in the vehicle. A car is an excellent seismometer, and will jiggle fearsomely on its springs during the earthquake; but it is a good place to stay until the shaking stops.

After the shaking:

1. Check your utilities, but do not turn them on. Earth movement may have cracked water, gas, and electrical conduits.

2. If you smell gas, open windows and shut off the main valve. Then leave the building and report gas leakage to authorities. Don't reenter the house until a utility official says it is safe.

3. If water mains are damaged, shut off the supply at the main valve.

4. If electrical wiring is shorting out, close the switch at the main meter box.

5. Turn on your radio or television (if conditions permit) to get the latest emergency bulletins.

6. Stay off the telephone except to report an emergency.

7. Don't go sight-seeing.

8. Stay out of severely damaged buildings; aftershocks can shake them down.

Project:			Requesting Agency:
Zone of deformation determined along a portion of the Wasatch fault in Provo, Utah			Provo City
By: R.H. Klauk	Date: 3/6/85	County: Utah	Job No.: GH-3
USGS Quadrangle: Orem (1088)			

85-005

PURPOSE AND SCOPE

This report presents the results of an investigation to determine the width of the zone of deformation along the Wasatch fault in part of the Provo-Orem area, Utah County, Utah. The report was completed as part of a larger review by the Utah Geological and Mineral Survey (UGMS) of a geologic hazards study conducted for the City of Provo by International Engineering Company, Inc. (IEC). The area investigated is in the SE1/4, sec. 18, T. 6 S., R 3 E., SLB&M (attachment 1). This area was chosen because previous work by the UGMS permitted a comparison of faulting observed in an excavation for the Ridge Athletic Club (UGMS unpublished data, 1978) with IEC hazard maps. In addition to reviewing the previous study, the scope of work included an evaluation of recent geologic literature and examination of stereo air photographs.

GEOLOGY OF THE SITE

The Ridge Athletic Club is located along the Wasatch fault between Provo Canyon to the north and Little Rock Canyon to the south (attachment 1). The site is between the Provo and Bonneville shorelines of Lake Bonneville at an elevation of 5100 feet. Lacustrine sediments of Lake Bonneville were exposed in the 400 foot long, 15 foot deep east-west oriented excavation for the athletic club and consisted of horizontal, interbedded sands and silts (attachment 2). These sediments may be underlain by landslide deposits consisting of weathered Manning Canyon Shale (C.G. Oviatt, oral commun., 1985).

The Wasatch fault in the Provo-Orem area consists of a series of grabens bounded by prominant west-dipping fault scarps on the east and by antithetic fault scarps on the west. Air photo interpretation identifies the main west -dipping scarp 300 feet east of the athletic club. This agrees with Hunt and others (1953), Baker (1964), and Davis (1983). The west half of the athletic club appears to be in a zone of antithetic faulting. More than thirty-five fractures were observed in a 150 foot length of the excavation. Faults in this zone are straight to curvilinear and produce a series of small horsts and grabens (attachment 2). No offsets greater than 2 feet were observed. Most fractures dip between 60 and 80 degrees, mostly to the west. The western limit of deformation was not determined because of the limits of the excavation.

Cluff and others (1973) do not identify a major fault in the immediate vicinity of the athletic club. They have, however, identified a small graben at the site (200 feet in width and 500 feet in length) bounded by Class III features (attachment 3). Class III features are defined as possible surface faults with little or no relief. This interpretation appears to be in error.

INTERNATIONAL ENGINEERING COMPANY, INC. HAZARDS MAP

The fault shown on the IEC hazard map at the Ridge Athletic Club is approximately 500 feet west of the main fault trace mapped by previous investigators (attachment 1). No evidence of this fault was found in the trench. The map also identifies a 100-foot wide (50 feet west and 50 feet east of the fault) zone of deformation. Examination of the excavation at the athletic club combined with the air photo analysis indicates the zone is more extensive, and may be 700 feet wide at this location.

SUMMARY AND CONCLUSIONS

Review of work by most previous investigators indicates the main trace of the Wasatch fault is approximately 500 feet east of the fault mapped by IEC in the vicinity of the Ridge Athletic Club. Air photo interpretation also placed the main fault 500 feet to the east. Faulting identified in the excavation for the athletic club is interpreted to be the result of antithetic faulting paralleling the main fault trace. No offset greater than 2 feet was observed. The western limit of the antithetic zone was not determined in the UGMS study because it extends beyond the excavation in that direction. However, indications are that the total width of the graben (zone of deformation) is approximately 700 feet, which is significantly greater than the 100 foot zone identified on the hazards map. Furthermore, the IEC map extends the zone equally in both directions from the fault whereas, field evidence indicates that deformation extends primarily west of the main fault trace.

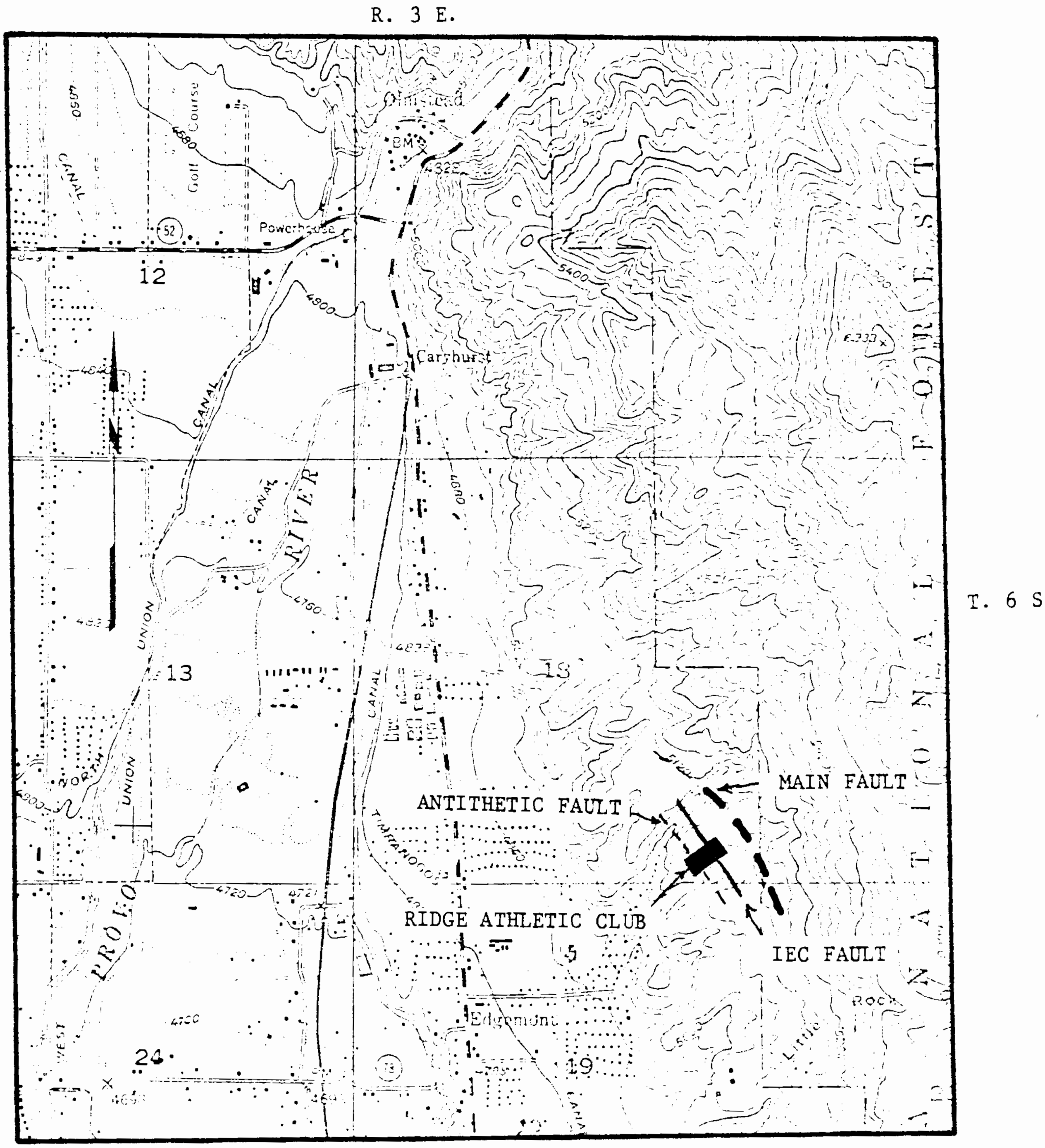
REFERENCES CITED

Baker, A.A., 1964, Geologic map and sections of the Orem quadrangle, Utah: U.S. Geological Survey Quadrangle Map GQ-241, scale 1:24,000.

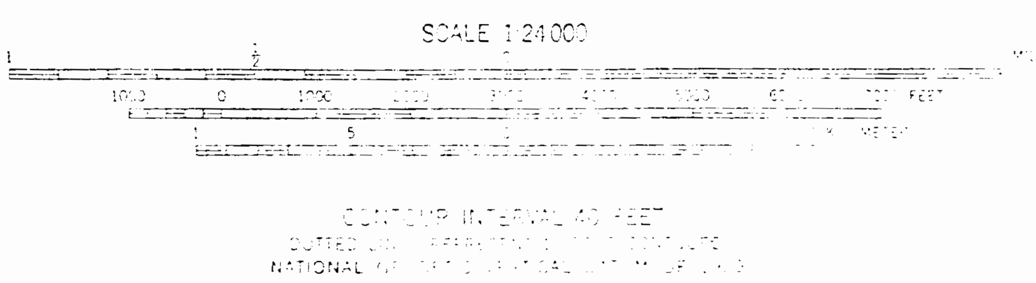
Cluff, L.S., Brogan, G.E., and Glass, C.E., 1973, Wasatch fault southern portion, earthquake fault investigation and evaluation: Woodward-Lungren and Associates, Oakland, California, 79 p.

Davis, F.D., 1983, Geologic map of the southern Wasatch front, Utah: Utah Geological and Mineral Survey Map 55-A, scale 1:100,000.

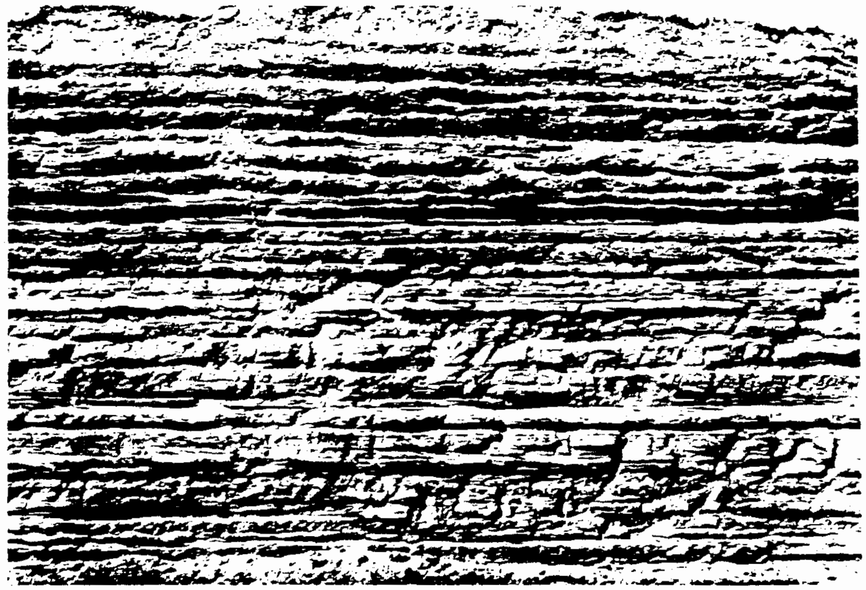
Hunt, C.B., Varnes, H.D., and Thomas, H.E., 1953, Lake Bonneville - geology of northern Utah Valley, Utah: U.S. Geological Survey Professional Paper 257-A, 99 p.



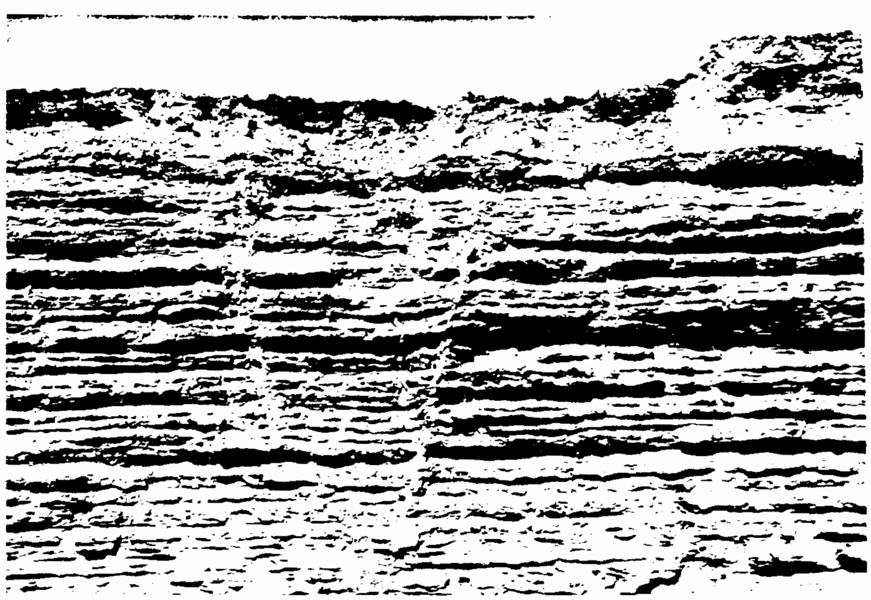
Base map from: U.S.G.S. 71/2' topographic quadrangle map Orem, Utah.



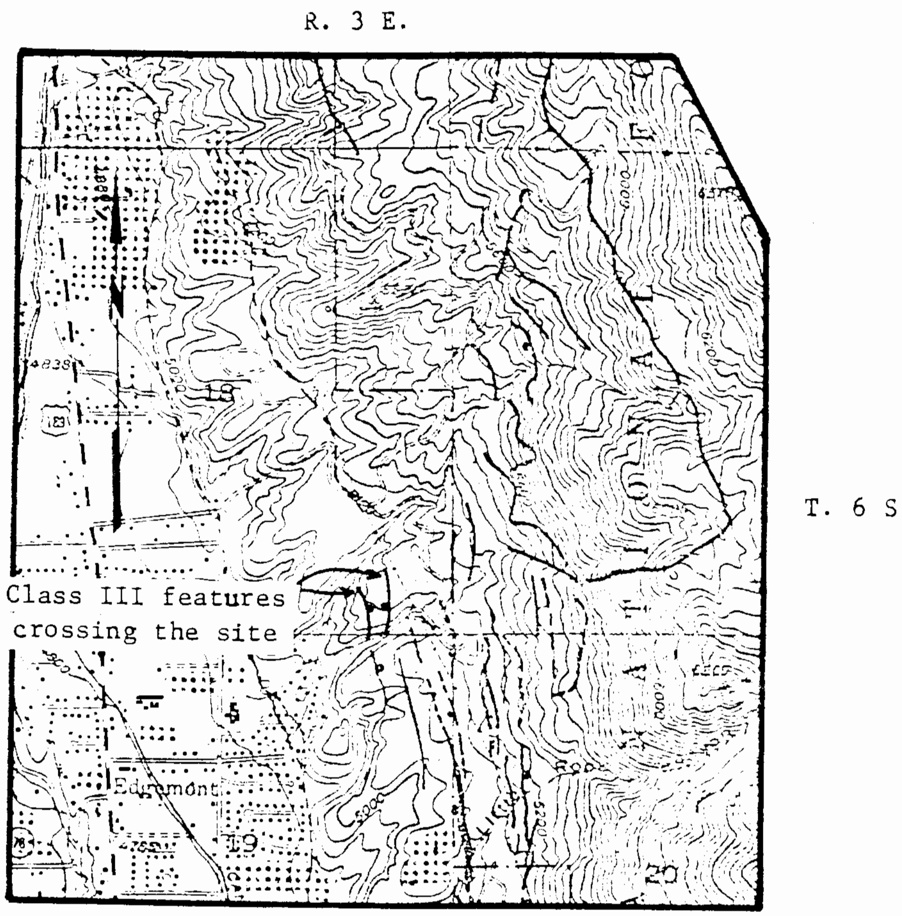
Location of the Ridge Athletic Club site.



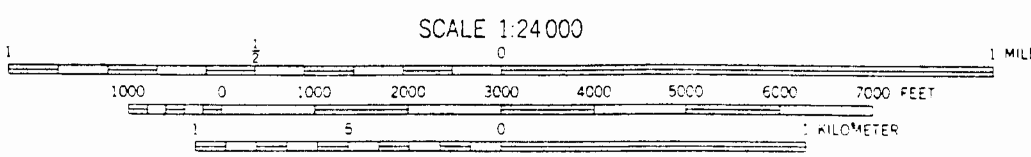
Photograph showing horizontal, interbedded silts and sands.



Photograph showing a series of horsts and graben.



Base map from: Cluff and others, 1973, and USGS
7 1/2' topographic quadrangle
map Orem, Utah.



CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10 FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Map showing location of Class III surface features crossing the site (after Cluff and others, 1973). Class III indicates a possible fault.

Project:			Requesting Agency:
Investigation of a fatal slope failure at a construction site in Sandy, Utah			Utah Division of Occupational Safety and Health
By: H. Gill	Date: 4/17/85	County: Salt Lake	Job No.: GH-4
USGS Quadrangle: Draper (1171)			

85-012

In response to a request from Mr. Donald L. Anderson, Compliance Supervisor for the Utah Division of Occupational Safety and Health, the Utah Geological and Mineral Survey (UGMS) made a geologic inspection at the site of a fatal slope failure in Sandy, Utah. The failure occurred on March 29, 1985. The UGMS was not contacted until April 2nd, and made its field visit on April 3rd.

SITE LOCATION AND DESCRIPTION

The failure occurred at the construction site for the new Lone Peak Elementary School at 11580 South and High Mesa Drive (2220 East) in Sandy, Utah. The failure was on the north side of a large amphitheater-shaped excavation (several hundred feet in width and length) being graded for the new school and surrounding playgrounds. When completed the amphitheater walls will consist of large earthen benches held in place by retaining walls. It was an excavation for one of these benches that failed. Most evidence of the slide had been removed or buried prior to the UGMS inspection by continued construction of a retaining wall. The estimated dimensions of the slope failure are 21 to 25 feet high, 40 feet wide, and 8 to 10 feet deep. The slip plane was oriented N 80° W and was dipping 51 degrees to the southeast. The original angle of the cut slope was 3/4:1 (orral commun., Deloy Adams, construction superintendent, April 3, 1985). In addition, approximately the bottom 3 feet of the slope stood as a vertical cut notched into the amphitheater wall.

GEOLOGY, SOILS, AND HYDROLOGY

The site is on the southwest edge of a large Lake Bonneville delta that formed at the mouths of Bell and Little Cottonwood Canyons. The delta is comprised of Provo and Bonneville level sand and gravel (Miller, 1980). Woodward-Clyde and Associates (1970), mapped a class III lineament (possible fault or rupture) 300 feet southwest of the site. A field reconnaissance and air photo examination conducted by the UGMS for the school site in November 1984, showed that the lineament is a Lake Bonneville erosional feature created by longshore currents eroding previously deposited lake sediments. During the 1984 study, the air photo analysis also showed a small debris flow in a drainage crossing the site. Grading for the new school has removed all evidence of the flow.

The soils involved in the slope failure consist of alternating layers of white to light-tan gravelly sand and sandy gravel. They exhibit a low density, are nonplastic and nonindurated, and at the time of the field visit were slightly moist. The sand grains are angular to subangular and the gravel clasts are subangular to rounded. The soil exposed in the slip plane of the slope failure is a gray-brown gravely sand that is loose to slightly dense, nonplastic, nonindurated, and moist. The U.S. Department of Agriculture Soil

Conservation Service has mapped the upper 60 inches of the soils at the site as the Preston and Wasatch series. Both are coarse-grained sand and gravel soils exhibiting medium- to high-shear strength, and high permeability.

Precipitation records were obtained for the month of March from the Metropolitan Water District of Salt Lake City - Little Cottonwood Water Treatment Plant weather station. The treatment plant is approximately 3.5 miles north and 100 feet higher in elevation than the school site. The record shows that 0.79 inches of precipitation (rain and snow) fell in the area during the period March 25 to 28. On March 25, 0.33 inches fell, and on March 27 and 28, 0.22 and 0.24 inches fell respectively. Mr. Adams reported that there had been intermittent light rain and snow on the day of the accident (March 29). Site soils are highly permeable, and depth to the unconfined water table is greater than 100 feet (Seiler and Waddell, 1984). Considering those facts, the soil moisture observed during the field visit is believed to be entirely the result of precipitation rather than ground water at the site.

SLOPE FAILURE

The following factors may have contributed to the slope failure.

1) The rain and snow which fell for three of the four days prior to the slope failure saturated the soil at the site creating additional weight in the slide mass and increasing the pore-water pressure between soil grains.

2) An 18 to 24 inch deep utility trench was observed at the top of the bench near the slip plane of the failure. The disturbed soil in the trench may have acted as a conduit for moisture to perculate into the

Project:			Requesting Agency:
Geologic hazards evaluation for a site in the Pole Canyon Area, Spanish Fork Canyon, Utah County			Division of State Lands and Forestry
By: R.H. Klauk	Date: 5/7/85	County: Utah	Job No.: GH-5
USGS Quadrangle: Spanish Fork Peak (1005)			

85-018

PURPOSE AND SCOPE

This report presents the results of an investigation by the Utah Geological and Mineral Survey to assess geologic hazards for property located in parts of secs. 12 and 13, T. 9 S., R. 3 E., and part of sec. 18, T. 9 S., R. 4 E., Salt Lake Baseline and Meridan, Utah County, Utah (attachment 1). The investigation was performed at the request of Richard P. Klason, Assistant Director of the Division of State Lands and Forestry. The Division of State Lands and Forestry is considering acquiring the land for development of single and multi-unit residential sites. Due to time constraints, the scope of work for this study was limited to a review of existing geological literature and a brief field reconnaissance on May 2, 1985.

SETTING

The property is located along the flood plain and adjacent mountain slopes of the Spanish Fork River above and below the mouth of Pole Canyon (attachment 1). An area above Green Flat, a small tributary to Pole Canyon is also included. Pole Canyon has been developed with single family housing units. Topography varies significantly across the property, the flood plain slopes less than 2 percent toward the river, whereas the mountainous areas have slopes greater than 90 percent in some areas.

GENERAL GEOLOGY AND HYDROLOGY

Geologic units on the site range in age from Pennsylvania to Quaternary and consist of consolidated rocks and unconsolidated residual soils and alluvium. Bedrock includes Pennsylvania/Permian Oquirrh Formation, Permian Kirkham Limestone, and Permian Diamond Creek Sandstone (Stokes and Madsen, 1961). Unconsolidated deposits consist of residual soils formed on bedrock and recent alluvium deposited in drainages and along the flood plain of the Spanish Fork River. The Oquirrh Formation consists of intercalated limestone and sandstone with minor beds of shale and siltstone, the Kirkham Limestone of brecciated, thin-bedded limestone, and the Diamond Creek Sandstone of crossbedded sandstone (Stokes and Madsen, 1961). Rigby (1962) has described sinkholes in the Kirkham Limestone at the mouth of Pole Canyon up to 40 feet in diameter.

Lone Pine Gulch, Thurber Canyon, Pole Canyon, and Green Flat are ephemeral drainages that empty into the Spanish Fork River at the mouth of Pole Canyon. At the time of the reconnaissance, all were dry. Depth to ground water below the flood plain of the Spanish Fork River is not known, but is thought to be shallow (less than 10 feet).

SITE CONDITIONS

For purposes of this study the site has been divided into three areas. Area 1 consists of all land above 4800 feet in elevation, area 2 includes part of the Spanish Fork River flood plain north of the mouth of Pole Canyon, and area 3 comprises the mouth of Pole Canyon and the flood plain to the southeast (attachment 1).

Area 1

Elevations in area 1 range from approximately 4,800 feet to 6048 feet. Slopes are steep, ranging from 22 percent to more than 90 percent. The area is dissected by many small ephemeral drainages. Soil cover is thin and residual in many areas with occaissional bedrock outcrops. Alluvium is present in drainages, and is also generally thin. Two small debris slides were noted on a steep north-facing slope above the Spanish Fork River (attachment 1). Kirkham Limestone forms most of the ridge between Pole Canyon and Green Flat and, where exposed, exhibits extensive solution cavities (attachment 1).

Area 2

The flood plain along the Spanish Fork River north of the Pole Canyon is characterized by alluvial soils of unknown depth. The surface of the flood plain is about 2 feet above the present elevation of the Spanish Fork River. The area appears to have been recently flooded, possibly during the draining of Thistle Lake. Vegetation consists of cattails and other plants characteristic of areas with high ground water or standing water. Evidence of active bank slumping due to undercutting by the river was also observed. The flood plain abruptly terminates against a bedrock slope of Oquirrh Formation.

Area 3

The flood plain southeast of Pole Canyon is characterized by alluvial deposits of unknown depth covered by grass. This area, at present, is approxiamtely 8 feet above the level of the Spanish Fork River and abruptly terminates against a steep cliff consisting of Diamond Creek Sandstone. A 2 foot dike has been constructed along this reach of the river. Depth to ground water is not known, but is probably less than 10 feet.

Area 3, at the mouth of Pole Canyon, is characterized by a change in slope. The drainage from Pole Canyon has incised through more than 40 feet of alluvium. Immediately southwest of the site, at this location, are the karst features described by Rigby (1962). No evidence of these features was noted on the site, however.

SUMMARY AND CONCLUSIONS

Area 1 is is characterized by steep slopes, thin residual soils, and thin alluvium along ephemeral drainages. Two small debris slides are also present in this area and cuts may cause additional soil failures. Kirkham Limestone outcrops exhibit solution cavities.

Area 2 is prone to flooding and is currently being actively eroded by the Spanish Fork River. Depth to ground water is possibly 2 feet or less.

Area 3 is predominantly on the flood plain of the Spanish Fork River, but is higher in elevation than area 2 and therefore the flood potential is lower. Depth to ground water is also unknown, but is likely 8 feet or less. Solution cavities in the Kirkham Limestone may underlie the area and present a hazard.

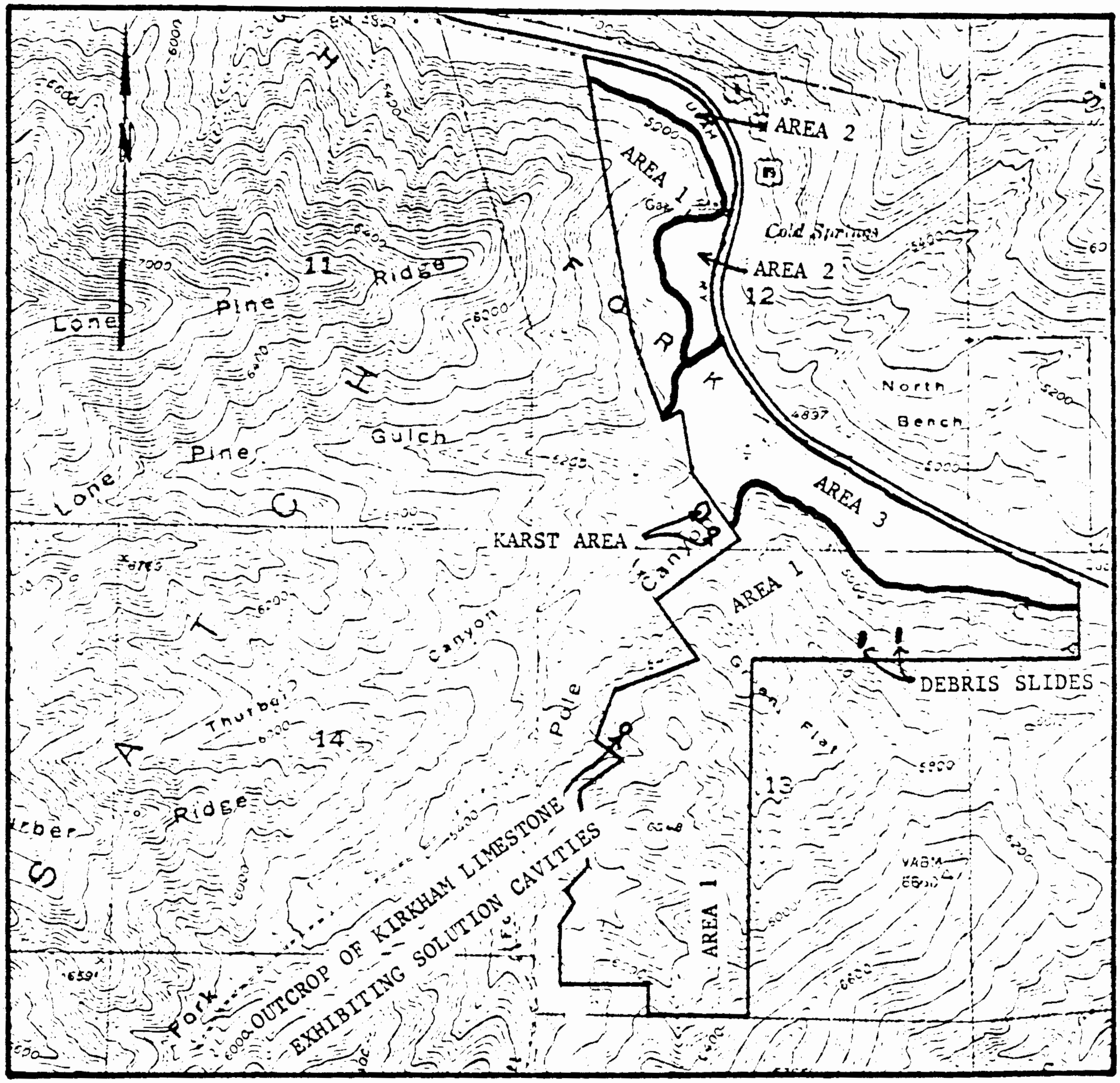
Areas 1 and 2 have severe constraints that appear to preclude development. Area 3 has limitations, but further study may establish that it is suitable for development.

REFERENCES CITED

Rigby, J.K., 1962, Some geomorphic features of the southern Wasatch Mountains and adjacent areas: Brigham Young University Geology Studies, v. 9, Part 1, p. 84.

Stokes, W.L., and Madsen, J.H., compilers, 1961, Geologic map of Utah northeast quarter: University of Utah Department of Mines and Mineral Industries, scale: 1:250,000.

Attachment 1, Job No. GH-5



SCALE 1:24000

1 ½ 0 1 MILE

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS

Base map from: U. S. G. S. 7 1/2' topographic quadrangle map Spanish Fork Peak, Utah.

LOCATION MAP OF THE SITE

Project:			Requesting Agency:
Investigation of a debris flow near the K&J Subdivision, Wasatch County, Utah			Wasatch County Recorder's Office
By: H. Gill	Date: 5/28/85	County: Wasatch	Job No.: GH-6
USGS Quadrangle: Brighton (1169)			

#85-020

In response to a request from Mr. Joe Don Huber, Wasatch County Recorder, a geologic investigation was made by the Utah Geological and Mineral Survey (UGMS) of a debris flow in the SE1/4 of sec. 18, T. 3 S., R. 4 E., SLBM, Wasatch County, Utah (attachment 1). The purpose of the investigation was to evaluate the hazard presented by the flow to a cabin in the K & J subdivision. A field reconnaissance was conducted on May 10, 1985, in the company of Mr. Huber. Observations were hampered by a one-inch cover of snow.

The debris flow occurred on a steep northeast facing hillside south of Snake Creek, and southwest of the K & J subdivision (attachment 1). The hillside is underlain by glacial moraine deposits (Baker and others, 1966). Several rotational slump landslides, ranging in length from tens of feet to several hundred feet, were also observed on the hillsides in the vicinity of the cabin. Two springs located high on the hillside have been developed as a source of water for the subdivision. A road providing access to the springs traverses the hill, and crosses several of the slope failures. According to Mr. Huber, movement of a number of landslides on the slope has occurred in the past year, and Wasatch Mountain State Park personnel responsible for maintenance of the road indicate that slide movement and subsequent road repairs have increased over the past two years. This time interval corresponds to a period of greater than normal precipitation for the area.

The debris flow occurred 3 to 5 days prior to the investigation (J. Huber, oral commun., May, 1985). It flowed down the west side of a large (approximately 500 feet long and 100 feet wide) pre-existing rotational slump failure, creating a channel about 6 feet deep and 10 feet wide. A small fan of debris (approximately 30 feet wide and 1 to 3 feet deep) was deposited on the toe of the older slide about 175 feet southeast of the cabin. The debris flow had stabilized by the time of the reconnaissance, but a small stream of water continued down the newly formed channel. The water issues from a minor scarp in the older slide located approximately 250 feet upslope from the toe. A section of black plastic pipe, about 20 feet long and 2 1/2 inches in diameter was observed lying in the debris flow channel. The two springs that supply water to the subdivision are above the older rotational slump failure and the debris flow, and a buried waterline extends across the slope to a water tank northwest of the area. Mr. Huber did not know if the black plastic pipe was part of the spring development, however, it is likely that the pipe is part of the waterline (or lines) from the springs to the storage tank. The older landslide shows evidence of several periods of movement at different times and locations within the slide mass. The area from which the water is issuing appears to have been recently active, and it is believed that movement there may have caused a break in the waterline. The slope eventually became saturated and failed, resulting in the debris flow.

The hazard presented to the cabin by the debris flow and the rotational slump failure is minimal at this time. There is no indication that the the debris flow caused renewed movement of the lower portion of the older landslide. Vegetation, primarily grass and scrub oak, was not disturbed and no open cracks were observed. However, other debris flows may occur if the waterline is again routed across the slump failure where it would be subject to another break. It is likely that the natural drainage on the hillside would direct a second debris flow away from the cabin, but if a large volume of water is again introduced to the slope it might cause the older slide to move. The toe of the rotational slump failure is only about 100 feet from the cabin, and might reach the structure if movement is renewed. Therefore, it is recommended that when the waterline is repaired, a new alignment be used that keeps it off the older failure.

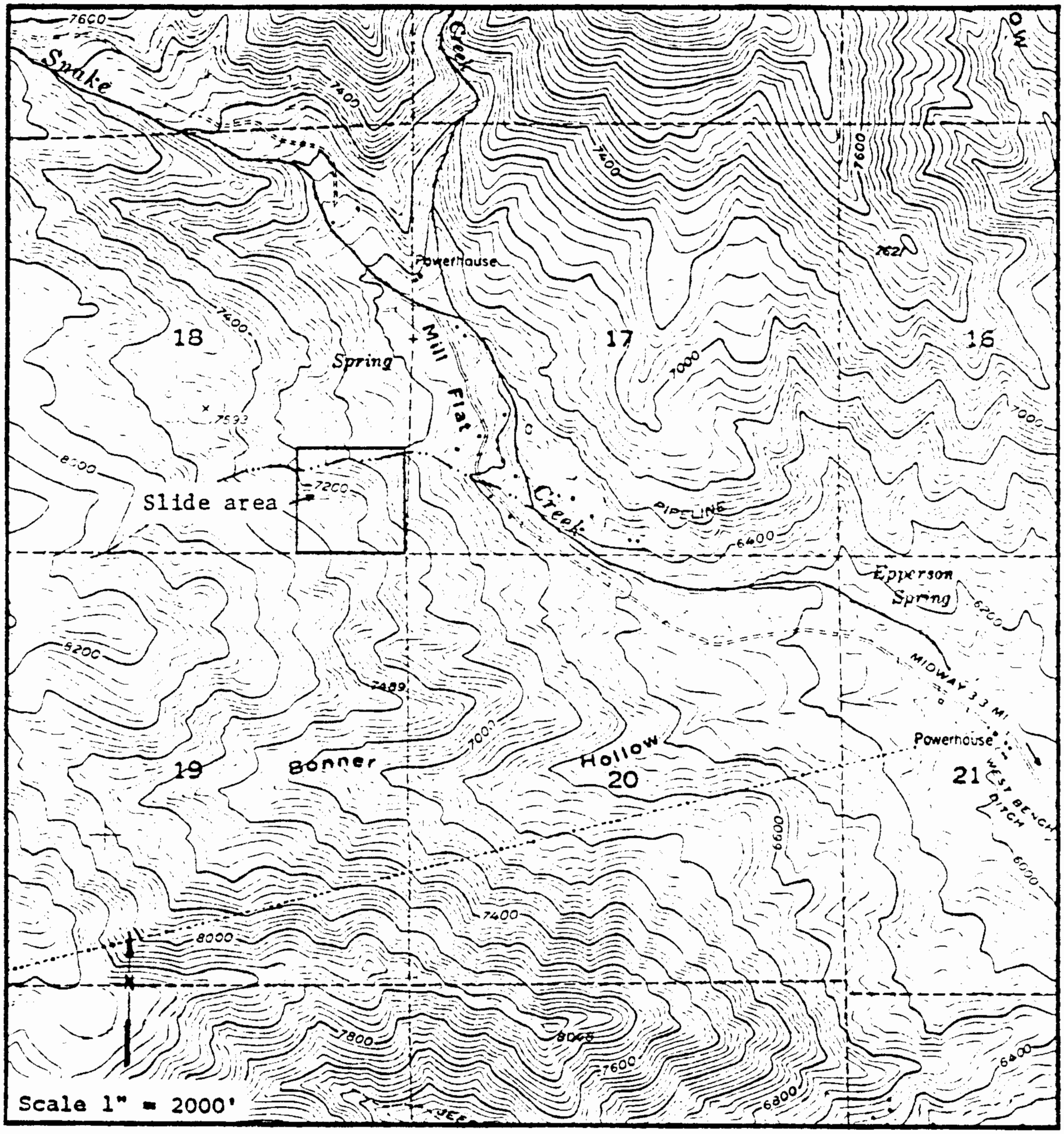
REFERENCES

Baker, A. A. and others, 1966, Geologic map of the Brighton Quadrangle, Utah: U. S. Geological Survey Geologic Quadrangle Map GQ-534, scale 1:24,000

Schuster, R. L., and Krizek, R. L., 1978, Landslides analysis and control, National Academy of Sciences Special Report 176, 234 p.

Attachment 1, Job No. GH-6

Base map from USGS topographic quadrangle, Brighton, Utah (7½ minute series)



General location map, Wasatch County debris-flow area

Project: Utah and Salt Lake Canal Embankment stability investigation			Requesting Agency: Salt Lake County Flood Control and Water Quality
By: R.H. Klauk	Date: 7/1/85	County: Salt Lake	Job No.: GH-7
USGS Quadrangle: Jordan Narrows (1131)			

#85-022

In response to a request from R. T. Holzworth, Director, Salt Lake County Flood Control and Water Quality, an investigation has been conducted to determine the stability of a portion of an embankment for the Utah and Salt Lake Canal. Concern was initiated when moist to wet soil and ponded water was observed in the vicinity of the canal embankment. Failure of the embankment would interrupt the supply of irrigation water to downstream users, flood the Denver and Rio Grande Western railroad tracks, and impair part of Salt Lake County's flood control effort. The scope of work for this investigation included a review of existing geologic and hydrologic literature, and a field reconnaissance of the site on June 18, 1985.

The section of canal investigated is located in the SE 1/4, sec. 22, T. 4 S., R. 1 W., Salt Lake Baseline and Meridian (attachment 1). In this reach, the canal is constructed on alluvial flood-plain deposits of the Jordan River at the base of a cliff consisting of Tertiary Salt Lake Formation overlain by Lake Bonneville deposits (Slenz, 1955; and Davis, 1983). A small ephemeral drainage has cut into the flood plain at this location. Prior to blockage by the canal and railroad embankments, this drainage carried surface runoff to the Jordan River. The moist to wet soil and ponded water are located within the drainage and immediately southwest of the railroad tracks, approximately 200 to 300 feet northeast and below the canal embankment (attachment 1).

Ponded surface water was noted, both north and south of the site, indicating a shallow ground-water system exists along this part of the Jordan River flood plain. This may be a perched system overlying the Salt Lake Formation. The canal is unlined and conceivably loses water to this shallow system. Canal infiltration combined with the wet years of 1983 and 1984 have likely resulted in an increase in the water level in this shallow system, producing the pond.

During the reconnaissance, moist to wet soil was observed from the base of the canal embankment, continuously to the pond within the confines of the drainage. No moisture was found on the embankment and no indications of potential failure were observed. The moist to wet soil is considered to be the result of a rise in the shallow ground water table and not do to increased canal leakage. Based on the reconnaissance and literature review, canal embankment failure is not thought to be imminent at the site. However, it is recommended that this area continue to be monitored for any adverse changes.

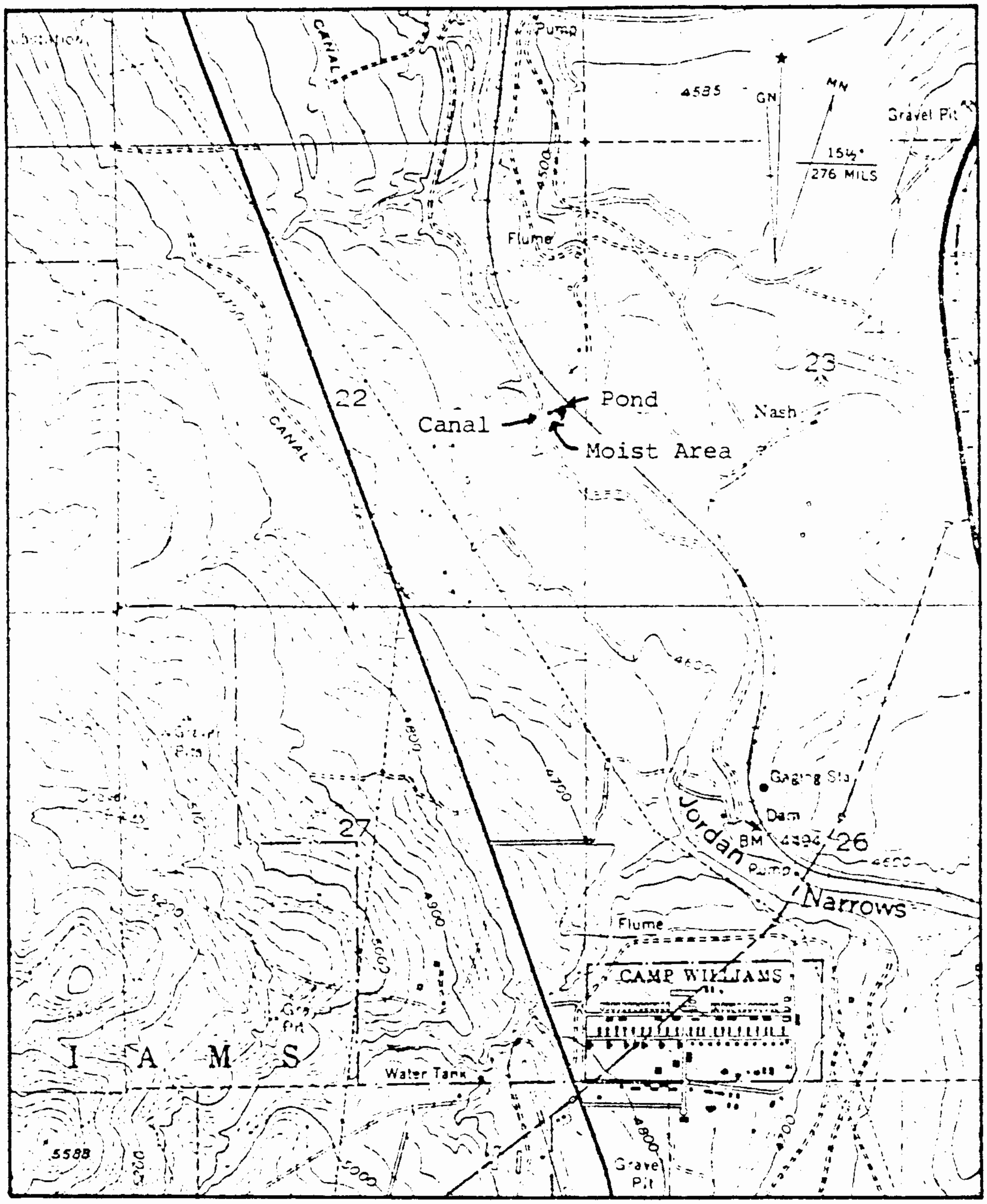
REFERENCES CITED

Davis, F.D., 1983, Geologic map of the southern Wasatch front, Utah: Utah Geological and Mineral Survey Map 55-A, scale 1:100,000.

Slenz, L.W., 1955, Salt Lake Group in lower Jordan Valley, Utah in Eardley, A.J., ed., Tertiary and Quaternary geology of the eastern Bonnevile basin: Utah Geological and Mineral Survey Guidebook to the Geology of Utah no. 10, p. 23-36.

Attachment 1, Job No. GH-7

R. 1 W.



Base Map from: U.S.G.S. 7½' topographic quadrangle map, Jordan Narrows, Utah.

SCALE 1:24000

1 ½ 0 1 MILE

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 5 FOOT CONTOURS

Location Map

APPENDIX

List of 1985 Applied Geology Publications

Special Studies

Christenson, G. E., Oviatt, C. G., Schroder, J. F., and Sewell, R. E., 1985, Contributions to Quaternary geology of the Colorado Plateau: Utah Geological and Mineral Survey Special Study 64, 85 p.

Reports of Investigation

Case, W. F., 1985, Dam failure inundation study for Deer Creek Dam, Utah County: Utah Geological and Mineral Survey Report of Investigation 197, 23 p.

Christenson, G. E., 1985, Causes of basement flooding along 11800 South near 3800 West, South Jordan and Riverton, Salt Lake County: Utah Geological and Mineral Survey Report of Investigation 195, 27 p.

Christenson, G. E., and Bishop, C., 1985, Preliminary geologic hazard and resource inventory for state lands in Washington County: Utah Geological and Mineral Survey Report of Investigation 199, 14 p.

Harty, K. M., 1985a, Technical Reports for 1984 Site Investigation Section: Utah Geological and Mineral Survey Report of Investigation 198, 291 p.

------------- 1985b, Geologic evaluation of a proposed land fill site in Weber County, Utah: Utah Geological and Mineral Survey Report of Investigation 203, 18 p.

Kaulk, R. H., 1985, Engineering geology for land-use planning for Research Park, University of Utah, Salt Lake City, Utah: Utah Geolgical and Mineral Survey Report of Investigation 206, 27 p.

Open-File Reports

Case, W. F., 1985, Significant drill holes of the Wasatch Front valleys including Cache Valley, and Tooele Valley: Utah Geological and Mineral Survey Open-File Report 82, 14 p.