No. 190

TECHNICAL LETTERS AND MEMORANDA FOR 1983
SITE INVESTIGATION SECTION

William R. Lund

Editor

February 1985

CONTENTS

ILLUSTRATIONS

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. Often, the best method of mitigating a geologic hazard is avoidance, a course of action greatly aided by the early review of alternate sites. The section also conducts investigations to answer specific geologic or hydrologic questions from state and local governments, the answers to which assist them in performing their regulatory functions. Examples include evaluation of protection zones required for culinary springs for local health departments, 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. From time to time, the Site Investigation Section conducts studies of a longer and more detailed nature. These investigations are also designed to meet a specific need, and are generally performed under a cost-sharing contract with the public entity requesting the study.

Information dissemination is a 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 publication list. Special Studies and Bulletins can be purchased from the UGMS and are placed in libraries throughout the state. Reports of Investigations 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 memorandum and are distributed on a need-to-know basis. Copies of the reports are maintained in the Site Investigation Section files, but a list of projects and their locations have not been generally available for public inspection.

The intent of this Report of Investigation is to gather in a single document the 33 special-purpose studies done by the Site Investigation Section in 1983 (figure 1) which received only limited distribution. The reports are grouped by topic, and the author and requesting agency are indicated. Minor editing has been performed for clarity and conformity, but no attempt was made to upgrade the original graphics, most of which were produced using a copying machine. This report represents the first 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 R. Lund
January 1985

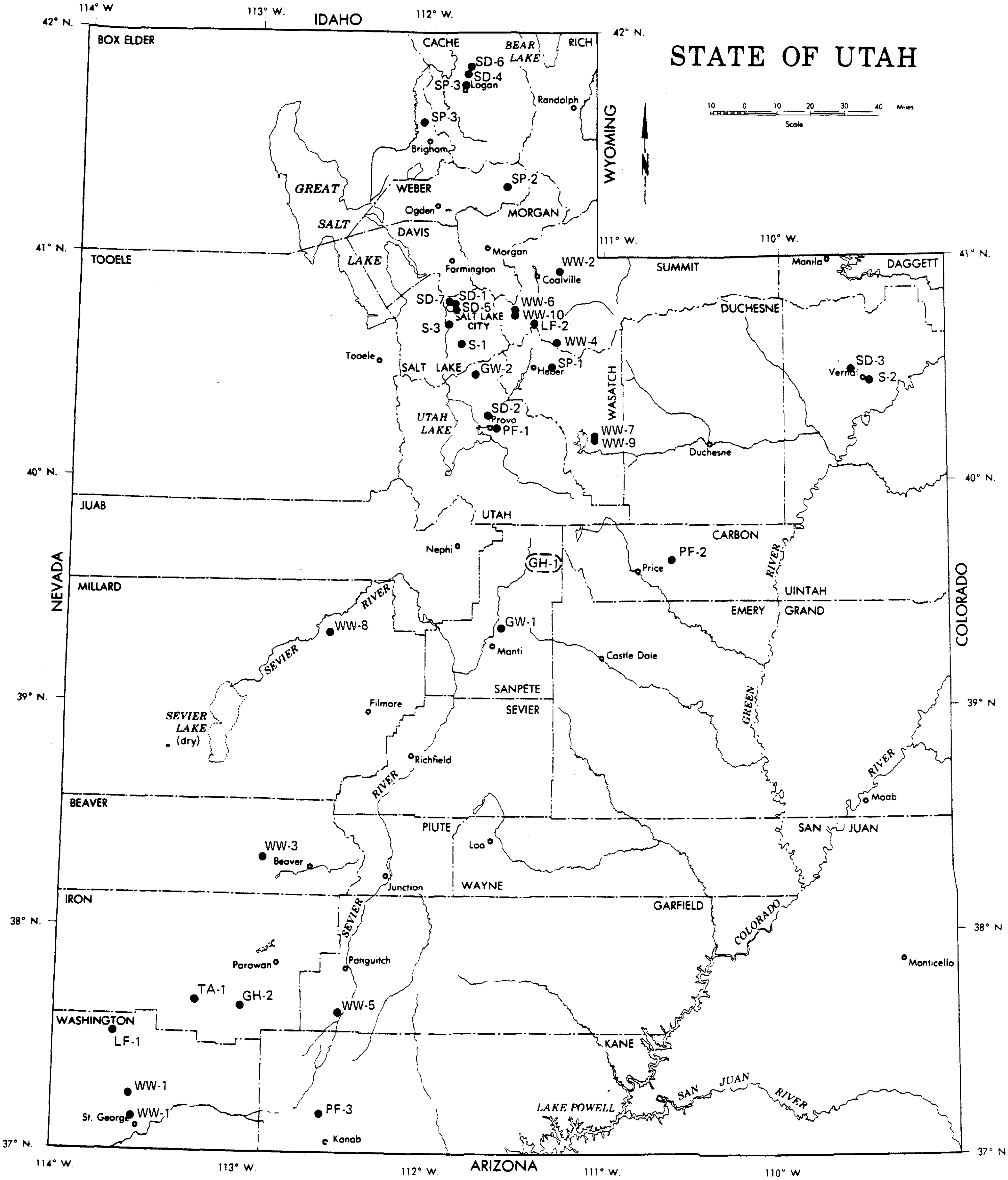


Figure 1. Location map.

SITE INVESTIGATIONS

Public Facilities
Schools
Subdivisions
Terrain analysis

PUBLIC FACILITIES

Project: Investigation of two proposed sites for a 5 million gallon water tank, Provo, Utah.			Requesting Agency: Provo City
By: H. E. Gill	Date: Feb. 14, 1983	County: Utah	Job No.: PF-1
USGS Quadrangle: Orem (1088)			

February 14, 1983

MEMORANDUM

TO: William R. Lund, Site Investigation Section

FROM: Harold E. Gill, Geologist

SUBJECT: Geologic investigation of two proposed sites for a 5 million gallon culinary water storage tank for the city of Provo, Utah

In response to a request from Mr. Jesse Robinson (Director, Water and Wastewater Department, Provo City Corporation) a geologic investigation was conducted on January 19, 1983, of two proposed sites for a new 5 million gallon culinary water storage tank. Mr. David Thurgood, the city engineer, has been in contact with the Utah Geological and Mineral Survey throughout the investigation. The reservoir will be a circular concrete tank 190 feet in diameter and 24 feet high. The floor elevation of the buried structure will be 4992 feet above sea level.

SCOPE OF WORK

The site investigations consisted of a review of available published and unpublished literature and examination of stereo aerial photographs covering both sites. A preliminary field reconnaissance was performed, after which site 1 was removed from further consideration. The field investigation of site 2 included detailed surficial geologic mapping and excavation of a 200-foot east-west trench. The purpose of the trench was to look for evidence of faulting in deposits and to observe soil types. Because of terrain constraints, the trench could not be located offsite and was excavated across the proposed tank location. This made it necessary to keep the trench bottom above final grade to avoid disturbing the foundation material. The trench was 21 feet deep at the eastern end and 3.5 feet deep at the western end. During the field reconnaissance, road cuts, power and gas line rights-of-way, and natural stream cuts were also examined. I was accompanied in the field on both occasions by personnel from Thurgood and Associates.

SITE 1

LOCATION AND DESCRIPTION

Site 1 is located in the east bench area of Provo in a small drainage incised into the Lake Bonneville sands and gravels approximately one mile north of Little Rock Canyon (attachment 1). The tank would be located on an alluvial fan deposited at the mouth of the drainage. East of the site the stream channel is cut 3 to 8 feet deep in the alluvium. At the east edge of the property the water in the channel is diverted into a small concrete ditch which runs along the east and south boundaries of the site. Therefore, the stream has not cut a channel across the site. At the time of the investigation, the site was used for grazing. Access is by an unimproved dirt road.

Two geologic hazards discovered during the initial field reconnaissance at site 1 resulted in its removal as a possible location for the water tank. A small earth slump was identified on the bench slope south of the stream drainage approximately 100 to 150 feet east-southeast of the tank location. A cut into the base of this slope would be required to accommodate the water tank. This would increase the danger of additional slope failures which might damage the tank. The second hazard involved the potential for increased erosion at the site. Once constructed, the reservoir would block the small drainage channel requiring the stream flow to be diverted around the property. Soils on the site are easily eroded and overflow of this diversion could result in undercutting of the tank foundation.

SITE 2

LOCATION AND DESCRIPTION

Site 2 is located on an alluvial fan deposited at the mouth of a small stream drainage incised into the Lake Bonneville sands and gravels approximately 1/2 mile north of site 1 (attachment 1). It slopes to the west with approximately a 17 percent grade. An orchard occupies the northern portion of the property and the stream, which has incised its channel three to five feet deep, trends across the southern edge. There is a small hill to the south of the stream which will be partially removed during the excavation for the reservoir. The stream will be diverted to the north of the reservoir. Access to the site is by a gravel road which will also be relocated to the north of the tank.

GEOLOGY AND SOILS

Bedrock does not crop out at the surface on the site, nor was it encountered in the trench. The nearest bedrock outcrop is in a small drainage approximately 600 feet north-northwest of the property. The outcrop is Manning

Canyon Shale which weathers to a highly expansive clay. Development on this material south of the site, including single family dwellings and a several-million gallon water tank at the mouth of Little Rock Canyon, have experienced foundation problems. No evidence of expansive clay was observed at the site, or in the hills in the immediate vicinity. The sediment at the site is primarily of two types: alluvial fan deposits of Holocene-age (present to 10,000 years B.P.) and Bonneville and Alpine Stage Lake Bonneville deposits of Pleistocene-age (10,000 to 1.6 million B.P.) (Hunt, 1953; Davis, in press). Detailed mapping during this investigation further subdivided the units according to type of deposit, predominant grain size, and depositional environment (attachment 2). Lake deposits consisted either of silty sand-silt [Lsm-m(b)] or thin silty sand with gravel and cobbles [Lsmgk(b)(3')]. Alluvial fan deposits contain silt, sand, gravel, cobbles, and boulders [Asm-b(f)]. Two other deposits identified consist of mixtures of these three principal units (attachment 2). The water tank is to be located principally in alluvial fan deposits [Asm-b(f)]. Observations in the trench indicate that the upper 2-3 feet of soil consists of dark brown, clayey sand (topsoil) with approximately 30 percent gravel. Silty sand with gravel was encountered from the base of the topsoil horizon to the bottom of the trench. The material had a maximum particle size of two feet and contained approximately 40 percent angular gravel and cobbles with about 5 percent boulders. The soil density was low to loose and, although no ground water was encountered (depth to ground water is estimated greated than 100 feet), the soil was moist to wet.

SEISMICITY AND FAULTING

The reservoir is located near a major trace of the Wasatch fault. Woodward-Lundgren and Associates (1973) mapped the Wasatch fault zone in the site vicinity from aerial photographs (attachment 3). Their mapping classifies lineaments into three categories: 1) class I, well-defined topographic features marking most recent surface fault ruptures; 2) class II, probably surface faults or ruptures; and 3) Class III, possibly surface faults or ruptures. A class III lineament is mapped as crossing the site. Armstrong (1975) also mapped a fault crossing the site which is very similar to, and appears to have been taken from, the Woodward-Lundgren map (attachment 3). No evidence for faulting was found in the trench or in exposures of alluvial fan or the Lake Bonneville sediments at or near the site. Baker (1964) mapped a bedrock fault which projects towards the site but terminates 1,000 feet north of the site. This fault is identified on the Woodward-Lundgren map as a class II fault (attachment 3). This fault is very old and no evidence of offset in site sediments was observed.

CONCLUSIONS AND RECOMMENDATIONS

Site 1 was removed from consideration because of geologic hazards observed on the site. The following conclusions and recommendations refer to site 2.

1. Flood hazard at the site is low, but erosion of the fine-grained sediments could present a hazard. Precautions should be taken during construction and after completion of the reservoir to allow for adequate drainage.

2. The low density, noncohesive, granular soils found on the site are unstable in verticle cuts, and shoring or sloping of temporary construction cuts may be required.

3. There is no evidence to indicate that the reservoir would be subject to slope failure, including rock fall.

4. A single fault has been mapped as crossing the site but no evidence of the fault was found in the trench or existing exposures. It is our opinion that the main trace of the Wasatch fault is located at the base of the bench or further to the west, possibly on the valley floor.

5. Earthquakes along the Wasatch fault present the greatest geologic hazard to the site. Depending upon the location of the epicenter and the magnitude of the event, an earthquake could produce intensive ground shaking and possible ground rupture on or near the site. The site is within Uniform Building Code seismic zone 3 (Seismic Safety Advisory Council sesimic zone U-4) and all structures should be designed accordingly.

6. Consideration should be given to safety features such as flexible joints and automatic shut-off valves that activate immediately if water lines to or from the tank are damaged by earth movement.

7. Some protection should be considered for structures downslope from the reservoir in the event of tank rupture due to a major seismic event.

8. Due to the great depth to ground water, soil liquefaction should not present a problem.

9. Compactive characteristics of site soils will be improved by removing all oversize material in accordance with established engineering procedures. Our investigation did not extend below the foundation level, and we recommend a detailed soils investigation be performed with borings to depths at at least 50 feet.

HEG/hg

SELECTED REFERENCES

Armstrong, R.M., 1975, Environmental geology of the Provo-Orem area: Brigham Young University Geology Studies, v. 22, part 1, p. 39-67.

Baker, A.A., 1964, Geologic map and sections of the Orem Quadrangle, Utah: U.S. Geological Survey Map Geological Quadrangle, 1:24,000.

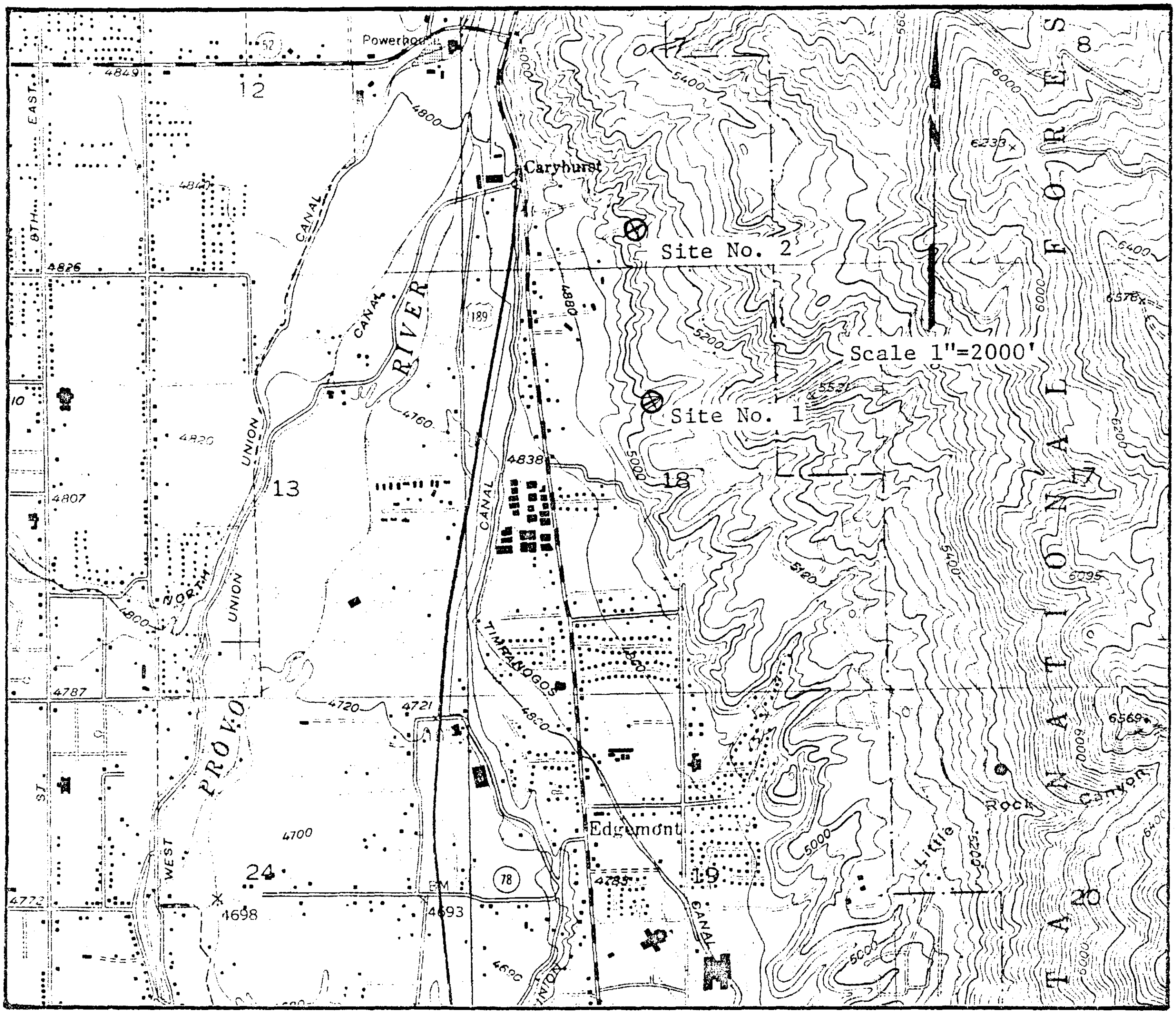
Cluff, L.S., Brogan, G.E., and Glass, C.E., 1973, Wastach fault southern portion, earthquake fault investigation and evaluation: Woodward-Lundgren and Associates, Consulting Engineers and Geologists, Oakland, California, map sheet 20.

Currey, D.R., 1980, Events associated with the last cycle of Lake Bonneville-Idaho, Nevada, and Utah: American Quaternary Association, 6th Biennial Meeting, Abstracts and Programs, p. 59-60.

Davis, F.D., in press, Geology of the southern Wasatch Front: Utah Geological and Mineral Survey map 55-A, scale 1:100,000.

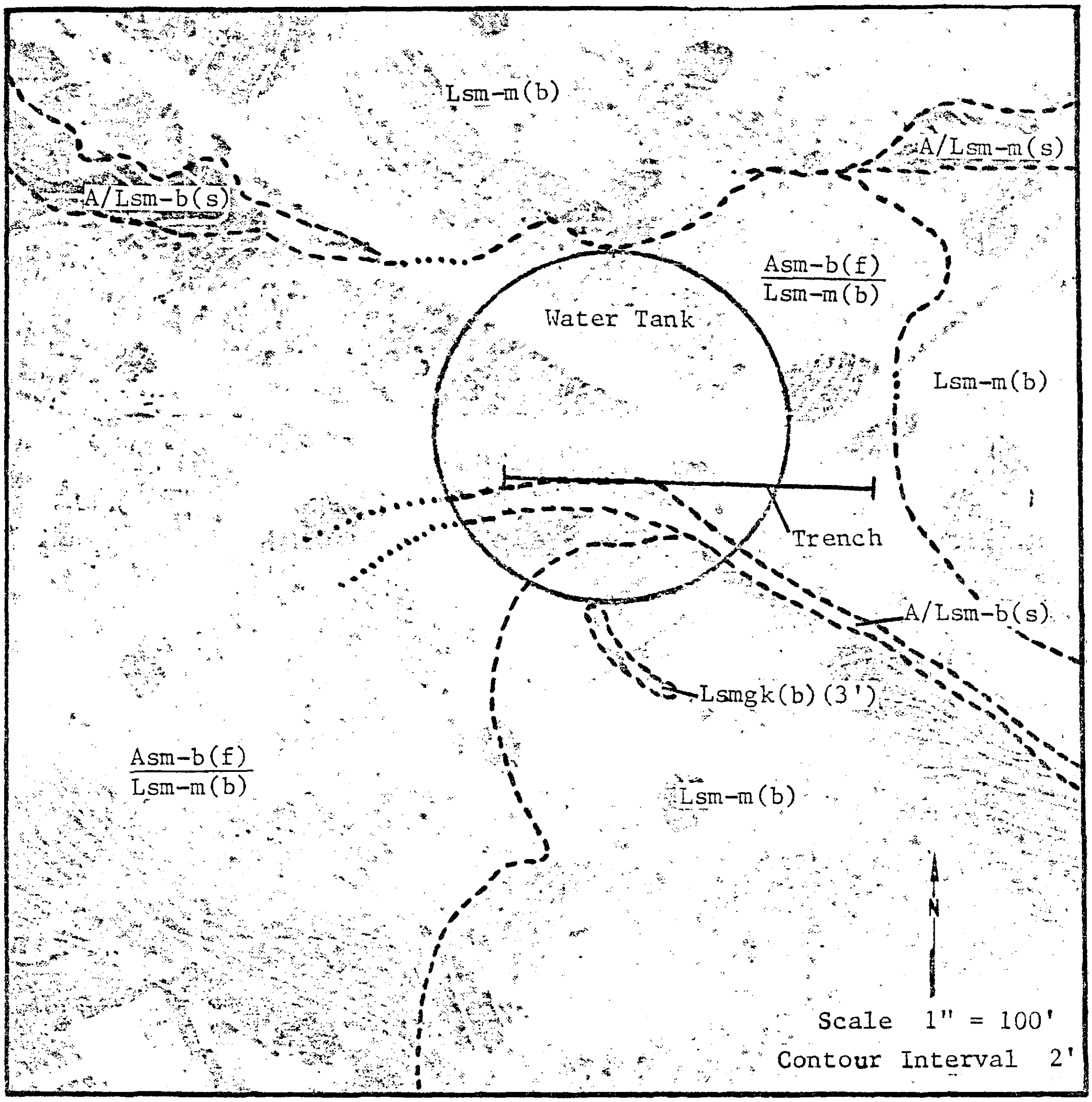
Hunt, C.B., Varnes, H.D., and Thomas, H.E., 1953, Lake Bonneville, geology of northern Utah Valley, Utah: U.S. Geological Survey Professional Paper 257-A, 99 p.

Scott, W.E., Shroba, R.R., and McCoy, W.P., 1982, Guidebook for the 1982 Friends of the Pleistocene, Rocky Mountain Cell field trip to Little Valley and Jordan Valley, Utah: U.S. Geological Survey Open-File Report 82-845, 58 p.



General Location Map

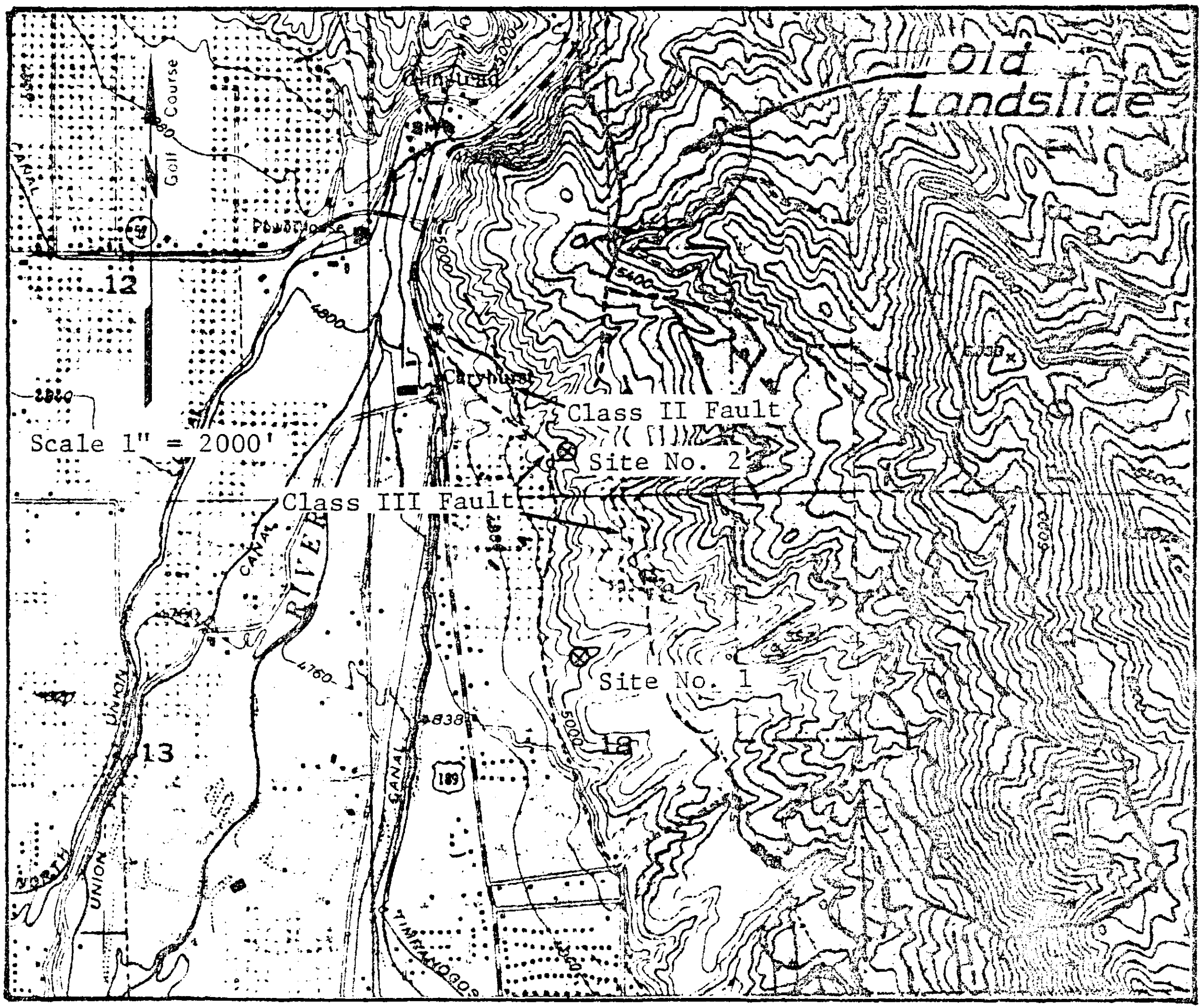
Proposed sites for five-million gallon culinary water storage reservoir



Explanation

Lsm-m(b)	Lake deposit (L) composed of a borderline silty sand-silt (sm-m); deposited in a beach environment (b).
Lsmgk(b)(3')	Lake deposit (L) composed of silty sand (sm), gravel (g and cobbles (k); deposited in a beach environment (b), thickness of 3 feet.
Asm-b(f) / Lsm-m(b)	Alluvial deposit (A) composed of a mixture of materials ranging from silty sand (sm) to gravel (g), cobbles (k) or boulders (b); forming a fan (f) overlying a lake deposit (Lsm-m(b).
A/L sm-b(s)	Combination of alluvial (A) and lake (L) deposits; composed of a mixture of materials ranging from silty sand (sm) to gravels (s), cobbles (k), or boulders (b) stream deposited (s).
A/L sm-m(s)	Combination of alluvial (A) and lake (L) deposits; composed of a borderline silty sand-silt (sm-m) stream deposited (s).

Surficial Geology Map
Site Number 2



Wasatch Fault Investigation

Woodward-Lundgren & Associates, 1973

Project: Site investigation for a 500,000 gallon water tank and water treatment plant, East Carbon, Utah			Requesting Agency: East Carbon City
By: G.E. Christenson	Date: Feb. 14, 1983	County: Carbon	Job No.: PF-2
USGS Quadrangle: Sunnyside (832), Patmos Head (831)			

February 14, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Proposed water system improvements, East Carbon City and Sunnyside

BACKGROUND

At the request of city officials of East Carbon City and Sunnyside, the Utah Geological and Mineral Survey was contacted by Gottfredson and Jueschke, Inc. (engineers for the project) to conduct a geologic hazards investigation of proposed sites for a water tank and water treatment plant. The water tank will be a 500,000 gallon steel tank with its base about 10 feet below present ground surface. It is located in Sunnyside between the Denver and Rio Grande Western railroad tracks and Grassy Trail Creek (attachment 1). The water treatment plant site is upstream in Whitmore Canyon near the mouth of Water Canyon (attachment 2). Site locations were identified from maps submitted by Gottfredson and Jueschke, Inc. and from discussions with Lynn Gottfredson (February 27, 1983).

SCOPE OF WORK

The scope of work included:

1. a review of existing geological literature and interpretation of air photos for the area, and

2. a field reconnaissance on January 31, 1983.

Both sites were covered with snow at the time of the field reconnaissance and no soil test pits were excavated. All soil data are from nearby stream cuts which are thought to represent soil types similar to those at the sites.

GEOLOGY AND HYDROLOGY

WATER TANK SITE

Sunnyside and East Carbon City are located at the base of the Book Cliffs in central Utah in an area of gently east-dipping Cretaceous and Tertiary sedimentary rocks. The Mancos Shale, a thick non-resistant unit, forms the piedmont lowland at the base of the cliffs. Gravel deposits of Quaternary age mantle the Mancos Shale in many areas at various levels above modern drainages. The streams draining the Book Cliffs-Roan Cliffs area cut broad pediments across the Mancos Shale and deposited a layer of gravel on these cut surfaces. Sunnyside is at the point where Grassy Trail Creek emerges from Whitmore Canyon in the Book Cliffs onto the Mancos lowland. The water tank site is on a gravel terrace overlying the Mancos Shale about 30-40 feet above Grassy Trail Creek. Cuts in the area indicate that gravels locally exceed 40 feet in thickness. The deposits consist of interbedded sandy gravel and bouldery gravel with boulders commonly exceeding 3-feet in diameter. No secondary calcium carbonate cementation (caliche) was observed in nearby cuts, but such a layer may be present at the water tank site. Depth to ground water at the site is unknown, but is probably below the construction zone. However, the possibility exists that the gravels at the site are thin and a perched water zone at the Mancos Shale contact could be encountered.

WATER TREATMENT PLANT SITE

The water treatment plant site is in Whitmore Canyon about 1.5 miles downstream from Grassy Trail Reservoir, the source of water for the plant (attachment 2). Sedimentary rock units exposed in the canyon near the plant site consist of sandstones and shales of, from youngest to oldest, the Price River, North Horn, Colton, and Green River Formations (Doelling, 1972). The contact between the Price River Formation and overlying North Horn Formation crosses Grassy Trail Creek just north of the site. In this part of Whitmore Canyon, the North Horn Formation is exposed in the lower slopes on the west side. This formation consists chiefly of shale and is subject to instability in steep slopes. Several slope failures, chiefly rotational slumps and earthflows, are present upstream from the site (attachment 2). Existing slope failures are large and, if active, would be slow moving. There was no obvious disruption of vegetation or snow, and no apparent major change from conditions recorded on air photos taken in 1955. As long as the slope is not altered (graded, wetted, loaded), these slope failures should not directly affect the site. Disruption of upstream drainages, including Grassy Trail Creek, may result if movement occurs.

The site is located in the canyon bottom on alluvial and colluvial soils. It is near the toe of a colluvial deposit composed of rock-fall and slope-wash debris from cliffs to the north. This debris has been deposited on an alluvial terrace about 10-15 feet above Grassy Trail Creek. Soils could not be observed at the site due to snow cover, but considering source rock types and depositional environments, probably consist of a mixture of many grain sizes from clay to boulders. Depth to ground water is not known but probably coincides with the stream level 10-15 feet below the terrace surface.

Flow in Grassy Trail Creek is controlled by the dam creating Grassy Trail Reservoir. The plant site is only 10-15 feet above the creek but is just downstream from the dam with no major tributaries between the dam and the site. Flooding from upstream should thus not present a problem as long as the dam is maintained and the reservoir can regulate flood waters. However, the plant site is also near the toe of an alluvial fan deposited in Whitmore Canyon from Water Canyon. A shift to the north of the channel of Water Creek across the alluvial fan could affect the southern part of the site.

A drill hole near the site encountered coal beds at a depth of 1225 feet. Doelling (1972) shows that mining had not yet extended beneath the site by 1972, although it may have since that time. Mayberry (1971) has documented ground cracking from subsidence due to underground mining in areas where coal is at a depth of up to 1200 feet in the Sunnyside area.

The nearest known active faults are about 45 miles west of Sunnyside (Anderson and Miller, 1979). Both the treatment plant and water tank sites are in Uniform Building Code (UBC) seismic zone 1, the zone of lowest seismic hazard in the state. However, this zonation does not consider earthquakes induced by underground mining operations. Earthquakes of Richter magnitude 1.5-3.0, considered large for those induced by underground mining, occurred at rates of up to 7 per day in 1969 and 1970 in the Sunnyside area (Dunrud and others, 1973) and continue today at variable rates. The magnitude and number of induced earthquakes varies with geologic conditions and depth, type, and rate of underground mining. Earthquakes as large as magnitude 4.5 have been recorded in the eastern Utah coal mining area (Smith and others, 1974).

CONCLUSIONS AND RECOMMENDATIONS

Both sites appear suitable for their projected uses. The water tank site is relatively free of hazards and should be underlain by good foundation materials. However, if the underlying gravels are found to be thin and Mancos Shale occurs at or near the foundation level, some alteration in foundation design may be required. In any case, tests should be performed on soils at the foundation level for compressibility and strength characteristics to determine final foundation design.

The treatment plant is in an area subject to a variety of potential hazards because of its canyon location. Flooding should not be a problem provided Grassy Creek Dam is maintained as a flood-control structure. Possible flooding from Water Canyon resulting from a shift of its channel northward can be minimized by insuring that the channel is unobstructed and maintained in its present position. Existing slope failures present on the west side of the canyon could not be inspected due to snow cover, but appear to be generally stabilized or at least very slow moving under present conditions and should not present a hazard. Rocks falling from cliffs of the Colton Formation above the site present a potential hazard, and large boulders are found on the flat area near the site. Snow cover made the extent of rock-fall hazards difficult to assess, but the possibility of rock fall affecting the site cannot be ruled out. The geologically young and suspected heterogeneous soils at the plant site may be subject to settlement and consolidation when loaded. Large boulders in the deposit which are incompressible may cause differential settlement of foundations. Because of this, it is recommended that soil tests be performed to evaluate foundation materials prior to construction.

An analysis of hazards due to subsidence above past, present, or future underground mines is beyond the scope of this study. However, if any ground cracks or related features are found at or near the treatment plant site, a re-evaluation of site suitability should be made.

The maximum expected modified Mercalli intensity at the epicenter of an earthquake of magnitude 4.5 (the maximum recorded mining-induced earthquake in the area) is about IV-V (attachment 3). Maximum expected intensities of V-VI are given in the UBC for seismic zone 1. Therefore, structures constructed in compliance with UBC design standards for seismic zone 1 should be sufficient to withstand shaking from both natural and mining-induced earthquakes.

GEC/co

REFERENCES

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

Clark, F. R., 1928, Economic geology of the Castlegate, Wellington, and Sunnyside Quadrangles, Carbon County, Utah: U.S. Geological Survey Bulletin 793, 165 p.

Doelling, H. H., 1972, Central Utah Coal Fields; Sevier-Sanpete, Wasatch Plateau, Book Cliffs, and Emery: Utah Geological and Mineral Survey Monograph Series No. 3, p. 369-388.

Dunrud, C. R., 1976, Some engineering geologic factors controlling coal mine subsidence in Utah and Colorado: U. S. Geological Survey Professional Paper 969, 39 p.

Dunrud, C. R., Osterwald, F. W., and Hernandez, Jerry, 1973, Summary of seismic activity and its relation to geology and mining in the Sunnyside Mining District, Carbon and Emery counties, Utah, during 1967-1970: U. S. Geological Survey Open-file Report 73-0063, 86 p.

Mayberry, J. O., 1971, Sedimentary features of the Blackhawk Formation (Cretaceous) in the Sunnyside District, Carbon County, Utah: U. S. Geological Survey Professional Paper 688, 44 p.

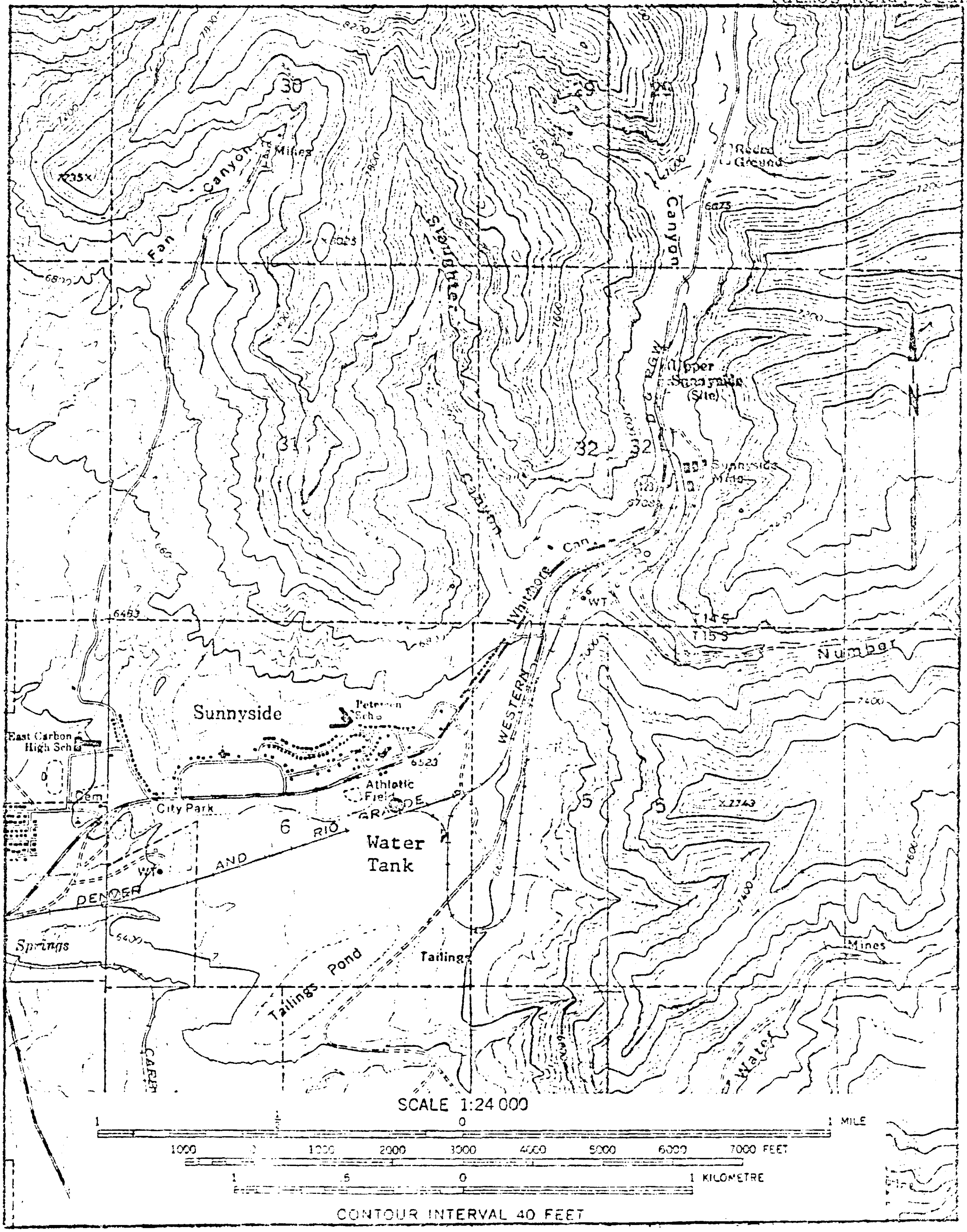
Osterwald, F. W., Mayberry, J. O., and Dunrud, C. R., 1981, Bedrock, surficial, and economic geology of the Sunnyside coal-mining district, Carbon and Emery counties, Utah: U. S. Geological Survey Professional Paper 1166, 68 p.

Smith, R. B., Winkler, P. L., Anderson, J. G., and Scholz, C. H., 1974, Source mechanisms of microearhtquakes associated with underground mines in eastern Utah: Seismological Society of America Bulletin, v. 64, no. 4, p. 1295-1317.

U.S.D.A. Soil Conservation Service and others, 1977, Flood hazard analysis for East Carbon and Sunnyside, Carbon County, Utah: 11 p.

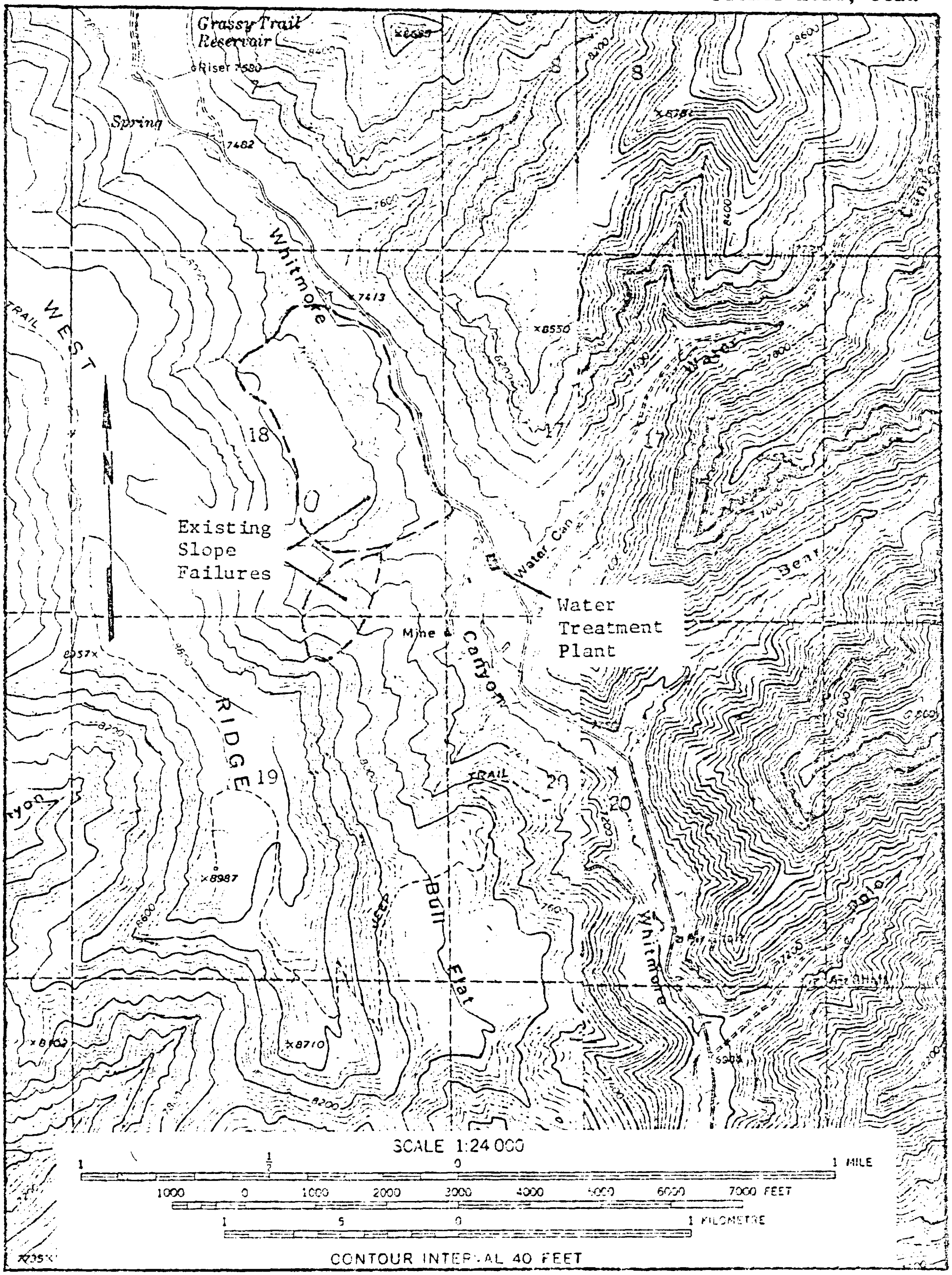
Attachment 1, memo of 2/14/83 to W. Lund

Base map from: USGS 7½' topo quads
Sunnyside, Utah
Patmos Head, Utah



Location map, 500,000 gallon water tank

Base map from: USGS 7½' topo quads
Sunnyside, Utah
Patmos Head, Utah



Location map, water treatment plant

Attachment 3, memo of 2/14/83 to W. Lund

EARTHQUAKE INTENSITY SCALE FOR WATER WORKS*

(Modified Mercalli, 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 make creaking 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.

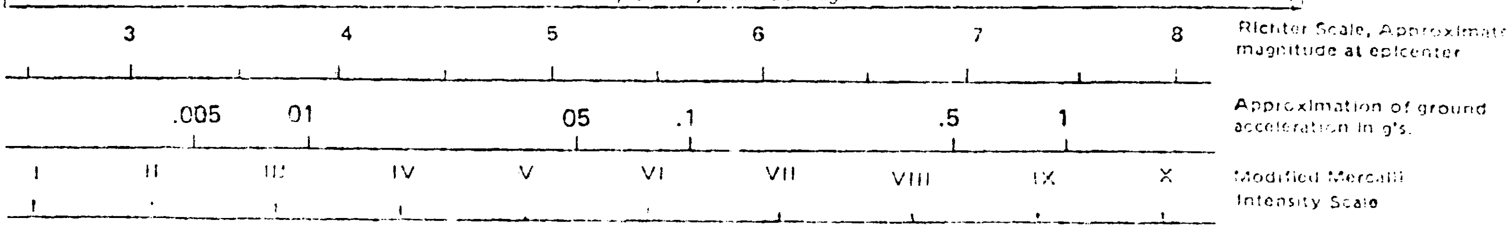
VI Felt by all; many frightened and ran outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. *Poorly sited above-ground tank may buckle. Pipe in poor condition may break. Unreinforced structures, including some pump stations, may suffer damage.*

VII Everybody runs outdoors. Damage negligible in buildings of good desing 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. *Debris from unreinforced masonry pump stations may misalign pumps.*

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. Persons driving motor cars disturbed. *Localized intensive pipe breakage (approximate 1 break/km) inlet and outlet connections may break. Wells may become contaminated.*

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. *Ground-surface offsets may cause damage to structures. Unanchored tanks may buckle. Treatment facilities may suffer structural damage. Unanchored equipment will move.*

X Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations, ground badly cracked. Rails bent. Landslides considerable from river bank and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. *Extreme pipe damage (up to 32 breaks/km). Most buried reservoirs will suffer sidewall and possibly roof damage.*



*Modified by Greg Taylor and Bruce Kelser.

Modified Mercalli Intensity Scale after Wood and Neumann, 1931. (Inte[illegible] XI and XII not included)

Magnitude [illegible] values taken from Nuclear R[illegible] [illegible] 024 United States Atomic Energy [illegible]

Project: Site investigation for a medical clinic, Orderville, Utah.			Requesting Agency: Orderville Town
By: W. R. Lund	Date: June 29, 1983	County: Kane	Job No.: PF-3
USGS Quadrangle: Glendale (111)			

June 29, 1983

Scot Goulding, Mayor
Orderville, UT

Dear Mayor Goulding:

This letter presents the results of a geologic investigation conducted on June 20, 1983, at the site proposed for the Long Valley Medical Center in Orderville, Utah. Neither design documents for the facility, nor its exact location on the property were available at the time of the investigation. It is our understanding that the medical center will be located near the north end of the property, and will be a single story structure of either frame or prefabricated metal construction approximately 30 x 60 feet in size. The investigation included a review of existing geologic, hydrologic, and soil information and a reconnaissance of the property during which two test pits were excavated.

The proposed site is located on a pair of stream terraces at the northeast end of Orderville (attachment 1). It is bordered on the north by First North Street, on the east by U.S. Highway 89, on the south by private property, and on the west by the East Fork of the Virgin River. The property is bisected by a steep slope that varies in height from a few feet on the north to approximately 12 feet on the south (attachment 2). The terrace surfaces above and below the slope are nearly flat. A portion of the site is occupied by a small outdoor theater which takes advantage of the slope to provide elevated seating. The remainder of the area is either vacant or used to store various vehicles and pieces of heavy equipment.

Site soils were examined in stream cuts along the East Fork of the Virgin River where it borders the property and in two backhoe-excavated test pits. The river has incised its channel 12 to 15 feet creating numerous good exposures and the test pits were each 8.5 feet deep. The soils observed consisted of fine-to medium-grained, well sorted quartz sand containing locally variable amounts of silt and gravel (attachment 3). A 2-to 3-foot thick layer of compacted gravelly fill material placed on the site several years ago by the Utah Department of Transportation was encountered in both test pits. The extent of the fill is not known, but is believed to be confined to the north end of the property. Natural soils are medium dense, non-to slightly plastic, and nonindurated. Bedrock does not crop out on the site, but sandstone and shale of the Straight Cliffs Sandstone and the Tropic Formation are exposed in the canyon walls bordering the town (attachment 4).

Cashion (1976) shows a concealed fault crossing the site in a northeast-south west direction and a second north-south trending fault passing just east of the property (attachment 4). Continuations of these faults are exposed in the bedrock of the canyon walls, but no evidence of faulting was observed in unconsolidated materials. Anderson and Miller (1979) indicate that the faults are of suspected Quaternary age (last 2 to 3 million years) but that they show no evidence of late Quaternary movement. Historic seismicity in the vicinity of Orderville has been low. Richter magnitude 6 earthquakes dating from the period prior to 1949 have been reported at Panguitch and Kanab. However, the lack of good instrumental data before 1962 makes those epicentral locations approximate at best (Arabasz, Smith, and Richins, 1979). Since 1962 there have been no seismic events with Richter magnitudes greater than 3 within a 10-mile radius of Orderville (Arabasz, Smith, and Richins, 1979; Richins and others, 1981).

Ground water was not encountered in the test pits, but soils became progressively more moist with depth and were wet at the bottom of test pit 2. Depth to ground water is controlled by the water level in the East Fork of the Virgin River and will fluctuate with changes in stream flow.

The western half of the proposed site (the area below the slope bisecting the property) lies within a Zone A flood hazard area on the HUD Flood Hazard Boundary Map for Orderville (attachment 5). The channel of the East Fork of the Virgin River is 12 to 15 feet below the lower terrace on the property so the possibility of overbank flooding is considered low. However, site soils are easily eroded and the potential for severe flood-related bank erosion is high. Orderville has experienced seven destructive floods since 1881 (State Division of Comprehensive Emergency Management, 1981) and areas of erosion and subsequent backfilling were observed in several places along the river.

Based on this investigation, it is concluded that with the exception of a flood-related erosion hazard the site proposed for the new medical center is well suited geologically for that purpose. Measures which may be taken to reduce the hazard from erosion include locating the structure east of (above) the slope bisecting the site, or if located west of (below) the slope providing some form of erosion control (rip rap) along the stream bank. Any structure placed west of the slope should be situated as far from the river as possible to provide a safety zone where erosion may occur without damaging the facility. Depending upon the final design of the structure, a soils investigation for foundation design purposes may be advisable.

It is hoped that the information provided in this letter will assist you in selecting the best possible site for the new medical facility. If you have any questions or if we may be of further assistance, do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigations Section

WRL/ay
cc: M.J. Stapley, Environmental Health
R.G. Cowley, Southwestern Health District
J. Williams, Five County Association of Governments

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, Salt Lake City, Utah, 552 p.

Cashion, W.B., 1967, Geologic map of the south flank of the Markagunt Plateau, northwest Kane County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-494, scale 1:62,500.

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 Division of Water Rights Technical Publication No. 70, 87 p.

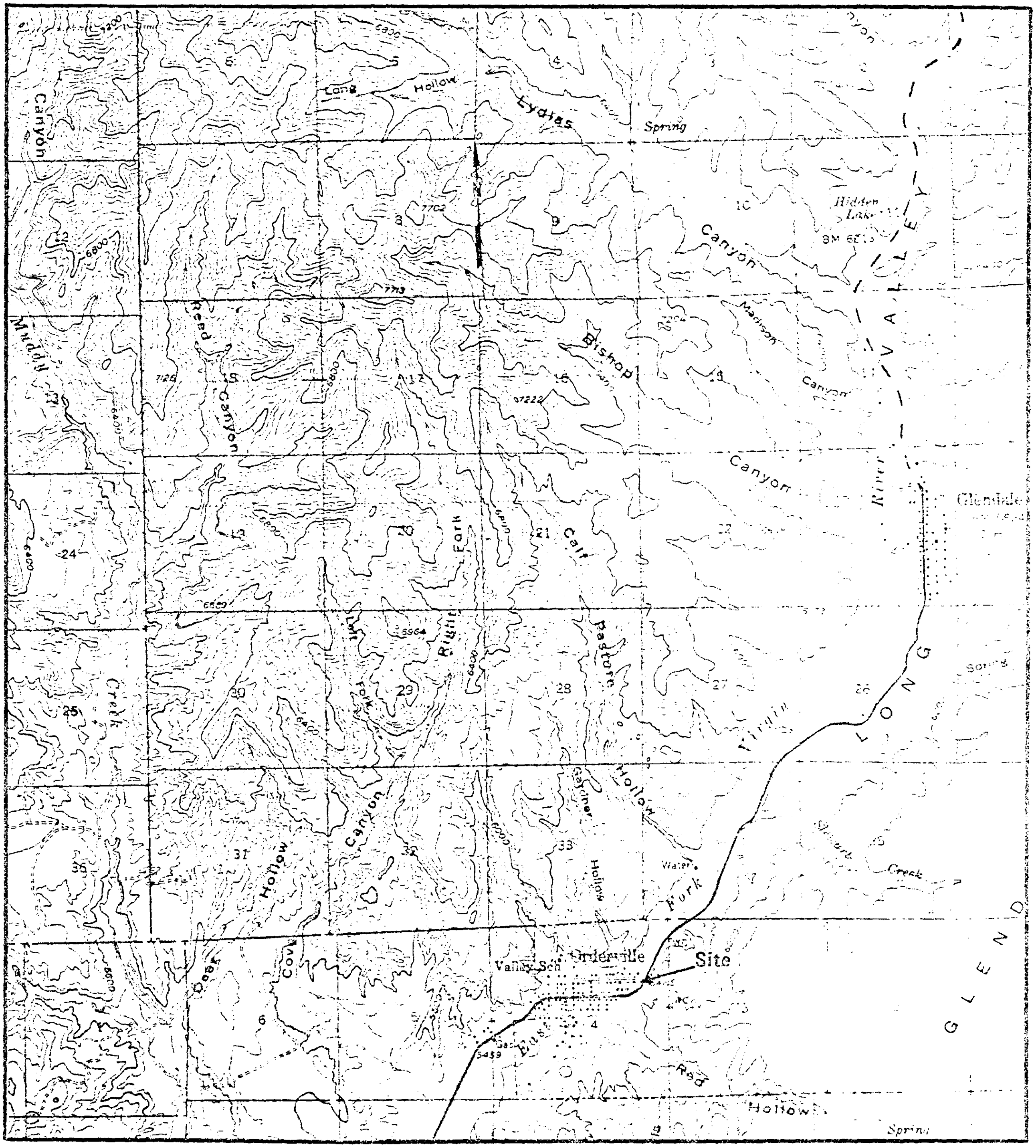
Department of Housing and Urban Development, 1977, Flood hazard boundary map town of Orderville, Utah: Federal Insurance Administration, plate 01, scale 1:7200.

Gill, H.E., 1981, Investigation of a new high school site in Orderville, Kane County, Utah: Utah Geological and Mineral Survey Memorandum to W.R. Lund, 7 p.

Richins, W.D., and others, 1981, Earthquake data for the Utah region: University of Utah Seismograph Stations, Salt Lake City, Utah, 127 p.

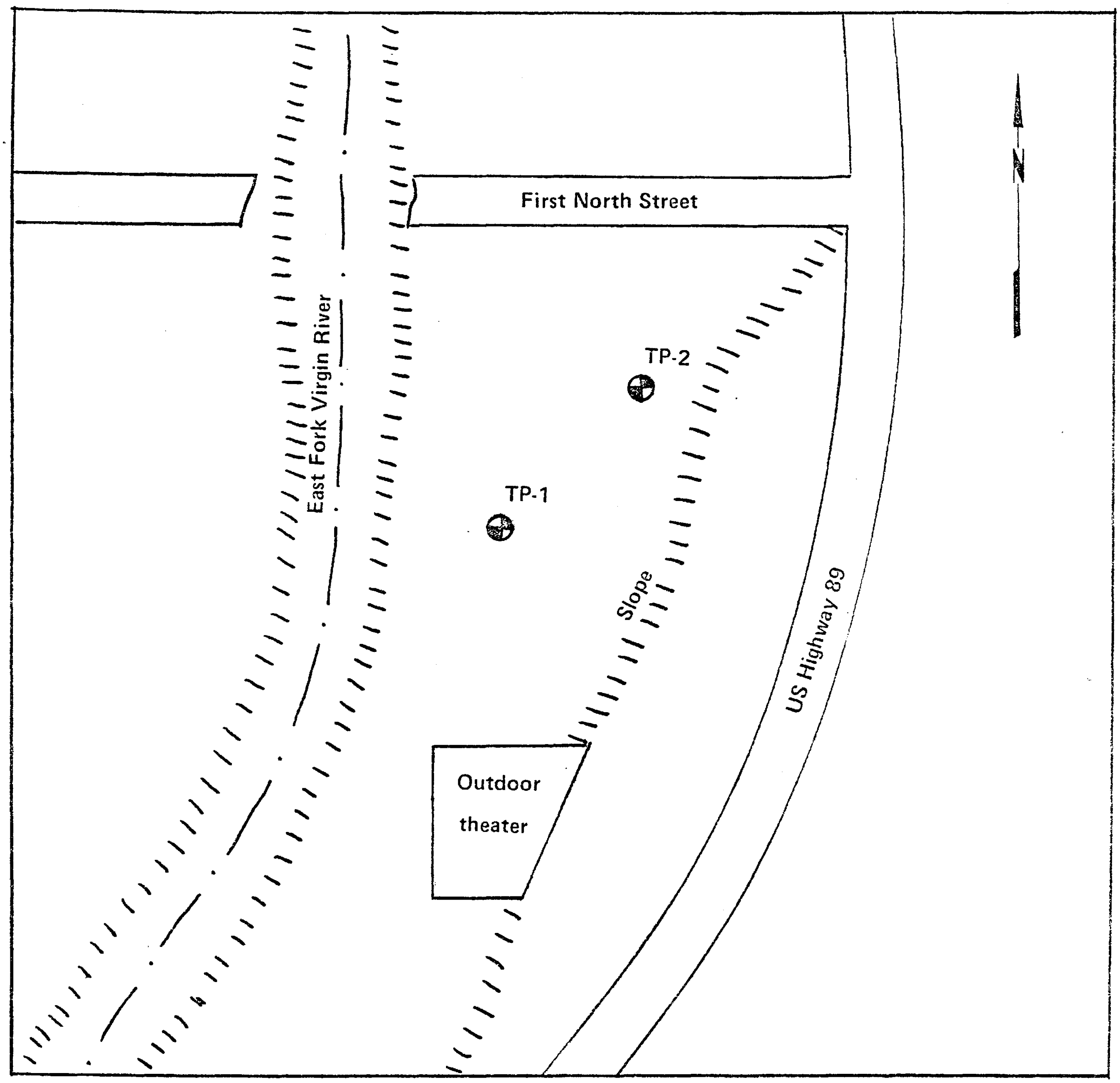
State of Utah Division of Comprehensive Emergency Management, 1981, History of Utah floods: Floodplain Management Status Report EMW-K-0223, 47 p.

Attachment No. 1, letter of 6-29-83 to Scot Goulding, Mayor town of Orderville



General location map showing proposed site for Long Valley Medical Center
Scale 1:62,500

Base map taken from USGS Orderville, Utah 15 minute series topographic quadrangle map.



Site plan showing test pit locations (not to scale)

Attachment 3, memo of 6-29-83 to S. Goulding

Test Pit Logs*
Long Valley Medical Center
Orderville, Utah

Test Pit 1

0.0' - 2.9' Gravelly silty sand (SM); dark brown to gray, high density, nonplastic, dry, nonindurated; gravel to 2-1/2 inch diameter, compacted fill.

2.9' - 8.5' Sand-silty sand (SP-SM); brown to light tan, medium dense, non-to slightly plastic, dry to moist with depth, non-indurated; well sorted quartz sand with 10 to 15 percent silt fines.

Test Pit 2

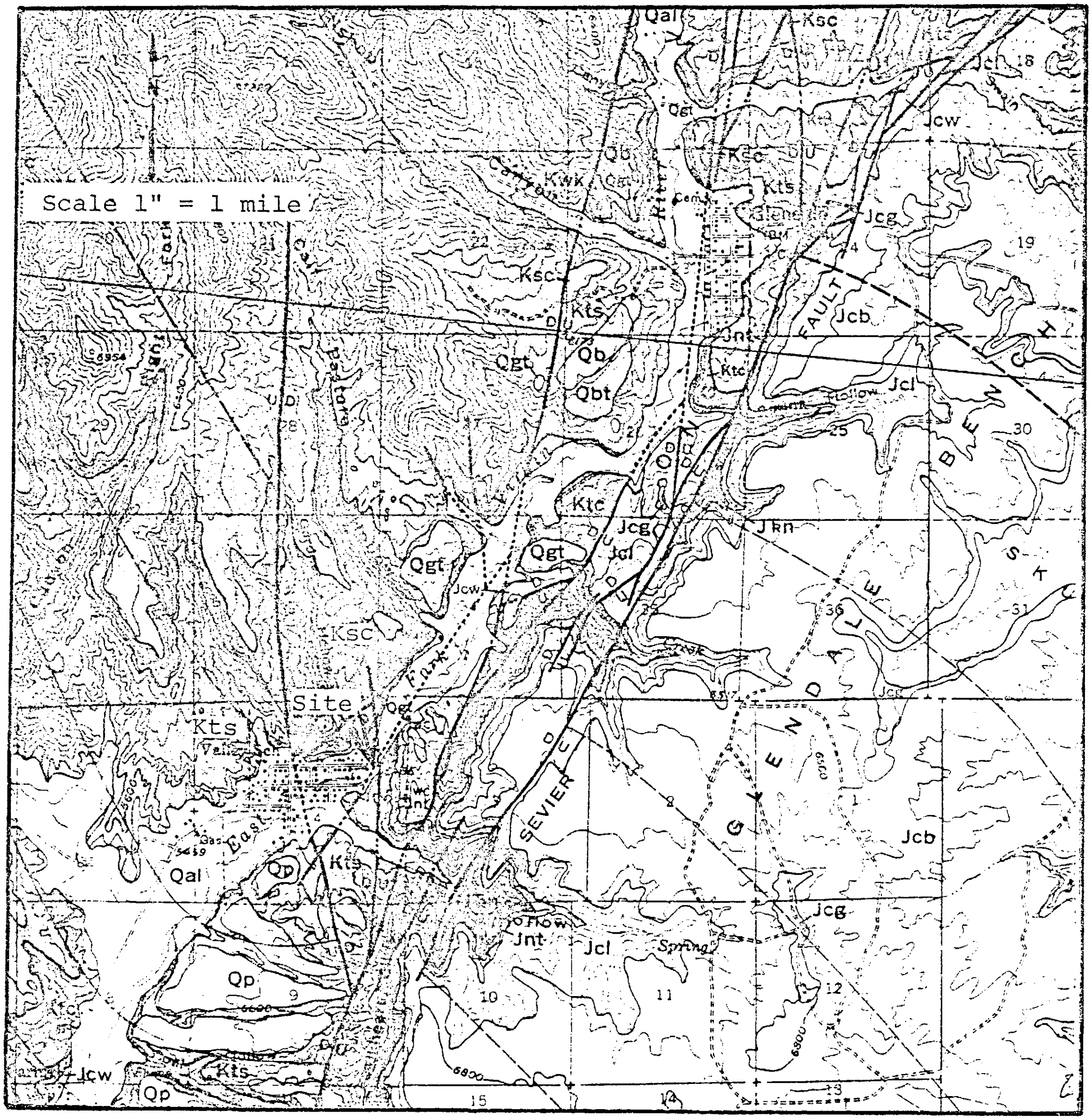
0.0' - 2.4' Gravelly silty sand (SM); brown, high density, nonplastic, dry, nonindurated; gravel to 2-inch diameter, compacted fill.

2.4' - 8.5' Sand-silty sand (SP-SM); brown to yellow brown, medium density, non-to slightly plastic, moist to wet with depth; well sorted quartz sand with 10 to 15 percent silt fines, higher percentages of fines locally.

Note: Ground water not encountered in test pits.

*Soils classified in accordance with precedures outlined in ASTM Standard D 2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various size fractions are field estimates.

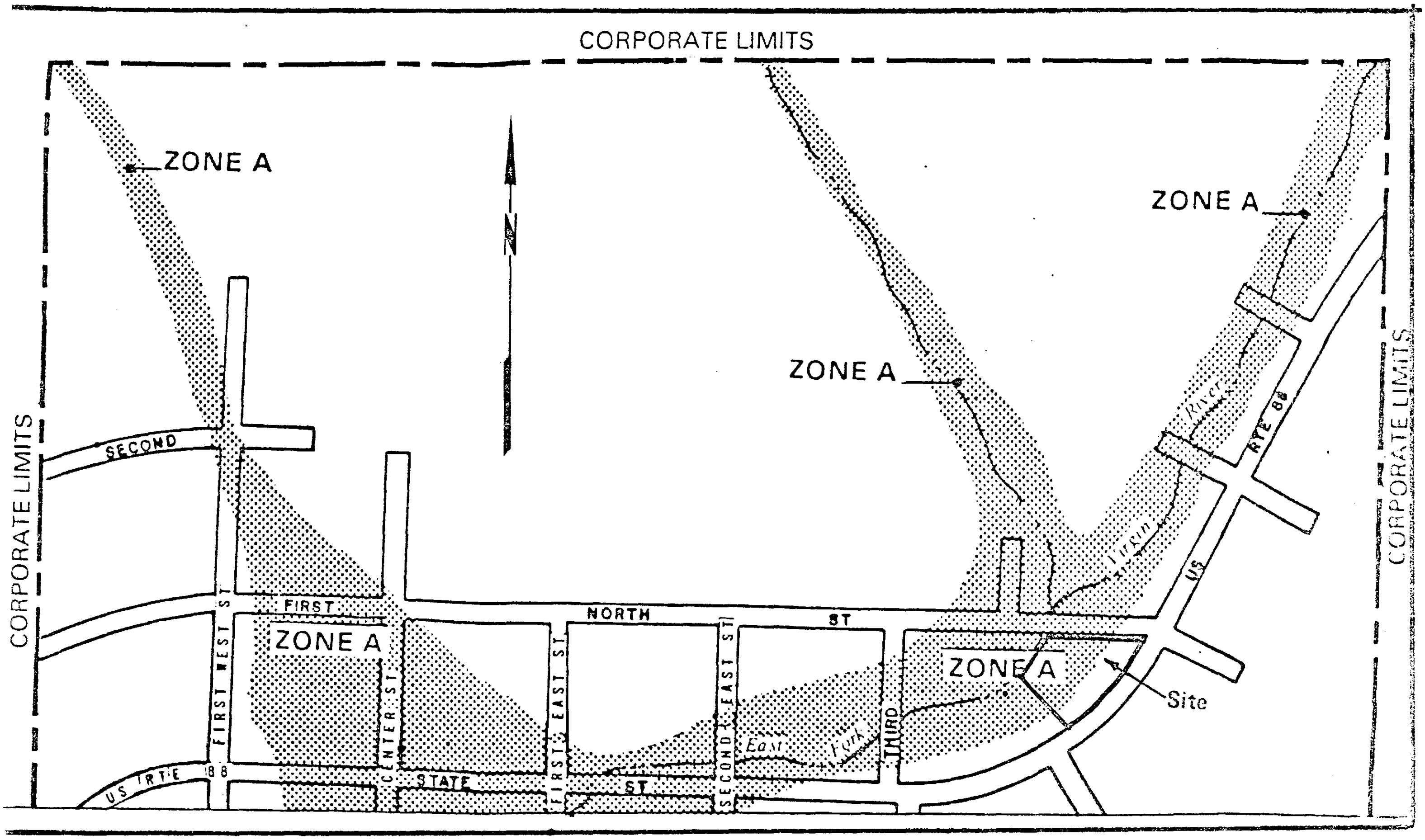
Attachment No. 4, letter of 6-29-83 to Scot Goulding, Mayor town of Orderville



(after Cashion, 1967)

Geologic Map
Orderville - Glendale Area

Qal	Alluvium: clay, silt, sand and gravel in channel, flood-plain, and alluvial fan deposits.
Kts	Tropic Formation: shaley member, shale, gray, carbonaceous; some littoral marine sandstone; few coal beds in western part of area.
Ksc	Straight Cliffs Sandstone: sandstone, brown and gray, very fine-grained, massive cliff-forming; some gray shale.
	Fault: dotted where concealed. U, upthrown side; D, downthrown side.



Flood hazard boundary map town of Orderville. Scale 1:7200 (after HUD Federal Insurance Administration, 1977)

SCHOOLS

Project: Site review for four proposed schools in the Jordan School District.			Requesting Agency: Jordan School District
By: G.E. Christenson	Date: January 27, 1983	County: Salt Lake	Job No.: S-1
USGS Quadrangle: Draper (1171)			

January 27, 1983

Clemont Bishop
Administrator, Support Services
Jordan School District
9361 South 400 East
Sandy, Utah 84070

Dear Mr. Bishop;

This letter is in response to your request of January 12, 1983, for our services in investigating four school sites for the Jordan School District. Since sites have already been acquired and soils reports are either complete or in progress, we have confined our investigation to a brief site visit and a review of the soils reports. Reports for the Rosemond Elementary School (2200 West, 12200 South) and the middle school at 8100 South 3200 West are complete.
When reports for the Albion Middle School and Columbia Elementary School are complete, please mail a copy to us for review.

A significant geologic hazard at all four sites is that due to ground shaking during an earthquake. As stated in the soils reports, the sites are located in the Uniform Building Code (UBC) seismic zone 3 and criteria in the UBC for this zone should be incorporated into the design of the proposed structures. The Utah Seismic Safety Advisory Council (USSAC) has stressed the hazard along the Wasatch Front by recommending delineation of an additional seismic zone (U-4) which would include all four proposed Jordan School sites. The USSAC does not recommend application of UBC seismic zone 4 design standards in this area, but suggests that design standards for UBC zone 3 be applied with more rigorous design review and inspection to assure complete compliance.

The soil reports completed for Rosamond Elementary School and the middle school in West Jordan (8100 South, 3200 West) appear to adequately address foundation conditions relating to soil type, depth to ground water, liquefaction potential, and possibility of surface faulting. Particular attention should be paid to their recommendation that granular materials be used for structural fill, and that on-site materials, most of which are fine grained, may not be suitable. Flood hazard is not addressed in the soils reports but is low at both sites and should present no problems.

The concern regarding the possibility of surface faulting is discounted in these two reports because available data indicate no surface faults in or near the area. While the majority of surface faulting in the Salt Lake Valley is associated with the Wasatch fault along the east side of the valley, excavations in several west valley locations have uncovered faults not evident at the surface. In view of this, we would recommend inspection of the foundation excavations for these schools for evidence of faults. The UGMS has an ongoing excavation inspection program for the Salt Lake Valley and would be happy to examine the excavations for you if notified when they are to grade.

If we can be of further assistance, please call our office.

Sincerely yours,

Gary E. Christenson

GEC/co
cc: Dr. Bill Boren
Specialist School Facility Planning
Utah State Office of Education

February 8, 1983

Clemont Bishop
Administrator, Support Services
Jordan School District
9361 South 400 East
Sandy, Utah 84070

Dear Mr. Bishop:

We have received copies of the soils reports for the Albion Middle School and Columbia Elementary School and are transmitting our comments herein. I would like to stress that comments made with regard to seismic hazard and the possibility of surface faulting in our letter of January 27, 1983, apply to these sites as well. Strict adherence to design specifications in the Uniform Building Code for seismic zone 3 is required, and all recommended increases in design specifications to accommodate earthquake loading given in the reports should be followed.

Foundation conditions at the Albion Middle School are favorable in terms of soil type, depth to ground water, and liquefaction potential. Site soils should be suitable for use in structural fill provided oversized particles are removed. At the Columbia Elementary School site, soils are much less suitable for either direct placement of foundations or use as structural fill. The point is made in the soils report (pages 6-7) that the upper 5-6 feet of soil includes a layer of highly elastic clayey silts which are sensitive and very easily disturbed, and that support characteristics are significantly reduced if disturbed. As a result, the report (page 15) recommends that care be taken not to disturb this layer during installation of foundations. Ground shaking during an earthquake is another possible source of disturbance of this layer, and it is not clear that this was considered in the report. If not, it may be advisable to run dynamic loading tests on the layer to evaluate its response to ground shaking. If it is found to be unstable, removal of the layer may be necessary prior to construction. We recommend that you discuss this point with Dames and Moore to see if disturbance due to earthquake ground shaking was considered. We will be happy to provide any assistance you may require in this.

As with other sites, please notify our office when foundation excavations are open for inspection.

Sincerely yours,

Gary E. Christenson, Geologist
Site Investigations Section

GEC/co
cc: Dr. Bill Boren
Specialist School Facility Planning
Utah State Office of Education

Project: Investigation of seven alternate sites for a proposed high school and elementary school, Uintah School District.			Requesting Agency: Uintah School District
By: W.R. Lund	Date: February 11, 1983	County: Uintah	Job No.: S-2
USGS Quadrangle: Dinosaur Quarry (1110), Naples (1111), Vernal NE (1112)			

February 11, 1983

Mr. Ted Taylor
Uintah School District
635 West 200 South
Vernal, UT 84078

Dear Mr. Taylor:

This letter is in response to your request of November 24, 1982, for assistance in evaluating seven sites (attachment 1) being considered by the Uintah School District for future school construction. Four of the sites are alternate locations for a new secondary school; the other three are intended for elementary schools. Our investigation consisted of a review of available literature on the geology, hydrology, and soils at each site (including unpublished USDA Soil Conservation Service soils mapping), a field reconnaissance and excavation of test pits to document soil and ground-water conditions.

Because of the large number of sites being considered, data sheets summarizing the investigation results have been prepared for each property (attachments 2A through 2G). Attachment 3 presents detailed soil logs for the test pits at each site. In general, conditions found at one or more of the sites which may affect school construction include: shrink-swell soils, collapse-prone soils, high ground water, flood hazard, and high soil sulfate content.

Fine-grained clay and clayey silt soils subject to volume changes in response to changes in moisture content were identified at all seven sites. Possible collapse-prone soils containing numerous tubular pores (worm or root holes?) were also found at all the sites. For that reason, a detailed soils/foundation investigation is recommended at the sites selected for school construction. Because all the sites appear to be affected equally, the potential for problem soils is not considered a significant discriminating factor between sites.

Ground water was encountered in test pits on the Rasmussen, Caldwell, and Tullis properties. Test pits on the Jensen property were dry, but USDA Soil Conservation Service mapping indicates that a seasonally high water table exists over much of the site. Shallow, unconfined ground water is usually lowest during the winter months, and highest during the spring and irrigation seasons. A rise in the water level beneath the Tullis property would be especially troublesome where depths to water of 2.0 to 3.5 feet were measured, and where much of the eastern third of the site was covered with standing water. Depending upon the foundation design and requirements for a basement. subsurface drains and site dewatering may be necessary for facilities constructed at the sites where shallow ground water was encountered.

Four of the sites (Davis. Caldewll. Tullis. and Sprouse) are either bordered by or crossed by drainages identified as special flood-hazard areas on HUD Flood Hazard Boundary Maps for Uintah County. The flood-hazard areas for the Davis and Tullis properties are confined to active stream or canal channels and involve relatively small portions of the sites. About one-third of the Caldwell property, and all of the Sprouse property. lie in a flood-hazard area. Locating school facilities away from streams or canals would probably avoid the flood hazard at the Davis and Tullis properties. Dikes, channelization, or other flood-control measures would be required at the Caldwell and Sprouse sites.

Sulfate has a deleterious effect on concrete and can cause spalling and cracking of foundations and sidewalks. Large amounts of gypsum (calcium sulfate) were identified in the soils at the Sprouse property. If this site is selected for school construction it is recommended that special sulfate-resistant cement (Type V) be used in the foundation and for all exterior applications. Gypsum was not observed at the other six sites, but sulfate-reactive soils are often not identifiable in the field. Laboratory procedures to test for sulfate reactivity are available and should be included as part of the soils/foundation investigation for any site selected. It should also be noted that gypsum is both water soluble and a low-density material. Both properties can have an adverse effect on the suitability of site soils for use as construction-fill material.

Except for the factors discussed above, no geologic problems or hazards were identified at the sites. From a geologic standpoint, the locations considered most suitable for construction of a school facility are the Davis and Slaugh properties. The Jensen, Rasmussen, and Caldwell properties have, or may have, ground-water and/or flood-hazard problems, the mitigation of which could result in additional construction expense for the facility. The Tullis and Sprouse properties either have ground-water, flood, or sulfate-reactivity problems of sufficient magnitude to add considerable construction and maintenance expense to schools built at those locations.

It is hoped that the information presented in this letter will aid the Uintah School District in selecting the location for their new schools. If you have any questions or if we may be of further assistance, please feel free to contact us.

Sincerely,

William R. Lund

Site Investigation Section

WRL/ay

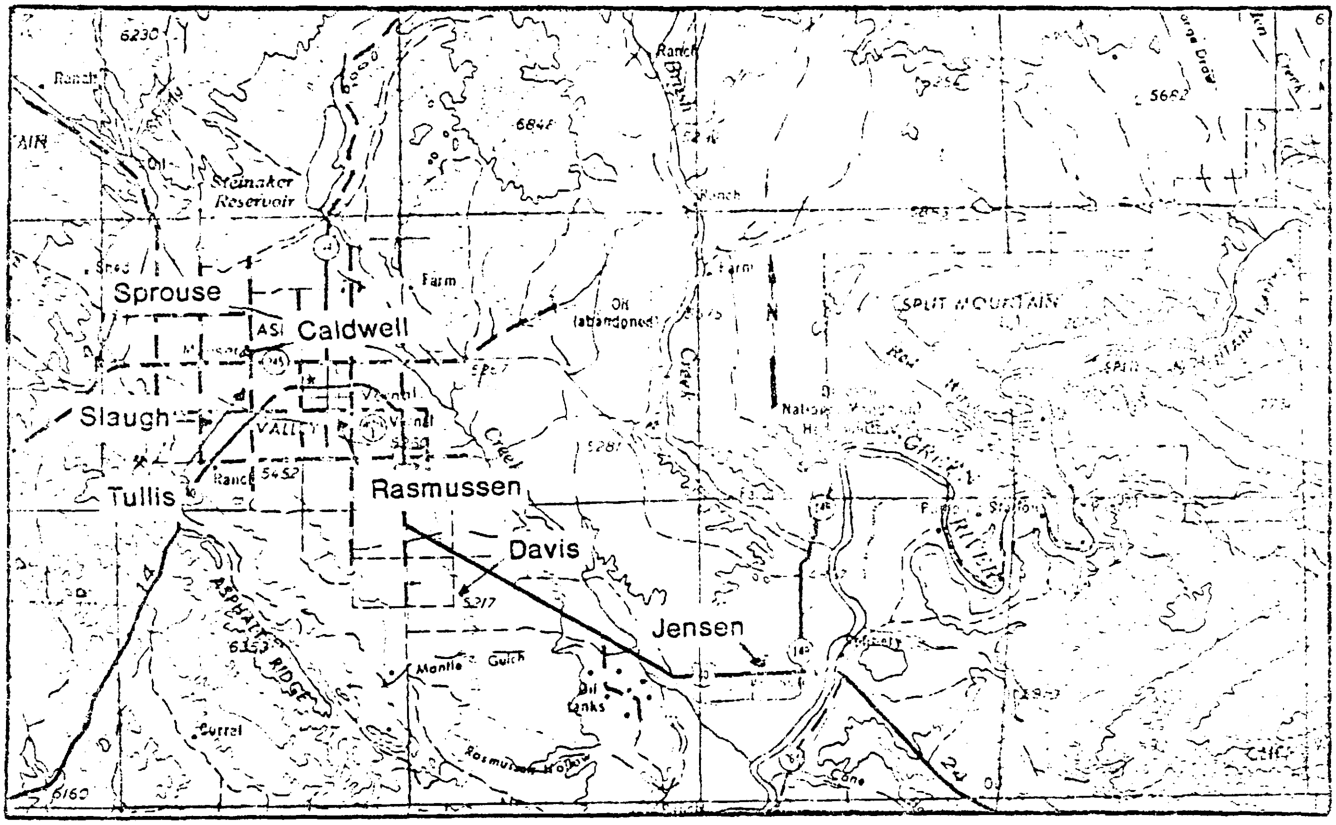
Selected References

Carrara, P.E., 1980, Surficial geologic map of the Vernal $1^{\circ} \times 2^{\circ}$ Quadrangle, Colorado and Utah; U.S. Geological Survey Miscellaneous Investigation Series Map I-1204, scale 1:250,000.

Hood, J.W., 1977, Hydrologic evaluation of Ashley Valley, northern Uintah Basin area, Utah: State of Utah Department of Natural Resources Technical Publication No. 54, 25 p.

Rowley, P.D., and others, 1979, Geologic map of the Vernal $1^{\circ} \times 2^{\circ}$ Quadrangle, Colorado, Utah, and Wyoming: U.S. Geological Survey Miscellaneous Field Studies Map MF-1163, scale 1:250,000.

USDA Soil Conservation Service, 1983, Soils mapping and descriptions from selected areas in Ashley Valley: unpublished, Vernal, Utah.



General location map showing proposed school sites. Scale 1:250,000

Jensen Property

Proposed Facility: Elementary School

Location: SE 1/4, SW 1/4, NW 1/4 of Sec. 20, T5S, R23E, SLB&M

Site Characteristics: Almost level (1/2 -1° slope to southeast); abandoned (?) unlined irrigation ditches form north and west property boundaries, seasonally active unlined irrigation ditch forms east boundary, south boundary U.S. Route 40. Former school site, building torn down within last 18 years; existing storage shed/garage near northeast property corner.

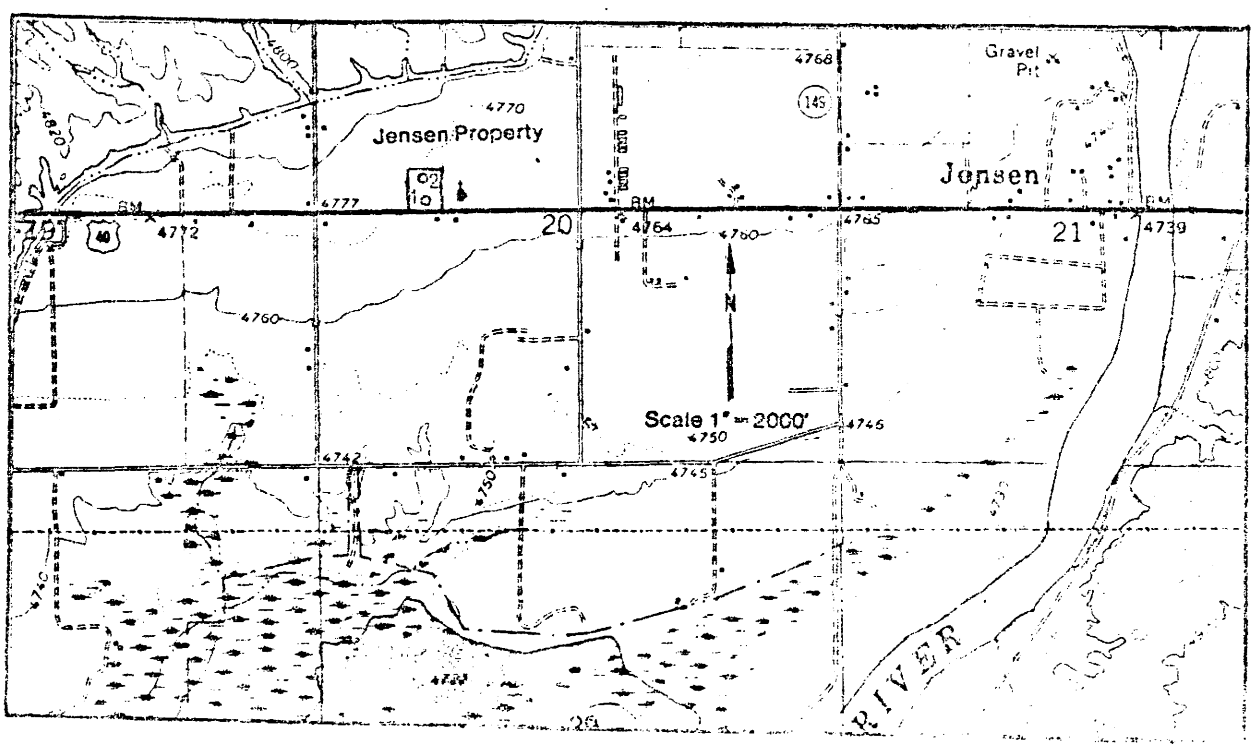
Geology: River terrace deposits (Pleistocene); alluvial remnant on dissected bench along Green River.

Soils: Sandy clay, silty clay, clayey silt, minor silty sand (see attached soil logs).

Ground Water: None encountered in test pits, unpublished USDA Soil Conservation Service mapping indicates seasonal depths to water of 40 to 60 inches possible over much of the property.

Hazards/Cautions: Moderate shrink/swell potential for clay soils, possible collapsing soils associated with tubular pores in some soil horizons; shallow ground water during spring and irrigation season.

Summary: Recommend a soil/foundation investigation to evaluate the shrink/swell and collapse potential of site soils; determine seasonal high stand of ground water across site.



Davis Property

Proposed Facility: Secondary School

Location: N 1/2, SW 1/4 of Sec. 3, T5S, R22E, SLB&M

Site Characteristics: Almost level (1/2-1° slope to the east) over northern three-fourths of property, gentle slopes (2-5°) along east-west stream drainage crossing site near southern property boundary. Stream is perennial, channel is identified as a special flood-hazard area on HUD Flood Boundary Map 490147 0015 B. Scrub willow and low brush common along drainage.

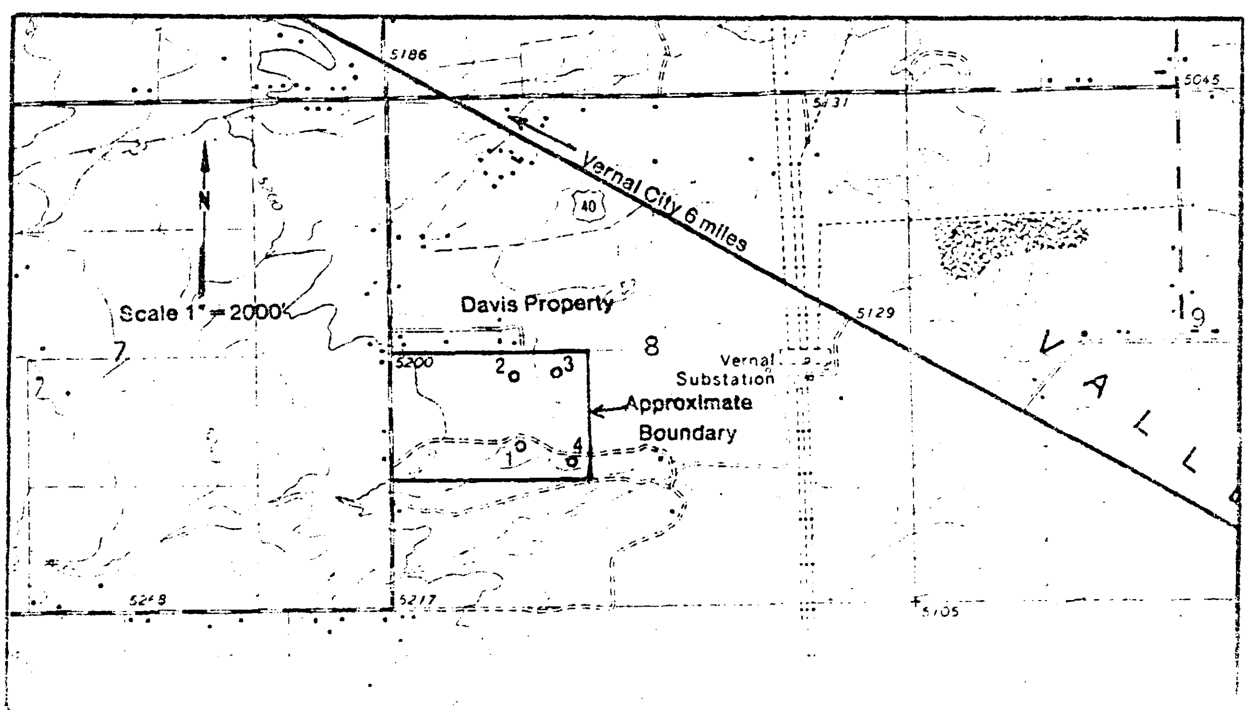
Geology: Old piedmont-slope deposits (Pleistocene); dissected remnants of alluvial fan and pediment deposits.

Soils: Sandy silt, silty sand, gravelly sand, sandy gravel with cobbles and boulders; well-developed caliche profiles; some cobbles are soft, highly weathered asphaltic sandstone (see attached soil logs).

Ground Water: None encountered in test pits, shallow ground water possible at lower site elevations along stream drainage (10 to 15 feet lower than proposed school location).

Hazards/Cautions: Possible collapsing soil associated with tubular pores in some soil horizons; soft asphaltic sandstone cobbles; flood hazard and high ground-water conditions along stream drainage.

Summary: Recommend a soils/foundation investigation to evaluate collapse potential of site soils; avoid flood hazard and high ground-water conditions by locating school on western half of property.



Attachment 2C, Memo of 2/11/83 to Ted Taylor, Uintah School District

Rasmussen Property

Proposed Facility: Secondary School

Location: NE 1/4, NE 1/4 of Sec. 26, T4S, R21E

Site Characteristics: Almost level (1/2 to 1° slope to southeast) irrigated pasture; small drainage channel (over-grown irrigation canal?) near southwest property boundary. Pond for collecting excess irrigation water just off site near southeast property corner.

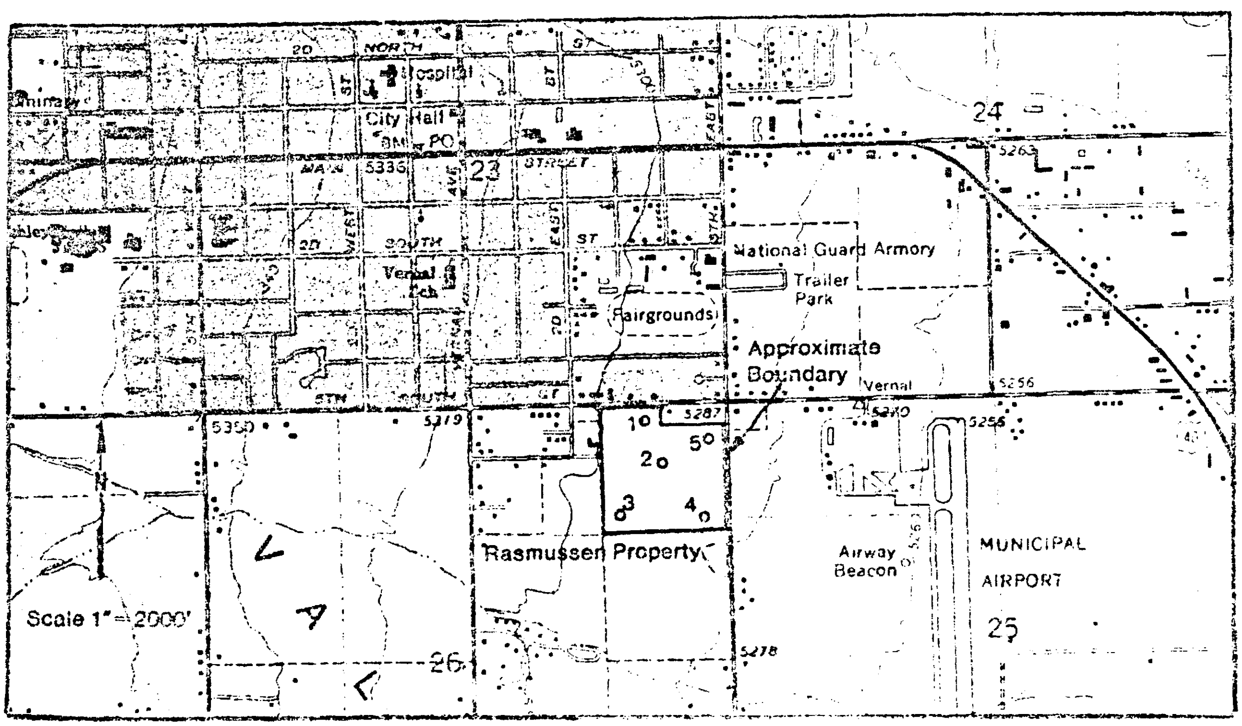
Geology: Old piedmont-slope deposits (Pleistocene); remnants of alluvial fan and pediment deposits.

Soils: Sandy clay, sandy silt, clayey silt, silty sand with gravel, sandy gravel; well-developed caliche profiles in some test pits (see attached soil logs).

Ground Water: Ground water encountered in three test pits (3, 4, and 5) at depths ranging from 5.8 to 9.5 feet below ground surface.

Hazards/Cautions: Moderate shrink/swell potential of clay and clayey silt soils, possible collapsing soils associated with tubular pores in some soil horizons; seasonally high ground-water conditions over much of the property.

Summary: Recommend a soils/foundation investigation to evaluate shrink/swell and collapse potential of site soils; determine seasonal high stand of shallow ground water across site.



Caldwell Property

Proposed Facility: Secondary School

Location: S 1/2, SE 1/4 of Sec. 16, T4S, R21E, SLB&M

Site Characteristics: Almost level (1/2 to 1^{o} slope to the southeast) irrigated pasture; small drainage channels border the property to the north and south. The northern drainage channel is identified as a special flood-hazard area on HUD Flood Hazard Boundary Map 490147 0014 B. Small unlined irrigation ditches cross the property at several locations.

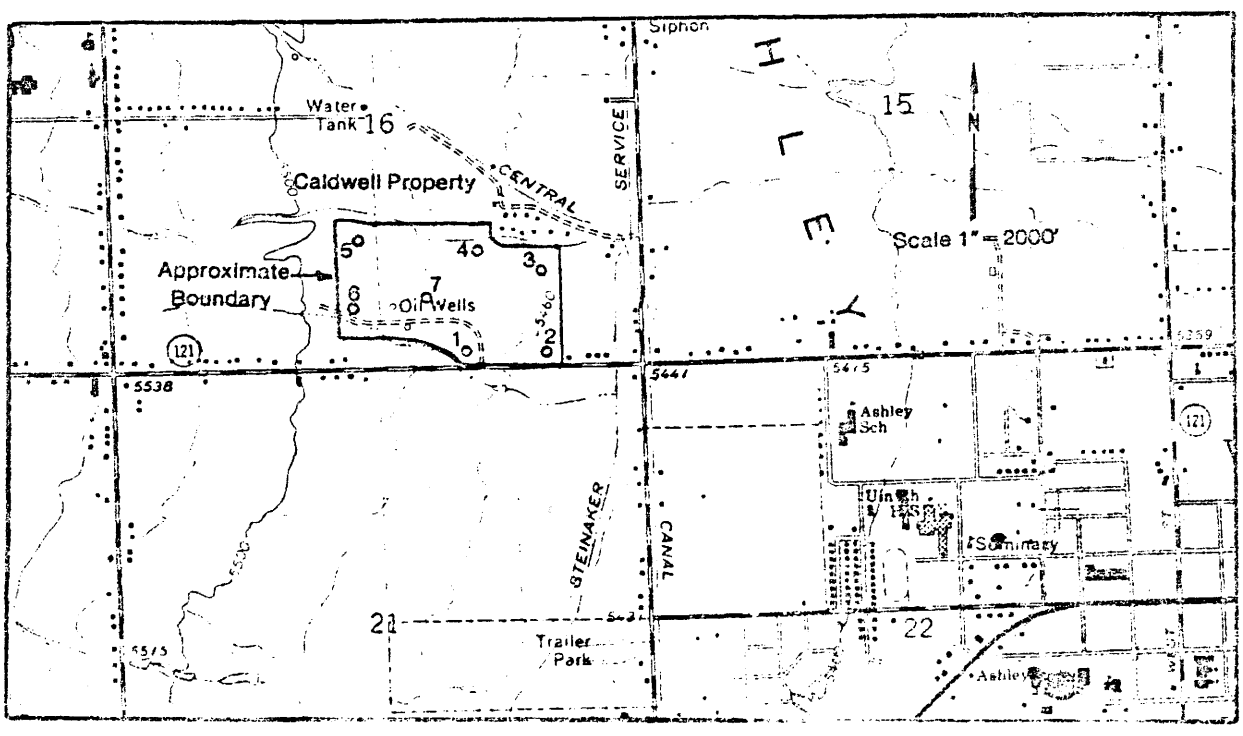
Geology: Old piedmont-slope deposits (Pleistocene); remnants of alluvial fan and pediment deposits.

Soils: Silty clay, sandy clayey silt, clayey sandy gravel, sandy gravel with cobbles (see attached soil logs).

Ground Water: Ground water encountered in all test pits at depths ranging from 4.7 to 7.9 feet below ground surface.

Hazards/Cautions: Moderate shrink/swell potential of clay and silt soils, possible collapsing soils associated with tubular pores in some soil horizons; seasonally high ground water; flood hazard over northern third of property.

Summary: Recommend soils/foundation investigation to evaluate shrink/swell and collapse potential of site soils; determine seasonal high stand of ground water across site; locate school on southern half of property to avoid flood hazard.



Tullis Property

Proposed Facility: Secondary School

Location: N 1/2, NW 1/4, SE 1/4 of Sec. 21, T4S, R21E, SLB&M

Site Characteristics: Almost level (1/2 - 1^{o} slope to southeast) pasture; bordered by Steinaker Service Canal on the east and a small intermittent drainage and pond on the south. Much of the eastern one-third of the property was covered with standing water at the time of inspection. Steinaker Service Canal is identified as a special flood-hazard area on HUD Flood Hazard Boundary Map 490147 0014 B.

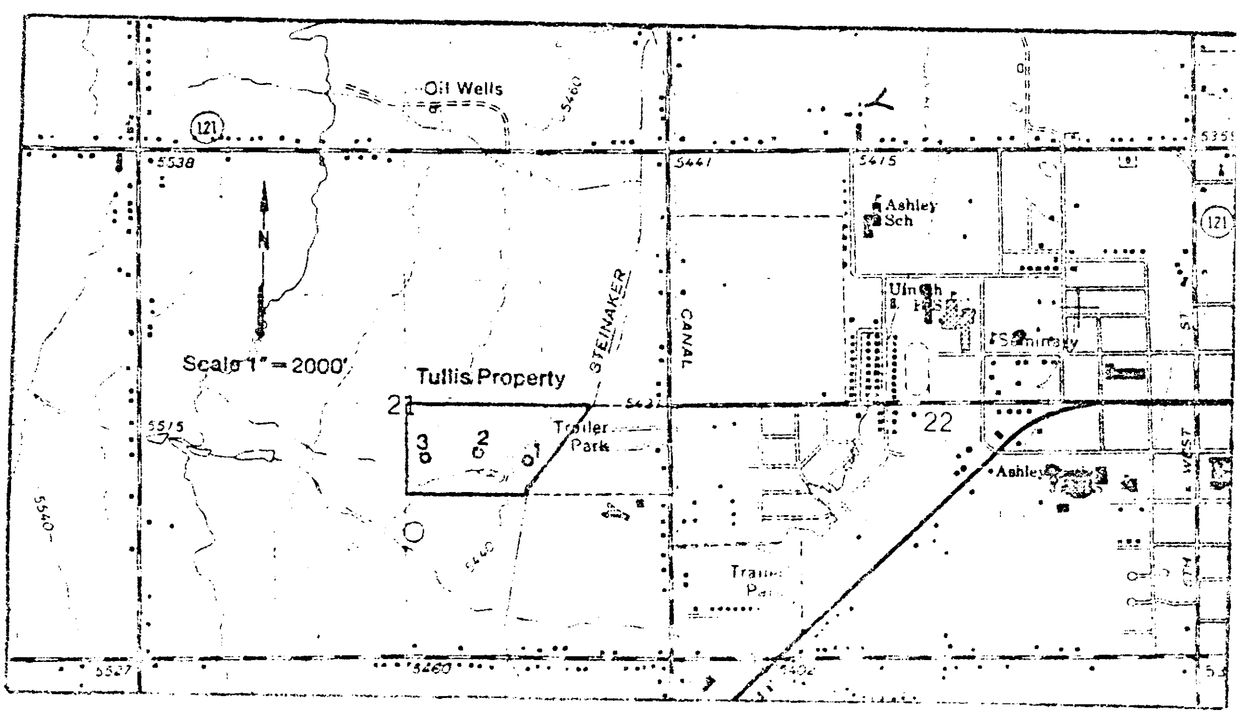
Geology: Old piedmont-slope deposits (Pleistocene); remnants of alluvial fan and pediment deposits.

Soils: Clay (see attached soil logs).

Ground Water: Ground water encountered in all test pits at depths ranging frc 2.0 to 3.5 feet below the ground surface.

Hazards/Cautions: Moderate to high shrink/swell potential of clay soil, possible collapsing soils associated with tubular pores ir some soil horizons; high ground-water conditions; flood hazard associated with Steinaker Service Canal.

Summary: High ground-water conditions; recommend soil/foundation investigatic to evaluate shrink/swell and collapse potential of site soils; locat school on west end of property to avoid flood hazard.



Slaugh Property

Proposed Facility: Elementary School

Location: N 1/2, NW 1/4 of Sec. 20, T4S, R21E, SLB&M

Site Characteristics: Gently sloping (1-2° to the east) pediment surface on the east flank of Asphalt Ridge. A series of low, east-west trending ridges produce somewhat irregular topography on the west end of the property. Site is bordered on three sides (north, east, and south) by housing developments.

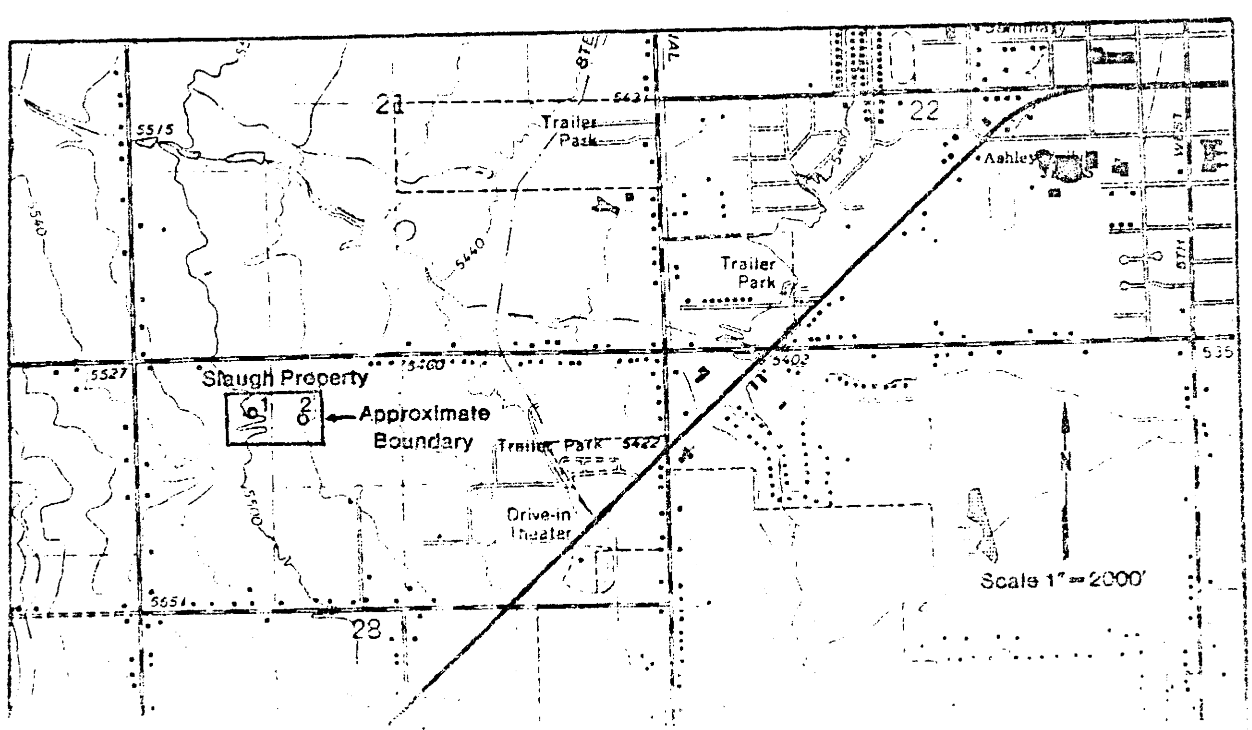
Geology: Old piedmont-slope deposits (Pleistocene); remnants of alluvial fan and pediment deposits.

Soils: Silty clay, sandy silty gravel with cobbles and boulders, gravelly sand, silty sand-sandy silt; well-developed caliche profiles (see attached soil logs).

Ground Water: None encountered in test pits, estimated depth to water greater than 20 feet.

Hazards/Cautions: Soil conditions across site are variable, horizons appear to pinch out over short distances - may lead to differential settlement without proper foundation design; local shrink/swell susceptible soils, collapse potential of soil horizons containing tubular pores.

Summary: Recommend a soils/foundation investigation to evaluate shrink/swell and collapse potential of site soils and to determine extent of soil variability across the site.



Sprouse Property

Proposed Facility: Secondary School

Location: SE 1/4, SE 1/4 of Sec. 13, T4S, R20E and SW 1/4, SW 1/4 of Sec. 18, T4S, R21E, SLB&M

Site Characteristics: Gently to moderately sloping (1-5^{o} to the southeast) alluvial deposits along a stream cut through Asphalt Ridge. Intermittent streams crossing property have incised their channels 5 to 10 feet. Entire site is identified as a special flood-hazard area on HUD Flood Hazard Boundary Map 490147 0014 B.

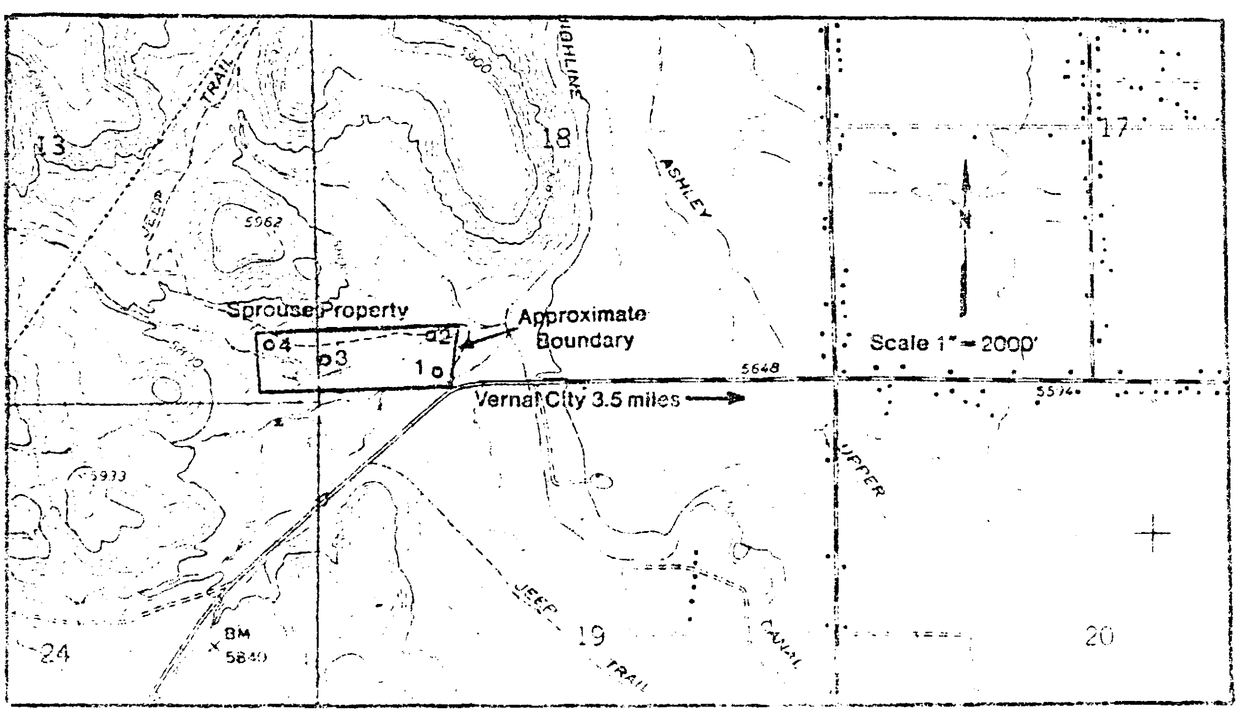
Geology: Pediment and alluvial deposits (Pleistocene, Holocene); dissected alluvial deposits; Mancos Shale bedrock encountered in test pit 2.

Soils: Clayey silt-silty clay, sandy clay, silty clay, clay; well-developed caliche and gypsum profiles; abundant disseminated gypsum in some soil horizons (see attached soil logs).

Ground Water: None encountered in test pits; high ground-water conditions likely adjacent to intermittent streams when flowing.

Hazards/Cautions: Shrink/swell potential of clay soil, collapse potential of soil horizons containing tubular pores and gypsum; deleterous effect of gypsum (sulfate) on concrete; flood hazard.

Summary: Recommend soils/foundation investigation to determine extent of soil problems on site, advise use of sulfate-resistant (Type V) concrete; mitigation of flood hazard necessary (dikes, channelization, etc.).



Attachment 3, Memo of 2/11/83 to Ted Taylor, Uintah School District

Test Pit Soil Logs*
Uintah School District
Property Evaluations

Jensen Property

Test Pit 1

0.0' - 0.7'	Rubble; bricks and concrete from a demolished school that previously occupied the same site.
0.7' - 1.9'	Sandy clay (CL): yellow brown, firm, low plasticity, moist, nonindurated; frozen to 1.5 feet.
1.9' - 3.2'	Silty sand with gravel (SM); yellow brown, medium dense, non to slightly plastic, moist, nonindurated: gravel to 1/2-inch diameter.
3.2' - 6.7'	Clayey silt-silty clay (ML-CL): brown to yellow brown, stiff, low to medium plasticity, moist, nonindurated: root holes.
6.7' - 9.2'	Silty clay (CL): brown to olive brown, stiff, medium to high plasticity, moist, nonindurated; numerous root holes.

Test Pit 2

0.0' - 3.3'	Sandy clay (CL): brown to yellow brown, stiff, low plasticity, moist, nonindurated; frozen to 1.5 feet.
3.3' - 4.5'	Clayey silt-silty clay (ML-CL): yellow brown, stiff, medium plasticity, moist, nonindurated; numerous root holes.
4.5' - 9.1'	Silty clay (CL): brown to olive brown, stiff, medium to high plasticity, moist, nonindurated; numerous root holes.

Note: Ground water not encountered in either test pit, but clay soils approach/exceed their plastic limit with depth.

Davis Property

Test Pit 1

0.0' - 0.8'	Sandy silt-silty sand (ML-SM): brown, none to very low plasticity, moist, nonindurated: very fine grained, ground frozen, density/consistency indeterminate.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure).

0.8' - 2.5'	Caliche: white, stage III, hard to very hard, original soil not identifiable.
2.5' - 4.7'	Sandy gravel with cobbles (GP): brown, loose to medium dense, nonplastic, dry, non to weakly indurated; some cobbles to 8-inch diameter, cobble-size pieces of highly-weathered asphaltic sandstone.
4.7' - 9.0'	Silty sand (SM): yellow brown to tan, medium dense, nonplastic, dry, weakly indurated; fine grained, isolated caliche nodules.

Test Pit 2

0.0' - 2.6'	Sandy silt with clay (ML): brown, stiff, low plasticity, dry, weakly indurated: isolated caliche nodules increasing with depth, numerous root holes, frozen to 1.5 feet.
2.6' - 4.9'	Caliche; white, stage III, hard, original soil not identifiable.
4.9' - 6.6'	Silty sand (SM): light brown to tan, medium dense, nonplastic, dry, weakly indurated: disseminated secondary carbonate.
6.6' - 7.6'	Sandy gravel with cobbles (GP); brown, medium dense, nonplastic, dry, non to weakly indurated: cobbles to 6-inch diameter.
7.6' - 9.1'	Silty sand (SM); light brown to tan, medium dense, nonplastic, dry, nonindurated: fine to medium grained.

Test Pit 3

0.0' - 0.9'	Sandy silt (ML): dark brown, low plasticity, nonindurated, moist: frozen, consistency indeterminate.
0.9' - 1.5'	Silty sand (SM): light brown, dense, non to slightly plastic, dry to moist, weakly indurated: numerous root holes.
1.5' - 3.5'	Caliche; white, stage II to III, hard, developed in silty sand.
3.5' - 5.4'	Silty sand with gravel (SM): light brown, medium dense to dense, nonplastic, dry, weakly indurated: gravel to 3-inch diameter.
5.4' - 9.3'	Silty sand (SM); light brown, medium dense, nonplastic, dry, non to weakly indurated: root holes locally abundant.

Test Pit 4

0.0' - 1.1'	Sandy silt (ML): dark brown, low plasticity, moist, nonindurated: frozen, consistency indeterminate.
1.1' - 3.3'	Caliche; white, stage III, hard, appears to be developed in a gravelly sand or sandy gravel.
3.3' - 4.5'	Gravelly silty sand (SM): light brown to white, dense, nonplastic, dry, indurated: stage II caliche development.
4.5' - 9.0'	Sandy gravel with cobbles (GP): brown, loose to medium dense, nonplastic, dry, nonindurated: minor wall caving in this horizon.

Note: Ground water not encountered in test pits.

Rasmussen Property

Test Pit 1

0.0' - 1.4'	Sandy clay-clayey sand (CL-SC): brown to dark brown, stiff to medium dense, low plasticity, moist, nonindurated.
1.4' - 2.5'	Caliche; white, stage II to III, appears to be developed in silty sand.
2.5' - 4.6'	Sandy silt with clay (ML): tan to light brown, stiff, medium plasticity, dry, weakly indurated: numerous root holes.
4.6' - 9.4'	Gravelly sand with cobbles (SP): brown, medium dense, nonplastic, dry, nonindurated: cobbles to 5-inch diameter.

Test Pit 2

0.0' - 1.0'	Sandy clay (CL): brown to dark brown, low to moderate plasticity, moist, nonindurated: frozen, consistency indeterminate.
1.0' - 3.5'	Sandy silt-silty sand (ML-SM): tan to light brown, stiff to medium dense, slightly plastic, dry, weakly indurated; stage I to II caliche development, root holes.
3.5' - 5.4'	Sandy silt with clay (ML): tan to light yellow brown, stiff, low plasticity, moist, weakly indurated: numerous root holes.
5.4' - 8.9'	Silty gravelly sand with cobbles (SM): brown, medium dense, nonplastic, dry to moist, nonindurated: cobbles to 6-inch diameter.

Test Pit 3

0.0' - 6.0' Sandy clayey silt (ML); soil wet to saturated and above plastic limit, walls of test pit badly smeared; standing water at 6.0 feet.

Test Pit 4

0.0' - 1.8' Sandy silt (ML): dark brown to brown, stiff, low plasticity, moist, nonindurated; numerous root holes.

1.8' - 3.2' Sandy silt (ML); white, stiff, low plasticity, moist, indurated; stage I to II caliche development.

3.2' - 4.9' Clayey silt (ML); brown, soft, low to medium plasticity, moist to wet, nonindurated; root holes.

4.9' - 9.5' Sandy silt-silty sand (ML-SM); olive brown, soft to low density, low plasticity, wet to saturated, nonindurated; standing water at 9.5 feet.

9.5' - 10.5' Sandy gravel (GP/GM): brown, low to medium density, nonplastic, saturated, nonindurated.

Test Pit 5

0.0' - 4.7' Silty clay-clayey silt (CL-ML); brown, soft, medium plasticity, wet, nonindurated; above plastic limit, smeared.

4.7' - 5.8' Sandy gravel with cobbles (GP/GM); brown, medium dense, nonplastic, saturated, nonindurated; standing water at 5.8 feet.

Note: Ground water encountered in test pits 3, 4, and 5.

Caldwell Property

Test Pit 1

0.0' - 5.6' Silty clay-clay (CL-CH); yellow brown, stiff to soft with depth, medium to high plasticity, moist to wet, nonindurated; above plastic limit at depth.

5.6' - 6.6' Sandy clayey silt (ML); red brown, soft, low plasticity, wet to saturated, nonindurated; standing water at 6.6 feet, walls of test pit badly smeared.

Test Pit 2

0.0' - 2.6'	Silty clay (CL); yellow brown, firm, medium plasticity, moist, nonindurated: root holes.
2.6' - 7.4'	Sandy clayey silt (ML); red brown, soft, low plasticity, moist to saturated, nonindurated: numerous root holes to 1/4-inch diameter, standing water at 7.4 feet.

Test Pit 3

0.0' - 1.9'	Silty clay (CL): brown to yellow brown, medium plasticity, moist, nonindurated: frozen, consistency indeterminate.
1.9' - 2.7'	Sandy clayey silt (ML); red brown, soft, low plasticity, moist to wet, nonindurated: numerous root holes.
2.7' - 3.8'	Caliche; white, stage II, soft, developed in silt.
3.8' - 5.9'	Sandy clayey silt (ML): red brown, soft, low plasticity, moist to wet, nonindurated; numerous root holes.
5.9' - 7.4'	Clayey silty gravel with cobbles (GC): brown to red brown, medium dense, low plasticity, wet to saturated, nonindurated; standing water at 7.4 feet.

Test Pit 4

0.0' - 1.2'	Silty clay (CL); yellow brown to dark brown, soft to firm, medium plasticity, moist, nonindurated.
1.2' - 2.8'	Sandy silty clay (CL): red brown, soft, low to medium plasticity, moist to wet, nonindurated: numerous root holes.
2.8' - 4.7'	Clayey sandy gravel with cobbles (GC): mottled red to gray and black, medium dense, low to medium plasticity, wet to saturated, nonindurated; mottled coloring indicates a seasonally fluctuating water table, standing water at 4.7 feet.

Test Pit 5

0.0' - 1.3'	Clay (CL-CH); dark brown, stiff, medium to high plasticity, moist, nonindurated.
1.3' - 2.4'	Sandy clayey silt (ML); light tan to white, firm to stiff, low plasticity, moist, moderately indurated: stage I to II caliche development.
2.4' - 3.1'	Sandy clayey silt (ML): red brown, stiff, low plasticity, moist, nonindurated; numerous root holes.

3.1' - 7.3' Sandy gravel with cobbles (GP/GM): brown, medium dense, non to slightly plastic, wet to saturated, nonindurated; standing water at 7.3 feet, a few boulders to 12-inch diameter.

Test Pit 6

0.0' - 6.3' Clay (CL-CH); yellow brown, firm, medium to high plasticity, moist to wet, nonindurated.

6.3' - 10.0' Sandy clayey silt (ML); red brown, soft, low plasticity, moist to saturated, weakly indurated: caliche nodules, root holes, standing water at 7.9 feet; test pit carried to 10 feet looking for gravel horizon.

Test Pit 7

0.0' - 2.8' Clay (CL-CH); yellow brown, firm, medium to high plasticity, moist, nonindurated; root holes.

2.8' - 4.0' Sandy clayey silt (ML); red brown, soft, low plasticity, moist, nonindurated; numerous small root holes.

4.0' - 5.2' Sandy silt (ML); white, firm, low plasticity, moist, weakly to moderately indurated; stage I caliche development.

5.2' - 12.0' Clayey silt (ML); red brown, soft, low to medium plasticity, wet to saturated, non to weakly indurated; standing water at 6.3 feet; test pit carried to 12 feet looking for gravel horizon

Note: Ground water encountered in all test pits.

Tullis Property

Test Pit 1

0.0' - 5.1' Clay (CL-CH); yellow brown, soft, medium to high plasticity, moist to saturated, nonindurated; root holes, standing water at 5.1 feet; test pit walls badly smeared below 2.5 feet.

Test Pit 2

0.0' - 5.6' Clay (CL-CH); yellow brown, soft, medium to high plasticity, moist to saturated, nonindurated; root holes, standing water at 5.6 feet; test pit walls badly smeared below 3.5 feet.

Test Pit 3

0.0' - 6.5' Clay (CL-CH); yellow brown, soft, medium to high plasticity, moist to saturated, nonindurated; root holes, standing water at 6.5 feet; test pit walls badly smeared below 2.0 feet.

Note: Ground water encountered in all test pits.

Slaugh Property

Test Pit 1

0.0' - 1.1' Silty clay (CL); brown, medium plasticity, moist, nonindurated; frozen, consistency indeterminate.

1.1' - 2.7' Caliche; white, stage III, very hard, original soil indeterminate.

2.7' - 7.8' Cobbly sandy silty gravel with boulders (GM); brown, dense nonplastic, dry, non to weakly indurated; boulders to 1-1/2 feet in diameter.

7.8' - 10.4' Gravelly silty sand (SM); yellow brown to tan, medium dense to dense, nonplastic, dry; gravel to 1-1/2-inch diameter.

Test Pit 2

0.0' - 1.2' Silty clay (CL); brown, medium plasticity, moist, nonindurated; frozen, consistency indeterminate.

1.2' - 2.6' Caliche; white, stage II, soft; appears to be developed in sand.

2.6' - 4.4' Clayey sand (SC); brown to red brown, low to medium dense, low plasticity, dry, weakly indurated; numerous root holes.

4.4' - 10.6' Sandy silt-silty sand (ML-SM); yellow brown to tan, stiff to medium dense, low plasticity, dry, weakly indurated; numerous root holes, isolated lenses of sandy gravel.

Note: Ground water not encountered in test pits.

Sprouse Property

Test Pit 1

0.0' - 5.3' Clayey silt-silty clay (ML-CL); yellow brown to light tan, firm, low to medium plasticity, dry, non to weakly indurated; numerous small root holes.

5.3' - 6.5'	Silty sand with gravel (SM); red brown, medium dense, non to slight plasticity, dry, weakly indurated; root holes.
6.5' - 8.0'	Caliche; white, stage III, hard; developed in sandy gravel.

Test Pit 2

0.0' - 3.1'	Sandy clay (CL); red brown, firm, low to medium plasticity, dry, nonindurated.
3.1' - 4.8'	Caliche and gypsum; tan to brown, moderately indurated, iron staining at lower contact; appears to be developed in a clay stratum.
4.8' - 7.2'	Clay (CL-CH); brown to olive brown, firm to stiff, medium to high plasticity, dry, weakly indurated; numerous gypsum crystals.
7.2' - 8.5'	Shale; olive gray, moderately hard; can be ripped by backhoe, gypsum crystals.

Test Pit 3

0.0' - 6.9'	Silty clay-clay (CL-CH); yellow brown, stiff, medium to high plasticity, dry, weakly indurated; root holes.
6.9' - 9.0'	Clay (CH); brown to red brown, very stiff to hard, high plasticity, dry, weakly indurated.

Test Pit 4

0.0' - 2.5'	Silty clay (CL-CH); yellow brown, very stiff, medium plasticity, dry, weakly indurated; root holes.
2.5' - 6.1'	Silt-clayey silt (ML); yellow brown, stiff, low plasticity dry, weakly indurated; numerous root holes.
06.1' - 8.3'	Gypsum and caliche; yellow brown to white, moderately indurated; appears to be developed in clay.
8.3' - 10.2'	Silty clay (CL-CH); yellow brown, stiff to very stiff, medium to high plasticity, dry, weakly indurated

Note: Ground water not encountered in test pits.

Project: Site investigation for three schools, Granite School District.			Requesting Agency: Granite School District
By: H. E. Gill	Date: June 3, 1983	County: Salt Lake	Job No.: S-3
USGS Quadrangle: Magna (1214)			

June 3, 1983

MEMORANDUM

TO: William R. Lund, Site Investigations Section, Utah Geological and Mineral Survey

FROM: Harold E. Gill, Geologist

SUBJECT: Inspection of three proposed school sites for Granite School District, Salt Lake County, Utah

In response to a request from Mr. Brent Hilton, Director, Granite School District, an engineering geologic investigation was conducted on May 17 and 18, 1983, of the proposed sites for two elementary schools and one junior high school in the Granite School District. It is understood that the buildings will be single story structures of cement block and masonry construction, without basements.

SITE LOCATIONS AND DESCRIPTIONS

Site 1, Magna Elementary School, is bounded on the northeast by 2700 South Street and on the west by 8275 West Street (attachment 1). A 2.5 foot deep unlined irrigation canal forms the southern boundary of the property, and a 3.5 foot deep unlined irrigation canal, which was filled with water at the time of the investigation, forms the eastern property line. The site encompasses an area of 11.9 acres which had been previously cultivated. The topography is relatively flat with a gentle 1 to 2-degree slope toward the northeast. The surface drainage has been greatly altered by the agricultural activity but flows generally toward the northeast.

Site 2, the junior high school, is located at 3785 South (Wending Lane) and between 6040 West (Patti Street) and 6180 West (Deann Drive) (attachment 1). A 3-foot deep unlined and apparently unused irrigation ditch forms the northern property line. Houses are located along the east boundary, and the area to the south and west of the property has been used as a dumping site for rubble. Two shallow unlined canals cross the property from east to west and it is evident, because of abundant vegetative growth down slope from the canals, that leakage occurs when water is present. Site topography is generally flat, with less than a 2-degree slope to the north. The property is currently used for grazing but has been cultivated, which has significantly altered the natural drainage pattern. However, the flow direction remains generally to the north.

At site 3, three test holes were excavated to depths of between 10.5 and 11 feet (attachment 4). The exact position of the building on the site is unknown; however, an attempt was made to locate the test holes in what was thought to be the general area of the structure. The property is underlain by Lake Bonneville sediments on which a thin layer of topsoil has been deposited. A low density, silty sand with 15 to 35 percent gravel was encountered in test holes one and two above a yellow, fine-grained, medium to low density, silty sand. Test hole three contained the yellow, silty sand only. The soils were moist throughout but no ground water was encountered.

SEISMICITY

All three sites lies within the boundaries of an area classified in the Uniform Building Code as being seismic zone 3 and by the Seismic Safety Advisory Council as zone U-4 (major damage; corresponds to intensity VIII and higher of the modified Mercalli Scale) (attachment 5). Jordan Valley has experienced a number of earthquakes in the past, the largest occurring in 1910 and having a Richter magnitude of 5.5 M/L and a modified Mercalli Intensity of VII. There are mapped faults located approximately 1500 and 3700 feet southeast and 6600 feet southwest from Site 1. The Granger fault and Jordan Valley fault zone are approximately 4100 feet southeast of site 2, and approximately 3000 feet northeast of site 3. Renewed movement along these faults, or any faults within the Jordan Valley, could produce strong ground shaking at all the proposed sites, the intensity of which would depend upon the magnitude and the location of the epicenter. It is unlikely that ground rupture would occur.

CONCLUSIONS AND RECOMMENDATIONS

1. The site investigations were of an engineering geologic nature only. Therefore, prior to the actual start of construction, a complete soils/foundation investigation with borings to depths of at least 50 feet should be performed.

2. In the event of a moderate to severe earthquake in Salt Lake County, the sites could encounter strong ground shaking. The structures should be designed accordingly by engineers and architects familiar with the principles of earthquake-resistant design.

3. Fine-grained silt and sand lenses were observed at site 2 and are not uncommon throughout the Lake Bonneville sediments. Although no ground water was encountered at the site, the possibility that water, as well as silt or sand lenses, exist beneath 20 feet is high. If this is the case, liquifaction caused by ground shaking from a moderate to strong earthquake could occur. A detailed soils investigation with appropriate boring depths could determine if this is the situation.

4. Due to the probable density differences in the subsurface soils at site 2, testing should be performed to determine the different loading responses, and the building designed accordingly.

5. No other major hazards were encountered at any of the sites.

SELECTED REFERENCES

Dames and Moore, 1979, Report of fault study UDOT/UDPS complex, Salt Lake County, Utah: for the Utah State Building Board.

Davis, F.D., 1983, Geologic map of the central Wasatch Front, Utah: Utah Geological and Mineral Survey Map 54-A, scale 1:100,000.

Eardley, A.J., 1964, Lake Bonneville, geology of Salt Lake County: Utah Geological and Mineral Survey and College of Mines Bulletin 69, University of Utah.

Tucker, E.W., 1971, Geologic map of the Magna Quadrangle, Salt Lake County, Utah: U.S. Geological Survey Map GQ-923, scale 1:24,000.

APPENDIX

Logs of Test Pits
Granite School District School Sites

Logs of Test Pits*

Magna Elementary School Site

Test Pit 1

0.0' - 1.0'	Silty clay (CL); topsoil, dark brown, firm, medium to high plasticity, nonindurated, moist.
1.0' - 9.5'	Silty clay (CL); brown, firm, medium plasticity at top to high plasticity at bottom, nonindurated, moist.

Test Pit 2

0.0' - 1.0'	Silty clay (CL); topsoil, dark brown, firm, medium to high plasticity, nonindurated, moist.
1.0' - 9.5'	Silty clay (CL); brown to light brown, firm, medium plasticity at top to high plasticity at bottom, nonindurated, moist.

Test Pit 3

0.0' - 1.0'	Silty clay (CL); topsoil, dark brown, firm, medium to high plasticity, nonindurated, moist.
1.0' - 3.0'	Gravelly clay (CL); channel gravel deposit 2 to 3 feet thick; brown, firm, medium to high plasticity, nonindurated, moist.
3.0' - 9.5'	Silty clay (CL); brown, firm, medium plasticity at top to high plasticity at bottom, nonindurated, moist.

*Soil descriptions conform to ASTM Standard D 2488-69 (Revised 1975). Description of Soils (Visual - Manual Procedure).

Logs of Test Pits*

Granite School District Junior High School Site

Test Pit 1

0.0' - 1.9'	Silty sand (SM); topsoil, dark brown, low density, none to low plasticity, nonindurated, moist.
1.9' - 4.4'	Silty sand (SM); brown, low density, nonplastic, nonindurated, moist to dry.
4.4' - 5.7'	Sand (SP); light gray, medium dense, nonplastic, weakly to moderately indurated, dry.
5.7' - 7.5'	Silt w/sand (ML); yellow, firm, nonplastic, none to weakly indurated, dry to moist.
7.5' - 9.5'	Silty sand-silty gravel (SM-GM); yellow brown, low density, nonplastic, weakly indurated, dry to moist.

Test Pit 2

0.0' - 1.6'	Silty sand (SM); topsoil, dark brown, low density, none to low plasticity, nonindurated, moist.
1.6' - 2.8'	Silty sand (SM); brown, low density, nonplastic, nonindurated, moist.
2.8' - 6.0'	Silty, sandy gravel (GM); yellow, high to medium density, nonplastic, moderately indurated, moist to dry.

Test Pit 3

0.0' - 1.2'	Silty sand (SM); topsoil, dark brown, low density, none to low plasticity, nonindurated, moist.
1.2' - 2.5'	Silty sand (SM); brown, low density, nonplastic, nonindurated, moist.
2.5' - 6.3'	Silty, sandy gravel (GM); yellow brown, high to medium density, nonplastic, moderately indurated, moist to dry.

Test Pit 4

0.0' - 1.0'	Silty sand (SM); topsoil, dark brown, low density, none to low plasticity, nonindurated, moist.
1.0' - 3.8'	Silty sand (SM); brown, low density, nonplastic, nonindurated, moist.

3.8' - 4.7'	Sand (SP); gray, medium to low density, nonplastic, weakly to moderately indurated, dry to moist.
4.7' - 7.1'	Sand (SP); light gray, high density, nonplastic, moderately to strongly indurated, dry.
7.1' - 9.2'	Silty sand-sand (SM-SP); yellow, low density, nonplastic, nonindurated, moist.
9.2' - 9.5'	Silty, sandy gravel (GM); yellow brown, high to medium density, nonplastic, moderately indurated, moist.

Logs of Test Pits*

Oquirrh Elementary School Site

Test Pit 1

0.0' - 1.2'	Silty sand (SM); topsoil, dark brown, low density, low plasticity, nonindurated, moist.
1.2' - 3.2'	Silty sand (SM); brown, low density, low plasticity, nonindurated, moist.
3.2' - 11.0'	Silty sand (SM); yellow, low to medium density, nonplastic, nonindurated, moist.

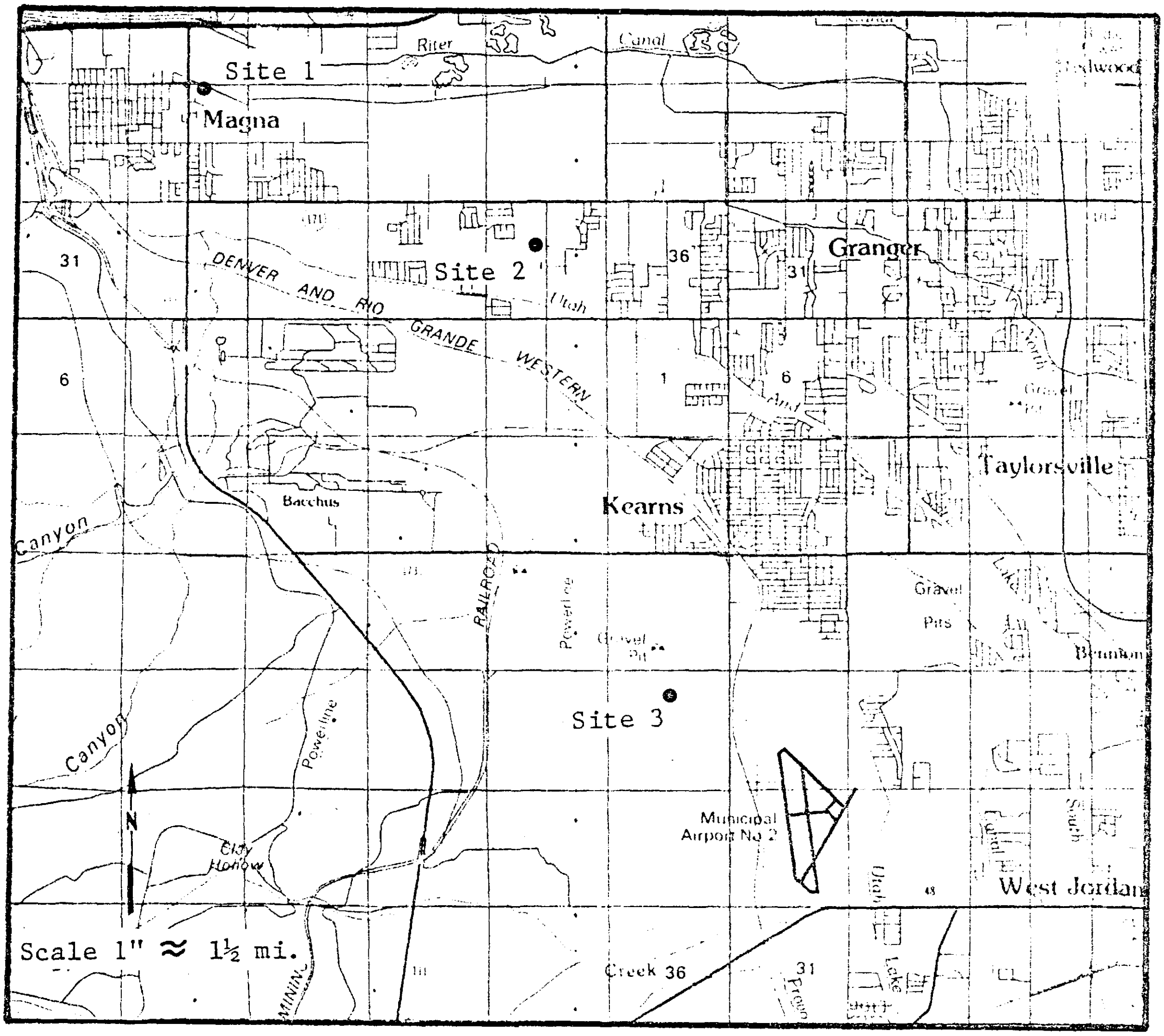
Test Pit 2

0.0' - 1.3'	Silty sand (SM); topsoil, dark brown, low density, low plasticity, nonindurated, moist.
1.3' - 3.0'	Silty sand (SM); brown, low density, none to low plasticity, nonindurated, moist.
3.0' - 6.0'	Silty sand w/gravel (SM); light brown, low to medium density, nonplastic, nonindurated, moist.
6.0' - 10.5'	Silty sand (SM); yellow, low density, nonplastic, nonindurated, moist.

Test Pit 3

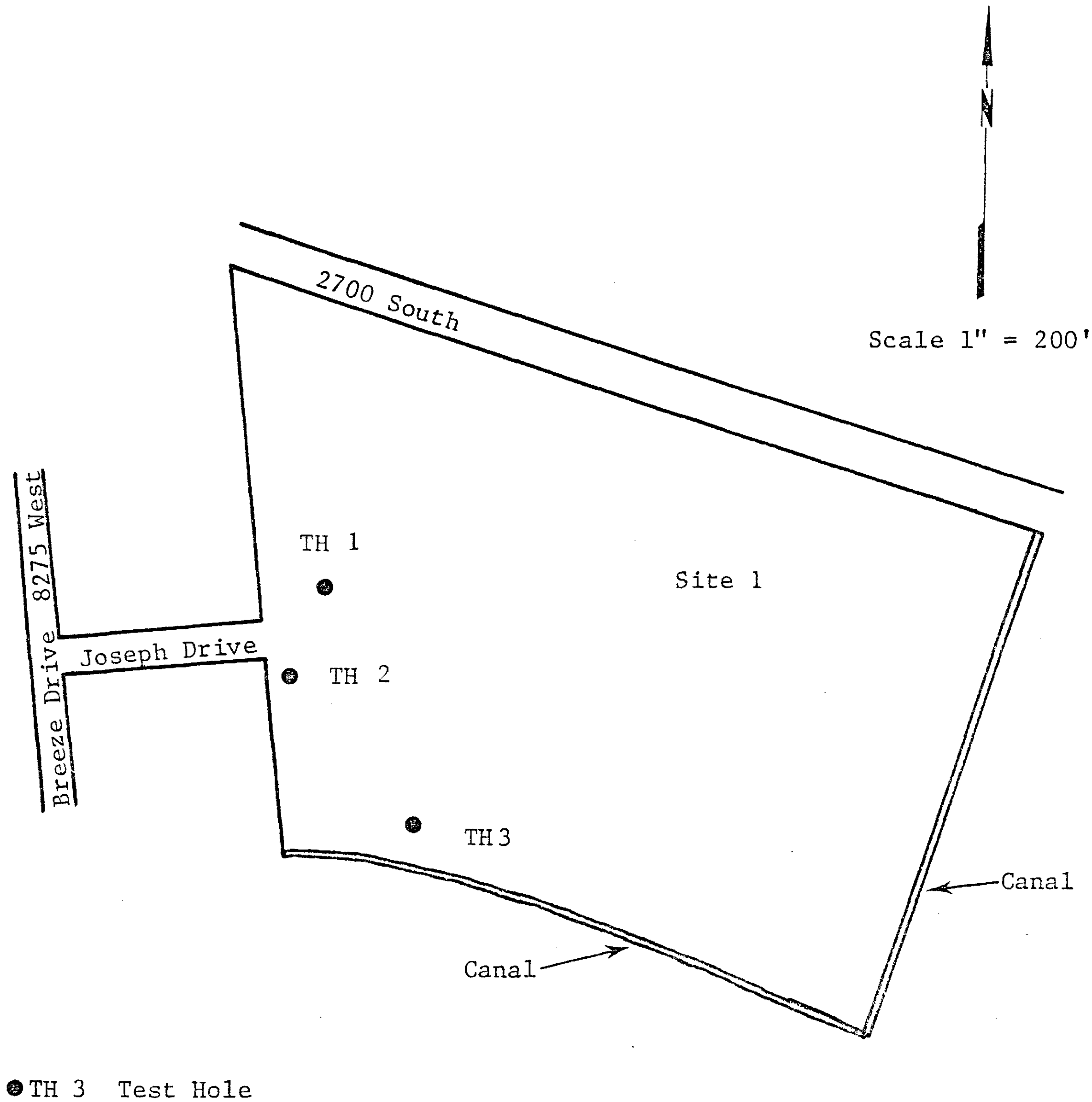
0.0' - 1.0'	Silty clay-silt (CL-ML); topsoil, dark brown, firm, low plasticity, nonindurated, moist.
1.0' - 10.0'	Silty sand (SM); yellow, low density, nonplastic, nonindurated, moist.

Attachment 1, memo of 6 / 3 /83 to W. R. Lund



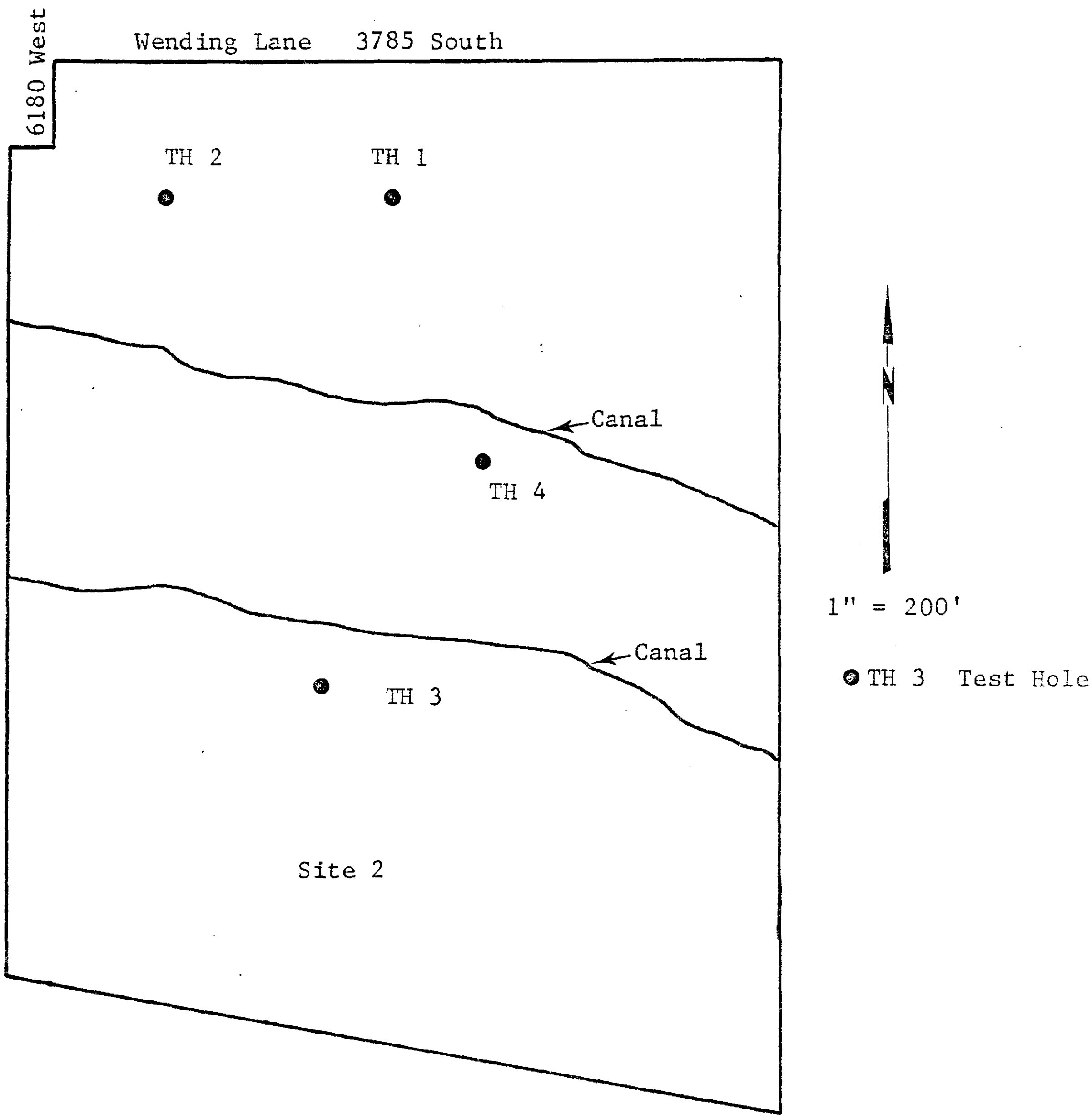
Location Map Granite School District Building Sites

Attachment 2, memo of 6/3/83 to W. R. Lund



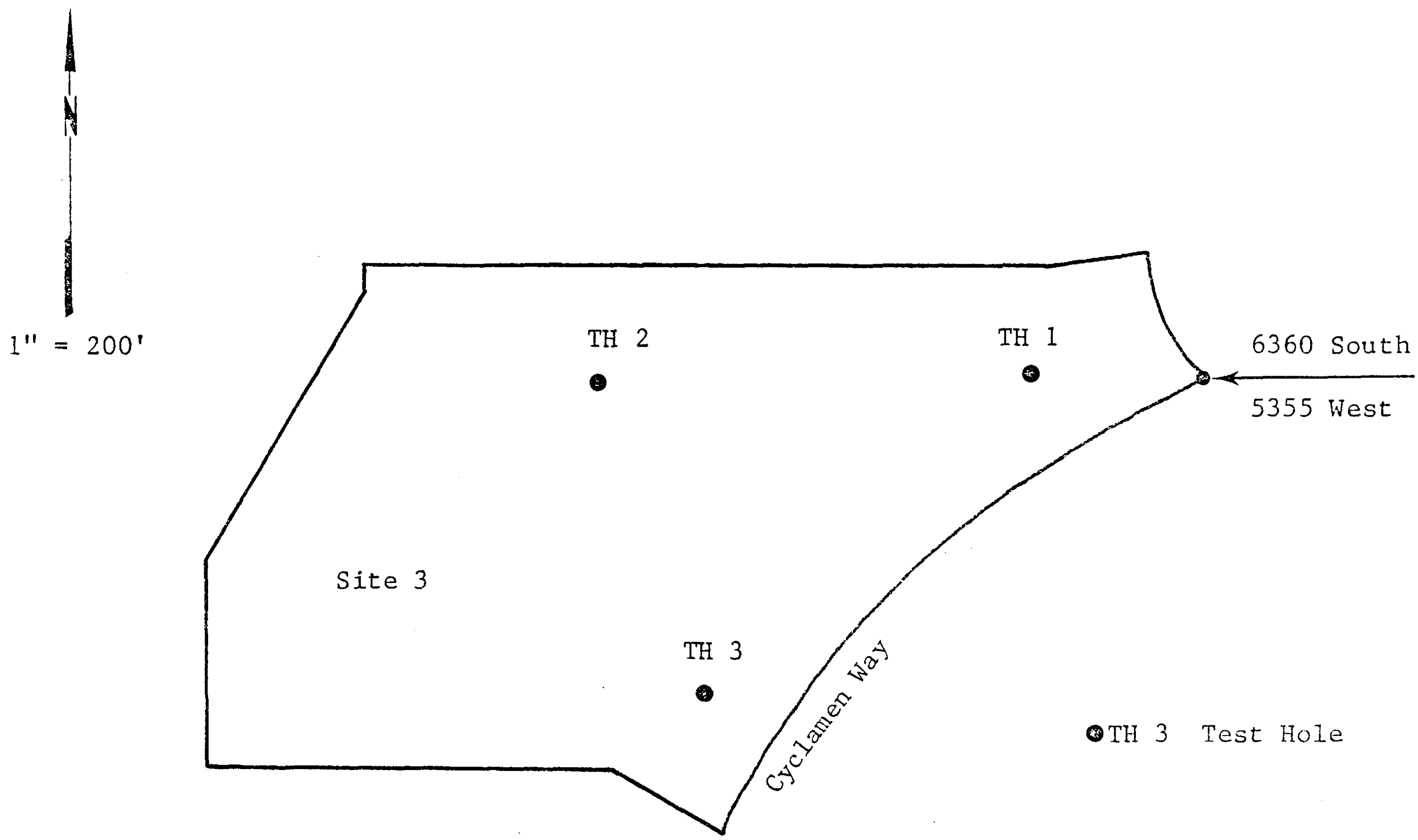
Site Plan Magna Elementary School

Attachment 3, memo of 6/ 3/83 to W. R. Lund



Site Plan Granite School District Junior High School

Attachment 4, memo of 6/3 /83 to W. R. Lund



Site Plan Oquirrh Elementary School

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.*

SUBDIVISIONS

Project: Arlington Circle Subdivision review, Salt Lake City, Utah.			Requesting Agency: Salt Lake Corp. Planning & Zoning Commission
By: G.E. Christenson	Date: Jan. 11, 1983	County: Salt Lake	Job No.: SD-1
USGS Quadrangle: Fort Douglas (1253)			

January 11, 1983

Douglas L. Wheelwright
Planner III/Current Planning
Salt Lake Corporation
414 City and County Building
Salt Lake City, Utah 84111

Dear Mr. Wheelwright:

This letter is in response to your request of December 23, 1982, for our comments regarding the proposed Arlington Circle Subdivision in northeast Salt Lake City. We have reviewed the geotechnical report prepared by Dames and Moore for the property and are returning it and the other materials to you with this letter. Our review consisted of a literature search and brief site visit with no additional investigations of soil types or analyses of slope stability.

Based on our review, the geotechnical report appears to be accurate and complete with respect to geological considerations and we generally concur with the conclusions presented. As outlined in the report, slopes are bedrock controlled and appear stable, soils are well-drained and suitable for use in engineered fill, and the site itself is not traversed by any known faults, although several pass nearby. The greatest hazard affecting the site is that due to ground shaking during an earthquake. Recommendations for mitigating this hazard through adherence to Uniform Building Code standards are given in the report.

Since it is outside our area of expertise, we hesitate to make comments regarding aesthetic or philosophical questions of the "total regrade" development concept as requested in your letter. Geological problems involved in "total regrading " differ from site to site. Where economics are favorable, total regrading is not uncommon and is not necessarily unsafe or undesirable from a geologic standpoint. In many cases, areas of potentially unstable slopes have been made suitable for development through placement of buttress fills and total regrading to control drainage and utilize existing favorable conditions. Care must be taken to control erosion during and after construction and cut and fill procedures used by contractors should be monitored by geotechnical personnel to see that specifications are met. If recommendations made in the soils report are followed at the Arlington Circle Subdivision, we are aware of no geological conditions which would preclude development as proposed.

Feel free to contact our office if you have further questions or wish to discuss the development further.

Sincerely yours,

Gary Christenson, Geologist
Site Investigations Section

GEC/co

Project: Evaluation of soil and geologic conditions at the proposed Heatheridge Subdivision and Hidden Hollow Condominiums, Orem, Utah			Requesting Agency: Orem City Corporation	
By: G.E. Christenson	Date: March 7, 1983	County: Utah		Job No.: SD-2
USGS Quadrangle: Orem (1088)				

March 7, 1983

Edward D. Stout, Planning Director
Orem City Corporation
56 N. State Street
Orem, UT 84057

Dear Mr. Stout:

This letter is in response to your request for assistance in evaluating soil and geologic conditions at the proposed Heatheridge Subdivision and Hidden Hollow Condominiums in Orem. We have reviewed existing geologic, hydrologic, and soils reports for the areas and performed a field reconnaissance at both sites on March 1, 1983. No soil test pits or other subsurface investigations were included in this evaluation.

At the Heatheridge Subdivision, the east-west ridge along the south side of the property is underlain by thin-bedded Lake Bonneville silt and clay with some sand layers. Expansive clays (high shrink-swell potential) predominate on the ridge and have washed onto surrounding flat areas. The ridge continues westward into the Executive Estates Subdivision where the expansive clays are probably responsible for the severe cracking and settlement of streets there. The Soil Conservation Service Soil Survey of central Utah County (1972) shows the expansive soil types to be principally the McMurdie-Taylorsville complex (map unit MtE2) with similar though perhaps less severe problems associated with Parleys (PaC) series soils. These soil units are shown on the soil survey plat map prepared by Dudley and Associates for the Heatheridge Subdivision. However, the soil boundaries shown on the plat map do not correspond to those in the SCS soil survey. No discussion is made in the soils report accompanying the plat map of data used to modify the SCS information to the larger map scale. Topographic relationships and soil types observed during our reconnaissance indicate that the SCS boundaries are correct. Test pit data by Dudley and Associates also confirms SCS mapping. Pits 1 and 2 indicate the upper five feet to be clayey soils (PaC) whereas test pit 3 shows alluvial gravelly soils (PlD) in the upper five feet. The soil boundary is thus between test pits 2 and 3, rather than west of test pit 1 as shown on the soil survey plat map. I have included with this letter a plat map of the Heatheridge Subdivision showing soil boundaries more accurately transferred from SCS maps (attachment 1). As you can see by comparison of this map with that by Dudley and Associates, much greater areas of the proposed subdivision are underlain by soils with moderate to high shrink-swell potential (PaC, MtE2). These soils are similar to those in the Executive Estates Subdivision where significant foundation problems have occurred. We recommend that soil tests to determine strength and moisture sensitivity characteristics of these soils be performed and that alterations be made in standard road and building foundation design to accomodate soil conditions. Where possible, the recommendation by Dudley and Associates to found buildings in gravelly materials beneath clays should be followed.

The principal concern in the Hidden Hollow Condominiums area is the stability of slopes. Hidden Hollow is an incised drainage about 40 feet deep at the west edge of the Provo (Orem) Bench. No fresh exposures of materials underlying the bench are present, but soils on slopes are chiefly silty sands and gravelly silty sands. Natural slopes have been altered by grading, removal for borrow, and filling from the bench top. Many slopes, particularly those resulting from dumping of fill from above, are near the angle of repose of loose sand (about 60 percent). Steeper slopes are found where sands are wet, vegetated, compacted, or contain finer-grained materials (silt and clay). Undercutting of an area on the steep southwest slope of Hidden Hollow has resulted in a small earth slide. A thin layer of sand has moved downslope, leaving an arcuate headscarp on the slope above the cut. The resulting slope of this slide mass is about 70 percent, which is probably the maximum stable slope angle in this material under existing natural conditions. This indicates that many of the steeper slopes are presently near their maximum stable slope angle and, while stable, may be readily destabilized by disruption of vegetation, undercutting, grading, or saturation. The loose, granular nature of soils indicates that slopes, if undercut, will retreat in a parallel fashion, maintaining an approximate 60-70 percent slope, and eventually affect the bench top. The high permeability and well-drained nature of soils in the area should preclude problems with slope failures induced by saturation from water applied to bench-top areas. However, heavy application of water to slopes causing saturation or channelization of water down slopes may cause local debris flow and erosion problems. In view of these considerations, we suggest that development in Hidden Hollow be restricted to the flat bottom area with adequate flood protection provided. The city hillside ordinances restricting grading on slopes greater than 35 percent should be strictly enforced with attention paid to prohibiting earthmoving and placement of buildings directly at the base of slopes and prohibiting any disturbance of existing steep slopes.

We hope this addresses your concerns sufficiently. Please contact our office if you have further questions. We will be in contact with you later with our recommendations regarding the more long-range project for the city of Orem discussed during our meeting here on February 25, 1983.

Sincerely yours,

Gary E. Christenson
Site Investigations Section

GEC/av

Project: Investigation of geologic conditions at Yellow Hills Subdivision, Uintah County			Requesting Agency: Uintah County Planning Office
By: W. R. Lund	Date: March 10, 1983	County: Uintah	Job No.: SD-3
USGS Quadrangle: Dry Fork (1154)			

March 10, 1983

Mr. Rob Hugie
Assistant City-County Planner
Room 103, Uintah County Building
Vernal, Utah 84078

Dear Mr. Hugie:

This letter is in response to your request of February 25, 1983, for assistance in evaluating geologic conditions at the proposed Yellow Hills Estates Subdivision near Maeser, Utah (attachment 1). Particular attention was paid to the stability of access roads to the development, portions of which are located on a mesa approximately 400 feet above Ashley Valley. The investigation consisted of a review of available published and unpublished information on the geology, hydrology, and soils in the area, analysis of 1:24,000 scale stereo air photographs, a field reconnaissance, and consultation with Utah Department of Transportation officials knowledgeable about road construction on the Mancos Shale.

The portion of the subdivision located at the foot of the mesa will rest on alluvial and colluvial soils derived primarily from the Mancos Shale. The area was covered with 10 to 12 inches of fresh snow at the time of the field reconnaissance so direct observations were not possible. Unpublished USDA Soil Conservation Service mapping indicates that the soils are fine-grained silt and clay possessing moderate shrink-swell potential. Laboratory tests on similar soils in a subdivision immediately adjacent to the north revealed the presence of collapsible soils. It is considered likely that some of the soils in Yellow Hills Estates Subdivision may also be subject to collapse upon wetting.

The mesa on which the remainder of the subdivision will be built consists of dark-gray to yellow-brown Mancos Shale capped by a 10-to 20-foot thick layer of sand and gravel representing a dissected pediment surface. Few foundation problems are anticipated in the sand and gravel, and because the subdivision will be served by community water and sewer systems, wastewater disposal is not a concern. However, two access roads to the mesa top must cross steep slopes underlain by the Manco Shale. Roads constructed in Mancos Shale terrain are habitually effected by subgrade failure resulting in a very irregular road surface. Utah Department of Transportation personnel indicate that the worst roadbed deterioration occurs where the road changes from a cut to a fill section. Slope failures (landslides) are not common in the Mancos Shale either on natural slopes or in road cuts. A detailed examination of the mesa edge revealed only one small slump failure (attachement 1), and an air photo analysis of a considerable area of Mancos terrain in the vicinity of the subdivision failed to identify additional indications of instability. Examination of over 50 road cuts in the Mancos Shale between Maeser and Jensen, Utah showed that cut slopes of 1-3/4:1 or less are generally stable and that slopes steeper than 1-3/4:1 can slough heavily creating maintenance problems. Large failures endangering the roadway were absent except at one location near Jensen where the Green River had undercut the roadbed. Natural slopes measured at several locations in the Mancos Shale averaged 22 degrees or approximately a 2-1/2:1 slope.

Based on the results of this investigation, UGMS makes the following recommendations concerning Yellow Hills Estates Subdivision:

- A soils/foundation investigation should be performed to identify possible problem soils: particularly in that portion of the subdivision located at the base of the mesa.

- Access roads to the mesa top should avoid alternate cut and fill sections whenever possible. Maximum use should be made of cut sections to minimize roadbed deterioration.

- Slopes of 1-3/4:1 or less are recommended for cuts in the Mancos Shale. Slope stability problems, other than some sloughing requiring routine maintenance, are not anticipated provided that the roads are properly designed and drained.

- Because a small slope failure was observed near the southeast end of the mesa, a 50-foot buffer zone around the edge of the mesa is recommended in which no lawn watering should be permitted.

- Open tunnels associated with an abandoned coal mine on the property (attachment 1) represent a hazard to subdivision residents and should be permanently closed.

It is hoped that this letter addresses your concerns regarding the Yellow Hills Estates Subdivision. Please contact our office if you have any questions or if we may be of further assistance.

Sincerely,

William R. Lund
Site Investigation Section

WRL/co

SELECTED REFERENCES

Carrara, P.E., 1980, Surficial geologic map of the Vernal $1^{\circ} \times 2^{\circ}$ Quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Investigation Series Map I-1204, Scale 1:250,000.

Covington, R.E., 1981, Geologic report on Painted Hills real estate development project, Uintah County, Utah: report prepared for U.S. Department of Housing and Urban Development, 4 p.

Dames and Moore, 1981, Soils, foundation, and roadway investigation, proposed Painted Hills Subdivision located near Maeser, Utah: report prepared for Painted Hills Development Company, 39 p.

Hood, J.W., 1977, Hydrologic evaluation of Ashley Valley, northern Uintah Basin area, Utah: State of Utah Department of Natural Resources Technical Publication No. 54, 25 p.

Lund, W.R., 1983, Investigation of seven proposed school sites for the Uintah School District: Utah Geological and Mineral Survey memo to Ted Taylor Uintah School District, 19 p.

Rowley and others, 1979, Geologic map of the Vernal $1^{\circ} \times 2^{\circ}$ Quadrangle, Colorado, Utah, and Wyoming: U.S. Geological Survey Miscellaneous Field Studies Map MF-1163, scale 1:250,000.

Untermann, G.E., and Untermann, B.R., 1968, Geology of Uintah County: Utah Geological and Mineral Survey Bulletin 72, 98 p.

USDA Soil Conservation Service, 1983, Soils mapping and descriptions for selected areas of Uintah County: unpublished, Vernal, Utah.

Project: Investigation of geologic conditions at Fairway Estates Subdivision, Smithfield, Utah.			Requesting Agency: Smithfield City Corporation
By: G.E. Christenson	Date: April 19, 1983	County: Cache	Job No.: SD-4
USGS Quadrangle: Smithfield (1469)			

April 19, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Fairway Estates Subdivision, Smithfield, Utah

Background

At the request of George Walker, Jr., Smithfield City Engineer, the Utah Geological and Mineral Survey performed an inspection of the proposed Fairway Estates Subdivision in southeast Smithfield (attachment 1). The purpose of the inspection was to evaluate the soils in terms of suitability for individual wastewater disposal systems utilizing seepage pits or soil absorption fields and to consider the potential for pollution of the principal ground-water aquifer by effluent from these systems. I was accompanied on the inspection by Jack Nixon (developer), Alex Hudson (engineer for the developer), and Mr. Walker.

Scope of Work

The scope of work included:

1. Review of geologic, hydrologic, and soils literature for the area, including a report on the site (formerly termed the Keith McMurdie property) by George Walker, Jr. and Associates (1976).

2. Collection of water well data from the Utah Division of Water Rights and U.S. Geological Survey (attachment 3).

3. Field reconnaissance and logging of 8 test pits on the property (attachment 2).

Test pits were subject to caving and were logged from the surface. The UGMS is beginning a detailed study of the Smithfield area to address geologic hazards, ground-water conditions, and wastewater disposal practices in the city. Thus, an analysis of all geologic hazards potentially affecting the site will be made in that study, and conclusions in this memo regard only wastewater disposal and are to be considered preliminary until the more comprehensive study is completed in December, 1983.

Geology and Soils

Deposits at the proposed Fairway Estates Subdivision consist of Holocene (0 - 10,000 years ago) alluvial fan deposits of Dry Creek underlain by Pleistocene (10,000 - 1.6 million years ago) alluvial fan and Lake Bonneville deposits. The area is about 200 feet below the upper shoreline level of Lake Bonneville and was a site for both shoreline and deeper lake sedimentation during lake phases as well as alluvial fan sedimentation between lake phases. Because of this complex depositional history, soils at the site consist of interbedded silt, silty sand, and silty gravel with local beds of clean sand and gravel (lake shoreline facies) and bouldery gravel (alluvial-fan facies). Grain size and gravel content in the deposits increase from west to east.

Soil test data from the study by Walker and Associates (1976) and by the Soil Conservation Service (Erickson and Mortensen, 1974) indicate that similar soils are present throughout the property. Percolation rates measured at depths of 3-4 feet range from 2 to 34 minutes/inch. Percolation rate generally decreases as silt and clay content increases.

Bedrock exposed in hills immediately east of Smithfield is chiefly a fanglomerate facies of the Tertiary Salt Lake Formation (Williams, 1962). No bedrock was encountered in test pits and the depth to rock beneath the property is not known. Bedrock was not encountered to 290 feet in a well near the northwest corner of the property, but conglomerate was reported at 140 feet in a well about 2500 feet southwest of the property (attachmemt 3). Because the bedrock consists of fanglomerate (consolidated alluvial-fan deposits), it is very similar to the gravels which overlie it and would be difficult to differentiate in drill holes unless well indurated. Because of this, drill-hole data cannot be relied upon to yield an accurate depth to rock. Soil types reported in drill-hole logs were principally clay and gravel but also included sand, cobbles, and boulders.

Hydrology

Unconsolidated basin-fill material constitutes the principal aquifer in the Cache Valley (Bjorklund and McGreevy, 1971). The aquifer is recharged along the mountain front by streams draining the mountains (e.g. Summit Creek), by underflow from rock aquifers, and by infiltration from irrigated fields and unlined irrigation canals. The Fairway Estates Subdivision is in an area of recharge for the principal aquifer where an unconfined water table exists. However, recharge to the aquifer from precipitation and snowmelt at the site is probably not significant and any recharge that does occur is probably from the Logan, Hyde Park, and Smithfield Canal.

Ground water was not encountered in any test pits for this or previous studies. The nearest measured depth to water is in the well near the northwest corner of the property (attachment 1). The depth to water was reported in 1960 at 227 feet below the ground surface which is at an elevation of 4710 feet above mean sea level. The depth to water in the well southwest of the property (approximate ground surface elevation 4610 feet) was reported at 95 feet in 1975. Ground surface elevations at the Fairway Estates Subdivision range from 4720 to 4840 feet, so the depth to ground water is probably 200 feet or greater.

Wastewater Disposal

Soils at the site are generally suitable for soil absorption systems or seepage pits. Locally, excessively high percolation rates may be encountered in clean gravel and sand lenses. However, these are not of great lateral or vertical extent and should not pose a problem. Most soils contain fine-grained material, principally silt, to help impede percolation and filter wastewater and thus allow systems to operate properly. The depth to ground water and bedrock is sufficient, and soil types are such that perched water tables are not likely to develop.

Results of water-quality testing planned for our upcoming detailed study will determine the extent to which ground water is presently affected by septic tank-seepage pit effluent in various parts of the city. This will allow a more accurate assessment of the potential for ground-water contamination by effluent from systems at Fairway Estates. Preliminarily, it seems unlikely that soil absorption systems or seepage pits at this subdivision would significantly degrade ground-water quality in the area given the great depth to water, content of fines in the soils, and distances to domestic and municipal culinary wells. The only well which does not alrady have homes located closer than those proposed for this subdivision is the one near the northwest corner of the property. The original record of this well could not be located, but it is listed as a commercial well in McGreevy and Bjorklund (1970) and, if still in use, presumably does not supply culinary water.

GEC/ay

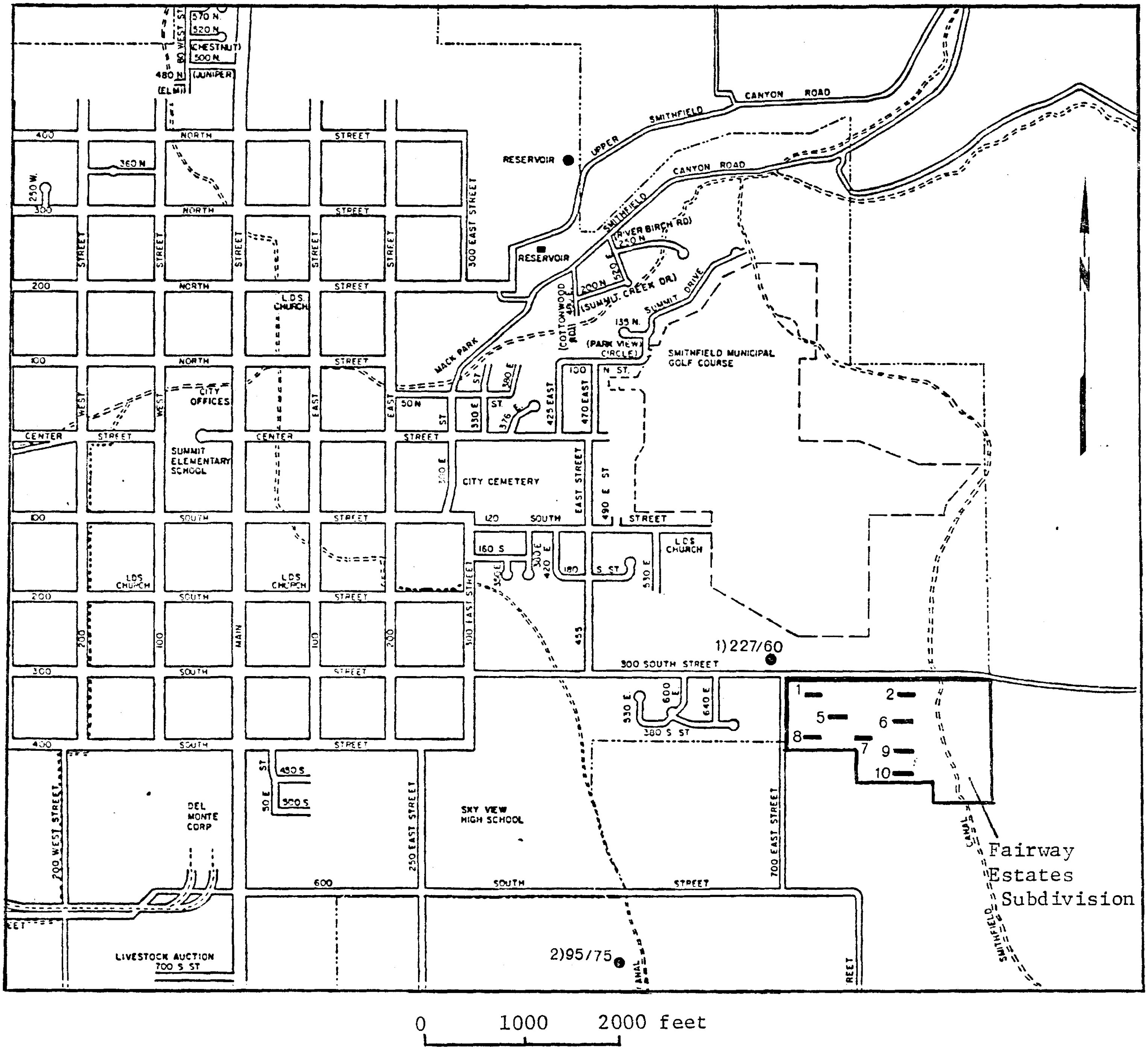
REFERENCES

Bjorklund, L.J., and McGreevy, L.J., 1971, Ground-water resources of Cache Valley, Utah and Idaho: Utah Department of Natural Resources Technical Publication 36, 72 p.

Erickson, A.J., and Mortensen, V.L., 1974, Soil survey of Cache Valley area, Utah: USDA Soil Conservation Service and Forest Service and Utah Agricultural Experiment Station, 192 p.

McGreevy, L.J., and Bjorklund, L.J., 1970, Selected hydrologic data, Cache Valley, Utah and Idaho: Utah Basic-Data Release No. 21, 51 p.

Williams, J.S., 1962, Lake Bonneville: Geology of southern Cache Valley, Utah: U.S. Geological Survey Professional Paper 257-C, 152 p.



Explanation

2)95/75 ● Water well showing depth to water (95) in feet and years of measurement (1975)

8▬ Soil test pit

Location map, Fairway Estates Subdivision, Smithfield

Attachment 2, memo of 4/19/83 to W.R. Lund

Logs of Test Pits
Fairway Estates

Soil Description*

Test Pit 1

0' - 2'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry.
2' - 4.5'	Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry to moist.
4.5' - 6'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated: lenticular.
6' - 11'	Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry to moist.
11' - 16'	Silty gravel (GM); brown, low to medium density, low plasticity nonindurated, dry: moderately indurated with $CaCO_3$ from 11-13 feet.

Test Pit 2

0' - 1'	Silty clay (CL): black, stiff, medium plasticity, nonindurated, moist.
1' - 3'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry.
3' - 5.5'	Silty sand (SM); brown, medium density, low plasticity, nonindurated, dry.
5.5' - 10'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry.
10' - 12'	Silty sand (SM); brown, medium density, low plasticity, nonindurated, dry.
12' - 18'	Silty gravel - sandy gravel (GM-GP): brown, low density, nonplastic, nonindurated, dry.

*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.

Test Pit 5

0' - 4'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry.
4' - 6'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry; 20 percent boulders and cobbles, maximum particle size 1.5 feet.
6' - 13.5'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry.

Test Pit 6

0' - 8'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry to moist.
8' - 9'	Silt (ML); brown, firm, low plasticity, nonindurated, dry to moist.
9' - 14.5'	Sandy gravel (GP); brown, loose, nonplastic, nonindurated, dry.

Test Pit 7

0' - 0.5'	Silty clay (CL); black, stiff, medium plasticity, nonindurated, moist.
0.5' - 5'	Silty gravel (GM); brown, medium dense, low plasticity, nonindurated, dry to moist.
5' - 7.5'	Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry.
7.5' - 11'	Silty gravel (GM); brown, medium dense, low plasticity, nonindurated, dry to moist; moderately indurated with $CaCO_3$ from 10-11 feet.
11' - 15.5'	Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry.
15.5' - 18'	Silty gravel (GM); brown, medium dense, low plasticity, nonindurated, dry.

Test Pit 8

0' - 0.5'	Silty clay (CL); black, stiff, medium plasticity, nonindurated, moist.
0.5' - 4'	Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry to moist.
4' - 12'	Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry to moist; moderately to strongly indurated with $CaCO_3$ below 11 feet, refusal at 12 feet.

Test Pit 9

0' - 11.5' Silty gravel (GM); brown, low density, low plasticity, nonindurated, dry to moist.

11.5' - 12.5' Clayey silt (ML); brown, firm, low to medium plasticity, nonindurated, moist.

12.5' - 15.5' Silty gravel (GM); brown, low density, low plasticity, nonindurated, dry to moist.

Test Pit 10

0' - 11' Silty gravel (GM); brown, low to medium density, low plasticity, nonindurated, dry to moist.

11' - 17' Sandy silt (ML); brown, firm, low plasticity, nonindurated, dry to moist.

NOTE: Test pit numbers are those used by C.A. Schwartz and Associates, engineers for the developer. Trenches were subject to caving and all soils were logged from the surface. No ground water was encountered in any test pits.

Attachment 3, memo of 4/19/83 to W.R. Lund

Logs of Water Wells

Well #1 (A-13-1) 35bbb
T.J. Burkhart Co.

Depth	Soil Description
0' - 2'	soil
2' - 22'	clay and cobbles
22' - 57'	clay and gravel
57' - 80'	gravel and cobbles
80' - 91'	gravel and boulders
91' - 130'	gravel, dirty
130' - 166'	clay and gravel
166' - 170'	boulders
170' - 186'	gravel, dirty
186' - 198'	clay and gravels
198 - 202	boulders
202 - 213	clay and gravel
213 - 216	boulders
216 - 231	gravel
231 - 239	clay and gravel
239 - 257	gravel
257 - 260	clay and gravel
260 - 263	clay and sand
263 - 266	gravel, dirty
266 - 269	boulders
269 - 288	gravel, dirty
288 - 290	clay

water level - 227' (11-19-60)

Well #2 (A-13-1) 34dac
Cache Valley Drilling Company

Depth	Soil Description
0' - 10'	clay and cobbles
10' - 30'	sand, gravel, and cobbles
30' - 90'	sand, gravel, cobbles, an boulders
90' - 120'	sand and gravel
120' - 140'	cemented sand and gravel
140' - 160'	conglomerate

water level - 95' (8-27-75)

Project: Hansen Hollow West Subdivision review, Salt Lake County.			Requesting Agency: Salt Lake County Planning Comm.
By: G.E. Christenson	Date: June 20, 1983	County: Salt Lake	Job No.: SD-5
USGS Quadrangle: Sugar House (1212)			

June 20, 1983

Jerold Barnes
Salt Lake County Planning Commission
2033 South State Street
Salt Lake City, Utah 84115

Dear Mr. Barnes:

We received your request for our comments on the Hansen Hollow West Subdivision and in response have reviewed the soil reports and performed a site reconnaissance. We can only respond to those issues dealing with earthquake risk and slope stability. Other concerns such as utility service and aesthetics are best addressed by others qualified in those fields.

From the information contained in the soils reports, it is difficult to determine the exact boundaries of the property. It is important to know the relationships between lot boundaries and topography before a detailed analysis can be done. On our site reconnaissance, cracks were found at the northern-most tip of the bluff on which the east parcel is located. The cracks indicate the potential instability of these slopes. In a generalized map of the area done in 1972 by Richard Van Horn (USGS Map I-766-E, Relative Slope Stability Map of the Sugar House Quadrangle, Salt Lake County, Utah), all of the slopes in this area are considered potentially unstable. Destruction of vegetation or introduction of water into the slopes may greatly reduce their stability and resistance to erosion.

It appears that most slope stability concerns, both under static and dynamic (earthquake ground shaking) loads, have been addressed in the report by Dames and Moore. We suggest strict adherence to their recommendation that "footings supporting the proposed residential structures fall below an imaginary line extending up from the toe of the slope at a slope of two horizontal to one vertical." Note, however, that their definition of the toe of the slope appears to be in error. They define it as the point where the slope is <u>steeper</u> than two horizontal to one vertical. It should have been defined as the point where the slope is <u>less (more gentle)</u> than two horizontal to one vertical. We would suggest preparation of a map showing where such a projection would intersect the 7-8 ft depth of standard basement foundations to ensure that sufficient area remains on lots planned for home construction. Also, dumping of material and disruption of vegetation on the slope should be avoided. All surface drainage should be directed away from the slope or, if necessary, piped or channeled in lined ditches down the slope and discharged well away from the base.

In terms of earthquake design for all buildings, whether near slopes or not, it is recommended by Bingham Engineering that "All structures must be designed to meet the minimum requirements of the Uniform Building Code for a zone 3 area." We further recommend that guidelines set forth by the Utah Seismic Safety Advisory Council (USSAC) be followed in which a zone 4 is identified which includes the subdivision area. Building in USSAC zone 4 does not require that UBC zone 4 design standards be met, but that design standards for UBC zone 3 be applied with more rigorous design review and inspection to assure complete compliance.

We hope this aids you in your decision regarding Hansen Hollow West Subdivision. If we can be of further assistance, please contact our office.

Sincerely yours,

Gary E. Christenson, Geologist
Site Investigation Section

GEC/co

Project: Investigation of geologic conditions at Summit Park Subdivision, Smithfield, Utah			Requesting Agency: Smithfield City Corporation
By: G.E. Christenson	Date: July 5, 1983	County: Cache	Job No.: SD-6
USGS Quadrangle: Smithfield (1469)			

July 5, 1983

Jim Gass
Public Works Director
Smithfield City Corporation
P.O. Box 96
Smithfield, UT 84335

Dear Jim:

This letter is in response to your request for geological background information and recommendations regarding the proposed Summit Park Subdivision (extension 3) in Smithfield. The principal question is whether or not to lift the present moratorium on building which was enacted because of concern that domestic wastewater disposal in soil absorption fields on the benchtop may adversely effect springs at the base of the slope to the north along Summit Creek. Note that conclusions drawn here confirm those previously presented in UGMS Report of Investigation No. 104 done in 1975 and subsequent correspondence for the Summit Park Subdivision.

The geology of the area is dominated by deposits of Pleistocene Lake Bonneville. The bench on which the Summit Park Subdivision is located is underlain by well-sorted, rounded, clean gravels deposited in a delta built by Summit and Birch Creeks as they flowed into Lake Bonneville when the lake was at a level of about 4800 feet above mean sea level. Prior to deposition of this delta, the lake was at a level roughly 400 feet higher. At this higher level, the mouths of Smithfield and Birch Canyons were arms of the lake with most of the gravels brought down from the mountains being deposited further up canyons or distributed along the mountain front by lake currents. Offshore, such as in the present Smithfield east bench area, finer-grained deeper lake deposits were accumulating on submerged slopes and on the lake bottom. These finer-grained lake bottom deposits of the older, higher lake are presently buried beneath the younger gravels of the east bench delta. It is probably these finer-grained deposits that form the impermeable layer on which the perched water table in the bench has developed.

The depth to water in the principal aquifer beneath the bench, which is fed in part by underflow from bedrock sources, is over 200 feet deep. The perched water table in gravels of the east bench is above this zone of principal bedrock underflow and may be largely isolated from underflow by the layer of fine-grained lake sediment. The chief source of ground water in the bench gravels is believed to be infiltration downward from the surface. Such infiltration occurs from mountain runoff, direct precipitation, irrigation, and septic tank effluent. Water recharged from these sources moves through the loose gravels of the bench and either is discharged in springs along

Summit Creek (Berg, Clark, and Taylor Springs), in the golf course spring, or enters shallow aquifers beneath Smithfield through subsurface flow along the west edge of the bench. Some evidence for this subsurface flow is found in wet sands at depths below 22 feet in a drill hole in the cemetary and in reports of shallow ground water in the cemetary and in the subdivision to the south.

The role of irrigation in recharge to the perched water table is shown by the gradual increase in discharge of both the Berg and Taylor springs when water was turned into the Logan, Hyde Park, and Smithfield Canal over the Memorial Day weekend. Flow in the Taylor Spring, which is closest to the canal, had nearly tripled (as of July 1) while flow in the Berg Spring has doubled in the same amount of time. It is expected that these higher discharges will be maintained or increase through the summer and then decrease when the irrigation season is over. A further indication that at least part of the source of water in the Berg and golf course springs is from local infiltration rather than underflow from bedrock sources is found in water quality analyses for these springs. Both nitrate and chloride concentrations are higher in these springs than in the mountain springs from bedrock aquifers which supply culinary water to Smithfield. The most likely sources of these elevated anion concentrations would be fertilized fields or lawns and/or septic tank effluent on the bench. Water quality analyses on the Berg and Taylor springs (samples taken June 14, 1983) show a continued increase in nitrate concentration in the Berg Spring (2.3-3.0 mg/l in 1979; 11.3 mg/l in 1983) but a very low concentration of nitrates (0.86 mg/l in 1983) in the Taylor Spring. This difference is probably due to the contribution of septic tank effluent from homes above the Berg Spring.

These lines of evidence are sufficiently convincing to indicate to me that water in the Summit Creek springs is principally derived from water applied on the bench. This could be conclusively shown with a tracer dye test. Such tests have been performed previously, but data are sketchy and in some cases contradictory with regard to the methods used and final results. Thus, I have not included conclusions drawn from these tests in this discussion.

The relative contributions of septic tank effluent and irrigation water in the degradation of spring water quality along Summit Creek is unknown, so the magnitude of the effect more septic tank systems may have cannot be determined. However, the high nitrate concentrations in the Berg Spring relative to the Taylor Spring indicate a significant effect, and it is likely that further development on the benchtop with homes utilizing septic tank soil absorption fields will result in further degradation in water quality through time. It is also likely that spring discharge will increase as water from septic tanks is added to the perched water table. Using a maximum septic tank loading rate of 400 gal/day for an average family of four, the six homes proposed for the Summit Park Subdivision north of the golf course will add about 2400 gal/day to the bench. Assuming no other changes in infiltration accompanying development and assuming that all of this water from septic tank systems is discharged along the Summit Creek springs to the north and none is lost to evapotranspiration, leakage through the lower layer, or to ground water flow in another direction, the probable maximum increase in discharge for the springs would be about 2 gallons per minute (gpm). This is about equal to the present discharge of the Berg Spring and would be spread over all the springs on the hillside. Present measured discharge in the Berg and Taylor springs is about 10 gpm, and an estimated total for the hillside including springs south of the Clark and Law properties would be 12-14 gpm. If 50 homes were constructed in the bench area, the increase in discharge needed to accommodate septic tank effluent would total about 14 gpm. This would be discharged through the golf course spring, the Summit Creek springs, and subsurface flow along the edges of the bench. In both cases, the only other additional water introduced into the subsurface due to development would be from watering of lawns. The amount of infiltration from this source cannot be calculated, but at least in the case of 50 homes on the bench would probably be more than offset by the decrease in infiltration due to paving and building with diversion of runnoff into storm sewers and replacement of irrigated farmland by homesites.

In order to evaluate the relative effects of large-scale bench development on individual springs, in particular to determine what part of the surface recharges the Summit Creek (Berg-Clark-Taylor) springs, a detailed study would be required. The principal requirement for this study would be drilling of numerous ground water monitoring wells on the benchtop to determine ground-water flow directions. It is thought that the northern part of the bench recharges the springs along Summit Creek, but the principal flow direction is to the southwest. The UGMS attempted to drill monitoring wells on the bench between Summit Creek and the golf course. Holes in the loose gravel caved in before casing could be emplaced to the depth required so these wells have not yielded the information needed. Such a problem will exist over much of the bench, so more sophisticated drilling equipment than we can provide will be required to install the wells needed for a detailed study. About 10-20 wells which would penetrate gravels into underlying less permeable beds at depths probable greater than 50 feet in most places would be required.

In terms of the effect higher ground-water tables may have on the stability of slopes around the bench, it can be said that the introduction of water into a slope generally reduces its stability through increases in pore pressure, effects of lubrication, and possible piping and removal of binding materials (silt, clay) by moving ground water. An increase in recharge to the benchtop may result in an increase in the water table and further saturation of slope materials which could reduce the stability of slopes, particularly if subjected to earthquake ground shaking. A slope failure has been reported on the Reid Law property north of the Taylor Spring. This failure occurred in an area where fine-grained soils constitute much of the slope with a relatively thin gravel cap, and failure appears to have occurred in the fine-grained materials. Vegetation is relatively sparce here, at least compared to that on slopes in the vicinity of the Summit Creek springs, and this may have contributed to the failure. According to long-time residents, the benchtop was previously covered by flood-irrigated fields. This would have introduced much more water into the subsurface than the present sprinkler irrigation of fields and lawns on the golf course, and it is likely that slopes around the bench have already been subjected to higher ground-water tables than at present. It is not known what role this may have played in the failure at the Reid Law property, but elsewhere slopes were apparently stable under these higher water-table conditions. It is suggested that the developer be required to submit a detailed slope stability analysis, considering both static and dynamic (earthquake) loading, for any proposed construction north of the road through the subdivision.

In summary, it is possible that development of the benchtop area by houses with septic tank soil absorption systems will result in a decrease in water quality and increase in discharge in springs around the bench. The extent of possible changes cannot be predicted at this time. An increase in water level beneath the bench may also decrease the stability of slopes along Summit Creek, although it would take a significant increase to effect the well-drained and well-vegetated slopes around the present springs. Due to the high percolation rate (tests run on four pits in 1975 ranged from 1.83 - 6.32 min/inch) and limited filtering capacity of gravels on the bench, they are not well suited for septic tank soil absorption systems. Installation of a sanitary sewer system to serve the bench area would alleviate all of these concerns, although setback of homes from steep slopes would still be advisable.

I hope this information helps you in your decision regarding the Summit Park moratorium. Contact me if I can be of further help.

Sincerely,

Gary E. Christenson. Geologist
Site Investigation Section

GEC/co

Project: Arlington Hills Plat "L" Subdivision site review, Salt Lake City, Utah.			Requesting Agency: Salt Lake Corp. Planning & Zoning Commission
By: G.E. Christenson	Date: Dec. 8, 1983	County: Salt Lake	Job No.: SD-7
USGS Quadrangle: Fort Douglas (1253)			

December 8, 1983

Douglas L. Wheelwright
Planner III/Current Planning
Salt Lake Corporation
Planning and Zoning Commission
414 City and County Building
Salt Lake City, UT 84111

Dear Mr. Wheelwright:

This letter is in response to your request of November 16, 1983, for our review of engineering plans by Bush and Gudgell, Inc. and the geotechnical report by Dames and Moore for the proposed Arlington Hills Plat "L" Subdivision. You asked that we review the engineering plans for the building site on lot 4 and for the design of roads and sewers according to our department's area of responsibility and the Site Development Ordinance. I should point out that the UGMS has no responsibilities or expertise in evaluating engineering specifications for compliance with site development ordinances, and thus cannot comment on these matters. The comments on the plans made by Dames and Moore which you submitted to us subsequently in your letter of December 5, 1983 should be heeded in this regard. Our review consists chiefly of an assessment of the accuracy and completeness of the engineering geologic sections of the geotechnical report by Dames and Moore. The scope of work for this review included a literature survey and brief site reconnaissance on November 22, 1983. The ground was covered with snow at the time of the site visit.

The report appears to be accurate and complete with respect to engineering geologic considerations and outlines the pricipal problems that may arise. Our principal comment is with regard to the decision to forego all laboratory soil testing. Although coarse-grained soils such as those at the site do not lend themselves to laboratory testing, we do feel that grain-size analyses should have been run to confirm field logs and demonstrate suitable gradation for use of natural soils as structural fill.

Several points brought out in the report that should be stressed are:

1. "Care should be taken in positioning the residential structures within lots located below alluvial fans to minimize any potential runoff problems," (p. 11). Structures should not be placed at the mouths of the gullies unless drainage waters are diverted or contained in some manner.

2. "The maximum particle size within natural site grading fill should generally not exceed four inches," (p. 14). Much of the

natural soil material at the site contains larger particles, and it will be necessary to remove them during site grading.

3. "Prior to commencement of major construction activities, all topsoil and deleterious materials, including nonengineered fill, should be stripped and removed from areas to be occupied by residential structures," (p. 12). Imported (nonengineered) fill simply dumped at the site is present (see Plate 2B, unit Fm-g) and must be removed or compacted prior to construction.

4. "As a minimum, criteria stated within the Uniform Building Code for a Zone 3 Area should be incorporated into the design of proposed structures," (p. 22). Possible traces of the Wasatch fault are mapped less than 1,000 feet east of the property in Spring Gulch, and the area is in Utah Seismic Safety Advisory Council (USSAC) seismic zone U-4. The USSAC recommends use of seismic design standards in Uniform Building Code zone 3 for their zone U-4, but with more rigorous monitoring and review to ensure compliance.

If recommendations made by Dames and Moore are followed, we do not anticipate any problems due to geotechincal conditions at this site. Feel free to contact our office if we can be of further asssitance.

Sincerely yours,

Gary E. Christenson, Geologist
Site Investigations Section

GEC/co

TERRAIN ANALYSIS

Project: Investigation of the Frank Nicholes-BLM property west of Cedar City, Utah.			Requesting Agency: Utah Division of State Lands and Forestry
By: G.E. Christenson	Date: Dec. 14, 1983	County: Iron	Job No.: TA-1
USGS Quadrangle: Desert Mound (240)			

December 14, 1983

Kevin S. Carter, Land Specialist
State Lands and Forestry
585 North Main
P.O. Box 761
Cedar City, Utah 84720

Dear Kevin:

This letter presents the results of an investigation of the Frank Nicholes-BLM property (N1/2, section 4, T. 37 S., R. 13 W., SLB & M) west of Cedar City (attachment 1). The State is attempting to acquire the property which is held in a combination of private (80 acres) and Federal (240 acres) ownership. The investigation consisted of a literature search and air photo analysis with a brief field reconnaissance performed on December 5, 1983. The purpose of the review was to identify any geologic hazards present on the property which may have a bearing on the use planned for the land. The state intends to lease the land for development of a residential subdivision.

The area is underlain principally by Cretaceous-age sedimentary rocks of the Iron Springs Formation (Bullock, 1970). This unit includes sandstone, siltstone, shale, conglomerate, and limestone. Bedding strikes roughly N.60°-70°E. and dips steeply to the southeast. The northeast-trending ridges which characterize the property (attachment 1) follow the strike of resistant beds. The prominent ridge in the northeast part of the area is underlain by fractured limestone, and ridges in the southeast are probably underlain by limestone, sandstone, or conglomerate. Valleys follow less-resistant shale and siltstone beds and are filled with Quaternary-age clayey to gravelly alluvium of unknown thickness. Rocks in the northwest corner of the area are mapped as either undifferentiated Tertiary-age volcanics, principally tuff (Bullock, 1970), or Claron Formation (Bjorklund and others, 1978). The Claron Formation consists chiefly of sandstone, limestone, and conglomerate.

In general, the land does not appear susceptible to any geologic hazards that would preclude its use for a residential subdivision. No evidence of slope instability was observed. Some lower slopes may be underlain by weathered shales and rockfall hazards exist locally below outcrops of resistant rocks (principally limestone). Prudent planning with respect to grading and placement of structures can avoid or mitigate these problems. No serious adverse soil conditions for foundations were observed, although test pits would be required to verify this. Clay soils at some localities will require special foundation engineering considerations.

No known active faults traverse the area (Anderson and Miller, 1979), although it is in Uniform Building Code seismic zone 2 (subject to moderate damage from earthquake shaking). A flood hazard exists in valley bottoms, but incision of streams into the alluvium has reduced the hazard area to a narrow strip along modern incised channels.

A potential problem may arise if septic tank and soil absorption systems are planned for disposal of liquid wastes at the proposed subdivision. Much of the area may be unsuitable for such systems because of steep slopes, possible shallow ground water and/or clayey soils, and exposed or shallow bedrock. The health department must issue permits for construction of septic tank systems, and permits can be withheld where conditions are deemed unsuitable. I suggest you contact William Dawson of the Southwestern Utah District Health Department in Cedar City for further information regarding this process. Many similar subdivisions in Utah have progressed to very late stages of development before discovering that site conditions were unsuitable for soil absorption systems and many lots already sold could not be occupied. This may result in litigation, and it would be unwise for the State to become involved in such a situation.

We hope this answers your questions and aids you in evaluating the proposed land acquisition. If we can be of further service, feel free to contact our office.

Sincerely,

Gary E. Christenson, Geologist
Site Investigations Section

GEC/co

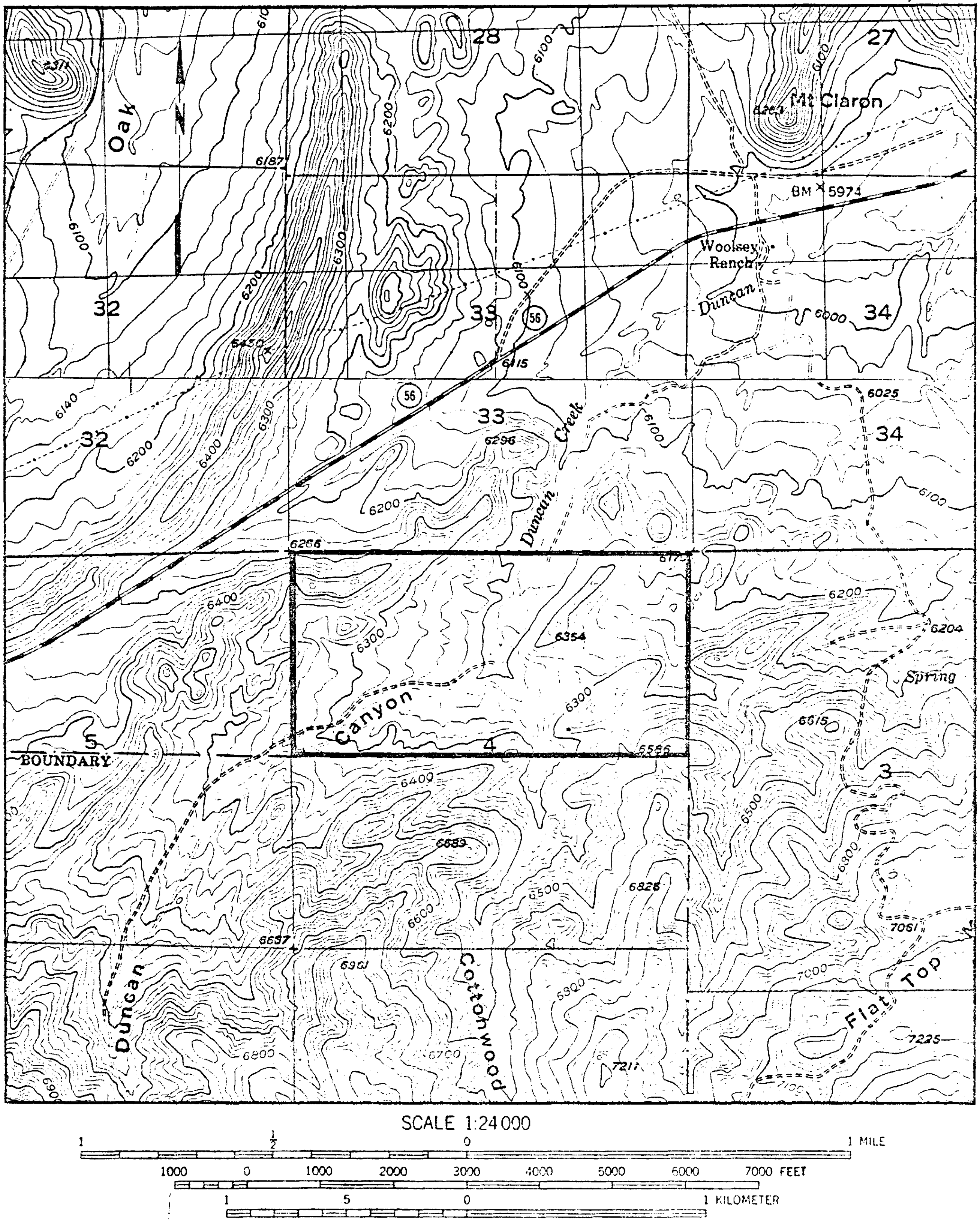
REFERENCES

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

Bjorklund, L.J., Sumsion, 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 60, 93 p.

Bullock, K.C., 1970 (updated 1976), Iron deposits of Utah: Utah Geological and Mineral Survey Bulletin 88, 102 p.

Base map from: USGS 7.5' Topo Quad
Desert Mound, Utah
Stoddard Mtn., Utah



CONTOUR INTERVAL 20 FEET

Location of Nicholes - BLM property

PUBLIC HEALTH

Culinary springs
Sanitary landfills
Wastewater disposal
Ground water
Geologic hazards

CULINARY SPRINGS

Project: Evaluation of two springs supplying culinary water to the unincorporated community of Center Creek, Utah			Requesting Agency: Wasatch County Health Department
By: W.R. Lund	Date: April 15, 1983	County: Wasatch	Job No.: SP-1
USGS Quadrangle: Francis (1167)			

April 15, 1983

Mr. Phil Wright
Wasatch County Health Department
Heber City, UT 84302

Dear Mr. Wright:

This letter is in response to your request for assistance in evaluating the geologic and hydrologic setting of two springs supplying culinary water to the unincorporated community of Center Creek, Utah. The investigation included a review of available geologic, hydrologic, and soils literature for the area; interviews with representatives from the Center Creek Water Company, the USDA Soil Conservation Service (SCS), and the Utah State Health Department; and a field reconnaissance of the springs on April 5, 1983. No test pits or other subsurface investigations were performed during the study.

The springs are two of several that discharge from a seep area on the west side of Center Creek in the NW1/4 of sec. 24, T. 4 S., R. 5 E., SLB&M (attachment 1). The flow from the springs has never been accurately metered, but the water company holds a right to 0.125 second feet (approximately 56 gallons per minute) of water. Reports concerning fluctuations in discharge vary; the water company indicates no noticeable change in discharge with the seasons, but SCS personnel report definite fluctuations between wet and dry times of the year. A third undeveloped spring, located about 250 feet south of those supplying water to the community, was observed during the field reconnaissance to be flowing at a rate of 3 to 5 gallons per minute.

The springs discharge from unconsolidated alluvial and colluvial deposits in the flood plain of Center Creek. The thickness of these deposits is not known, but bedrock does not crop out in the vicinity of the springs. Baker (1976) has mapped the area as underlain by the Keetley Volcanics, a thick sequence of rhyodacite to andesite tuffs and rubble breccia (air fall deposits). The volcanics extend from about a 1/4 mile south and west of the springs to the Heber Valley (attachment 2). The Keetley Volcanics unconformably overlie the Wallsburg Ridge Member of the Oquirrh Formation, a fine-to medium-grained quartzite with some interbedded sandstone and limestone. The Oquirrh Formation crops out at higher elevations on the ridge above the springs where it strikes to the northwest and dips 15 to 25 degrees to the northeast. The Charleston thrust fault is the closest mapped fault to the spring area. It is located approximately 1-1/4 miles north of the springs, trends roughly east-west, and dips about 20 degrees to the south (Baker, 1976). Depth to the fault plane beneath the springs is estimated by Baker to be 1500 to 2000 feet.

Mapping by the USDA Soil Conservation Service shows that the soils in the flood plain along Center Creek contain a high percentage of silt-and clay-size material (75 to 95 percent), and possess poor drainage characteristics. Soils mapped on the mountain slopes above the springs have some clay fines, but consist mainly of gravel, cobble, and boulder-size material. Depth to bedrock is 12 inches or less beneath many mountain slopes. The seep area containing the two springs is located along the contact between the relatively permeable, coarse-grained mountain soils and the relatively impermeable, fine-grained valley soils (attachment 3).

Little hydrologic data is available for the Center Creek area. Two wells drilled in section 24 are on file with the Utah Division of Water Rights. Both wells are located in the flood plain of Center Creek and encountered water at relatively shallow depths (3 and 16 feet, respectively). The wells are drawing water from saturated stream sediments and are not considered indicative of the hydrologic system. Infiltration of snowmelt and precipitation into the coarse-grained soils in the mountain watershed above the springs is believed to be the principle recharge mechanism. The water then moves down slope until it encounters the less permeable, fine-grained valley soils and is directed back to the ground surface. A strong seasonal fluctuation in discharge or a significant change in flow between wet and dry years would be indicative of a shallow hydrologic system. However, the absence of any long-term monitoring of flow rates, and conflicting reports concerning seasonal fluctuations makes this avenue of investigation inconclusive. Recharge from the unlined irrigation ditch, some of which may actually reach the springs as overland flow, is also a possibility during the summer months.

Shallow-source springs are by their nature more susceptible to contamination than those supplied from a deep aquifer system. It is our understanding that samples taken from the Center Creek water system have shown high bacteria counts, but because the only accessible sampling points are the water taps served by the system, the source of the bacteria (springs, water lines, storage reservoir) has not been determined. Possible sources of contamination which may affect the springs include the large number of sheep (several hundred head) pastured each year in the field where the springs surface, flooding of the spring collection areas by overland irrigation flow, and near-source recharge to the springs by infiltration of irrigation water used to flood irrigate the field in which the springs are located. In addition, the protection mound for the southernmost spring is constructed in a manner that allows water to pond directly over the spring collection point, and the northern spring sits in a gentle swale that directs surface runoff directly to the spring area.

It is hoped that the information provided in this letter will assist you in your evaluation of the two springs. If you have any questions or if we may be of further assistance, please do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigation Section

WRL/ay

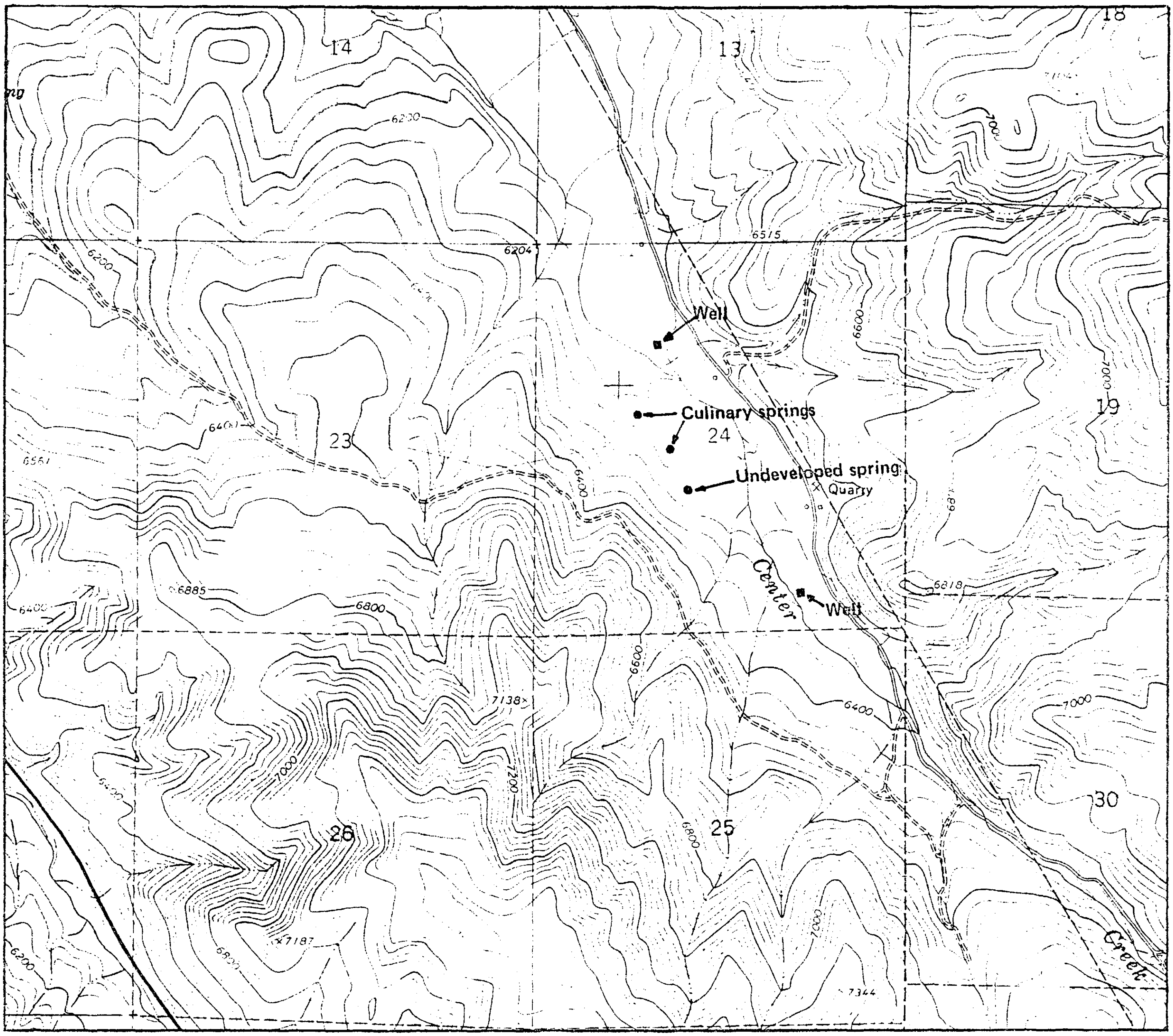
Selected References

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

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

Woodward, L., Jensen, E. H., and Harvey, J. L., 1976, Soil survey of the Heber Valley area Utah, parts of Wasatch and Utah counties: United States Department of Agriculture Soil Conservation Service and Forest Service.

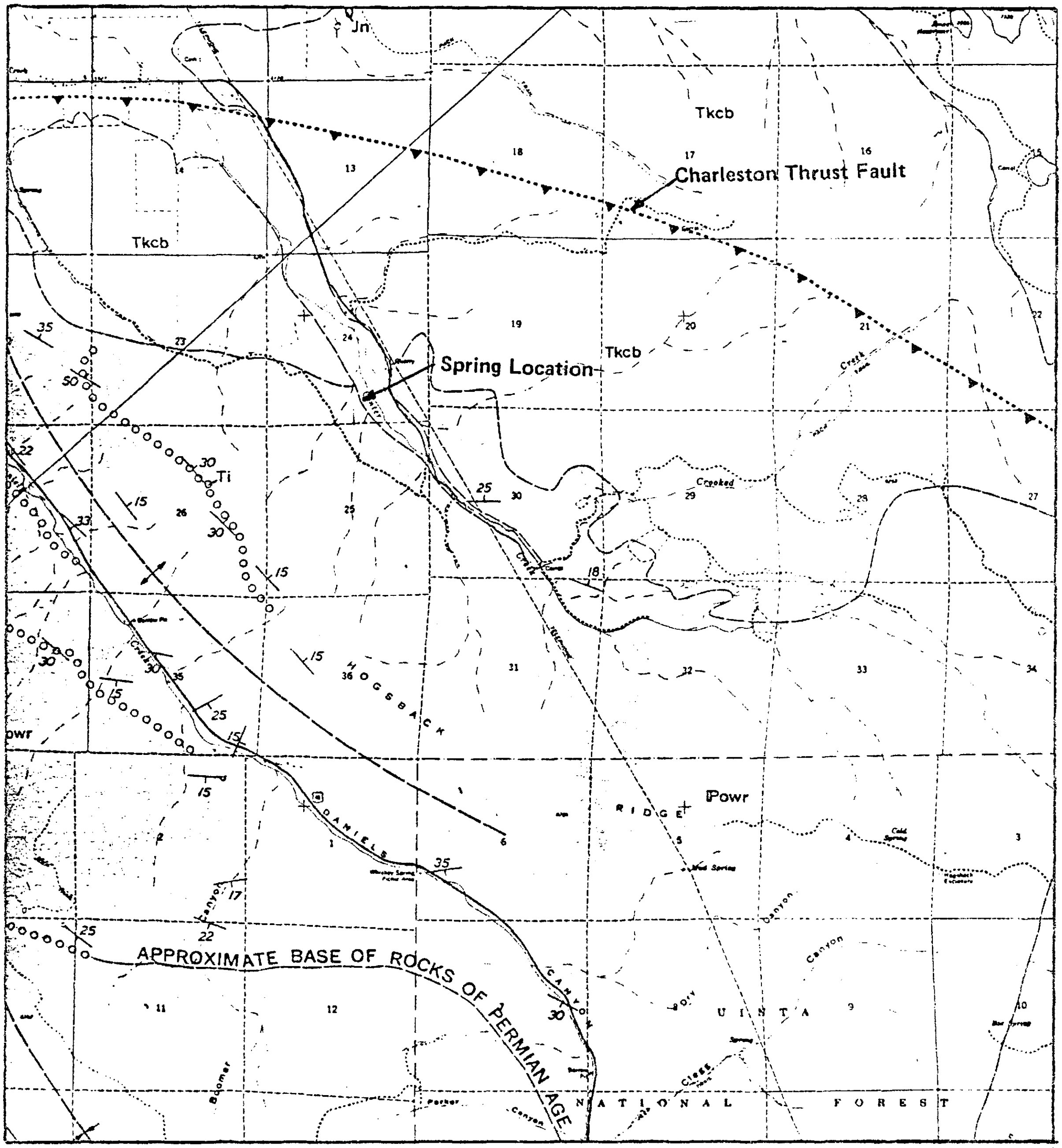
Attachment No. 1, letter of 4/15/83 to Wasatch County Health Department



General location map showing Center Creek drainage and springs. Scale 1:24,000

Topographic Base: U.S. Geological
Survey Center Creek, Utah
7-1/2' quadrangle map

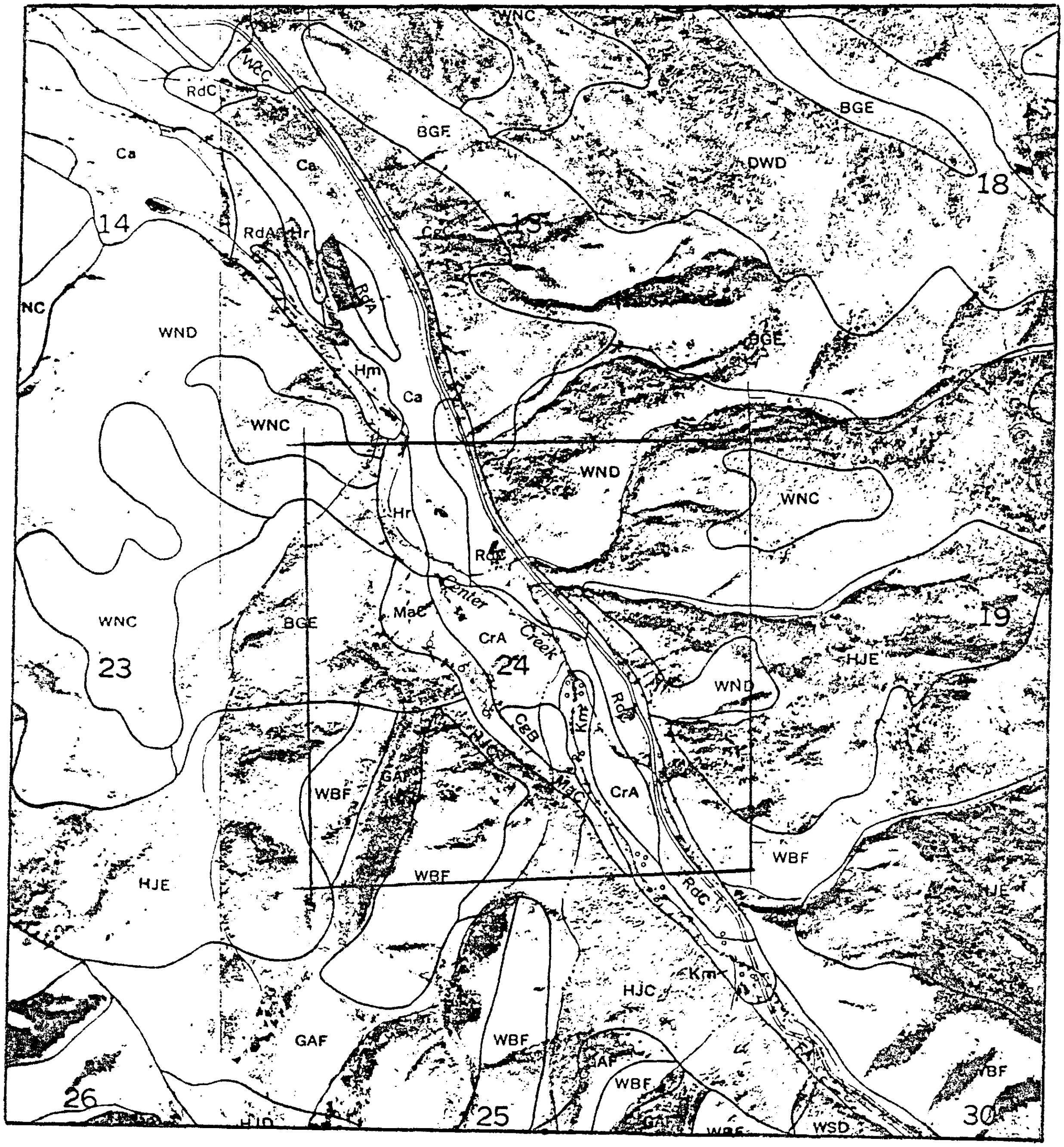
Attachment No. 2, letter of 4/15/83 to Wasatch County Health Department



Geologic map (after Baker, 1976). Scale 1:63,360

Explanation

Tkcb	Keetley Volcanics
Ti	Limestone Marker
Powr	Wallsburg Ridge Member, Oquirrh Formation
	Contact, dashed where approximate
15	Strike and dip
	Thrust fault
	Anticline



Soils map (after USDA Soil Conservation Service, 1976). Scale 1:24,000

Explanation

BGE WBF GAF HJC	Relatively coarse-grained mountain soils
MaC CrA	Clay and silt valley soils

Project: Investigation of Camp Kiesel Boy Scout camp culinary spring, Weber County.			Requesting Agency: Utah State Department of Health
By: H.E. Gill	Date: Nov. 28, 1983	County: Weber	Job No.: SP-2
USGS Quadrangle: Causey Dam (1367)			

November 28, 1983

Tim Pine
Bureau of Public Water Supplies
Division of Environmental Health
150 West North Temple
Salt Lake City, UT 84103

Dear Mr. Pine:

This letter presents the results of a hydrogeologic inspection performed on November 9, 1983, of the spring presently supplying culinary water to Camp Kiesel Boy Scout camp. The purpose of the inspection was to determine the source of the spring and to assess the potential for pollution from a proposed nearby sewer line.

The spring is in Dry Bread Hollow approximately 1500 feet north of Causey Reservoir (attachment 1). Camp Kiesel is located at the mouth of the hollow. Causey Spring, which discharges approximately seven million gallons of water per day, is about 4000 feet upstream (north) from the spring. The spring is at the base of a cliff on the west side of the canyon. The creek, which receives most of its flow from Causey Spring, runs along the east side of the canyon approximately 10 to 15 feet from the spring and at about the same elevation. The spring was originally developed by constructing a concrete collection box at the base of the cliff. To increase the spring flow, a trench (approximately 15 to 20 feet long) was excavated in alluvium at the base of the cliff and six-inch diameter perforated PVC pipe was installed to serve as a collector system.

Bedrock in the vicinity of the spring is the Lodgepole Limestone, a dark gray, medium-bedded, fossiliferous limestone which crops out on both sides of the creek. Bedding planes are well developed and strike N. 57° to 70° E.; the bedding dips to the northwest from 22 to 43 degrees. The spring is located on the west limb of the Causey Dam anticline, explaining the moderate to steep dip of the bedding. Examination of the outcrops showed only minor fracturing, all healed by secondary calcium carbonate. Travertine deposited by Causey Spring has accummulated on the canyon floor for a considerable distance along the stream channel (attachment 1). The travertine locally obtains a thickness of 60 feet, and thins to the south (downstream) toward the spring. Mapping by Mullens (1969) shows the spring located at the downstream end of the travertine deposit, although additional thin layers of travertine were observed below the spring during this reconnaissance.

The travertine is very porous and, along with the thin layer of coarse alluvium that covers it, acts as an aquifer. Water enters the travertine both from Causey Spring and from infiltration along the creek. As the travertine thins to the south, it can no longer transport the same volume of water and the excess is forced to the surface at the spring. It is possible that most, if not all, of the water issuing along the cliff face, although originally from Causey Spring, is infiltration from the creek. A comparison of chemical analyses from the two springs and the creek and a dye test could be used to help verify the source of the water.

The Lodgepole Limestone also acts as an aquifer in the area. Ground water is readily transmitted along bedding planes and through solution channels. However, there is no evidence that the aquifer is discharging water at the Dry Bread Hollow spring site.

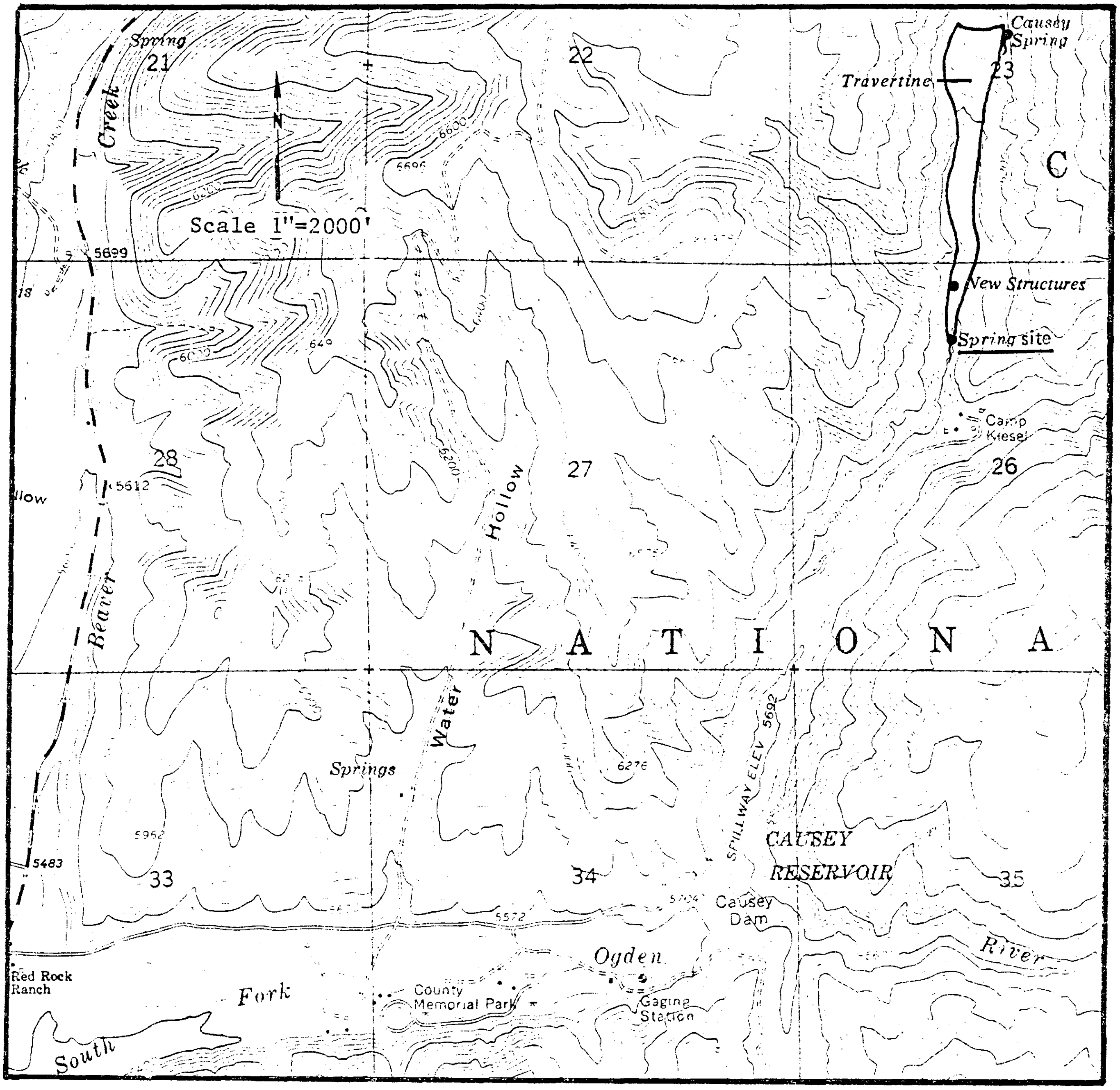
Additional camp facilities are being built in the canyon approximately 700 feet above the spring. Because the structures are within the 1500-foot spring protection zone required by the State Health Department, septic tank drain fields probably will not be allowed. Therefore, a sewer line running down the east side of the canyon is being considered. Based on the geologic conditions observed during the reconnaissance, it is apparent that any leakage from the proposed sewer line occurring upstream from the spring would infiltrate into the alluvium/travertine aquifer and eventually reach the spring.

I hope this answers any questions you may have. Feel free to contact me or our office if we can be of any further assistance.

Sincerely,

Harold E. Gill
Geologist, Site Investigations

hg
cc: Richard K. Schwartz
Chief Sanitarian, Weber-Morgan Counties



General Location Map
Camp Kiesel Culinary Spring

Project: Investigation of Tremonton and North Logan springs, Box Elder and Cache Counties.			Requesting Agency: Utah State Department of Health
By: G.E. Christenson	Date: Nov. 29, 1983	County: Box Elder and Cache	Job No.: SP-3
USGS Quadrangle: Honeyville (1446), Mt. Elmer (1468)			

November 29, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Investigation of Tremonton and North Logan springs, northern Utah

BACKGROUND

In response to a request from Tim Pine, Utah State Department of Health, an investigation was made on October 25, 1983, of two springs being developed for culinary water supplies in northern Utah. One spring is in Box Elder County east of Deweyville at the mouth of South Maple Canyon (section 4, T. 11 N., R. 2 W.; attachment 1) and will supply water to Tremonton. The other spring (termed the upper North Logan spring) is in Cache County in Water Canyon east of Hyde Park (section 4, T. 12 N., R. 2 E.; attachment 2). The housing for this spring was destroyed by a flood in August, and the spring area is being redeveloped by North Logan for its water supply. The purpose of the investigation was to make an evaluation of the recharge and discharge areas of these springs and assess the potential for contamination and reliability of flow. Coliform bacteria have been found at the Tremonton spring.

TREMONTON SPRING

Geology

The Tremonton spring is on the west flank of the Wellsville Mountains and discharges from an alluvial-fan deposit at the mouth of South Maple Creek. Rocks in the South Maple Creek drainage basin and throughout most of the probable spring recharge area consist principally of limestone, quartzite, and sandstone of the Pennsylvanian-age Oquirrh Formation (Beus, 1958). The regional bedding dip is steep to the northeast and the rocks are highly fractured. Along the base of Chocolate Peak in the vicinity of the spring (attachment 1), the Mississippian-age Great Blue limestone (which underlies the Oquirrh Formation) is exposed. North of the spring and elsewhere along the mountain front are outcrops of late Tertiary-age conglomerate of the Salt Lake Formation (C.G. Oviatt, oral commun., October 25, 1983). Details of stratigraphic and structural relationships between these units are not known and are complicated by their location along the Wasatch fault zone. The bedrock geology in the vicinity of the spring is obscured because much of the mountain front is buried beneath Quaternary-age deposits of Lake Bonneville (10,000 - 20,000 years old).

The spring discharges from a gravelly alluvial-fan deposit on a bench at about elevation 4800 feet. This bench represents a shoreline elevation, termed the Provo level, which was occupied by Pleistocene Lake Bonneville from 13,500 to 14,300 years ago (Currey and others, 1983). The alluvial fan deposit is thus less than 13,500 years old. Garland Spring to the south and the old Tremonton spring (Willow Spring) to the north (attachment 1) both discharge from the same bench but in areas where it has not been covered by alluvial-fan deposits. Several other benches occur in the area at elevations up to 5200 feet, and represent other shoreline positions of Lake Bonneville. Most of the deposits on these benches are gravelly.

Woodward-Lundgren and Associates (1974) map numerous possible traces of the Wasatch fault zone trending north-south through the spring area. The parallelism of the possible fault traces with the Lake Bonneville shoreline benches makes it difficult to delineate scarps of definite fault origin. However, the presence of a fault zone here is indicated by the complex geologic structure, steep mountain front, presence of springs, highly fractured bedrock, and position along the mapped trend of the Wasatch fault zone.

Hydrology

The spring now being developed was encountered recently in excavations by gold prospectors into the alluvial-fan deposits of South Maple Creek. South Maple Creek is an intermittant stream that was dry at the time of this investigation. Air photos taken in 1966 and 1974 show no trees, dense vegetation, or evidence of surface flow from the spring, and it is believed that flow previously must have been in the subsurface to recharge springs at lower elevations or to recharge the principal basin-fill aquifer in the lower Bear River drainage. Reports by the Tremonton city engineer in charge of developing the spring indicate that water was flowing along a sand and gravel layer about 2 feet thick above an impermeable "hardpan" about 6 feet below the surface. Flow in the spring at the time of this investigation was estimated to be 1500 gallons per minute (gpm). Flow in the old Tremonton spring has been reported at 45 gpm and Garland Spring at 100 gpm, although the date of measurement is not known (Bjorklund and McGreevy, 1973). Flow is probably higher than normal this year, but if the estimate of flow in the new spring is correct, it is substantially larger than neighboring springs. From local reports, all springs maintain flow year-round with no periods of turbidity, even during spring runoff. Chemical analyses of water in all springs indicate low total dissolved solids concentrations ranging from 180-240 mg/l. Anion concentrations are generally similar and all waters are of the bicarbonate-chloride-sulfate type (Back, 1961). Cation concentrations show the new spring to be higher in potassium and sodium and lower in calcium than the other springs. Although water quality is generally similar, firm conclusions about the source of the water cannot be made from these data. The chemical quality of water may vary both seasonally and annually, and the water analyses used in this report were taken at different times of different years (new Tremonton spring, 9/1/83; old Tremonton spring, 7/28/82; Garland Spring, 4/21/81).

From the geologic evidence, it is believed that all three of these springs probably tap the same aquifer. This aquifer consists principally of the Oquirrh Formation which occurs at higher elevations in the Wellsville

Mountains east of the springs. Permeability in this formation is chiefly due to fractures and solution openings (Bjorklund and McGreevy, 1974); bedding probably plays only a minor role in directing ground-water flow. Although the new Tremonton spring occurs at the mouth of South Maple Canyon, it is not believed that underflow through the alluvium in the canyon is a significant source of recharge to the spring. This alluvium is very thin and locally absent, i.e. bedrock is exposed in the channel, and recharge to the spring from the channel probably only occurs during periods of surface flow.

Localization of the new Tremonton, old Tremonton, and Garland springs as well as several other springs along linear trends at the mountain front is probably related to the presence of the Wasatch fault zone. Water may be directed to the surface along the fault zone either by: 1) interception of underflow along more permeable, highly fractured rocks in the zone providing a conduit to the surface, or 2) the presence of less permeable materials west of or within the zone which preclude underflow, causing water to build up and discharge at the surface.

Conclusions and Recommendations

To make more meaningful use of water quality data to determine whether these springs have a similar source area and discharge from the same aquifer, we recommend sampling of all three springs at the same time. Samples should be analyzed for sodium, calcium, potassium, magnesium, bicarbonate, carbonate, chloride, and sulfate. Pending these water quality analyses, the preliminary evidence indicates a similar source of water for the three springs in the area. It is probable that the new spring will provide a discharge as reliable as that of adjacent springs, although actual quantities of water are unknown. Chemical quality of water will also be similar except perhaps during runoff periods. Coliform bacteria presently found in the water of the new Tremonton spring are probably caused by construction activity at the site releasing soil coliforms into the water. However, the presence of the new spring at the mouth of South Maple Canyon makes it probable that water infiltrating into the alluvial-fan gravel during periods of flow (e.g. spring snowmelt or summer cloudburst floods) in South Maple Creek will discharge at the spring. Because of this, it would be advisable to monitor water quality in the spring during and shortly after periods of surface flow in South Maple Creek. Also, development of this spring has intercepted flow which was previously in the subsurface and it is possible that some recharge to springs downslope (e.g. Jensen Spring, attachment 1) has been tapped and flow there may be reduced as a result.

UPPER NORTH LOGAN SPRING

Geology and Hydrology

The springs being developed by North Logan are in Water Canyon, a tributary to Green Canyon in the Bear River Range east of Logan. Rocks in Water Canyon consist of the Silurian-age Laketown Dolomite and the overlying Devonian-age Water Canyon Formation (Williams, 1948). The area is on the west flank of a generally north-trending syncline. Bedding strikes approximately N. 20° E. and dips 35° E. and is generally consistent in attitude throughout the area. Water Canyon trends northeasterly along the strike of the beds and approximately follows the contact between the Laketown Dolomite and the Water Canyon Formation. Both units are predominantly dolomite (Williams, 1948). Thin, discontinuous alluvial sand and gravel deposits are found in the bottom of Water Canyon, with rock exposed locally along the stream channel.

Fracturing in bedrock units is variable, but locally fractures are closely spaced and open. Permeability is chiefly along these fractures and solution channels in the dolomite (Bjorklund and McGreevy, 1971). This bedrock aquifer in Water Canyon is recharged principally from rainfall and snowmelt at higher elevations which percolates into the fractured rock. Discharge in springs occurs when the canyon intersects major fractures carrying water in the bedrock aquifer. In a reconnaissance of springs upstream, it was found that most springs discharge from bedrock fractures on the west (updip) side of the canyon. This may indicate that some flow is being directed downdip along bedding planes and discharged where intercepted by the canyon.

Springs are present in Water Canyon for about one mile upstream from the upper North Logan spring, and flow is reportedly maintained in this area year-round by these springs. In the fall during dry years, flow above the upper North Logan spring is primarily in the subsurface through permeable alluvium in the channel bottom. During these times, water comes to the surface only where a bedrock ledge or other impermeable barrier crosses the channel. Evidence for this type of underflow through channel sands and gravels was apparent during this investigation. While the zone of springs above the upper North Logan spring is primarily a discharge area, it is probable that some of the water that is present year-round in the channel infiltrates back into the bedrock aquifer. At the upper North Logan spring, Water Canyon makes an abrupt bend above the spring (attachment 2) such that surface water infiltrating just upstream may flow directly through bedrock fractures and reappear at the spring. It is probable that a certain percentage of discharge at all springs in Water Canyon (except the uppermost one) is from infiltration of surface water in the channel a short distance upstream. The quantity of water at any given spring which has at some point flowed at the surface and reinfiltrated is unknown, but is probably not great.

Conclusions

Past usage of the upper North Logan Spring has shown it to be a reliable source of high quality culinary water. However, the potential for contamination of water in the spring through contact with the surface is present and has probably always been present as long as flow has occurred in the channel upstream. Tracer dye tests would be required to confirm this and to estimate the percentage of water at the spring which has infiltrated from surface flow upstream. Water flowing through the permeable channel gravels or through bedrock fractures receives little treatment to remove contaminants. If water were contaminated during surface flow, it may not receive sufficient treatment during underground flow before being discharged at a lower spring.

These problems with surface contamination could be reduced by either lining the channel between the upper North Logan spring and springs higher in the canyon, or by developing these higher springs as well. In the latter case, however, contamination may still occur during surface runoff periods.

GEC/co

REFERENCES

Back, W., 1961, Techniques for mapping of hydrochemical facies: U.S. Geological Survey Professional Paper 424-D, p. D380-D382.

Beus, S. S., 1958, Geology of the northern part of Wellsville Mountain, northern Wasatch Range, Utah: unpublished Utah State University M.S. thesis, 84 p.

Bjorklund, L. J., and McGreevy, L. S., 1971, Ground-water resources of Cache Valley, Utah and Idaho: Utah Department of Natural Resources Technical Publication 36, 72 p.

_ _ _ _ _ _ 1973, Selected hydrologic data, lower Bear River drainage basin, Box Elder County, Utah: Utah Basic-Data Release 23, 22 p.

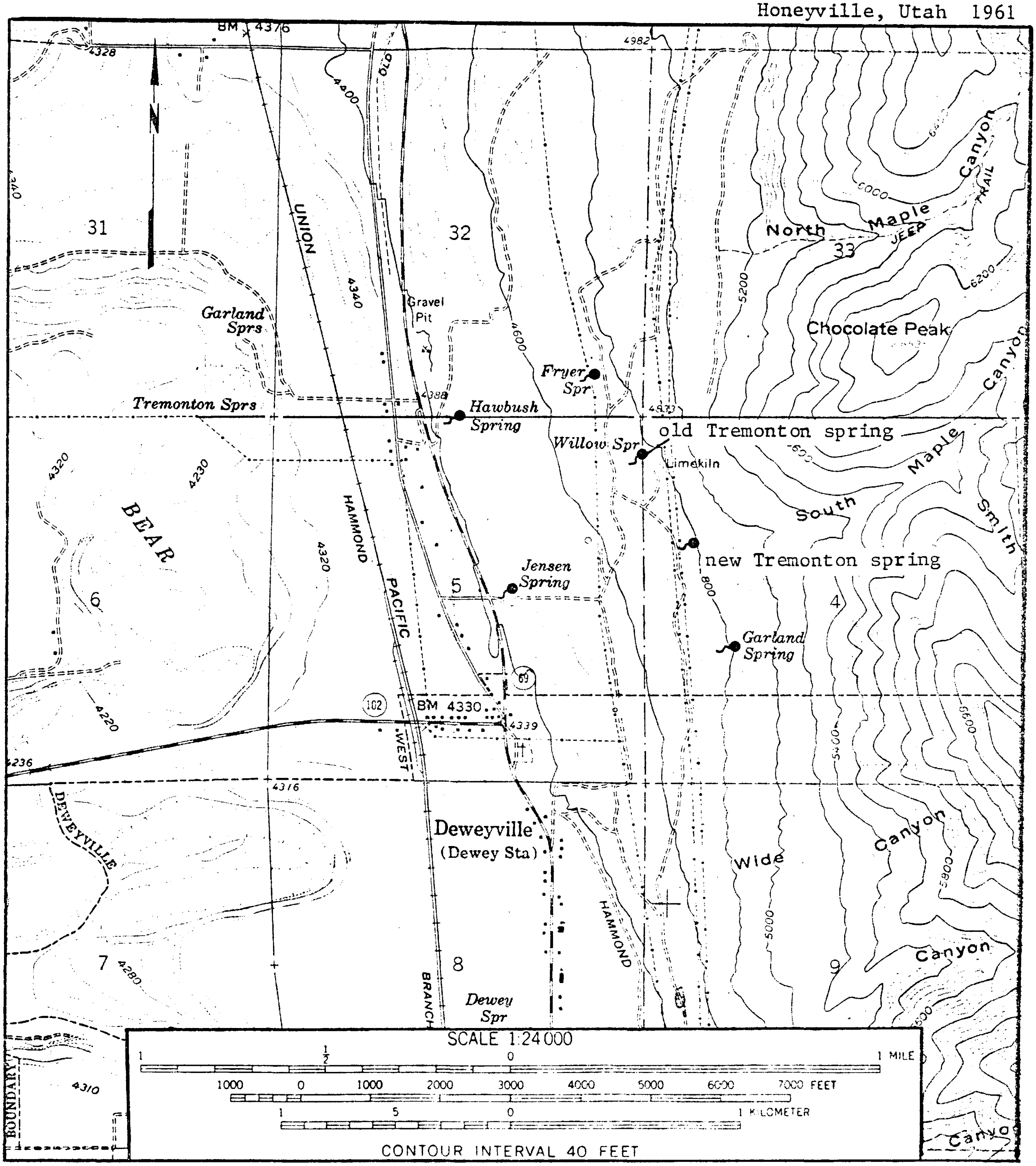
_ _ _ _ _ _ 1974, Ground-water resources of the lower Bear River drainage basin, Box Elder County, Utah: Utah Department of Natural Resources Technical Publication 44, 65 p.

Currey, D. R., Oviatt, C. G., and Plyler, G. B., 1983, Stansbury shorelines and Bonneville lacustral cycle: Geological Society of America Abstracts with Programs, v. 15, p. 301.

Williams, J. S., 1948, Geology of the Paleozoic rocks, Logan quadrangle, Utah: Geological Society of America Bulletin, v. 59, p. 1121-1164.

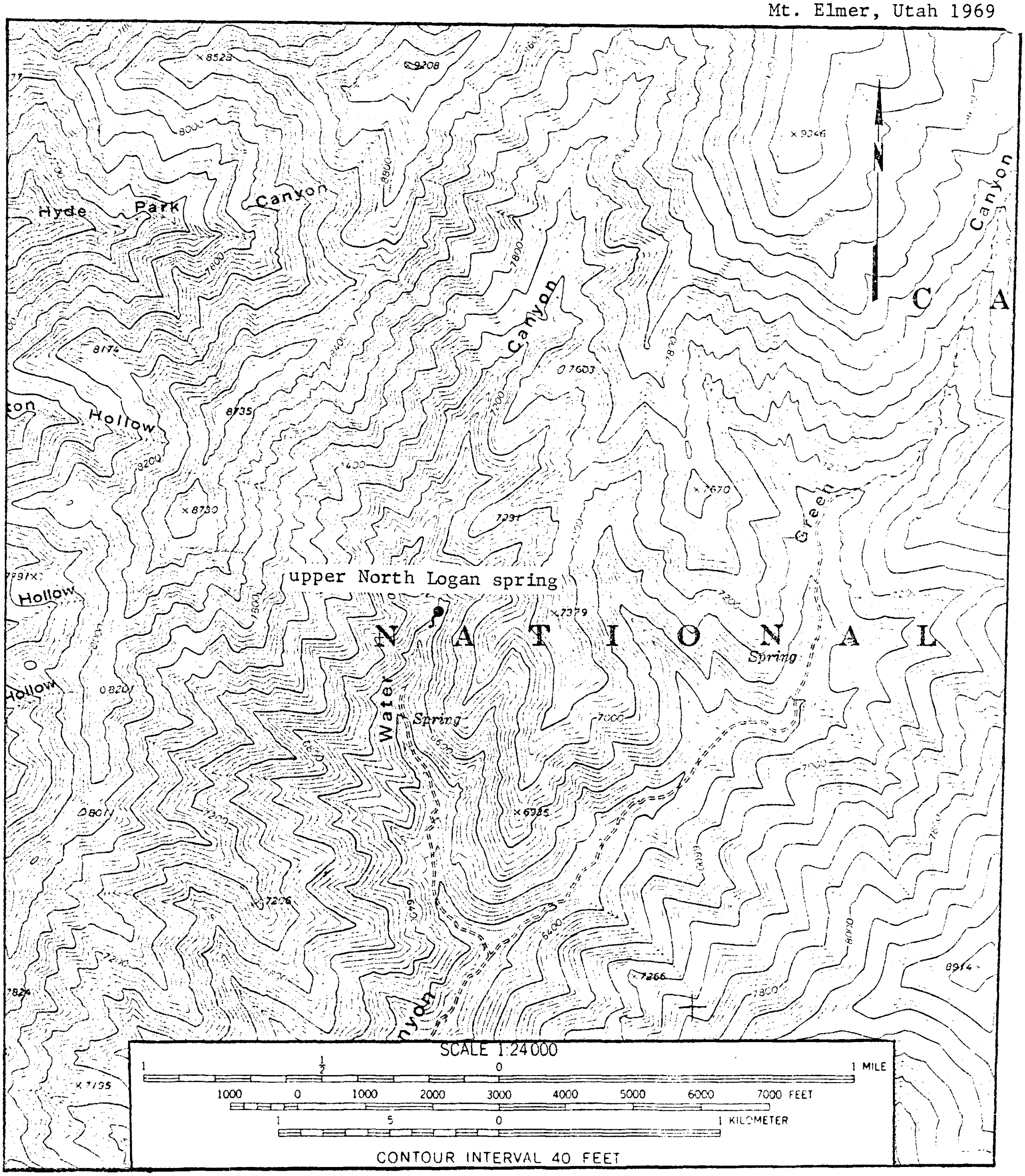
Woodward-Lundgren and Associates, 1974, Investigation and evaluation of the northern Wasatch and Cache Valley faults: consultants report for the Utah Geological and Mineral Survey, 147 p.

Base map from: USGS 7½' Topo Quad
Honeyville, Utah 1961



Location of new Tremonton spring, Box Elder County

Base map from: USGS 7½' Topo Quad
Mt. Elmer, Utah 1969



Location of upper North Logan spring, Cache County

SANITARY LANDFILL

Project: Investigation of a proposed sanitary landfill site, Washington County.			Requesting Agency: Southwestern Utah District Health Department.
By: W.R. Lund	Date: May 12, 1983	County: Washington	Job No.: LF-1
USGS Quadrangle: Enterprise (202)			

May 12, 1983

William K. Dawson, R.S.
Chief Environmental Health Specialist
Southwestern Utah District Health Department
P.O. Box 643
Cedar City, UT 84720

Dear Mr. Dawson:

This letter presents the results of a geologic investigation conducted at a site proposed by Enterprise City for the location of a sanitary landfill. The investigation included a review of existing geologic, hydrologic, and soil information for the area, and a field reconnaissance during which two soil test pits were examined.

The proposed landfill is located approximately 3-1/2 miles northeast of Enterprise, and encompasses 10 acres in the W1/2 E1/2 SE1/4 SE1/4 sec. 4, T. 37 S., R. 16 W, SLB&M (attachment 1). The site lies on a gently sloping (2 to 4 degrees) piedmont surface at the north end of the Bull Valley Mountains. Drainage is to the north by means of sheet flow and a few small ephemeral stream channels. A large intermittent stream emerges from Holt Canyon about 1/2 mile east of the site (attachment 1). Vegetation on the property is sparse to moderate and consists of sagebrush, range grass, and a few juniper. Average annual precipitation at the site is about 12 inches, average yearly pan evaporation is estimated at approximately 78 inches (Mower and Sandberg, 1982). Access from Enterprise is provided by State Highway 18 and a combination of hard surfaced and unimproved dirt roads (attachment 1).

Bedrock does not crop out on the proposed site. The Tertiary-age Muddy Creek Formation, a loosely consolidated sequence of silt, sand, nonwelded tuff, and volcanic agglomerate, is exposed less than a mile south of the site at the base of the Bull Valley Mountains (Stokes, 1963). Further to the south, Quaternary basalts and Tertiary ignimbrites crop out at higher elevations. The volcanic rocks in the mountains are highly faulted, but no known faults pass within 1-1/2 miles of the site.

The soils at the site have been mapped by the USDA Soil Conservation Service (SCS) as Dixie gravelly loam (Ulrich and others, 1960). Mechanical analyses performed by the SCS indicate that this soil can range from 4 to 60 percent gravel and may contain more than 50 percent silt and clay. This variability was confirmed during the logging of the two test pits excavated at the site (attachment 1). The soils exposed in test pit 1 were gravelly silty sand and silty sand containing from 5 to 40 percent gravel and small cobbles. Test pit 2 soils were gravelly silty sand-clayey sand and silty sand with up to 30 percent slightly plastic fines. Detailed soil logs prepared according to the Unified Soil Classification System are included as attachment 2. No difficulty was experienced in excavating the soils to a depth of 8.0 feet with a small tractor-mounted backhoe. A slightly indurated caliche horizon was observed in both test pits, but the stage of development was not sufficient to cause excavation or soil workability problems.

Depth to ground water in wells located in the site vicinity (2-mile radius) is greater than 150 feet. The Beryl-Enterprise area is one of recognized ground-water mining and declining water levels. It is possible that the depth to water recorded on well logs filed with the State Division of Water Rights may have increased significantly since the wells were drilled in the 1960's and 70's. Mower and Sandburg (1982) show the direction of ground-water flow in the site vicinity to be toward the north-northeast. They also identify five principal sources of recharge to the ground-water reservoir in the Beryl-Enterprise area: 1) subsurface inflow from outside the area, 2) subsurface inflow from bedrock in the mountains, 3) infiltration from stream channels, 4) infiltration from farms, and 5) precipitation on the valley floor. Because of its location, only recharge from direct precipitation is a factor at the proposed landfill. Average annual precipitation in the site vicinity is genrally less than the optimal annual requirement for cultivated crops and most natural plants. Therefore, Mower and Sandberg discount the importance of direct precipitation as a source of ground-water recharge except during exceptional storm events when infiltration from intermittent streams may take on some importance. No significant intermittent stream drainages cross the proposed site.

Based upon the results of this investigation, it is concluded that from a geologic standpoint the site selected by Enterprise City for a sanitary landfill is well suited for that purpose. Depth to bedrock is greater than 8 feet and probably much greater than that. The soil is sandy and easily worked under all weather conditions but contains sufficient fines to allow good compaction when used as cover material. Depth to ground water is greater than 150 feet and recharge to the ground-water reservoir from the site area is not significant. Flood hazard is very low and surface drainage can be easily controlled with low dikes and diversion ditches. Leachate production is considered unlikely since evapotranspiration of the site is expected to exceed precipitation by a considerable margin.

It is hoped that the information provided in this letter will assist you in evaluating the proposed sanitary landfill. If you have any questions or if we may be of further assistance, please do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigations Section

WRL/ay
cc: Dale Parker, Bureau of Solid & Hazardous Waste

SELECTED REFERENCES

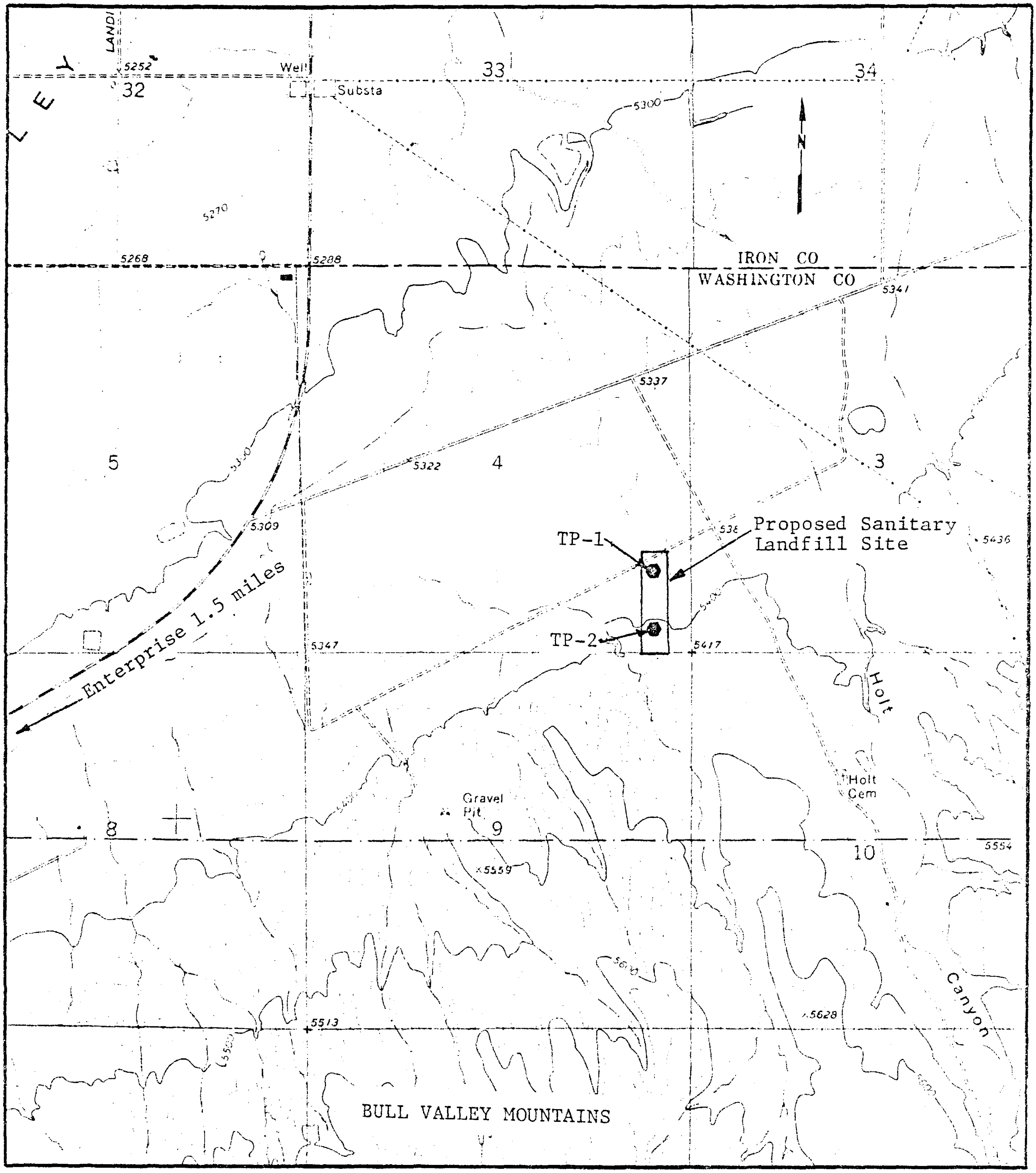
Brunner, D.R., and Keller, D.J., 1972, Sanitary landfill design and operation: U.S. Environmental Protection Agency Environmental Protection Publication (SE-65ts), 59 p.

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

Mower, R.W., and Sandberg, G.W., 1982, Hydrology of the Beryl-Enterprise area, Escalante Desert, Utah, with emphasis on ground water: Utah Department of Natural Resources Division of Water Rights Technical Publication 73, 66 p.

Stokes, W.L., 1963, Geologic map of Utah, SW Quadrant: College of Mines and Mineral Industries, University of Utah, scale 1:250,000.

Ulrich, R., and others, 1960, Soil survey of the Beryl-Enterprise area, Utah: USDA Soil Conservation Service Series 1952, No. 9, 75 p.



General location map showing proposed sanitary landfill site. Scale 1:24,000

Base map taken from USGS Enterprise, Utah 7.5 minute series topographic quadrangle map.

Attachment 2, memo of May 12, 1983 to William Dawson

Test Pit Logs*
Proposed Sanitary Landfill
Enterprise, Utah
W1/2 E1/2 SE1/4 SE1/4 sec. 4, T. 37 S., R. 16 W.
SLB&M

Test Pit 1

0.0' - 3.5' Gravelly silty sand (SM); red brown, medium dense to dense, slightly plastic, dry, non to slightly indurated with depth; 20 to 40 percent gravel to 3-inch diameter and some small cobbles, stage I caliche development near lower contact.

3.5' - 7.0' Silty sand (SM); red brown, medium dense, slightly plastic, dry, slightly indurated near upper contact; minor gravel.

7.0' - 8.0' Gravelly silty sand (SM); red brown, medium dense, slightly plastic, dry, nonindurated; gravel to 3-inch diameter.

Test Pit 2

0.0' - 4.0' Gravelly silty sand - clayey sand (SM-SC); brown, dense, slightly plastic to low plasticity, dry, moderately indurated; gravel to 2-inch diameter, stage I - II caliche development at lower contact, approximately 30 percent clay and silt.

4.0' - 7.5' Silty sand (SM); red to red brown, medium dense, non to slightly plastic, dry, slightly indurated.

NOTE: Water table not encountered in either test pit.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various grain size fractions are field estimates.

Project: Investigation of a proposed sanitary landfill in Browns Canyon, Summit County.			Requesting Agency: Summit County Planning Office
By: G. E. Christenson	Date: 10/25/83	County: Summit	Job No.: LF-2
USGS Quadrangle: Park City East (1209)			

October 25, 1983

MEMORANDUM

TO: William Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Investigation of a proposed landfill site in Browns Canyon, Summit County

BACKGROUND

In response to a request from Summit County, the UGMS accompanied personnel from the county and from Forsgren-Perkins Engineering (engineers for Summit County) on an investigation of a proposed county landfill site east of Park City on September 29, 1983. The site is at the head of Browns Canyon in the NW1/4 sec. 32, T. 1 S., R. 5 E., Salt Lake Baseline and Meridian (attachment 1). The purpose of the investigation was to evaluate geologic, hydrologic, and soils conditions in terms of suitability of the site for a sanitary landfill. Stan Strebel (Summit County Planning Department), Frank Singleton (Summit County Health Department), Kent Montague (Utah State Health Department), and R. Paul Kelly and Klane Forsgren (Forsgren-Perkins Engineering) were present during the investigation.

GEOLOGY AND SOILS

The site is underlain by gently southeast-dipping volcanic rocks of the Oligocene-age (24-37 million years) Keetley Volcanics (Bromfield and Crittenden, 1971). Rhyodacitic to andesitic volcanic breccia is found in the hills surrounding the site. Rocks in the canyon bottom are chiefly tuff and volcanic gravels which are overlain by a variable thickness of fine-grained alluvium. Bedrock, or bouldery colluvium derived from nearby outcrops, was encountered in test pits 3 and 4 on the canyon sides (attachments 1 and 2). A thin zone of weathered rock was present, but rock sufficiently fresh to be impenetrable with a backhoe was encountered at 3-5 feet. In the center of the canyon, bedrock is buried beneath at least 6-8 feet of alluvium (test pits 1, 2, and 5, attachment 2).

The USDA Soil Conservation Service (SCS) (1977) soil survey of the area shows two soil types at the site. The predominant soil in the canyon bottom west of the reservoir (attachment 1) is a low permeability sandy clay (CL, CH). Soils along the canyon margin and in the reservoir area are similar but include gravel, cobbles, and boulders over shallow bedrock. As shown in the logs in attachment 2, test pit data obtained during this study are in general agreement with the SCS information. A typical profile consists of an upper organic clay up to 4.4 feet thick overlying either weathered bedrock and bouldery colluvium along the canyon margin or interbedded sandy clay and clayey sand along the canyon axis. The total thickness of alluvial soil in the canyon is unknown, but probably exceeds 8 feet over most of the area.

HYDROLOGY

Tertiary volcanic rocks similar to those at the site provide water to more wells in the Heber-Park City-Kamas area than any other consolidated rock unit (Baker, 1970). All rock units are highly fractured and, on a broad scale, act as a single aquifer with water contained in interconnecting fractures. On a local scale, the availability of water to wells depends on whether major fractures are penetrated. Water is recharged into the fracture system from the surface and moves rapidly downward. A well 6 miles south of the site in Tertiary volcanic rocks shows a water-level rise within hours of precipitation events (Baker, 1970).

According to records at the Utah State Engineer's office, the well nearest the site is about 0.5 miles to the north (Attachment 1). This well is on the south side of Browns Canyon and had a static water level on May 30, 1977, of 85 feet below the surface. The location of this well was not confirmed in the field, but if present it indicates a relatively shallow depth to ground water in bedrock in the area. Some question as to the well location exists because the driller's log indicates clay and boulders to 70 feet overlying blue shale to 205 feet. Interpretations by Bromfield and Crittenden (1971) indicate volcanic rock at or near the surface extending to a depth of several hundred feet in this area. In any case, the site area is probably one of recharge to local bedrock aquifers, although recharge amounts and flow directions are not known.

Shallow ground water in alluvium was encountered in three of the five test pits at the site. No water was present in test pits 3 and 4 along the canyon margin. However, water flowed from several horizons in the alluvium in test pits 1, 2, and 5. The water occurs along the interface between the two principal soil units (upper black clay and lower yellow sandy clay-clayey sand) or within sandy layers in the lower unit. Clay layers within the lower unit are generally moist but unsaturated and act as confining layers for water in sandy units. The ground water encountered is not thought to represent the top of a saturated zone within the alluvium, but rather appears to be water that has infiltrated from the surface and is moving laterally through the ground along permeable layers. Surface water was present along the canyon bottom near test pit 1 and in the reservoir at the east end of the site. The ground water is most probably a result of water infiltrating into the alluvium from recent heavy rains in the area.

The site is in the headwaters of Browns Canyon. The drainage basin above the reservoir at the east end of the site is approximately 0.5 square miles with total relief of about 500 feet. The presence of surface water and marshy areas with tall grasses along the valley bottom indicate that surface flow occurs there. Flooding of low areas probably occurs during spring runoff and periods of heavy precipitation, but the extent is not known. The relatively small drainage area above the site indicates that large magnitude flooding probably does not occur from spring snowmelt but may occur during very intense summer thunderstorms.

SITE SUITABILITY FOR A SANITARY LANDFILL

Natural conditions important in siting a landfill include: (1) flood hazard, (2) depth to bedrock and ground water, and (3) soil types, as they relate to use for cover material and impermeable material for a bottom seal. Flood hazard at the site is low, but diversion of all surface drainage away from the site will be required to ensure that dry conditions are maintained and erosion is prevented. Runoff from direct precipitation and snowmelt on the landfill during operation should be collected and diverted away from the site.

Depth to bedrock and ground water are not known. Since this area is probably one of recharge to bedrock aquifers, leachate must be prevented from reaching the underlying bedrock. This can be done either by preventing leachate development or ensuring that an impermeable layer exists between the landfill and bedrock. The ground water encountered in test pits is probably the result of direct precipitation on the surface of the alluvium. It is thought that such water could be removed by installing a subdrain system and prevented, at least in part, from reoccurring through diversion of surface flow. However, ground water at greater depths could potentially be contaminated or could adversely affect the site during periods of high water tables.

The USDA Soil Conservation Service (1977) has interpreted the soils at the site as presenting only slight limitations for area-type landfills (refuse placed on surface with importation of cover material) but severe limitations for trench-type landfills (refuse placed in trenches using excavated material for cover) because of shallow bedrock and lack of soil cover. The report also considers onsite soils less than optimal for use as cover because of high clay content which makes them difficult to work under wet conditions. This investigation indicates that soils may be sufficiently deep for a trench-type landfill and that, although soils are clayey, the sand content is locally high making them more suitable for use as cover. However, the apparent increase in sand content with depth (attachment 2) indicates that sufficiently low permeability materials may not be present to preclude downward migration of leachate into bedrock fractures, making lining of the site necessary.

In conclusion, this preliminary investigation indicates that the site is potentially suitable for a landfill and merits further investigation. Additional work required before a final evaluation can be made includes drilling of test holes to determine: (1) distribution and thickness of alluvium at the site (2) soil characteristics, particularly as they relate to cover and lining materials, and (3) ground-water conditions at depth. Installation of monitoring wells in the alluvial materials would provide information necessary to evaluate the possibility of draining shallow ground water and preventing its reoccurrence. A sufficient number of deep wells should be drilled to characterize the bedrock aquifer beneath the site. Factors to be determined include depth to water, potential for culinary use, susceptibility to contamination, direction and rate of flow, and baseline water quality for long-term monitoring purposes.

GEC/co

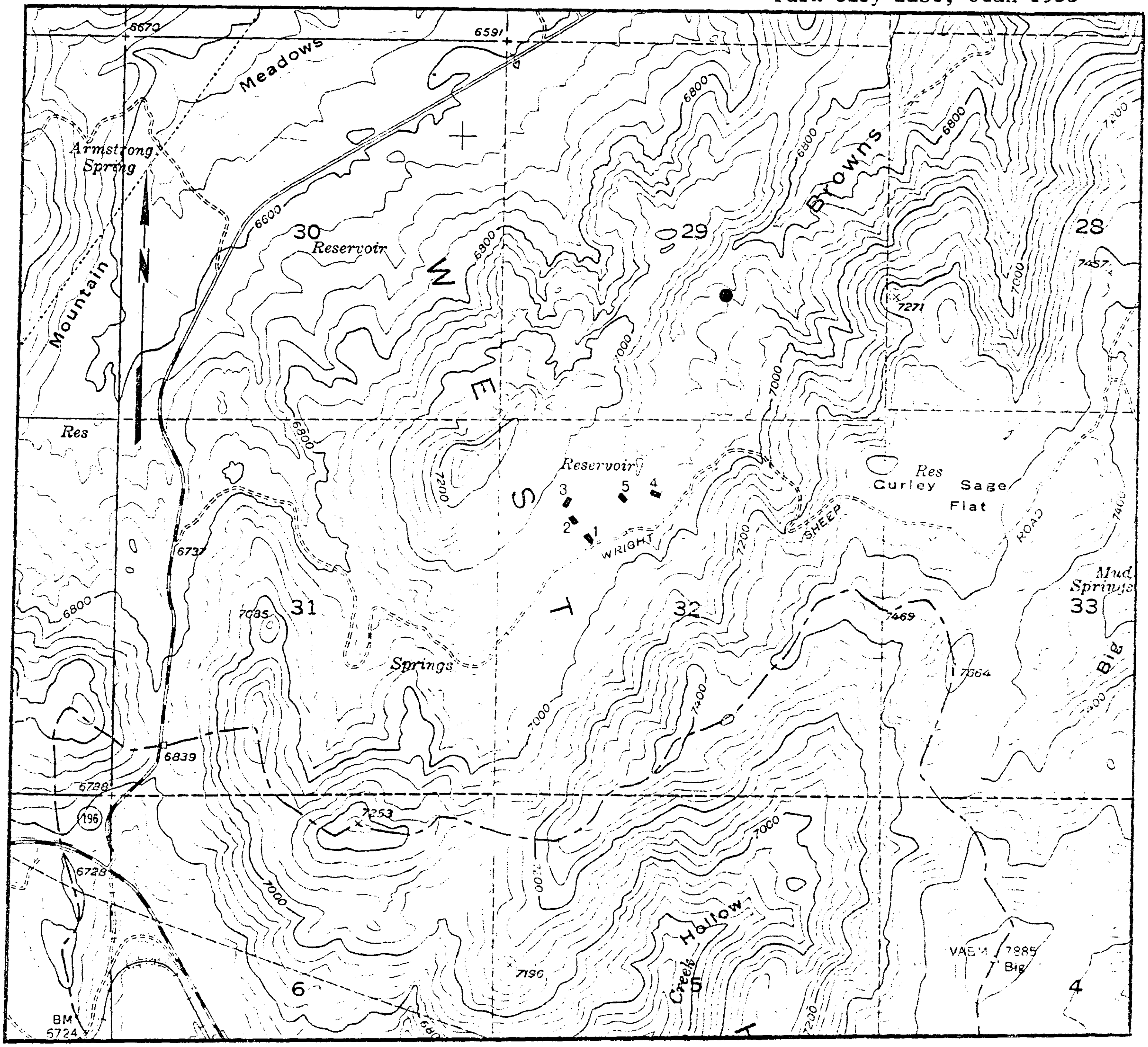
REFERENCES

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

Bromfield, C. S., and Crittenden, M. D., Jr., 1971, Geologic map of the Park City East Quadrangle, Summit and Wasatch Counties, Utah: U.S. Geological Survey Geological Quadrangle Map GQ-852, scale 1:24,000.

USDA Soil Conservation Service; 1977, Soil survey and interpretations, Parley's Park portion of soil survey of Summit Valley, Summit County, Utah: Utah Agricultural Experiment Station Bulletin 495, 302 p.

Base Map from: USGS 7½' Topo Quad
Park City East, Utah 1955



SCALE 1:24000

CONTOUR INTERVAL 40 FEET

Explanation

4 Test Pits ● Well

Location of test pits and well, proposed Summit County landfill site

Attachment 2, memo of 10-25-83 to W. R. Lund

Logs of Test Pits
Proposed Summit County Landfill Site

Soil Description*

Test Pit 1

0' - 3.3' Sandy clay (CL); black, firm, medium to high plasticity, wet to saturated, nonindurated.

3.3' - 6.7' Sandy clay (CL); yellow-brown to gray, stiff, medium to high plasticity, moist to saturated, nonindurated; percentage of sand variable.

Note: Water flowing into test pit at 3.3 feet and below, trench walls unstable.

Test Pit 2

0' - 2.7' Sandy clay (CL); black, firm, medium to high plasticity, dry to moist, nonindurated.

2.7' - 8.3' Interbedded sandy clay (CL) and clayey sand (SC); yellow-brown to gray, stiff-medium dense, medium plasticity, moist to saturated, nonindurated.

Note: Water flowing from clayey sand lenses at 6.7 feet and below.

Test Pit 3

0' - 1.5' Sandy clay (CL); black, firm, medium plasticity, dry, nonindurated.

1.5' - 2.7' Interbedded sandy clay (CL) and clayey sand (SC); yellow-brown, very stiff-medium dense, medium plasticity, dry, nonindurated; refusal on tuffaceous bedrock or boulders at 2.7 feet.

Note: No ground water encountered.

*Soils classified according to ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure).

Test Pit 4

0' - 4.4' Sandy clay (CL); black, firm, medium plasticity, dry, nonindurated.

4.4' - 5.3' Clayey sand (SC); yellow, medium to high density, medium plasticity, dry, nonindurated; weathered volcanic bedrock, refusal at 5.3 feet

Note: No ground water encountered.

Test Pit 5

0' - 3.3' Sandy clay (CL); black, firm, medium plasticity, wet to saturated, nonindurated.

3.3' - 7.9' Interbedded sandy clay (CL) and clayey sand (SC); yellow-brown to gray, stiff-medium dense, medium plasticity, moist to saturated, nonindurated.

Note: Water flowing into test pit at 4.7 feet and below.

WASTEWATER DISPOSAL

Project: Investigation of geology and soil conditions for wastewater disposal, C. Blake property and Dammeron Valley Farms Subdivision, Washington County.			Requesting Agency: Southwestern Utah District Health Dept.
By: G.E. Christenson	Date: Jan. 12, 1983	County: Washington	Job No.: WW-1
USGS Quadrangle: St. George SE (37), Veyo (120)			

January 12, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Suitability for soil absorption systems, C. Blake property and Dammeron Valley Farms Subdivision

BACKGROUND

At the request of Stephen Labrum, Southwestern Utah District Health Department, two sites proposed for individual or community septic tank and soil absorption systems were investigated. One site is in St. George at 1353 North 1100 West on property belonging to Mr. C. Blake. This is a single lot with a septic tank and soil absorption field already in use in the northwest corner of the lot. Mr. Blake plans to construct another dwelling on the lot with a separate system to be located in the southwest corner. The property owner to the west has raised a question regarding possible seepage of effluent from the proposed system onto his property which is adjacent and about 6 feet lower than the Blake property.

The second site investigated is 15 miles north of St. George (3 miles south of Veyo) along Highway 18 in the Dammeron Valley Subdivision (formerly Carter Ranch Subdivision; sec. 17, T. 40 S., R. 16 W., SLB&M). This phase of the subdivision is called Dammeron Valley Farms and is east of the highway. The purpose of investigations at both sites was to determine whether geologic conditions were suitable for the use of soil absorption systems for disposal of domestic wastewater.

SCOPE OF WORK

The scope of work included:

1. Review of existing literature regarding geology and soils.

2. Inspection and logging of one test pit at the Blake property (attachment 1) and four test pits at the Dammeron Valley Farms Subdivision (attachments 2 and 3).

Two of the test pits inspected at Dammeron Valley Farms had been previously logged by Stephen Labrum. All test pits were excavated under his direction and had been open for several days prior to my inspection.

GEOLOGY AND SOILS

The C. Blake property is on a stream bank underlain by alluvial sands of unknown thickness which overlie the Triassic Moenave Formation. An old drainage channel, modified to follow lot lines, forms the north and west boundaries of the lot. Drainage water is presently diverted and no longer flows in the channel. The lot west of the Blake property has a corral area adjoining the lot line in the bottom of the old channel. The test pit on the Blake property exposed sand and silty sand to a depth of at least 8.0 feet with two continuous strongly indurated zones cemented by calcium carbonate from 2.0 - 4.5 feet and 7.0 - 7.5 feet (attachment 1). The depth to ground water and bedrock is at least greater than 8.0 feet since neither was encountered in the test pit.

The Dammeron Valley Farms Subdivision is on an alluvial fan overlying the Carmel Formation of Jurassic age (Cook, 1960). The thickness of alluvial-fan deposits is not known except in the area of the easternmost test pit (no. 3, attachment 3) where limestone of the upper Carmel Formation was encountered at 7.0 feet. The possible presence of shallow bedrock throughout this area is indicated by several bedrock outcroppings on the fan surface. The alluvial-fan deposits range from gravelly sand in the eastern part nearest the source to silty sand with gravel along the highway. All deposits are strongly indurated with calcium carbonate from 1.5 feet to the bottom of the test pits (9-10 feet, attachment 2). Laminar layers of calcium carbonate at 1.5 feet capping these massive indurated layers indicate that at least the upper parts of the profiles are impermeable. In test pit 4, multiple strongly indurated layers separated by thin, weakly to moderately indurated layers are present. No ground water was encountered in any of the test pits.

SUITABILITY FOR SOIL ABSORPTION SYSTEMS

Conditions at both sites are marginal to unsuitable for soil absorption systems. Indurated layers generally reduce permeabilities and act as barriers to downward migration of water. At the Blake property, it is planned that the separation distance between the nearest drain line and the slope along the western property line will be about 20 feet. With the presence of the low permeability indurated zone at 7 feet which would project to near the base of the slope, the possibility of westward migration of water trapped on this layer with resultant seepage on the slope cannot be ruled out. In addition, it is thought that the percolation rates in indurated layers which constitute about half of the profile below 2 feet would be considerably less than that measured in the percolation test. This test was performed in the interval from 7-8 feet which was partially in less indurated material.

Conditions at Dammeron Valley Farms are very similar except that indurated layers are thicker and bedrock is locally shallow. The Soil Conservation Service (Mortensen and others, 1977) considers the soils to present severe limitations for soil absorption systems because of low permeabilities and shallow rock. Our findings generally confirm this, and previous investigations by Kaliser (1973, 1976) have also noted these conditions.

REFERENCES

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

Kaliser, B. N., 1973, Southern Utah subdivision inspections, Washington County Utah: Utah Geological and Mineral Survey Report of Investigation 75, 4 p.

Kaliser, B. N., 1976, Preliminary geologic reconnaissance of six southern Utah subdivisions: Utah Geological and Mineral Survey Report of Investigation 106, 5 p.

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

Attachment 1. memo of 1/12/83 to W.R. Lund

LOG OF TEST PIT

C. Blake property (1353 North 1100 West, St. George, Utah)

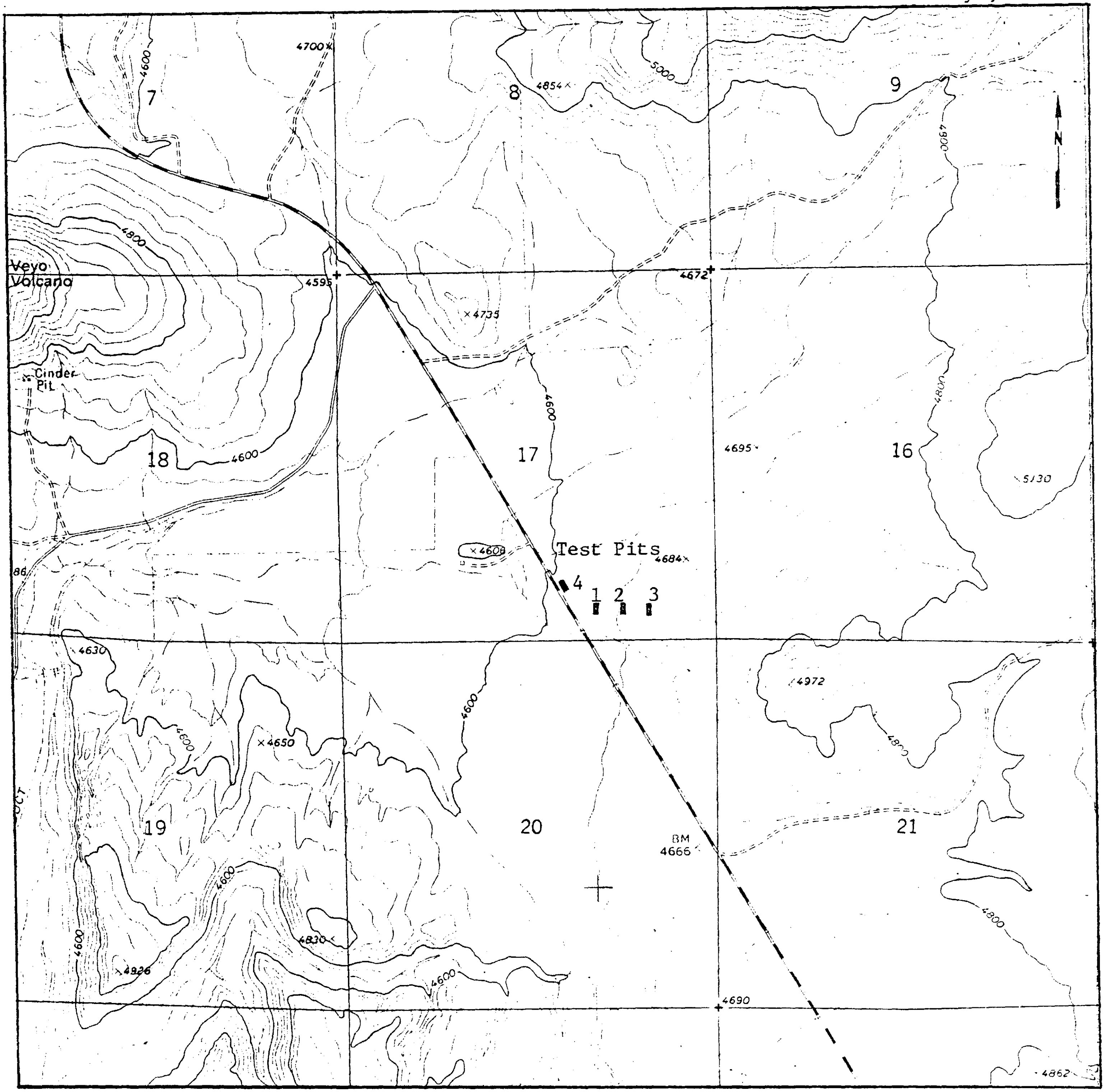
	Soil Description*
0' - 2.0'	Sand-silty sand (SP-SM): red, medium dense, nonplastic, moist, nonindurated.
2.0' - 4.5'	Sand-silty sand (SP-SM); white, high density, nonplastic, moist, strongly indurated: caliche horizon, platy to massive.
4.5' - 7.0'	Sand-silty sand (SP-SM); red, medium dense, nonplastic, moist, weakly to moderately indurated.
7.0' - 7.5'	Sand-silty sand (SP-SM); white to red, high density, nonplastic, moist, strongly indurated: buried zone of calcium carbonate cementation.
7.5' - 8.0'	Sand-silty sand (SP-SM); red, medium dense, nonplastic, moist, weakly to moderately indurated.

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).

Attachment 2, memo of 1/12/1983 to W.R. Lund

Base map from: USGS 7½' Topo Quad
Veyo, Utah



0 1 2 miles

Scale 1:24,000

Approximate location of test pits, Dammeron Valley Farms

Attachment 3, memo of 1/12/83 to W. R. Lund

LOGS OF TEST PITS
Dammeron Valley Farms Subdivision
(see attachment 2 for test pit locations)

Soil Description*

Test Pit 1

0' - 1.5' Sandy clay-clayey sand (CL-SC): red, stiff-medium dense, medium plasticity, dry, nonindurated: 20 percent gravel.

1.5' - 9.5' Secondary calcium carbonate cementation masks soil type (silty sand?): white, high density, dry, strongly indurated: stage III caliche with thin laminar stage IV zone at 1.5 feet.

Note: No ground water encountered: hole not entered, logged from ground surface.

Test Pit 2 (Test pit 3 in original investigation by Stephen Labrum)

0' - 1.5' Sandy clay - clayey sand (CL-SC): red, stiff-medium dense, medium plasticity, dry, nonindurated.

1.5' - 9.0' Secondary calcium carbonate cementation masks soil type (gravelly sand?); white, high density, dry, strongly indurated; stage III caliche, thin laminar stage IV zone at 1.5 feet.

Note: No ground water encountered.

Test Pit 3 (Test pit 4 in original investigation by Stephen Lambrum)

0' - 1.5' Sandy clay - clayey sand (CL-SC): red, stiff-medium dense, medium plasticity, dry, nonindurated.

1.5' - 7.0' Secondary calcium carbonate cementation masks soil type (gravelly sand?): white, high density, dry, strongly indurated: stage III - IV caliche.

7.0' - 10.0' Limestone, highly fractured.

Note: No ground water encountered.

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

Test Pit 4

0' - 2'	Clay (CL): brown, stiff, medium plasticity, moist, nonindurated.
2' - 3.5'	Silty sand (SM): white, high density, low plasticity, dry, moderately to strongly indurated; 20 percent gravel with local gravel lenses, stage III caliche.
3.5' - 5.5'	Silty sand (SM); red, medium dense, low plasticity, dry, weakly to moderately indurated: stage I - II caliche.
5.5' - 9'	Secondary calcium carbonate masks soil type (silty sand?): white, high density, dry, strongly indurated: stage III caliche.

Note: No ground water encountered.

Project: Site evaluation of a proposed wastewater disposal pond for oil well drilling fluids, Summit County.			Requesting Agency: Summit County Health Dept.
By: H.E. Gill	Date: June 6, 1983	County: Summit	Job No.: WW-2
USGS Quadrangle: Turner Hollow (1290)			

June 6, 1983

Mr. Steve Jenkins, Sanitarian
Summit County Health Department
Summit County Courthouse
Coalville, UT 84017

Dear Steve:

I have evaluated the information collected during the field reconnaissance of the two proposed wastewater disposal ponds we visited on May 26 and submit the following conclusions and recommendations:

The investigation was a preliminary engineering geology field reconnaissance with no lab testing or subsurface exploration of soils.

Logs were prepared of the soils exposed in the pond walls. The pond to the north contained a mixture of sand, gravel, and cobbles in the walls of the excavation with a red, sandy clay in the pond bottom. A lense of river gravels and cobbles, in the form of a channel cut and fill, was observed in the northeast corner. The same river gravels and cobbles make up the walls and bottom of the southern pond. No sandy clay was observed in the bottom of the second pond. Therefore, it appears that the river channel trends toward and dips to the south.

The possibility of leakage from the northern pond is low as long as the water level is maintained below the contact of the sandy clay with the upper gravel and cobbles. However, leakage could occur if water rises above this contact. Leakage through the gravels and cobbles observed in the walls and floor of the southern pond is very likely.

No subsurface information is available on the lower red, sandy clay. Neither its thickness or lateral extent are known. If it everywhere underlies the gravel and cobble channel cut, and continues to dip in the direction observed, seepage from the southern pond would move toward the south on top of the clayey horizon.

Contamination of Chalk Creek, which is approximately 1/4 mile to the west, would be unlikely due to its distance from the ponds. Migration of pollutants may occur along the clay horizon beneath the gravel and cobble stream cut. However, if the clayey bed is continuous and the dip of the bed remains the same as observed at the disposal site, effluent reaching the creek would probably be too deep to pose any problem.

Contamination of the spring to the north is also unlikely. The spring is approximately 1/8 mile north of the ponds and if the apparent dip of the clayey horizon remains unchanged, migration of water would be to the south away from the spring. The recharge area for the spring is to the east and in a different drainage from that of the ponds.

As you are aware, Part 6 of the State's wastewater disposal regulations covering brine ponds has recently been rewritten. The sections applicable to the siting of brine disposal facilities are quite specific and should be complied with.

I hope this answers any questions you may have. If this office or I can be of any other service, please feel free to contact us.

Sincerely,

Harold E. Gill, Geologist
Site Investigation Section

hg

Project: Investigation of geology and soil conditions for wastewater disposal, Kolt Mining Company mine, Beaver County.			Requesting Agency: Southwestern Utah District Health Dept.
By: W.R. Lund	Date: June 10, 1983	County: Beaver	Job No.: WW-3
USGS Quadrangle: Cove Canyon (442), Ranch Canyon (483)			

June 10, 1983

Mr. Rod Cosslett
Southwestern Utah District Health Department
P.O. Box 643
Cedar City, UT 84720

Dear Mr. Cosslett:

This letter presents the results of a geologic inspection conducted on May 17, 1983, of the proposed Kolt Mining Company mine and mill complex near Milford, Utah. The purpose of the inspection was to evaluate site soils in terms of suitability for individual wastewater disposal systems utilizing septic tanks and soil absorption fields. The investigation included a review of existing geologic, hydrologic, and soil information for the area, and a field reconnaissance during which four soil test pits were examined.

The proposed complex is located on a moderately sloping pediment surface on the west side of the Mineral Mountains approximately 6 miles southeast of Milford, Utah (attachment 1). The project area occupies portions of sec. 17 and 20, T. 28 S., R. 9 W. SLB&M. The four test pits examined during the investigation are all in the N1/2 of sec. 20. Surface drainage across the site is poorly defined. Streams crossing the pediment surface are ephemeral and have not significantly incised their channels. Drainage in the project area is largely by overland flow. A moderate cover of vegetation, consisting primarily of juniper and range grass, exists on the property. Average annual precipitation is about 14 inches and pan evaporation at Milford (approximately 1000 feet lower in elevation) is 78 inches (Mower and Cordova, 1974). Access to the property from State Route 21 is via a combination of graded and unimproved dirt roads.

Bedrock crops out in many areas on the property. The pediment surface generally exhibits low relief and is underlain by a complex assemblage of easily eroded Tertiary granitic rocks. A steep-sided hill, approximately 150 feet high, located near the center of the site consists of resistant Paleozoic limestone. The limestone represents a portion of the magma chamber roof that either collapsed into or was surrounded by the granitic intrusive.

The area being considered for individual wastewater disposal systems is located on the pediment surface south of the limestone hill (attachment 1). Soil cover in that area is generally very thin; three of the four test pits encountered granitic bedrock at depths of less than 3 feet (attachment 2). The fourth test pit exposed 5.7 feet of coarse sand with gravel and silt derived from weathered granite. The excavation had been open for several days and the walls had caved. Depth of the test pit was originally reported as 8 feet, all in silty sand. The areal extent of the deeper soil profile is not know, but bedrock crops out at several locations in the near vicinity.

Ground water was not encountered in any of the test pits and is estimated to be greater than 100 feet and probably greater than several hundred feet in the project area.

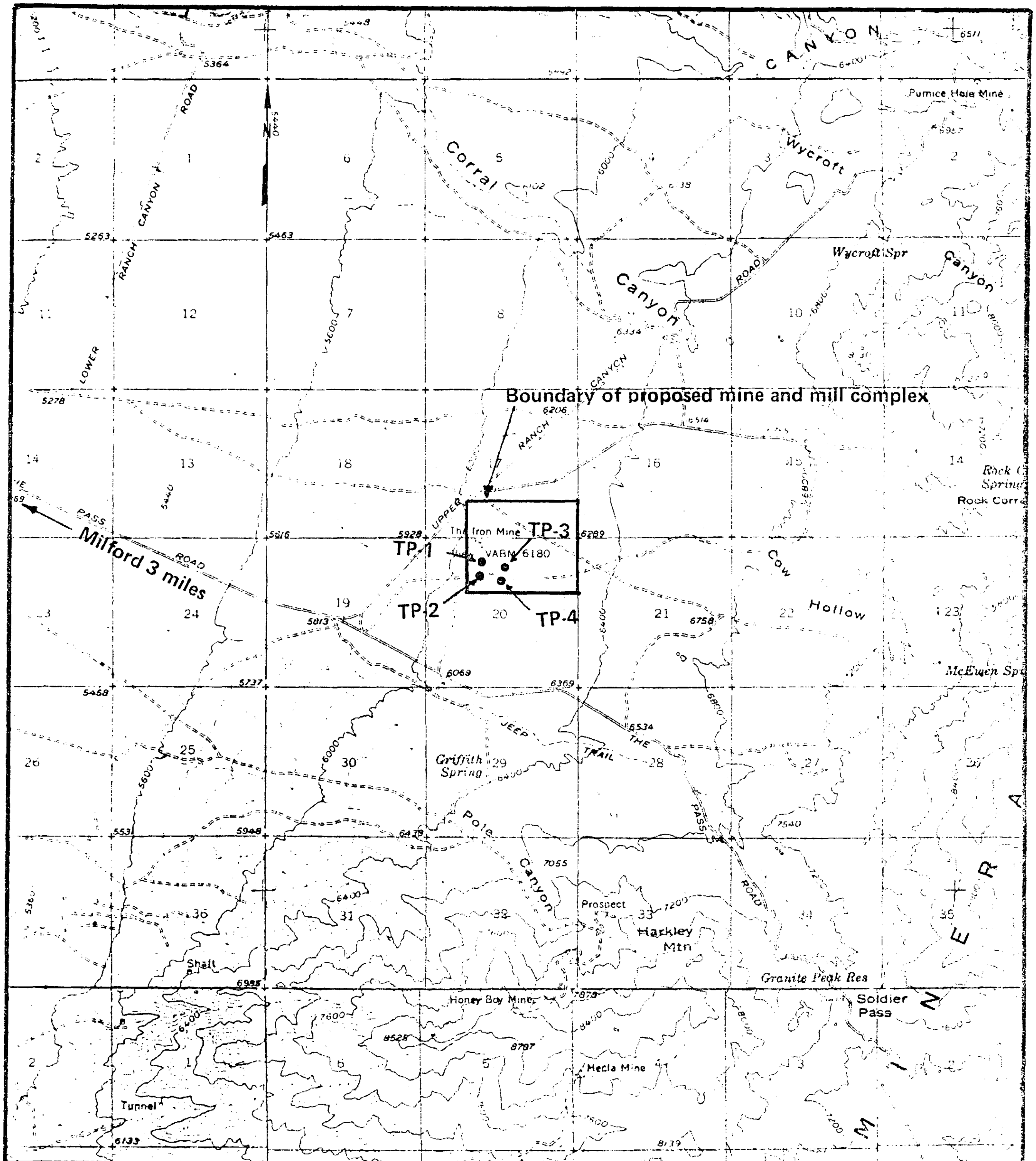
Based on this investigation, it is concluded that the siting of individual wastewater disposal systems in accordance with Part IV of the State Health Code will be difficult on the Kolt Mine property. Most of the area presently considered for disposal systems is underlain by shallow bedrock. Deeper, coarse-grained, silty sand soils which would prove satisfactory for septic tank and soil absorption fields do exist locally. The areal extent of such deep soils is unknown, but the numerous exposures of granitic bedrock in the area indicate they are limited. Considerable exploration may be required to identify a suitable disposal site.

It is hoped that the information provided in this letter will assist you in evaluating the suitability of septic tank and soil absorption fields as a method of waste disposal at the Kolt property. If you have any questions or if we may be of further assistance, do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigations Section

WRL/ay
cc: Mervin Reid, Division of Environmental Health,
Bureau of Sanitation



Location map showing proposed mine/mill complex and approximate test pit locations
Scale 1:62,500

Utah Geological and Mineral Survey

Site Investigations Section

Test Pit Logs*
Kolt Mining Company Property
T. 28 S., R. 9 W., Sec. 20, SLB&M

Test Pit 1

0.0' - 1.4' Gravelly silty sand (SM); brown, medium dense, nonplastic, moist, nonindurated; 20 percent gravel to 3-inch diameter.

1.4' - 2.8' Gravelly silty sand (SM); white, medium dense to dense, nonplastic, moist, non- to slightly indurated; decomposed granitic bedrock forming a residual soil.

2.8' Granitic bedrock; white, moderately weathered sufficiently hard to prevent further excavation by backhoe.

Test Pit 2

0.0' - 2.0' Silty sand with gravel (SM); brown, low to medium density, nonplastic, moist, nonindurated; 15 percent gravel to 1-inch diameter.

2.0' Granite bedrock; white, moderatley weathered; sufficiently hard to prevent further excavation by backhoe.

Test Pit 3

0.0' - 1.3' Clayey sand with gravel (SC); brown to dark brown, medium dense, low to medium plasticity, moist, nonindurated; 30 to 40 percent fines.

1.3' - 2.7' Granitic bedrock; white, highly weathered; in-place rock sufficiently soft to be excavated with a backhoe.

2.7' Granitic bedrock; white, moderately weathered; refusal with backhoe.

Test Pit 4

0.0' - 1.1' Silty sand with gravel (SM); brown to dark brown, medium dense, non- to slightly plastic, moist, nonindurated.

1.1' - 5.7' Sand with gravel and silt (SP-SM); brown, medium dense, nonplastic, dry to moist, non- to slightly indurated; nonstratified.

Note: Ground water not encountered in test pits.

*Soils classified in accordance with procedures outlined in ASTM Standard D 2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various size fractions are field estimates.

Selected References

Mower, R.W., and Cordova, R.M., 1974, Water resources of the Milford area. Utah, with emphasis on ground water: Utah Department of Natural Resources Division of Water Rights Technical Publication No. 43, 106 p.

Nielson, D.L., and others, 1978, Geology of Roosevelt Hot Springs KGA, Beaver County, Utah: Earth Science Laboratory University of Utah Research Institute, DOE Contract EG-78-C-07-1701, 120 p.

Stokes, W.L., 1963, Geologic map of southwestern Utah: College of Mines and Mineral Industries University of Utah, scale 1:250,000.

Utah Division of Water Resources, no date, Hydrologic atlas of Utah: Utah State University.

Project: Investigation of septic tank and soil absorption system failures in Francis, Summit County, Utah.			Requesting Agency: Francis Town
By: G.E. Christenson	Date: June 17, 1983	County: Summit	Job No.: WW-4
USGS Quadrangle: Francis (1167), Kamas (1208)			

June 17, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section, UGMS

FROM: Gary E. Christenson, Geologist

SUBJECT: Septic tank soil absorption field failures, Francis, Summit County, Utah

Background

At the request of Glade Prescott, mayor of Francis, the Utah Geological and Mineral Survey performed a study of the geology, soils, and ground-water conditions in the city. Francis is in Summit County about one mile south of Kamas on a bluff along the Provo River (attachment 1). The city has experienced numerous failures of septic tank soil absorption systems in this and previous years, and desires geologic and hydrologic backgound information which may have a bearing on the problem. Valley Engineering serves as the city engineer and is presently preparing a report on waste disposal alternatives for the city. A reconnaissance of problem areas was performed on June, 2, 1983, with Glenn Stott of Valley Engineering, Mayor Prescott, and Tim Atkinson, city councilman.

Scope of Work

The scope of work included:

1. Review of published geologic and hydrologic reports for the area.
2. Discussion with Lael Harvey of the Soil Conservation Service, and review of his preliminary soil map and interpretations for the area.
3. Brief discussion with Steve Jenkins, sanitarian for the Summit County Health Department.
4. Interpretation of aerial photographs.
5. Collection of water-well data from the Utah Division of Water Rights.
6. Brief field reconnaissance.

No test pits were excavated for this study, and field examination of soils was restricted to existing gravel pits. The brief reconnaissance of problem areas included discussions with residents regarding the nature and timing of system failures.

Geology and Soils

Francis is located on a thick alluvial fill deposited in Rhodes Valley by what is now the upper Provo River. The upper Provo River previously flowed north and northwestward and was a part of the Weber River drainage. Abandoned channels trending to the northwest and northwestly dip of the surface indicate that the alluvial fill beneath Francis was deposited when the river was flowing to the northwest. Following deposition of this alluvium, the upper Provo River was diverted to the west into the present lower Provo River drainage and subsequently became incised into the alluvial fill at Francis (Baker, 1970).

Presently, the Provo River flows in a canyon cut about 100-150 feet below the old surface. Outcrops of volcanic rocks are present in this canyon southwest of Francis in the lower 15-20 feet, indicating that the river has locally cut through the overlying alluvium into bedrock. In most of Rhodes Valley, however, the alluvium is believed to be more than 300 feet thick (Baker, 1970).

Exposures in gravel pits south of Francis indicate that the alluvium beneath Francis consists chiefly of sandy gravel with a variable thickness of clay at the surface. The gravels are well-rounded, poorly sorted, and weakly stratified. Beds of less permeable silts and clays are not found in these exposures and are not reported in well logs. Soil textures are generally uniform. Preliminary mapping by the Soil Conservation Service (Harvey, 1982) indicates that fine-grained soils at the surface contain high percentages of clay and include CL-ML, CL, and CH soils (Unified Soil Classification System) of the Manila and, to a lesser extent, Crooked Creek series. The thickness of these clayey materials overlying gravels is reported to be up to 12 feet.

Ground Water

Shallow ground water occurs throughout Francis and much of Rhodes Valley to the north. Except for a narrow zone along the bluff overlooking the Provo River, movement of ground water in Rhodes Valley is toward Beaver Creek and the Weber River (Baker, 1970). The ground-water divide between the Provo and Weber drainages is near the edge of the bluff, with a very steep ground-water gradient to the south (Provo River Basin) and a much more gentle gradient toward the north (Weber River basin) (attachment 2). This great variation in gradient, which causes the divide to be so near the edge of the bluff, is due to a reported large differential in vertical and lateral permeabilities of the alluvium (Baker, 1970). Bedding in the alluvium dips to the northwest, and infiltrating water moves laterally along bedding much more readily than it moves vertically across bedding.

Few wells have been drilled in Francis to depths of greater than 100 feet. In all wells drilled, subsurface materials consist of sand, gravel, cobbles, and boulders with only very local occurrences of less permeable clayey gravel or "hard pan." Bedrock was only encountered in one well, where it was at a depth of 65 feet in a well about 2000 feet south of the NW1/4 of section 34 (attachement 1.) Gravels above bedrock are saturated to near the ground surface, with recharge chiefly from irrigation and snowmelt and some subsurface underflow from rock aquifers (Baker, 1970). Baker (1970) reports annual water-table fluctuations of about four feet in southern Rhodes

Valley. Well data indicate and residents report local annual fluctuations and long-term fluctuations of 15 feet and more, whereas elsewhere shallow levels are maintained year round. Only the narrow zone along the bluff overlooking the Provo River is well-drained with a relatively deep water table.

Suitability for Septic Tank Soil Absorption Systems and Sewage Lagoons

The clayey surface soils and shallow ground water make much of Francis poorly suited for soil absorption systems. This is readily indicated by the high percentage of system failures in the area. Along the south edge of town where the water table is relatively deep, systems buried below the surface clay layers in underlying gravel operate properly. Elsewhere, shallow ground water precludes installation of systems in gravels below the upper clay layer. Engineering interpretations by the Soil Conservation Service also indicate severe limitations for the use of soil absorption systems in much of the city (Harvey, 1982).

Because of shallow ground-water conditions, much of the Francis area is likewise poorly suited for placement of sewage lagoons. One possible site for such lagoons is shown on attachment 1 in the northwestern part of the city. This site was tentatively proposed by Valley Engineering, chiefly on the basis of land availability and topographic/geographic location with respect to a collection system and distance from existing homes. Lagoons in which water loss is by both infiltration and evaporation are proposed. Depth to water at the site apparently is variable from year to year. Logs of wells drilled in 1947-48 indicated depths to water of 3 - 5 feet, whereas one drilled at the same location in 1975 reported a depth to water of 20 feet. Depending on design of the lagoon, periods of shallow water could result in either inflow into the lagoon (if the lagoon bottom is partially below the ground surface) or in pollution of the ground water if a sufficient thickness of material is not present between the water table and lagoon bottom. Also, percolation rates in clayey soils at the site may be very low and insufficient to provide the necessary infiltration to keep lagoon size from becoming too large. The Soil Conservation Service (Harvey, 1982) maps two soil types in this area, one of which is interpreted to present slight limitations for sewage lagoons (Manila Series) and one of which presents severe limitations due to flooding and wetness (Crooked Creek Series). Although a more detailed investigation of the proposed lagoon site would be required to make a difinitive evaluation, preliminary analysis from available data indicate that the site is not well-suited.

Much of the city is poorly suited for septic tank soil absorption fields and sewage lagoons. The areas best-suited for absorption fields are in the narrow band along the bluff where ground-water flow is toward the Provo River and the water table is deep. Few areas that meet both setback requirements for a sewage lagoon and satisfy topographic grade requirements for a sewer system are available in the Francis area. A more detailed investigation would be required to identify possible alternatives to the proposed site.

GEC/ay

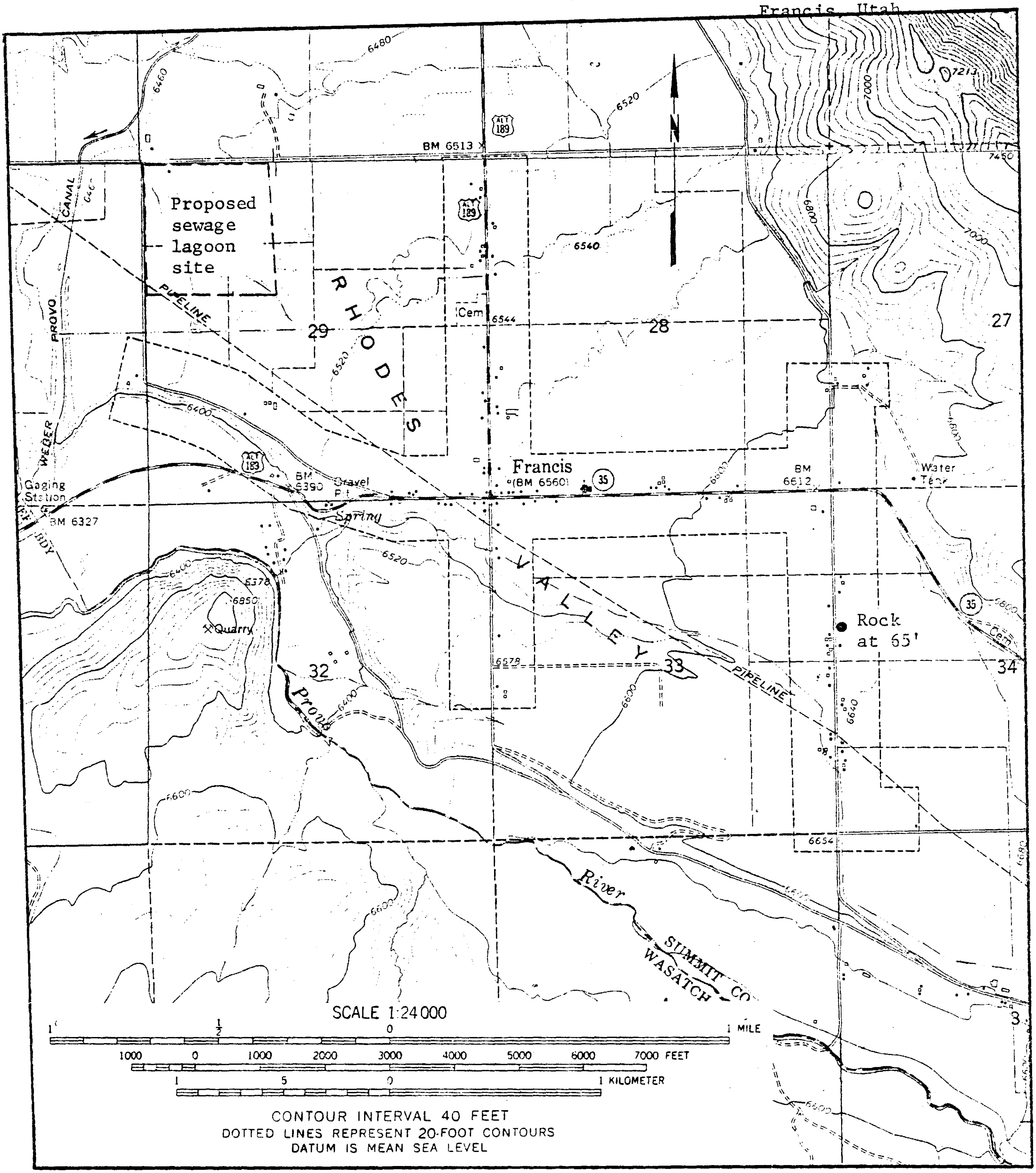
References

Baker, C.H., Jr., 1970, Water resources of the Heber-Kamas-Park City area, north-central Utah: Utah Department of Natural Resources Technical Publication Number 27, 79 p.

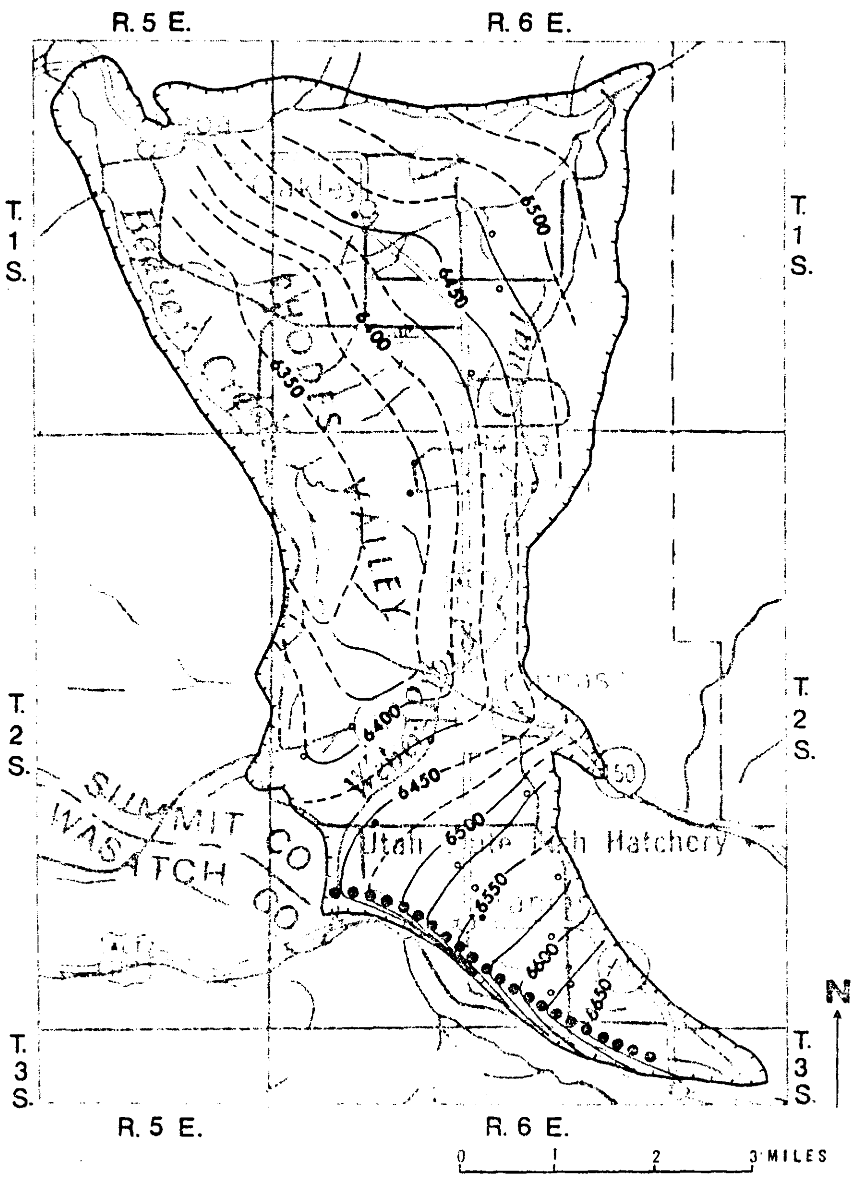
Harvey, L., 1982, Preliminary soils information, Francis, Utah area: report by USDA Soil Conservation Service for the Summit County Planning Commission.

Attachment 1

Base map from: USGS 7.5' Topo Quads
Kamas, Utah
Francis, Utah



Location map, Francis, Utah



Base from U.S. Geological Survey 1:250,000 (AMS) series: Salt Lake City, Utah; Wyoming (1963)

EXPLANATION

6500

Water level contour

Dashed where approximate. Contour interval 25 feet. Datum is mean sea level

Observation well

Other well used for control

Ground-water divide

Boundary of valley fill

Map showing water level contours and location of ground water divide between Provo and Weber River basins, Rhodes Valley, Utah (from Baker, 1970)

Project: Evaluation of Hatch Town culinary well No. 3 and the effect of nearby septic tanks and soil absorption systems.			Requesting Agency: Utah State Dept. of Health
By: W.R. Lund	Date: July 11, 1983	County: Garfield	Job No.: WW-5
USGS Quadrangle: Hatch (233)			

July 11, 1983

Mr. Dan Blake
Division of Environmental Health
P.O. Box 2500
Salt Lake City, UT 84110-2500

Dear Mr. Blake:

In response to your request on behalf of the town of Hatch, Utah, a geologic investigation was conducted on June 21, 1983 of the town's no. 3 water well. The purpose of the investigation was to determine the geologic setting of the well and to evaluate the potential affect of septic tank and soil absorption systems on the well's water quality. The scope of the investigation included a review of existing geologic and hydrologic information, air photo analysis, and a field reconnaissance of the area.

Well No. 3 is located on a moderately sloping hillside at the south end of Hatch in the SE1/4 Se1/4 sec. 29, T. 36 S., R. 5 W., SLB&M (attachment 1). The well is housed in a small cement block building at the edge of a fenced pasture which held approximately 20 head of sheep at the time of the investigation. An unlined irrigation ditch lies approximately 1400 feet upslope to the west, as do several large piles of wood scrap from a local sawmill. No other development has taken place in that direction. A tourist information office is located about 127 feet (oral commun., Don Wudarski) downslope to the southeast and a Burger Boy Drive-in is 150 feet downslope to the east. Both the tourist information office and the drive-in use septic tank and soil absorption systems. The drive-in plans to expand and is seeking permission to install an additional waste disposal system.

According to the driller's log, well no. 3 is 176 feet deep and penetrates 8 feet of "soil" and 168 feet of "Wasatch Lime." The term "Wasatch Lime" probably refers to the Tertiary-age Wasatch Formation mapped in western Garfield County by Gregory (1949, 1951) and Carpenter and others (1967). Based on a review of well site geology, it is concluded that the unit encountered in the well is not the Wasatch Formation. Geologic maps for the area (Gregory, 1949; Carpenter and others, 1967; Doelling, 1975) show that the well is located in a thick sequence of Quaternary-Tertiary-age deposits (attachment 2) and that the Wasatch Formation (Doelling indicates that Clarion Formation is the preferred designation in Garfield County) lies considerably deeper than 8 feet below the ground surface. The following table presents a generalized geologic section for the Quaternary-Tertiary-age units present at the Hatch no. 3 well site.

System	Series	Stratigraphic Unit	Thickness	Description
Tertiary or Quatern-ary	Upper Pliocene or lower Pliocene	Sevier River Formation	0-450+	Poorly sorted and poorly bedded deposits of unconsoli-dated cobbles, gravel, sand, silt, and clay; typical alluvial fan deposit containing some lacustrine deposits of light-colored clay, marl, and argillaceous limestone.
		Brian Head Formation-upper unit	0-600?	Roughly bedded but generally poorly sorted deposits of dark-gray water-laid agglomerate and conglomerate; contains interbedded dark-gray to black sandstone and intraformational volcanic flows.
Tertiary	Eocene & Miocene	Brian Head Forma-tion-lower unit	0-1,000	Well stratified white, gray, green, tan, and black siliceous limestone, impure marl, calcareous silt, shale, sandstone, conglomerate and water-laid pyroclastics.
		Wasatch (Clarion) Formation	0-1,100	Thick-bedded pink to red fresh-water limestone; contains irregularly bedded pink to yellow shale, siltstone, sandstone, and conglomerate.

After Carpenter and others, 1967

The Sevier River Formation crops out at the ground surface at the well site (Gregory, 1959; Carpenter and others, 1967; Doelling, 1975). Total thickness of the unit at the well is not known, but its presence indicates that the Brian Head Formation also exists at depth. The thickness of the Brian Head Formation is variable (see table), but there is no doubt that the combined Sevier River and Brian Head section greatly exceeds 8 feet. It is likely that the "Wasatch Lime" reported in the driller's log is actually the light-colored lacustrine material found in the Sevier River Formation or, less likely, part of the lower Brian Head Formation. This analysis is supported by the logs of other wells in the vicinity of well no. 3 (attachments 1 and 3). The logs for those wells correspond to what would normally be expected for wells drilled in either the Sevier River or Brian Formation. Well E (attachments 1 and 3) is deep enough (350 feet) to possibly have reached the Wasatch Formation, and that probably accounts for the brightly colored material reported for depths greater than 260 feet.

Carpenter and others (1967) indicate that the Sevier River Formation has a low permeability and generally makes a poor aquifer; typically yielding small to moderate quantities of water to wells. The Brian Head Formation is described as having low to high permeability and is known to supply large quantities of water to a few springs. The lithologic characteristics of both formations are highly variable in both a lateral and vertical direction. Relatively permeable zones are frequently interbedded with or grade laterally into less permeable zones. Evidence for this variability was exposed in the walls of the excavation dug for the septic tank next to the Burger Boy Drive-in (attachment 4). Coarse, permeable, poorly consolidated gravel was observed overlying a much finer-grained, less permeable silty sand layer. Similar differences in material types can be expected at depth where some of the less permeable horizons may contain significant amounts of silt and clay. Without accurate test hole information, the thickness and lateral extent of low permeability horizons in the vicinity of well no. 3 remains unknown. If such horizons exist and provide a barrier to the downward percolation of water, the well may be adequately isolated from septic tank and soil absorption systems in the area. However, if low permeability horizons do not exist, disposal system effluent may reach the water table. It should be noted that a similar hazard may exist from the sheep pastured around the well's pump house.

Because of the variability of the materials involved, and the lack of reliable subsurface data, only a preliminary assessment can be made of the effect on well No. 3 of increased development within a 1500-foot zone around the well. Based on the information presently available, the well is properly classified as a "shallow well" under State Health Code regulations. However, it is felt that the existing low level of development within the protection zone (including the proposed expansion to the Burger Boy Drive-in), combined with the nature of the materials at the site and a depth to water of more than 20 feet in the well, presents little hazard to water quality. It is recommended that future large-scale development within 1500 feet of the well be permitted only if it can be demonstrated that a suitable confining layer exists between the ground surface and the water table. A pump test to determine the size of the cone of depression for the well and the direction of ground-water flow beneath the site may also provide a means of zoning the area to avoid adverse impacts to water quality.

If you have any questions regarding the information presented in this letter or if we may be of further assistance, do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigations Section

WRL/ay
cc: William Dawson
Don Wudarski
Marvin Barnhurst

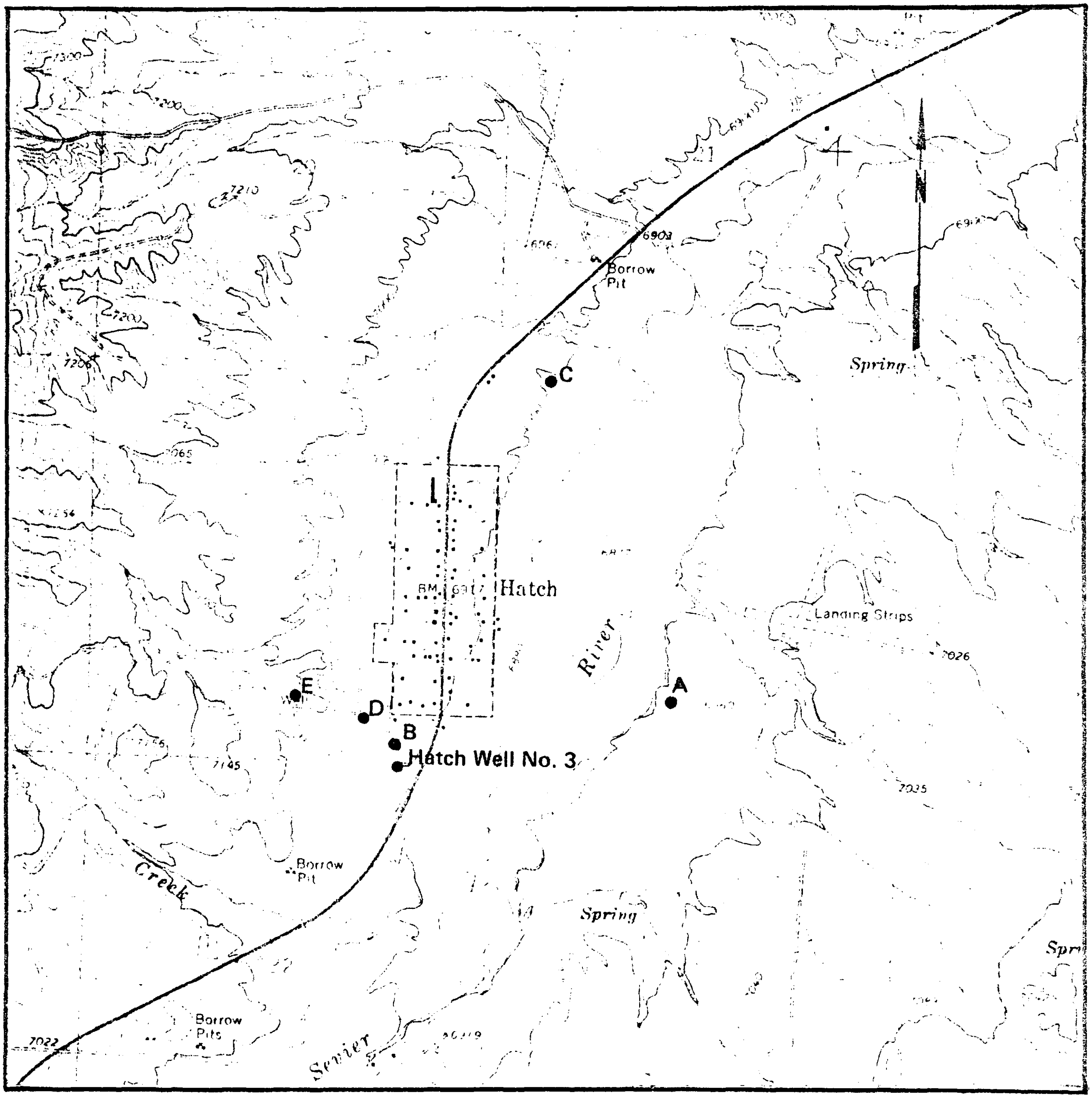
Selected References

Carpenter, C.H., Robinson, G.B., and Bjorklund, L.J., 1967, Ground-water conditions and geologic reconnaissance of the Upper Sevier River Basin, Utah: U.S. Geological Survey Water-Supply Paper 1836, 91p.

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

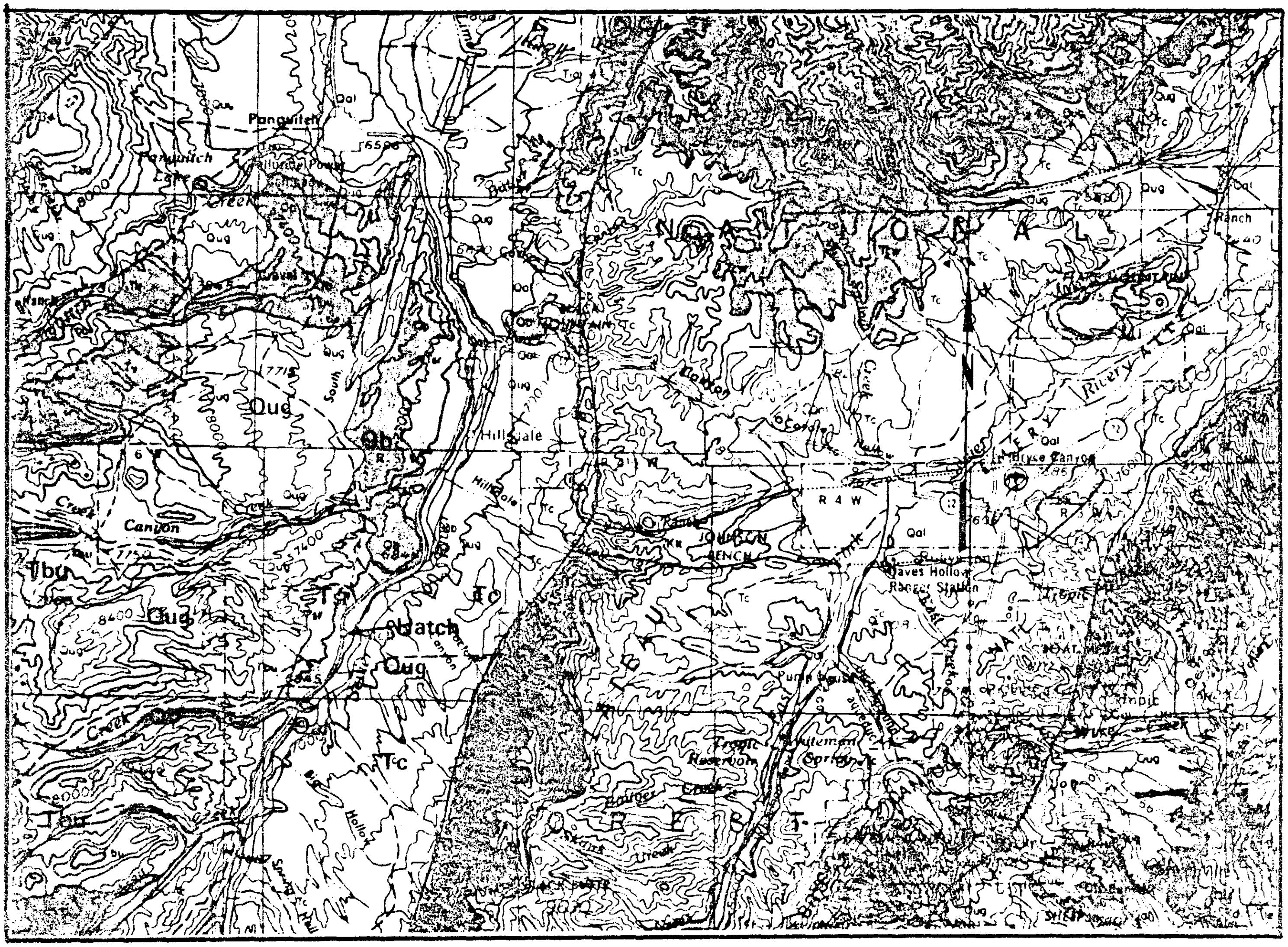
Gregory, H.E., 1949, Geologic and geographic reconnaissance of eastern Markagunt Plateau, Utah: Geological Society of America Bulletin, v. 60, pp. 969-998.

1951, The geology and geography of the Paunsaugunt Region, Utah: U.S. Geological Survey Professional Paper 226, 116p.



Location map showing Hatch Well No. 3 and other water wells in vicinity. Scale 1:24,000

Base map taken from Hatch, Utah
7-1/2 minute series topographic
quadrangle map.



Geologic map of Hatch and vicinity. Scale 1:250,000. (After Doelling, 1975)

Explanation*

Qal	Alluvium; larger alluvial areas along stream course or in low places.
Qug	Undifferentiated gravel; unconsolidated gravels and associated clastics of undifferentiated origin.
Qb	Basalt; conspicuous basaltic volcanics and flows of Quaternary age (some may be Late Tertiary).
Tsr	Sevier River Formation; interstratified gray or gray brown conglomerate, sandstone, and impure clay.
Tbu	Brian Head Group (undifferentiated); volcanics, flows, tuffs, sandstone, shale, limestone and conglomerate.
Tc	Clarian (Wasatch) Formation; red or pink limestone, conglomerate, white dolomite.

*Geologic units shown in explanation restricted to those found in the vicinity of Hatch

Attachment 3, memo of July 11, 1983 to D. Blake

Driller's Logs for Wells in the Vicinity of
Hatch Culinary Water Well No. 3*
(Refer to Attachment 1 for Well Locations)

Well A

Total depth 242 feet, date complete 8/24/82, water level 15 feet.

0' - 15'	clay, gravel
15' - 75'	clay, gravel
75' - 160'	clay, sand
160' - 215'	clay
215' - 242'	gravel

Well B

Total depth 175 feet, date complete 8/6/75, water level 24 feet.

0' - 172'	Sevier conglomerate
172' - 175'	lime

Note: Well drilled and logged by same company that completed Hatch Well No. 3.

Well C

Total depth 86 feet, date complete 2/17/78, water level 37 feet.

0' - 86'	clay, gravel, cobbles

Well D

Total depth 186 feet, date complete 9/48, water level 38 feet.

0' - 140'	hard pan with lava gravel
140' - 150'	yellow clay
150' - 165'	lava sand and stone
165' - 186'	lighter sandstone

Well E

Total depth 350 feet, date complete 8/11/71, water level 105 feet.

0' - 50'	gravel
50' - 75'	clay, sand, gravel (fine gravel, 1/2-inch minus)
75' - 100'	sand, gravel (very fine gravel, 1/4-inch minus)
100' - 120'	sand, gravel (fine gravel)
120' - 145'	sand, gravel (tight and very fine)
145' - 155'	clay, sand (cemented)
155' - 165'	clay, gravel (very little clay)
165' - 182'	gravel (tight)
182' - 194'	limestone.

194' - 200'		brown shale
200' - 210'		sand bedrock (tight)
210' - 220'		clay, gravel, bedrock (fine gravel)
220' - 250'		clay, sand, bedrock
250' - 260'		clay, bedrock
260' - 270'		clay, sand, bedrock (red)
270' - 280'		clay, sand, gravel (fine gravel)
280' - 310'		clay, bedrock (red)
310' - 350'		clay, sand, bedrock

*Logs reproduced exactly as they appear on driller's report; no new test borings completed for this investigation.

Attachment 4, memo of July 11, 1983 to D. Blake

Loa of Septic Tank Excavation*
Burger Bov Drive-In
Hatch, Utah
6-21-83

Depth	Soil Description
0.0' - 2.5'	Gravelly clayey sand (SC); dark brown to gray brown, dense, low to moderate plasticity, dry, nonindurated.
2.5' - 4.5'	Sandy gravel with cobbles (GP); brown, medium dense, nonplastic, dry, nonindurated; some thin discontinuous sand stringers.
4.5' - 5.5'	Silty sand with gravel (SM); red brown, dense, non-to slightly plastic, dry, nonindurated; discontinuous layer not found on east side of excavation.

*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: Investigation of geology and soil conditions for wastewater disposal, Pine Meadow Ranch Plats E, F, and G, Summit County.			Requesting Agency: Utah Division of Environmental Health
By: G.E. Christenson	Date: July 29, 1983	County: Summit	Job No.: WW-6
USGS Quadrangle: Wanship (1250), Big Dutch Hollow (1251)			

July 29, 1983

M E M O R A N D U M

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary Christenson, Geologist

SUBJECT: Suitability of soils in Plats E, F, and G of the Pine Meadow Ranch Subdivision, Summit County, for soil absorption fields.

Background

At the request of Steven Thiriot, Utah Division of Environmental Health, an inspection was made of plats E, F, and G of the Pine Meadow Ranch Subdivision in Summit County. The subdivision includes parts of sections 16, 17, 20, and 21, T. 1. N., R. 4 E., Salt Lake Baseline and Meridian, about 5 miles west of Wanship at the heads of Tollgate and Alexander Canyons. The purpose of the inspection was to evaluate geologic conditions in the area with respect to suitability for disposal of domestic liquid wastes in septic tank soil absorption fields. The field inspection was performed on July 18, 1983, with Mr. Thiriot and Brent Southerland, representative of the Pine Meadow Ranch Owners Association.

Scope of Work

The scope of work consisted of:

1. Review of existing literature, including previous geologic reports for this and adjacent areas (Kaliser, 1972: McGriffin, 1973).
2. Interpretation of aerial photographs.
3. Review of soil logs and percolation tests submitted to the Summit County Health Department by the Pine Meadow Ranch Owners Association.
4. Excavation and logging of 12 backhoe test pits (attachments 1 and 2).
5. Field reconnaissance.

Geology and Soils

The entire portion of Pine Meadow Ranch (plats E, F, and G) studied is underlain by the Eocene Wasatch Formation (Hintze, 1982; Mullens, 1971), previously termed the Knight Conglomerate (Intermountain Association of Geologists, 1969) or the Knight Formation of the Wasatch Group (Intermountain Association of Petroleum Geologists, 1959). The unit is generally described as consisting of fluvial deposits of conglomerate and shale. Such deposits occur locally in the area, but the majority of rock observed during the field inspection was gray volcanic tuff, tuff breccia, and tuffaceous sandstone which probably overlies the Wasatch Formation. Outcrops of these volcanic rocks are few and are generally restricted to road cuts and steep slopes. In seven of the 12 test pits, weathered rock was within two feet of the surface (attachment 2). It was within six feet in another. Rock sufficiently fresh that it could not be penetrated by the backhoe was encountered in five of the 12 test pits at depths ranging from three to seven feet.

Soils overlying bedrock are variable but consist generally of silty topsoil underlain by silty to clayey gravel or gravelly clay (attachment 2). Much of this material contains well-rounded quartzite and sandstone clasts and is thus of colluvial origin, i.e. it is derived from another unit in the Wasatch Formation and not from the underlying volcanic bedrock. Where weathered rock occurs, it commonly is decomposed to sandy clay or clayey sand with gravel. No ground water was encountered in any test pits.

Suitability for Soil Absorption Systems

Shallow bedrock, clayey soils, and steep slopes make much of the area poorly suited for soil absorption systems. The soil data submitted to the Summit County Health Department by the owner's association does not accurately reflect the conditions we found at Pine Meadow Ranch. Several of our test pits were excavated within tens of feet of the previous test pits, but the logs for their pits show little similarity to ours.

Our test pits were located to evaluate geologic conditions and were not chosen specifically to test the most likely suitable areas on individual lots. However, it appears that some lots as presently platted may be without sufficient suitable area for a soil absorption field. Slopes exceed 25 percent over large parts and in some cases all of some lots, and shallow rock can be expected over much of the steeply sloping area as well. In some cases, weathered rock is sufficiently decomposed to be considered soil and may be suitable for soil absorption fields as long as adequate separation distances to fresh rock are maintained. Soils in the form of both weathered rock and colluvial materials are clayey and may locally lack the necessary permeability (e.g. test pit 2), but in general sufficient sand and gravel is present in the soil to produce acceptable percolation rates. Data are insufficient at this time to predict which or how many lots will not have sufficient area with adequate soil thickness and permeability for soil absorption systems. Many may require extensive investigations to delineate sufficient suitable area on the lot and some may require an alternate method of domestic waste disposal.

Another aspect of disposal of liquid wastes in soil absorption fields is the potential for contamination of the ground water which serves as the culinary water supply for Pine Meadow Ranch. The presence of shallow bedrock increases the potential for contamination because effluent receives little filtration or treatment when flowing through fractured bedrock. An analysis of the potential for ground-water contamination was not within the scope of this study, but if soil absorption systems are approved attention should be paid to maintaining protection zones around discharge points (wells and springs) and recharge areas.

GEC/ay

References

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 Uinta Mountains, Utah's maverick range: Sixteenth Annual Field Conference, 237 p.

Intermountain Assocation of Petroleum Geologists, 1959, Guidebook to the geology of the Wasatch and Uinta Mountains transition area: Tenth annual Field Conference, 235 p.

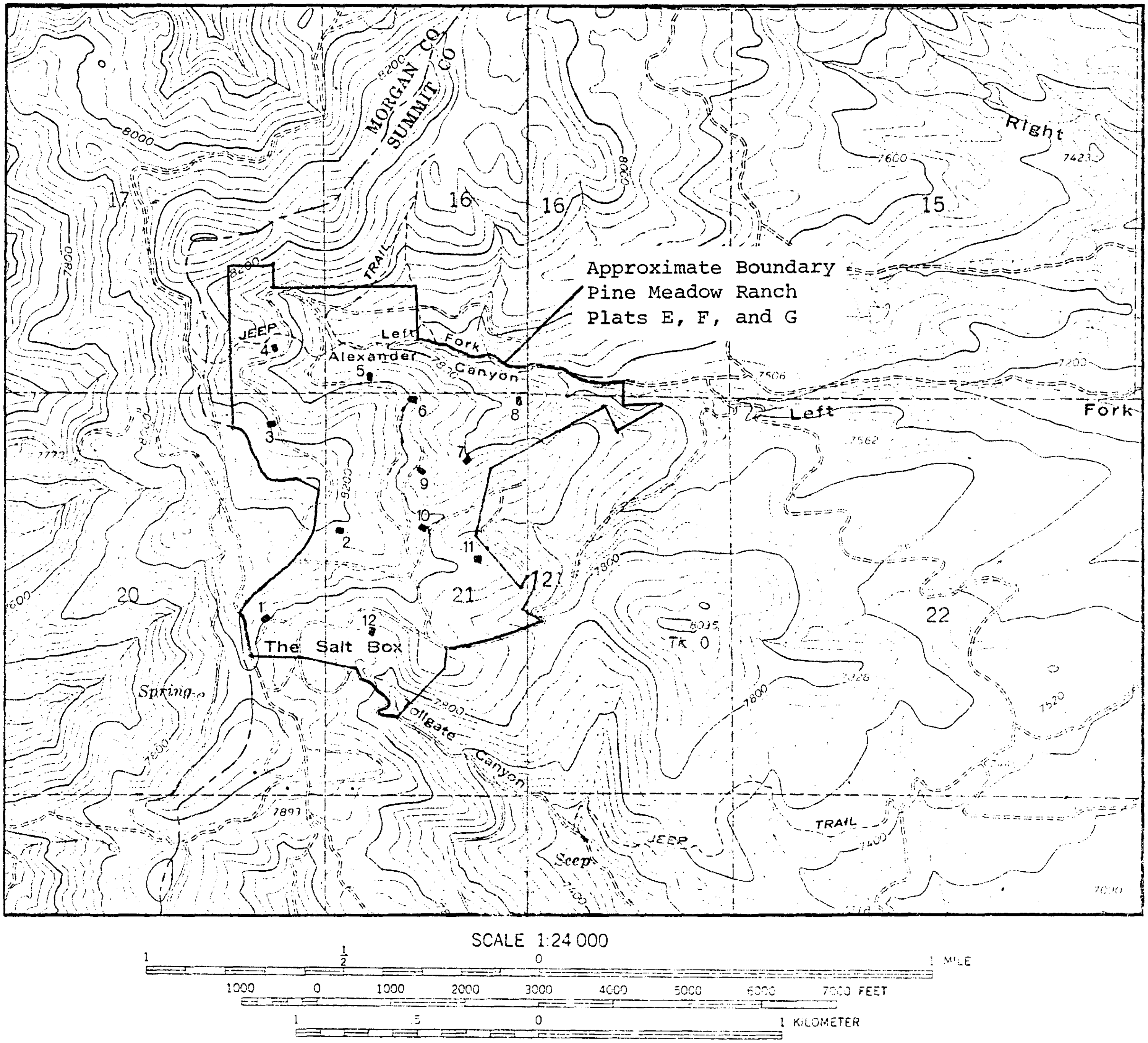
Kaliser, B.N., 1972, Preliminary geologic reconnaissance of the Forest Meadow Ranch properties in Summit and Morgan Counties, Utah: Utah Geological and Mineral Survey Report of Investigation 68, 3 p.

McGriffin, K., 1973, Geologic report on the Pine Meadow Ranch and Forest Meadow Ranch properties in Summit and Morgan Counties, Utah: 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.

Attachment 1, memo of July 29, 1983 to W.R. Lund

Base map from: USGS 7.5 topo quads
Big Dutch Hollow, Utah
Wanship, Utah



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Explanation

2 ◆ Test Pit

Location of test pits, Pine Meadow Ranch, Summit County

Attachment 2, memo of July 29, 1983 to W.R. Lund

Test Pit Logs

Soil Description*

Test Pit 1

0' - 1.5' Sandy silt (ML); black, firm to stiff, low plasticity, dry, nonindurated; topsoil.

1.5' - 6' Weathered pumiceous lithic tuff and tuff breccia; fractured, locally altered to gravelly clayey sand (SC).

Test Pit 2

0' - 2' Sandy silt (ML); black to brown, firm to stiff, low plasticity, dry, nonindurated; topsoil.

2' - 5' Sandy silt (ML); black, stiff, low plasticity, dry, nonindurated.

5' - 8' Sandy clay (CL); red to black, very stiff, medium to high plasticity, dry, nonindurated.

Test Pit 3

0' - 2' Sandy silt (ML); black, firm to stiff, low plasticity, dry, nonindurated; topsoil.

2' - 7' Weathered lithic tuff and tuff breccia; massive, refusal at 7 feet.

Test Pit 4

0' - 2' Sandy silt (ML); black, firm to stiff, low plasticity, dry, nonindurated; topsoil.

2' - 9' Silty gravel-clayey gravel (GM-GC); yellow, medium density, low to moderate plasticity, moist, nonindurated; weathered, rounded quartzite and tuff clasts.

Test Pit 5

0' - 2' Sandy silt (ML); black, firm to stiff, low plasticity, dry, nonindurated; topsoil.

2' - 7' Weathered tuff and tuffaceous sandstone, fresh to completely altered to sandy clay (SC).

*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.

Test Pit 6

0' - 1'	Gravelly silt (ML); black, firm to stiff, low plasticity, dry, nonindurated; colluvium, rounded gravel clasts.
1' - 3'	Gray pumiceous tuff; refusal at 3 feet.

Test Pit 7

0' - 3'	Gravelly silt (ML); black, firm to stiff, low plasticity, dry, nonindurated.
3' - 5'	Clayey sand (SC); red, medium density, medium plasticity, moist, nonindurated.
5' - 10'	Sandy clay-clayey sand (CL-SC); brown, medium density (stiff), high plasticity, moist, nonindurated.

Test Pit 8

0' - 2'	Gravelly silt (ML); black, firm to stiff, low plasticity, dry, nonindurated.
2' - 6'	Weathered tuff; locally weathered to clayey sand (SC).
6' - 8'	Weathered and fresh tuff; refusal at 6 feet in north end of test pit, more deeply weathered in south end.

Test Pit 9

0' - 2'	Silty gravel (GM); black, medium density, low plasticity, dry, nonindurated.
2' - 7'	Gray to yellow, weathered tuff and tuffaceous sandstone; locally altered to clayey sand (SC).

Test Pit 10

0' - 2'	Silty sand-sandy silt (SM-ML); black, medium density, low plasticity, dry, nonindurated.
2' - 4'	Weathered to fresh, gray tuff and tuffaceous sandstone; refusal at 4 feet.

Test Pit 11

0' - 7'	Silty gravel (GM); black to yellow, low density, low plasticity, dry, nonindurated; 30 percent cobbles of fresh quartzite and weathered tuff.

Test Pit 12

0' - 2' to Silty gravel-clayey gravel (GM-GC); black, medium density, low moderate plasticity, dry, nonindurated.

2' - 5' Gravelly clay (CL); red, hard, moderate to high plasticity, dry, nonindurated.

5' - 6' Red, white, and yellow-gray conglomerate; matrix of tuffaceous siltstone and claystone, clasts of rounded sandstone and quartzite; refusal at 6 feet.

NOTE: No ground water encountered in any test pits.

Project: Investigation of geology and soil conditions for wastewater disposal, Strawberry Lake Estates Subdivision, Wasatch County			Requesting Agency: Wasatch County Health Dept.
By: G. E. Christenson	Date: 8/26/83	County: Wasatch County	Job No.: WW-7
USGS Quadrangle: Strawberry Reservoir NE (1042)			

August 26, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Suitability of soils in Strawberry Lake Estates Subdivision, Wasatch County, for soil absorption fields.

BACKGROUND

At the request of Phil Wright, Wasatch County Health Department, an inspection was made of the Strawberry Lake Estates Subdivision, Wasatch County. The parts of the subdivision studied are in section 32, T. 3 S., R. 10 W., and sections 6 and 7, T. 4 S., R. 10 W., Uintah Baseline and Meridian (attachement 1). The purpose of the inspection was to evaluate geologic conditions in the area with respect to suitability for disposal of domestic liquid wastes in septic tank soil absorption fields. The field inspection was performed on August 16, 1983, with Mr. Wright.

SCOPE OF WORK

The scope of work consisted of:

1. Review of published geologic literature
2. Interpretation of aerial photographs
3. Logging of 23 test pits (attachment 2)
4. Field reconnaissance

GEOLOGY AND SOILS

The entire portion of Strawberry Lake Estates studied is underlain by the Eocene Uintah Formation (Intermountain Association of Petroleum Geologists, 1959; Mundorff, 1977). The unit consists of interbedded sandstone and claystone. Bedding strikes generally north-south and dips gently to the east. Rocks of the Uintah Formation are generally nonresistant and weather rapidly. Alternating beds of sandstone and claystone have weathered to sand, silty and clayey sand, and clay and were encountered in nearly all test pits. In area A (attachment 1) Uintah Formation rocks are very highly weathered and overlain locally by several feet of clayey gravel and gravelly clay. Gravel clasts in these layers are chiefly well-rounded sandstone and are probably reworked terrace gravels of Soldier Creek. The underlying Uintah Formation is completely decomposed to sand and clay to depths generally exceeding 9 feet.

In area B, the Uintah Formation is not so deeply weathered and is not overlain by younger gravelly deposits. A typical profile consists of a thin topsoil underlain by alternating layers of weathered sandstone and claystone. Locally sandstone layers are not completely decomposed and several test pits encountered layers sufficiently fresh that they could not be penetrated with a backhoe. Several other tests pits exposed fresh sandstone layers which were sufficiently thin and fractured to be penetrated. Sandstone outcrops are found throughout the area.

No ground water was encountered in any test pits. Clumps of vegetation on hillsides in area B indicate possible shallow ground-water areas but no springs were found.

SUITABILITY FOR SOIL ABSORPTION SYSTEMS

Conditions on the property are variable. Area A appears to be generally suitable for drainfields. Although materials below 4-5 feet are technically bedrock, they are sufficiently weathered to be classified as residual soils and are very sandy. The overlying clayey gravels and gravelly clays probably have very low percolation rates as do clay layers between sands. However, sufficient thicknesses of sand were present in most test pits to provide adequate percolation. Slopes are gentle in this area and surface seepage should not be a problem.

Conditions in area B are somewhat less suitable. While many test pits encountered relatively thick layers of sand, others encountered shallow fresh rock and thick clay beds. Also, topography in area B is irregular with some steep slopes. Wastewater introduced into sand layers between clay beds may migrate along the layer and seep out along slopes where gullies have cut through the sand beds. For these reasons, it is believed that some lots in area B may prove unsuitable for drainfields. Considerable investigation will be required on some lots to determine if a suitable drainfield location exists, and deep trenches may be needed to find adequate soils and avoid possible surface seepage problems on others.

GEC/co

REFERENCES

Bissel, H. J., 1952, Stratigraphy and structure of northeast Strawberry Valley Quadrangle, Utah: American Association of Petroleum Geologists Bulletin, v. 36, p. 575-634.

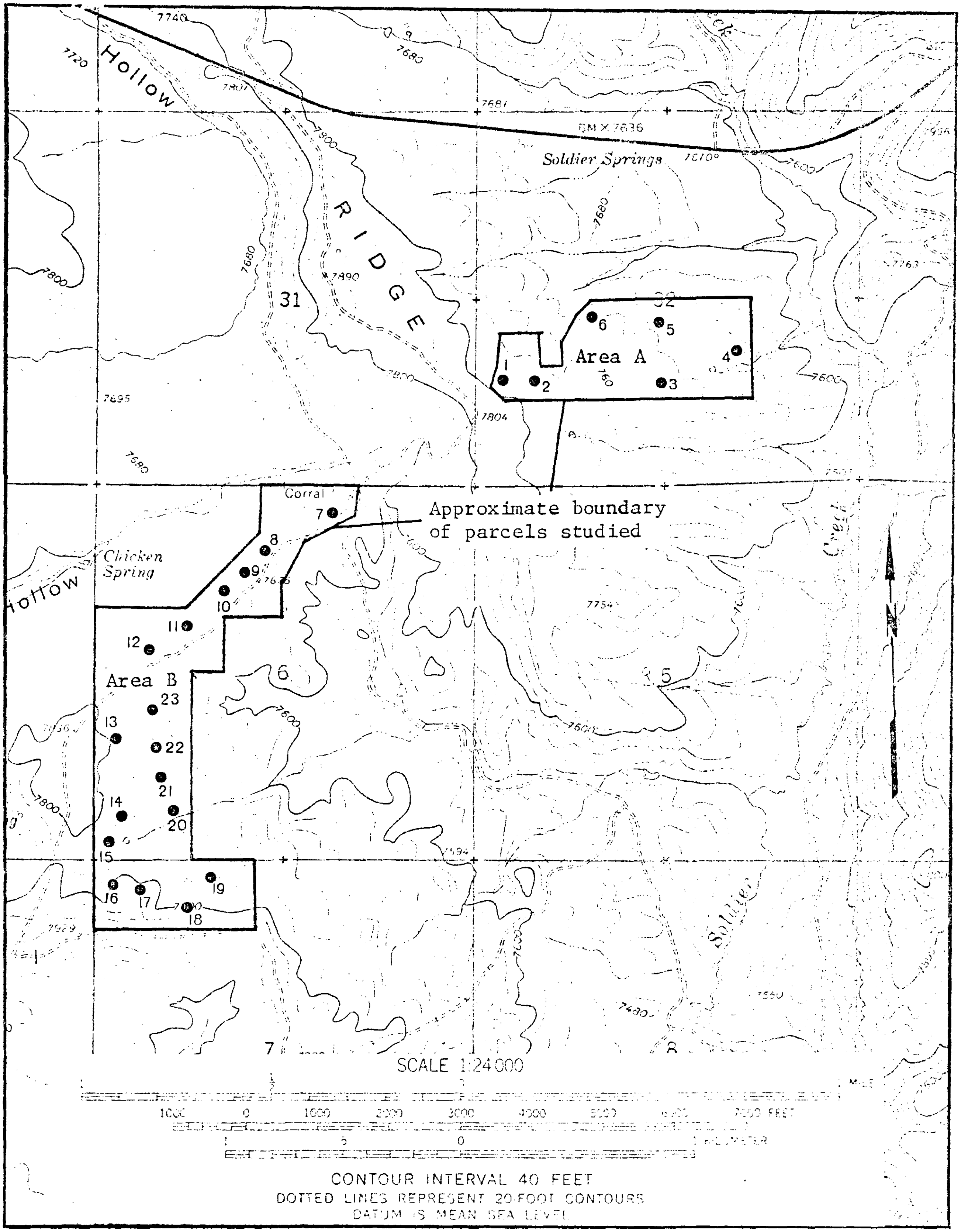
Hood, J. W., Mundorff, J. C., and Price, D., 1976, Selected hydrologic data, Uinta Basin area, Utah and Colorado: Utah Basic-Data Release No. 26, 321 p.

Intermountain Association of Petroleum Geologists, 1959, Guidebook to the geology of the Wasatch and Uinta Mountains transition area: Tenth Annual Field Conference, 235 p.

Mundorff, J. C., 1977, Reconnaissance of water quality in the Duchnesne River Basin and some adjacent drainage areas, Utah: Utah Department of Natural Resources Technical Publication No. 55, 47 p.

Attachment 1, memo of 8/26/83 to W. R. Lund

Base map from: USGS 7½' Topo Quad
Strawberry Reservoir NE, Utah



Approximate location of test pits, Strawberry Lake Estates, Wasatch County

Attachment 2, memo of 8/26/83 to W.R. Lund

Logs of Test Pits

Strawberry Lake Estates Subdivision

Soil Description*

Test Pit 1

0' - 1.5' Sandy clayey silt (ML); black, firm to stiff, low plasticity, moist, nonindurated; topsoil, 15 percent gravel and cobbles.

1.5' - 3.5' Clayey gravel (GC); red, medium dense, medium plasticity, moist, nonindurated.

3.5' - 5.5' Sandy clay (CL); red, stiff, medium to high plasticity, moist, nonindurated.

5.5' - 8.5' Sand - clayey sand (SP-SC); red to orange, medium dense, nonplastic to medium plasticity, moist, nonindurated.

8.5' - 9.5' Clayey sand (SC); green, low to medium dense, medium plasticity, moist, nonindurated; vesicular.

Test Pit 2

0' - 1.5' Sandy clayey silt (ML); black, firm to stiff, low plasticity, moist, nonindurated; topsoil, 15 percent gravel and cobbles.

1.5' - 4' Clayey gravel (GC); red, medium dense, medium plasticity, moist, nonindurated.

4' - 9' Interbedded clayey sand and sandy clay (SC, CL); red to green, medium dense to stiff, low to medium plasticity, moist, nonindurated.

Test Pit 3

0' - 1' Sandy clayey silt (ML); black, firm to stiff, low plasticity, moist, nonindurated; topsoil, 15 percent gravel and cobbles.

1' - 3.5' Gravelly clay (CL); red, stiff, medium plasticity, moist, nonindurated.

*Soils classified in accordance with procedures outlines in ASTM Standard D2488-66 (Revised 1975), Description of Soils (Visual Manual Procedure). Percentages recorded for various grain size fractions are field estimates.

3.5' - 5' Sandy gravel (GP); red, medium dense, nonplastic, dry, nonindurated.

5' - 7' Sand (SP); yellow, medium dense, nonplastic, dry, nonindurated.

7' - 7.5' Sandy clay (CL); green, stiff, medium plasticity, dry, nonindurated.

Test Pit 4

0' - 1.5' Sandy clayey silt (ML); black, medium dense, low plasticity, moist, nonindurated.

1.5' - 3.5' Gravelly clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated.

3.5' - 9.5' Silty sand (SM); yellow, medium dense, nonplastic, moist, nonindurated.

Test Pit 5

0' - 1' Silty gravel (GM); black, medium density, low plasticity, moist, nonindurated; topsoil.

1' - 8' Silty sand - sand (SM-SP); yellow, medium dense, nonplastic, moist, nonindurated.

Test Pit 6

0' - 1' Sandy clayey silt (ML); black, medium dense, low plasticity, moist, nonindurated; topsoil.

1' - 5' Gravelly clayey sand (SC); red, medium dense, low to medium plasticity, moist, nonindurated.

5' - 8.5' Silty sand - sand (SM-SP); yellow, medium dense, nonplastic, moist, nonindurated.

8.5' - 9' Sandy clay (CL); green, firm to stiff, medium plasticity, moist, nonindurated.

Test Pit 7

0' - 2' Clay (CL); red, stiff, medium to high plasticity, moist, nonindurated.

2' - 7.5' Silty sand (SM); green, medium dense, nonplastic, moist, nonindurated; unweathered sandstone beds present locally.

7.5' - 8' Sandy clay (CL); red, stiff, medium to high plasticity, moist, nonindurated.

Test Pit 8

0' - 2.5'	Clay (CL); red, stiff, medium to high plasticity, moist, nonindurated.
2.5' - 5.5'	Silty sand (SM); green, medium dense, nonplastic, moist, nonindurated; unweathered sandstone encountered at 4.5 feet, refusal at 5.5 feet.

Test Pit 9

0' - 2.5'	Clayey sand (SC); red, medium dense, low to medium plasticity, dry, nonindurated.
2.5' - 5.5'	Clayey sand (SC); red, high density, medium plasticity, dry, moderately indurated.
5.5' - 7'	Yellow to green sandstone, fractured; refusal at 7 feet.

Test Pit 10

0' - 4'	Clay (CL); brown, very stiff, medium to high plasticity, dry, nonindurated.
4' - 8'	Sandy clay - clayey sand (CL-SC); yellow, medium dense, low to medium plasticity, dry, nonindurated.

Test Pit 11

0' - 1.5'	Clay (CL); red, firm, medium to high plasticity, moist, nonindurated.
1.5' - 2.5'	Sand (SP); yellow, medium to high density, nonplastic, moist, nonindurated; unweathered sandstone present locally.
2.5' - 3.5'	Clay (CL); red, firm, medium to high plasticity, moist, nonindurated.
3.5' - 7'	Sand (SP); yellow, medium density, nonplastic, moist, nonindurated.

Test Pit 12

0' - 6'	Clay (CL); red, firm, medium to high plasticity, dry, nonindurated.
6' - 6.5'	Sand (SP); yellow, medium density, nonplastic, moist, nonindurated.

Test Pit 13

0' - 6.5'	Silty sand - clayey sand (SM-SC); red, medium dense, low to medium plasticity, moist, nonindurated.
6.5' - 8.5'	Sand (SP); yellow, medium density, nonplastic, moist, nonindurated.

Test Pit 14

0' - 2.5'	Sandy clayey silt (ML); black, firm to stiff, low plasticity, moist, nonindurated; topsoil and colluvium; includes weathered, angular sandstone clasts.
2.5' - 7.5'	Sand (SP); yellow, medium to high density, nonplastic, moist, nonindurated; unweathered sandstone beds present locally.

Test Pit 15

0' - 0.5'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.
0.5' - 1.5'	Clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated.
1.5' - 7'	Sand (SP); red to yellow, medium dense, nonplastic, moist, nonindurated.

Test Pit 16

0' - 1.5'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.
1.5' - 3'	Clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated.
3' - 4.5'	Yellow sandstone.
4.5' - 5'	Gray-green claystone; refusal at 5 feet.

Test Pit 17

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.
1' - 4'	Clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated.

4' - 5' Red-gray claystone; weathered.

5' - 6' Yellow sandstone; weathered.

6' - 7' Red-gray claystone; weathered.

<u>Test Pit 18</u>

0' - 0.5' Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.

0.5' - 1.5' Sandy clay (CL); red, very stiff, medium to high plasticity, dry, nonindurated.

1.5' - 5' Yellow sandstone; weathered, fine-grained.

<u>Test Pit 19</u>

0' - 0.5' Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.

0.5' - 3' Sandy clay (CL); red, very stiff, medium to high plasticity, dry, nonindurated.

3' - 6' Silty sand (SM); yellow, medium dense, low plasticity, moist, nonindurated.

6' - 6.5' Sandy clay (CL); red, very stiff, medium to high plasticity, dry, nonindurated.

<u>Test Pit 20</u>

0' - 1' Sandy silt (ML); black, firm, low plasticity moist, nonindurated; topsoil.

1' - 3' Sandy clay (CL); gray to yellow, stiff, medium to high plasticity, moist, nonindurated.

3' - 5.5' Silty sand (SM); yellow, medium dense, low plasticity, moist, nonindurated.

<u>Test Pit 21</u>

0' - 1' Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.

1' - 8.5' Clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated; lenses of yellow sand (SP).

Test Pit 22

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated; topsoil.
1' - 4'	Sandy clay (CL); red, very stiff, medium to high plasticity, moist, nonindurated.
4' - 5.5'	Clayey sand (SC); yellow to red, medium dense, medium plasticity, moist, nonindurated.
5.5' - 7'	Silty sand (SM); yellow, medium dense, nonplastic, moist, nonindurated.

Test Pit 23

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated.
1' - 6'	Yellow sandstone; blocky, jointed.
6' - 9'	Sandy clay (CL); yellow, firm, medium plasticity, moist, nonindurated.

Note: No ground water encountered in any test pits, test pit walls stable.

Project: Investigation of geology and soil conditions for wastewater disposal, Delta Valley Estates, Millard County.			Requesting Agency: Central Utah District Health Department
By: W.R. Lund	Date: Sept. 2, 1983	County: Millard	Job No.: WW-8
USGS Quadrangle: Delta (767)			

September 2, 1983

Jerald A. Finlinson, R.S.
Environmental Health Specialist
Central Utah District Health Department
P.O Box 176
Delta, Utah 84624

Dear Mr. Finlinson:

This letter presents the results of a geologic investigation conducted on August 22, 1983, of Delta Valley Estates Subdivision in Millard County. The subdivision consists of 28 five-acre lots located 2-1/2 miles east of Delta in the NW1/4 sec. 10, T. 17 S., R. 6 W., Salt Lake Baseline and Meridian (attachment 1). The purpose of the inspection was to evaluate geologic conditions at the property with respect to suitability for individual wastewater disposal systems utilizing septic tanks and soil absorption fields. The investigation included a review of geologic, hydrologic, and soil information for the area, a field reconnaissance, and logging of ten backhoe test pits.

The ground surface at the proposed subdivision is gently undulatory with a general 2 to 4 percent slope to the southwest. Surface drainage is by means of overland flow and small ephemeral streams. A moderate cover of vegetation, primarily greasewood, exists on the property. The climate is arid to semiarid with an average annual precipitation of 6 to 8 inches (Stott, 1977). Access to the subdivision is provided by State Highway 125 which forms the southern property boundary.

Bedrock does not crop out in the subdivision nor does it lie close to the ground surface. The entire site is underlain by Lake Bonneville sediments which are covered in most places by a variable thickness of eolian sand or alluvium deposited by ephemeral streams. The eolian sand is fine-to medium-grained, loosely consolidated, and consists mainly of subrounded quartz grains. The alluvium ranges from silty sand to clay and is comprised of reworked dune sand and lake sediment. The Lake Bonneville sediments include fine-grained silty sand, sandy silt, silty clay, and clay (attachment 2). In the test pits, the lake sediments usually become finer-grained with depth and thick layers of varved sand and clay were observed at several locations. A very stiff to hard, medium to high plasticity clay was encountered in the bottom of nine of the test pits. Desiccation cracks, often 1/8-inch or more wide, have formed where the clay is dry (attachment 2).

Ground water was not encountered in any of the test pits and is estimated to be 20 feet or more below the surface.

Although ranging from good to poor in suitability for soil absorption systems, the eolian and alluvial surface deposits covering the property are too thin (usually 3 feet or less) to be of significance in waste disposal considerations. Most absorption fields would be placed in the Lake Bonneville sediments. Where adequately thick, the sand layers in the lake sediments would be satisfactory for a soil absorption system. The varved deposits of alternating sand and clay could also accommodate absorption systems, provided that the varved section contains 40 percent or greater sand. The medium to high plasticity clay found in the bottom of most of the test pits is not suitable for soil absorption systems. Percolation test results faster than 60 minutes per inch reported for the clay likely reflect the presence of desiccation cracks. Depth to the clay layer in the test pits varies from less than 1-1/2 feet to more than 8 feet (attachment 2) indicating that while some areas of the subdivision may be suitable for soil absorption systems others are not. The large size of the lots (5 acres) allows for some latitude in locating a suitable disposal site, but it should be anticipated that some lots may not possess an acceptable site. A backhoe test pit at each proposed absorption field location is recommended so that soils may be evaluated prior to installation of waste disposal systems.

It is hoped that the information provided in this letter will assist you in evaluating the suitability of septic tank and soil absorption systems for the lots in Delta Valley Estates Subdivision. If you have any questions, or if we may be of further assistance, do not hesitate to contact our office.

Sincerely,

William R. Lund
Site Investigation Section

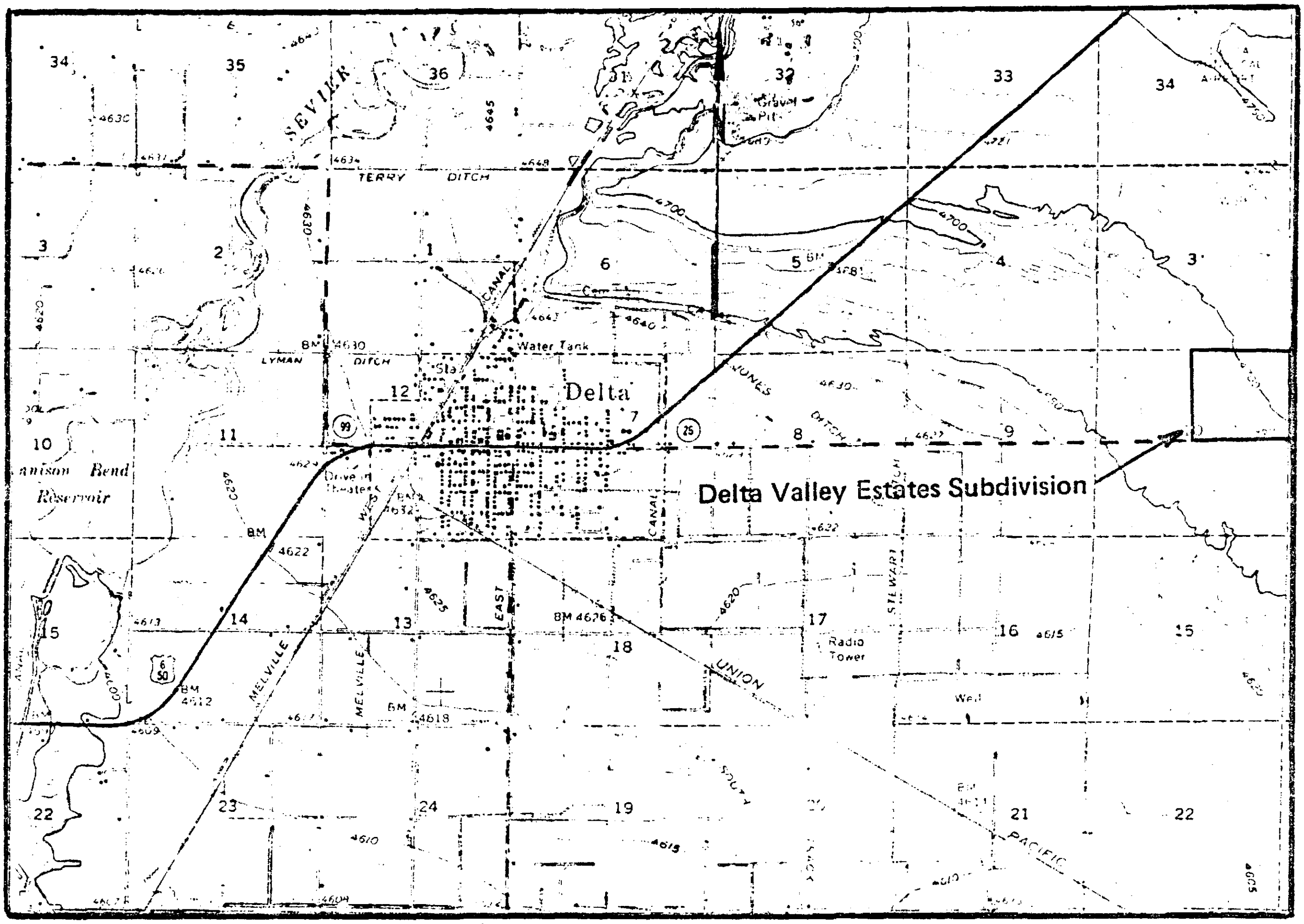
WRL/co

Selected References

Stokes, W.L., 1963, Geologic map of southwestern Utah: College of Mines and Mineral Industries University of Utah, scale 1: 250,000.

Stott, L.H., 1977, Soil survey of Delta area, Utah, part of Millard County: U.S.D.A. Soil Conservation Service, 77 p.

Attachment 1, letter of 9/2/83 to Jerald Finlinson, Central Utah District Health Dept.



Location map showing Delta Valley Estates subdivision. Scale 1:62:000

Base map from: USGS 15' topographic quadrangle map Delta, Utah

Utah Geological and Mineral Survey

Site Investigations Section

Attachment 2, letter of 9/2/83 to Jerald Finlinson, Central Utah Dist. Health Dept.

Test Pit Logs*
Delta Valley Estates Subdivision
T. 17 S., R. 6 W., NW1/4 sec. 10, SLB&M

Lot 6

0.0' - 4.0' Silty sand (SM); light brown, medium dense, nonplastic to low plasticity, dry, weakly indurated.

4.0' - 10.0' Silty clay (CL); gray to light tan, very stiff to hard, medium plasticity, dry to moist with depth, nonindurated; numerous desiccation cracks where clay is dry.

Lot 4

0.0' - 4.4' Silty sand (SM); light brown, low to medium density, nonplastic to low plasticity, dry, weakly indurated.

4.4' - 8.7' Sandy silt (ML); light brown, stiff, low plasticity, dry, weakly indurated.

8.7' - 9.6' Silty clay (CL); gray, very stiff to hard, medium plasticity, dry, nonindurated.

Lot 2

0.0' - 2.4' Clay (CL/CH); dark brown, hard, high plasticity, dry, nonindurated; numerous desiccation cracks.

2.4' - 3.7' Silty sand (SM); brown, medium dense, nonplastic, dry, weakly indurated; numerous tubular root holes.

3.7' - 5.6' Sand (SP); light brown, loose, nonplastic, dry, nonindurated; well sorted fine sand.

5.6' - 9.7' Varved sand and silty clay (SP & CL); alternating layers of loose to medium dense, nonplastic quartz sand and very stiff, medium plasticity silty clay; average width sand layers 0.05 feet, clay 0.1 feet - 0.12 feet.

*Soils classified in accordance with procedures outlined in ASTM Standard D2488-69 (Revised 1975), Description of Soils (Visual Manual Procedure).

Lot 12

0.0' - 3.3' Sandy clay-clayey sand (CL-SC); dark brown, stiff to medium dense, low plasticity, dry, weakly indurated.

3.3' - 8.1' Varved silty sand and silty clay (SM & CL); alternating layers of medium dense, nonplastic silty sand and very stiff, medium plasticity silty clay; average width sand layers 0.05 feet - 0.07 feet, clay 0.1 feet - 0.12 feet.

8.1' - 9.4' Silty clay (CL); light brown to gray, very stiff, medium plasticity, dry, nonindurated.

Lot 10

0.0' - 1.3' Silty sand (SM); light brown, loose, nonplastic, dry, nonindurated.

1.3' - 5.5' Varved silty sand and silty clay (SM & CL); alternating layers of medium dense, nonplastic silty sand and very stiff, medium plasticity silty clay; average width sand layers 0.05 feet, clay 0.1 feet.

5.5' - 9.9' Silty clay-clay (CL-CH); light brown to gray, very stiff, medium to high plasticity, dry, nonindurated; numerous desiccation cracks.

Lot 19

0.0' - 1.4' Sandy silt (ML); brown, soft to firm, low plasticity, dry, nonindurated.

1.4' - 8.0' Silty clay-clay (CL-CH); light brown to gray, very stiff to hard, medium to high plasticity, dry to moist with depth, nonindurated.

8.0' - 10.2' Silty clay with sand (CL); light brown, very stiff, low to medium plasticity, moist, nonindurated.

Lot 17

0.0' - 2.1' Sandy clay (CL); brown, stiff, low plasticity, dry, nonindurated.

2.1' - 5.5' Varved silty sand and silty clay (SM & CL); alternating layers of medium dense, nonplastic silty sand and very stiff, medium plasticity silty clay; average width silty sand 0.05 feet, clay 0.1 feet - 0.15 feet.

5.5' - 8.9' Silty clay-clay (CL-CH); brown, very stiff, medium to high plasticity, moist, nonindurated.

Lot 28

0.0' - 1.0' Silty sand (SM); brown, loose, nonplastic, dry to moist, nonindurated.

1.0' - 1.9' Clayey sand-sandy clay (SC-CL); brown, low density/stiff, low plasticity, dry, weakly indurated.

1.9' - 3.6' Varved silty sand and silty clay (SM & CL); alternating layers of medium dense, nonplastic silty sand, and very stiff, medium plasticity clay; average width sand 0.05 feet, clay 0.1 feet.

3.6' - 8.5' Silty clay-clay (CL - CH); light brown, very stiff to hard, medium to high plasticity, dry to moist, nonindurated; a few small desiccation cracks.

Lot 26

0.0' 1.3' Clayey sand (SC); brown, loose, low plasticity, dry, nonindurated.

1.3' - 8.4' Silty clay-clay (CL-CH); light brown to gray, very stiff to hard, medium to high plasticity, dry to moist, nonindurated.

Lot 22

0.0' - 2.7 Silty sand (SM); brown, low density, nonplastic to low plasticity, dry, nonindurated.

2.7' - 7.2' Silty clay-clay (CL-CH); light brown, very stiff to hard, medium to high plasticity, dry to moist, nonindurated.

Note: Ground water not encountered in any test pits.

Project: Investigation of geology and soil conditions for wastewater disposal, Strawberry Lake Estates Area C, Wasatch County.			Requesting Agency: Wasatch County Health Dept.
By: G.E. Christenson	Date: Sept. 26, 1983	County: Wasatch	Job No.: WW-9
USGS Quadrangle: Strawberry Reservoir NE (1042)			

September 26, 1983

Phil Wright
Wasatch County Health Department
25 North Main
Heber City, Utah 84032

Dear Phil:

Enclosed are the results of the investigation conducted on September 8, 1983, of the additional area proposed for development at Strawberry Lake Estates in Wasatch County. Results of the previous study in two other parts of this subdivision (areas A and B, attachment 1) were reported in my memorandum of August 21, 1983 to W.R. Lund, copies of which were sent to the Wasatch County Health Department. The location of the new area (area C) and eight test pits on the tract, as well as the areas and test pits studied previously, are shown in attachment 1. Logs of the eight test pits in Area C are included in attachment 2.

Geologic conditions in area C are generally similar to those in Area A. A typical soil profile consists of a thin (1-2.5 feet thick) organic silty topsoil overlying clayey gravels and gravelly clayey sands which in turn overlie highly weathered sandstone and mudstone of the Eocene Uintah Formation. Gravelly layers are probably reworked stream terrace materials and range in thickness from 2 to 6 feet. The underlying sandstone and mudstone is in most cases sufficiently weathered to be considered soil material. However, a relatively fresh sandstone bed was encountered in the bottom of test pit 24 at 7.5 feet, and moderately weathered sandstone beds were present in test pits 25 and 26 at a depth of about 2.5 feet.

In terms of utilization for septic tank soil absorption systems, area C appears marginally suitable. It is anticipated that clay layers in the weathered Uintah Formation will have very slow percolation rates. Thick (3-4 feet) clay layers were found in two test pits, and thin layers were present in nearly all test pits (attachment 2). Gravel and sand layers four feet thick or greater were present in over half of the test pits, although sufficient clay is present in some sands and gravels to significantly reduce percolation rates. Thin clay beds within and beneath sand and gravel layers will reduce vertical permeabilities and most migration of effluent will be laterally away from drainlines along sandy beds. The terrain in area C is gentle for the most part so emergence of untreated effluent along slopes is only of local concern in steeper areas. No ground water was encountered in any test pits.

Because of slow percolation rates, it is probable that some lots in area C will not be suitable for soil absorption fields. Exploration on a lot by lot basis will be required to determine if acceptable conditions exist. Deep systems may be required locally to exploit sand layers and reduce hazards of laterally migrating effluent.

An observation regarding slope stability in this subdivision was made in area C and applies here and in areas A and B of this subdivision. East of the eastern boundary of area C in the vicinity of test pit 25, a small, shallow slump is present on a slope of about 25 percent just above a cut for a subdivision road. While such slumps may be relatively minor, they could undermine or destroy structures built on slopes. It is likely that introduction of water (effluent) into slopes as well as undercutting could induce other such failures in similar slopes. Natural steep slopes subject to failure are generally absent in areas A and C, but they are common in area B. In test pit 17 (area B), bedding in weathered Uintah Formation materials dips steeply into the slope (35°S), indicating that rotational slumping has probably occurred here in the past. Slumps in similar materials in road cuts along Highway 40 in the vicinity of Strawberry Reservoir are a further indication of the potential instability of slopes here.

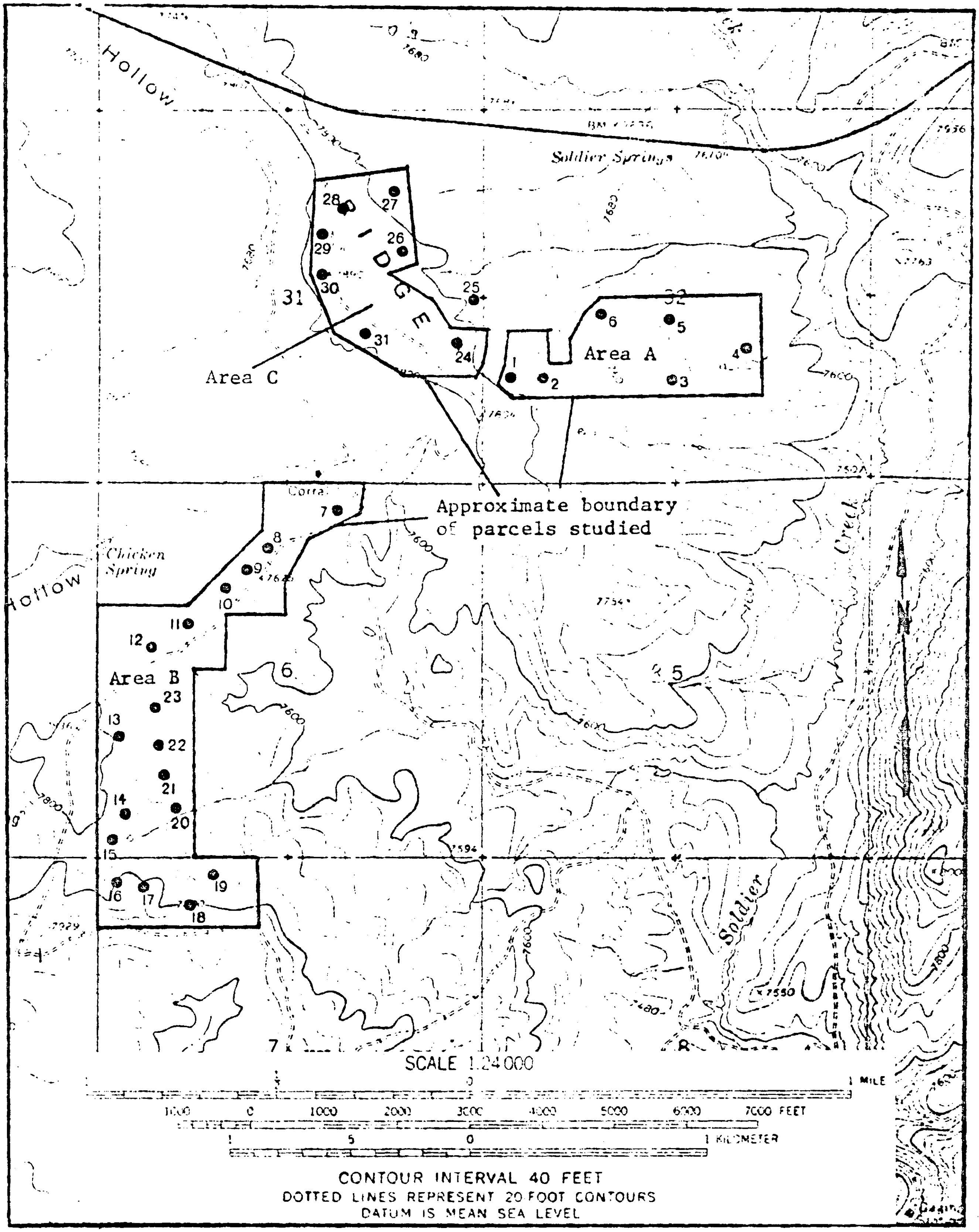
If you have any questions or if I can be of further assistance, please call.

Sincerely,

Gary E. Christenson, Geologist
Site Investigations Section

GEC/co
cc: Mervin Reid, Division of Environmental Health

Base map from: USGS 7½' Topo Quad
Strawberry Reservoir NE, Utah



Approximate location of test pits, Strawberry Lake Estates, Wasatch County

Attachment 2, letter of 9/26/83 to Phil Wright

Logs of Test Pits
Strawberry Lake Estates
Area C

	Description*
Test Pit 24	
0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
1' - 2'	Gravelly clayey sand (SC): yellow-red, medium dense, medium plasticity, dry, nonindurated.
2' - 4.5'	Clay (CL); red, very stiff, medium plasticity, dry, nonindurated.
4.5' - 6'	Sandy clay (CL); red, very stiff, medium plasticity, dry, nonindurated.
6' - 7.5'	Silty sand (SM); yellow, medium dense, nonplastic to low plasticity, dry, nonindurated: refusal at 7.5 feet on sandstone bedrock.
Test Pit 25	
0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
1' - 2.7'	Gravelly clayey sand (SC): yellow-red, medium dense, medium plasticity, dry, nonindurated.
2.7' - 7.5'	Silty sand (SM); yellow, medium to high density, nonplastic to low plasticity: moderately weathered sandstone.
7.5' - 8.5'	Clayey sand (SC); red, medium dense, medium plasticity, moist, nonindurated.

*Soils classified in accordance with procedures outlines in ASTM Standard D2488-69 (Revised 1975): Description of Soil (Visual Manual Procedure).

Test Pit 26

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated topsoil.
1' - 2.5'	Gravelly clayey sand (SC); yellow-red, medium dense, medium plasticity, dry, nonindurated.
2.5' - 5'	Silty sand (SM); yellow, high density, nonplastic, moist, nonindurated: moderately weathered sandstone.
5' - 5.3'	Clay (CL); red, stiff, medium plasticity, moist, nonindurated.
5.3' - 7.5'	Silty sand (SM): yellow, medium dense, low plasticity, moist, nonindurated.

Test Pit 27

0' - 1.5'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
1.5' - 3.5'	Gravelly clayey sand (SC): yellow-red, medium dense, medium plasticity, dry, nonindurated.
3.5' - 5.6'	Clay (CL): red, stiff, medium plasticity, moist, nonindurated.
5.6' - 6'	Silty sand (SM): yellow, medium dense, low plasticity, moist, nonindurated.
6' - 7'	Clay (CL); red, stiff, medium dense, low plasticity, moist, nonindurated.
7' - 8'	Silty sand (SM); yellow, medium dense, low plasticity, moist, nonindurated.

Test Pit 28

0' - 2.5'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
2.5' - 4.5'	Gravelly clayey sand (SC): yellow-red, medium dense, medium plasticity, dry, nonindurated.
4.5' - 5.2'	Sand (SP): yellow, medium dense, nonplastic, moist, nonindurated.
5.2' - 5.5'	Clayey sand (SC): yellow, medium dense, medium plasticity, moist nonindurated.
5.5' - 7'	Clay (CL); red, firm, medium to high plasticity, moist, nonindurated: local thin sand lens.
7' - 8'	Silty sand (SM); gray, medium dense, low plasticity, moist, nonindurated.

Test Pit 29

0' - 2'	Sandy silt ML); black, firm, low plasticity, moist, nonindurated: topsoil.
2' - 8'	Gravelly clayey sand - sandy clayey gravel (SC-GC): red, medium dense, medium plasticity, dry to moist, nonindurated.

Test Pit 30

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
1' - 6'	Gravelly clayey sand - sandy clayey gravel (SC-GC): red, medium dense, medium plasticity, dry to moist, nonindurated.
6' - 8'	Sand (SP): yellow, medium dense, nonplastic, moist, nonindurated.

Test Pit 31

0' - 1'	Sandy silt (ML); black, firm, low plasticity, moist, nonindurated: topsoil.
1' - 5'	Gravelly clayey sand - sandy clayey gravel (SC-GC): red, medium dense, medium plasticity, dry to moist, nonindurated.
5' - 8'	Clay (CL): yellow to red, stiff, medium to high plasticity, moist, nonindurated.

Note: No ground water encountered in any test pits

Project: Field review of test pit logs to evaluate geologic and soil conditions for wastewater disposal, Pine Meadow Ranch Subdivision, Summit County.			Requesting Agency: Utah State Department of Health
By: G.E. Christenson	Date: Nov. 22, 1983	County: Summit	Job No.: WW-10
USGS Quadrangle: Wanship (1250), Big Dutch Hollow (1251)			

November 22, 1983

Mervin Reid
Bureau of Sanitation
Utah State Department of Health
150 West North Temple
Salt Lake City, UT 84110

Dear Mr. Reid:

On November 7, 1983, Steven Thiriot and I performed a field review of test pit logs prepared by Dames and Moore for the Pine Meadow Ranch Subdivision in Summit County. Dames and Moore is the geotechnical consultant retained by Pine Meadow Ranch to evaluate the property and prepare maps indicating suitability of the land for septic tank soil absorption systems. They have excavated over 100 test pits at the subdivision and submitted preliminary logs for 87 of them to the Utah State Department of Health. About one-half of these test pits were checked and compared with preliminary logs for completeness and accuracy.

The soil logs were found to be satisfactory for most of the test pits observed. In some cases (e.g. test pits 51, 52, 54, and 64), soils appeared to contain more clay than is indicated on preliminary field logs. Laboratory analyses of samples taken in these test pits will presumably be used in the final evaluation, so this difference in field classification should not be significant. An item to note with regard to terminology used by Dames and Moore is that horizons given the parenthetical designation "residual soil" refer to weathered or soft bedrock. Bedrock type at the subdivision is highly variable and includes tuffaceous sandstone, dacitic to andesitic tuff, pumiceous air-fall ash, and other pyroclastic rocks. Locally the rock is hard and fractured (e.g. test pits 19, 39), but in general it is weathered and/or soft in the upper part. It is these weathered and/or soft rocks which could be excavated with the backhoe that are termed "residual soil" on the Dames and Moore logs. Finally, ground-water levels in test pits had risen slightly since the time of the Dames and Moore investigation, and water not previously present had appeared in at least one test pit (no. 46).

In conclusion, the work completed and the general approach being used by Dames and Moore in this study look good. The final product to be delivered will include maps showing areas suitable for septic tank systems. We commend Pine Meadow Ranch for enlisting the aid of a geotechnical consultant to help plan the subdivision, and feel that everyone involved will benefit greatly from this study. Based on our experience with this and other recreational subdivisions in areas of highly variable topographic, geologic, and hydrologic conditions, we recommend that in the future the appropriate health authority require similar geotechnical evaluations (to include maps of areas suitable for siting of soil absorption systems) as part of materials submitted in a feasibility report. Maps in the geotechnical evaluation should clearly delineate unsuitable areas and will provide a firm basis for a feasibility assessment by the health authority. If the proposed Regulations for Individual Wastewater Disposal (Part IV) are adopted, such a report could be requested, once it is determined that conditions warrent preparation of maps, under the provisions of section 10.2P in which it is stated:

10.2P After review of all information, plans, and proposals, the health authority will send a letter to the individual who submitted the feasibility report stating the results of the review or the need for further information.

We hope this satisfies your needs, and offer our services in reviewing the final plans when submitted by Pine Meadow Ranch.

Sincerely yours,

Gary Christenson, Geologist
Site Investigation Section

GEC/co
cc: Steven Thiriot, Bureau of Sanitation, Utah State Department of Health
Steve Jenkins, Summit County Health Department

GROUND WATER

Project: Geologic reconnaissance of high ground-water conditions in portions of Ephraim City, Utah.			Requesting Agency: Ephraim City	
By: W.R. Lund	Date: Sept. 2, 1983	County: Sanpete		Job No.: GW-1
USGS Quadrangle: Ephraim (759)				

September 2, 1983

Halbert K. Jensen, Mayor
City Building
Ephraim, Utah 84627

Dear Mayor Jensen:

This letter presents the results of a geologic reconnaissance conducted on August 23, 1983, of high ground-water conditions in portions of Ephraim City. The purpose of the reconnaissance was to evaluate the geologic and hydrologic setting of the affected area to determine the source of the water and to provide recommendations for possible remedial action. In addition to the field reconnaissance, the scope of work for this investigation included a review of maps, memos, and reports concerned with the geology, hydrology, soil, and climate of the study area.

SETTING

Ephraim is located on the east side of Sanpete Valley, a major north-south trending trough marking the west edge of the Wasatch Plateau. The town is 1/2-mile north and one mile west of the mouth of Ephraim Canyon and sits on the northwest edge of the alluvial fan that had developed at the canyon mouth (attachment 1). Ephraim Creek is a perennial stream that flows in a northwest direction across the fan and through the town. Several irrigation canals obtain water from Ephraim Creek and numerous unlined canals and ditches are found throughout the city. The area affected by high ground water begins at about 1st West Street and continues on to the west toward the center of the valley (attachment 1). High ground water has been a problem west of the Denver and Rio Grand Western (D&RGW)railroad tracks in the past, but this is the first year basements east of the tracks have been flooded (oral commun., T. Clark, 1983).

GEOLOGY AND SOILS

Moderate to steep west-dipping sedimentary rocks crop out along the Wasatch Plateau east of Ephraim. Rocks exposed there consist chiefly of late Cretaceous to early Tertiary-age (100 to 30 million years before present) limestone, sandstone, conglomerate, and shale of the North Horn, Flagstaff, Colton, and Green River Formations (Pratt and Callaghan, 1970). Detritus derived from those formations created the alluvial fan at the mouth of Ephraim Canyon and fills Sanpete Valley. U. S. Soil Conservation Service mapping (1981) shows that the alluvial fan consists of a coarse-grained, northwest trending core grading rapidly to the north, west, and south into silt and clay. The contact between the coarse- and fine-grained soils on the west side of town lies just east of 1st West Street (attachment 2). Examination of pits dug for sump pumps at one home along that street and a shallow trench near the cemetary confirmed the presence of low permeability silt and clay in those areas.

HYDROLOGY

Water levels in Sanpete Valley generally rise from about April through July or August and decline from about September to the beginning of the rise in the following year (Carpenter, 1971). Ground water in the Ephraim area moves westward from recharge areas on the Wasatch Plateau toward the Sanpete Valley. The two major sources of recharge to the ground-water reservoir in the valley-fill material are seepage of water from stream channels and underflow of streams at the mouths of canyons. Both processes are active along Ephraim Creek where Richardson (1907) measured a 10 percent flow loss in the first 0.6 miles of stream channel below the canyon. Other sources of recharge include return seepage of irrigation water from canals, ditches, and irrigated fields; subsurface inflow to ground water through the bedrock/valley fill interface; and direct infiltration of precipitation on the valley floor.

Carpenter (1971) identified portions of Sanpete Valley immediately west and north of Ephraim as shallow ground-water areas (0-10 feet) and shows most of the central part of the valley as a marsh subject to seasonal flooding. He further indicates that rapid fluctuations of the shallow water table both seasonally and annually occur in Sanpete Valley in response to changes in precipitation. Increases in water table elevations of 10 to 20 feet are reported as common and fluctuations in excess of 45 feet have been recorded in some areas (Carpenter, 1971).

The field reconnaissance revealed the following specific information concerning hydrologic conditions in Ephraim:

- drainage is to the west and northwest towards the high ground-water areas,
- the channel of Ephraim Creek is unlined and passes through the coarse-grained permeable materials for much of its length,
- numerous unlined irrigation canals and ditches criss-cross the town and most eventually flow to the west,
- flooded areas are underlain by low permeability silt and clay soils.

The average annual precipitation for Ephraim is 10.65 inches (U.S. National Weather Service, 1951-1980 period of record). Ephraim has experienced above normal levels of precipitation for the last five water years (see table below) and has received 9.42 inches of precipitation during the first six months of this year indicating that 1983 will also likely be an above normal year.

Annual Precipitation Ephraim, Utah
1978-1982
(inches)

1978	13.17
1979	11.01
1980	16.38
1981	13.14
1982	15.68
1983 (Jan. through June)	9.42

Cumulative departure from normal 1978-82, +16.13 inches

CONCLUSIONS AND RECOMMENDATIONS

The high ground-water conditions that affect Ephraim are the natural result of the town's geologic and hydrologic setting. Coarse-grained soils on the east side of town permit the rapid infiltration of precipitation and snowmelt to the subsurface. Additional recharge is provided by leakage from Ephraim Creek and irrigation canals. The subsurface water migrates down slope until it reaches the fine-grained soils on the west side of town. There the reduced slopes and slower soil permeability retard the rate of ground-water advance and cause the water table to rise. Changes in the elevation of the water table correspond directly to the amount of recharge received. Five consecutive years of greater than normal precipitation have produced a significant increase in ground-water levels and caused basement flooding in previously dry areas.

Following such a prolonged period of increased recharge, the water table can be expected to stay high for some time (2-3 years) and may go even higher if increased rates of precipitation continue. Recharge to the problem area can be reduced by lining the channel or diverting the flow of Ephraim Creek and by lining irrigation canals and ditches. When combined with a return to normal precipitation, these actions could substantially lower ground-water levels. They would, however, be effective only in the long term and have little immediate affect on this year's basement flooding problems. The installation of drains along 1st and 2nd West Streets appears to be the only way to quickly lower the water table in those areas. Drains running parallel to the streets would be at nearly right angles to the direction of ground-water flow and should intercept substantial amounts of water.

The actions recommended above will also help lower water levels west of the D&RGW railroad tracks. The area west of the tracks is a natural discharge point for shallow alluvial aquifers in Sanpete Valley and though the water table would be affected, it is unlikely that it would be lowered enough to permit full basements. It is recommended that the portion of Ephraim lying west of the tracks be zoned for slab on grade or split entry construction only, and that where necessary, fill be imported to bring building grades above wet or marshy ground.

It is hoped that this information will be of help to you in dealing with Ephraim's ground-water problems. Feel free to contact this office if you have any questions or require additional assistance.

Sincerely,

William R. Lund
Chief, Site Investigation Section

WRL/co
Attachments

Selected References

Christenson, G. E., 1981, Site investigations for three proposed school sites in Sanpete County, Utah: Utah Geological and Mineral Survey Technical Memorandum to W.R. Lund dated 12/28/81, 9 p.

Pratt, A. R., and Callaghan, Eugene, 1970, Land and mineral resources of Sanpete County, Utah: Utah Geological and Mineral Survey Bulletin 85, 69 p.

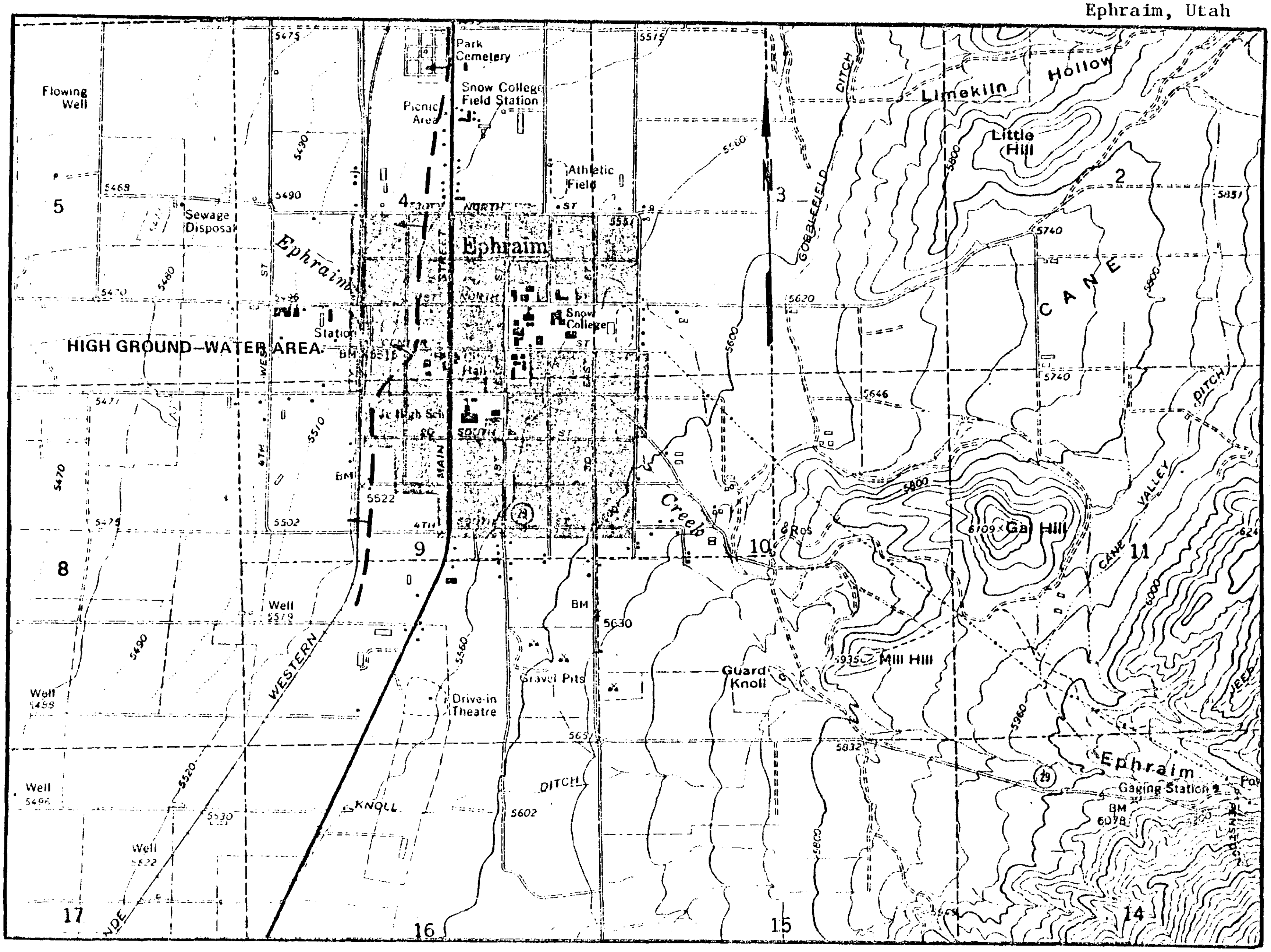
Richardson, G. B., 1907, Underground water in Sanpete and central Sevier Valleys, Utah: U.S. Geological Survey Water-Supply Paper 199, 63 p.

Robinson, G. B., Jr., 1971 Ground-water hydrology of the San Pitch River drainage basin, Sanpete County, Utah: U.S. Geological Survey Water-Supply Paper 1896, 80 p.

United States Department of Agriculture, 1981, Soil survey of the Sanpete Valley, Utah, parts of Utah and Sanpete Counties: U.S. Soil Conservation Service, 179 p.

Attachment 1, letter of 9/8/83 to Halbert Jensen, Mayor of Ephraim City

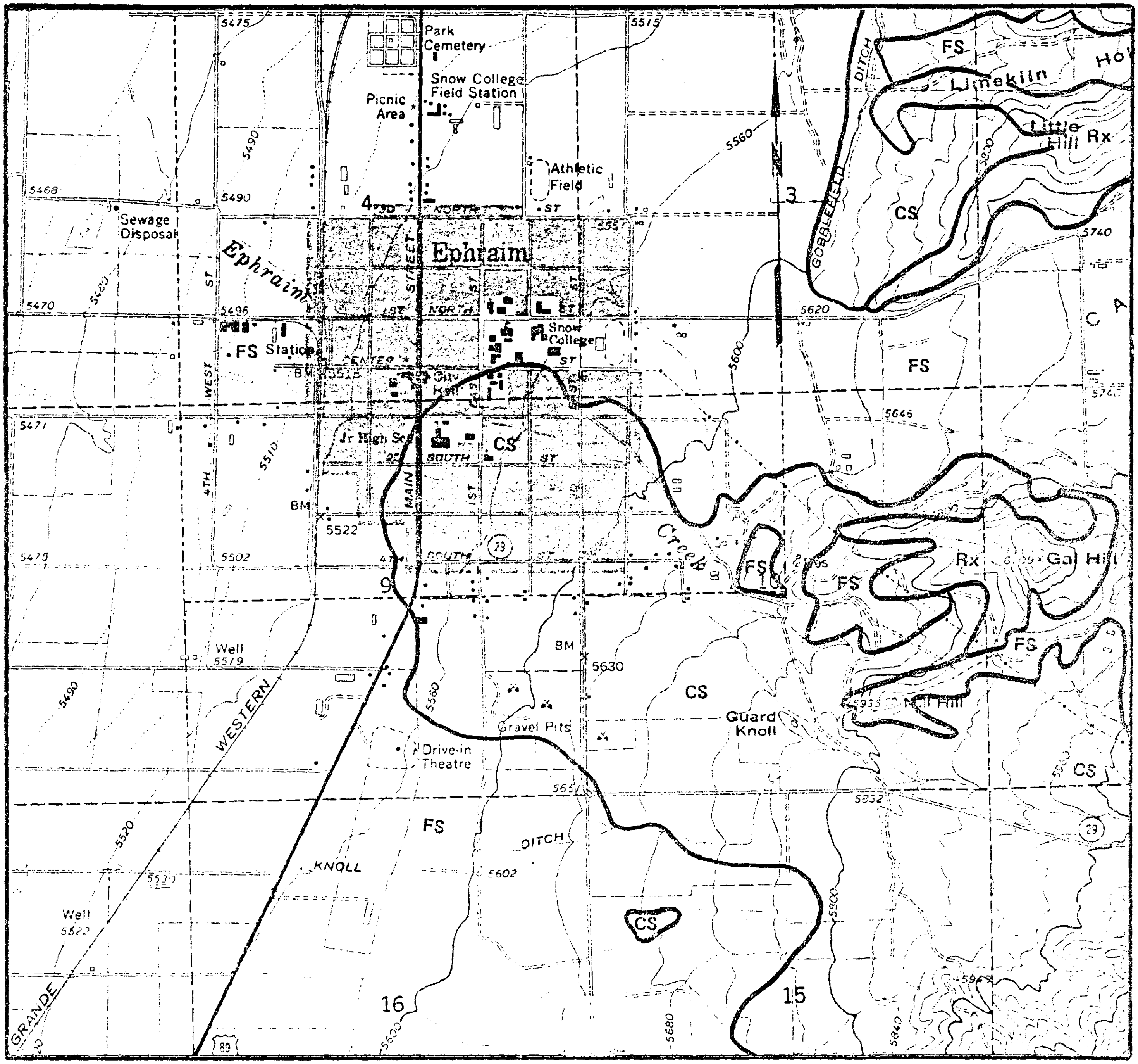
Base map from USGS 7½' topo quad
Ephraim, Utah



Location of high ground-water area Ephraim City. Scale 1:24,000

Atachment 2, letter of 9/ 8 /83 to Halbert Jensen, Mayor of Ephraim City

Base map from: USGS 7½' topo quad
Ephraim, Utah



Map showing distribution of soil types in Ephraim City. Scale 1:24,000
(modified from U.S. Department of Agriculture soil mapping)

Explanation

CS	Coarse-grained soils; sand, gravel, cobbles
FS	Fine-grained soils; silt, clay
Rx	Rock with none or thin soil cover

Project: Geologic investigation to locate additional sources of culinary water for Highland City, Utah.			Requesting Agency: Highland Water Company	
By: H.E. Gill	Date: Sept. 20, 1983	County: Utah		Job No.: GW-2
USGS Quadrangle: Timpanogas Cave (1129), Lehi (1130)				

September 20, 1983

MEMORANDUM

TO: William R. Lund, Site Investigation Section

FROM: Harold E. Gill

SUBJECT: Geologic investigation to locate additional sources of culinary ground water for Highland City, Utah

A geologic investigation to locate possible additional culinary water sources for Highland City was completed in August, 1983. The project was undertaken at the request of Mr. Reed Thompson, president Highland Water Company, and is an extension of UGMS Report of Investigation 159, December 1980. Three possible alternative sources of water were considered: 1) development of existing springs, 2) utilization of horizontal drifts to intercept ground water within bedrock formations, and 3) placement of horizontal drift beneath the alluvium of American Fork Creek. Several locations within American Fork Canyon and along the mountain front immediately south of the canyon were evaluated as possible ground-water sources.

SCOPE OF WORK

To assist in the location of additional water sources pertinent geologic, hydrologic, and topographic information on the area was compiled and evaluated. To accomplish this objective, the following work was performed:

1. An initial meeting between William R. Lund (UGMS), Mr. Reed Thompson (Highland Water Company), and Mr. Lorin T. Powell (ARIX, the engineering firm representing the water company) to establish the purpose and objectives for the study.

2. Review of applicable published and available unpublished literature including reports, memos, maps, and other data pertaining to the study area.

3. Examination of vertical color stereoscopic aerial photographs covering the area.

4. Review of State Division of Water Rights files to locate springs in the study area for which water rights have been adjudicated.

5. Telephone conversation with Mr. Bryce Montgomery, State Division of Water Resources, pertaining to studies his office has completed in the area.

6. Telephone conversation with personnel at Timpanogos Cave National Monument concerning ground-water conditions in the cave.

7. Field reconnaissance of the study area.

SETTING

The area under investigation is located in the northeast corner of Utah Valley. It is bordered on the east by the Wasatch Range and is approximately 4 miles south of the Traverse Mountains (attachment 1). The study area extends for approximately 2 miles into American Fork Canyon and 2 miles south of the canyon mouth (attachment 2).

The climate in northern Utah Valley is temperate and semi-arid. The annual precipitation at Highland City is approximately 20 inches per year while near the mountain front it can reach as high as 29 inches per year.

GEOLOGY

The type and structure of the rock units within the study area determine the occurrence and availability of ground water. The relative ease with which water can move through rocks depends on their permeability (the ability of the rock to transmit fluids), which in turn depends upon the size, number, and interconnection of voids in the rock. The most productive aquifers generally are well-sorted sand and gravel deposits or rocks with increased permeability due to fracturing or dissolution. The rock units exposed in the study area range from Cambrian through Pennsylvanian-Mississippian in age, and from oldest to youngest include the: Tintic Quartzite, Maxfield Limestone, Ophir Formation, Fitchville Formation, Gardison Limestone, Deseret Limestone, Humbug Formation, Great Blue Limestone, and Manning Canyon Shale. These rock units are shown on attachment 2, and described in table 1.

Evidence for two major periods of tectonic activity can be found in the area (Baker and Crittenden, 1961). Regional thrust faulting (predominently lateral movement) occured during the Late Cretaceous Period (approximately 135 million years ago) along the Charleston-Nebo Thrust. This was followed by an episode of Cenozoic normal faulting (nearly vertical movement) beginning in the mid-Tertiary (36 million years ago). Approximately 100 million years separates these two tectonic events, which may account for the varying degree of healing (precipitation of calcium carbonate along fractures) observed in limestones in the study area. Almost all of the limestone outcrops examined were highly fractured but the fractures were partially to completely healed.

FIELD INVESTIGATION

Two approaches were taken during the field investigation to locate possible additional water sources. First, highly vegetated areas and rock outcrops near faults were investigated for the presence of springs and seeps. Mapped springs (USGS topographic maps and Division of Water Rights files) and those discovered during the investigation were considered for development. Second, outcrops located at the intersection of two or more faults were considered as possible horizontal drift locations.

The possibility of an horizontal drift in the alluvium beneath American Fork Creek was discussed at the initial meeting between UGMS, Highland Water

Company, and ARIX. At that time, it was felt by UGMS that the alluvial thickness beneath the creek might not be adequate to protect the drift from surface water contamination. The field reconnaissnace confirmed that impression. American Fork Canyon is too narrow and it's gradient is too steep to permit the accumulation of an alluvial thickness greater than about 30 feet, and that thickness is achieved in only a few places. The alluvium is extremely coarse grained and would allow a direct connection between the stream and a drift. State Health Department drinking water regulations require that water obtained frm such sources receive the same level of treatment as water taken from a surface water source. Therefore, no further consideration is given to the possibility of locating a horizontal drift in the alluvium.

SPRINGS

The area south of the canyon mouth was investigated extensively for springs. The Great Blue Limestone is the only formation found in this area. Fracturing and jointing in that rock unit is extensive; however, most of the discontinuities are partially to completely healed. Two minor seeps and one small spring were located (attachment 2). The lower seep, which at the time of the field reconnaissance was discharging approximately 0.5 gallons per minute, is on the south wall of a small canyon approximately 6000 feet south of the mouth of American Fork Canyon (location 1). The upper seep (location 2) is much higher in the drainage to the east and emerges on a shelf of rock. This seep discharges approximately 0.1 gpm. About 100 to 150 feet east of location 2 is a small spring (location 3) discharging approximately 2 gpm. Careful development of these water sources may result in an increase in their productivity; however, any increase will probably be very small. It is estimated that the two seeps could be developed and combined to produce a flow no greater than 5 gpm. After development the spring might produce 10 to 15 gpm, however the steep terrain in the area may make development economically unfeasible. October 1, 1981 to September 31, 1982, was the wettest water year on record in Utah, and as of September, 1983, the current water year is ahead of the record. It is unknown if the water sources described above would be capable of producing a continuous flow during more typical years.

No new springs were observed in American Fork Canyon and all existing springs have had water rights adjudicated. According to personnel at Timpanogos Cave National Monument, the ground-water flow in the cave increases during spring thaw and after heavy rains, but the caves are dry by the end of August. It appears that ground water in the area moves rapidly to depth along large joints and fractures in the rock, draining the mountain areas on either side of the canyon. The water discharges at the level of American Fork Creek where it feeds several large springs.

Mr. Bryce Montgomery, geologist for the Division of Water Resources, stated that based on his work in the area, it is his opinion that the aquifers with the highest potential for development are the alluvial and lacustrine sequences at the mouth of the canyon and along the mountain front. However, because of the topographic constraints, only vertical wells can be used to develop those aquifers.

HORIZONTAL DRIFT LOCATIONS

Using geologic criteria, seven sites for horizontal drifts in bedrock were identified for further study (attachment 2 and table 2). Locations were chosen based on rock type, density of faulting, and estimated water-bearing properties of the rock unit. Five sites are within American Fork Canyon (attachment 2). Location A is in the Ophir Formation and had one major open joint set. Several good water sources occur in this formation elsewhere in the study area, but no evidence of water was found at this location. Outcrops of limestone or dolomite occur at locations B through E (attachment 2 and table 1) and although the rocks are highly fractured a moderate to high degree of healing has occurred. No evidence of water was found at any of these locations. Two sites south of the canyon mouth (F & G) are in the Great Blue Limestone. All fractures were partially to completely healed, and there was no indication of water at either location.

CONCLUSIONS AND RECOMMENDATIONS.

Based upon the results of this investigation, the following conclusions and recommendations are presented:

1) The alluvium beneath American Fork Creek probably does not attain a thickness greater than 30 feet. This does not provide an adequate aquifer for development or satisfactory protection against surface water contamination from the creek. For these reasons, no further consideration was given to an horizontal drift in such material.

2) All existing springs within American Fork Canyon have been developed and the water rights adjudicated. No new springs were discovered.

3) Two seeps and one spring were located in the area south of the canyon mouth. Development and combination of the seeps may produce a flow of approximately 5 gpm. Development of the spring may produce a flow as high as 10 to 15 gpm. The past 12 months were the wettest on record in Utah and it is very possible that even with development, the seeps and springs would not produce a continuous flow during more typical water years.

4) Of the seven possible horizontal drift locations investigated only one (site A) is in a formation from which water has been obtained in the study area. However, there was no evidence of water observed at this location or any of the other locations during the field reconnaissance. Based upon this investigation we cannot recommend any of the locations as potential source of significant amounts of ground water.

Selected References

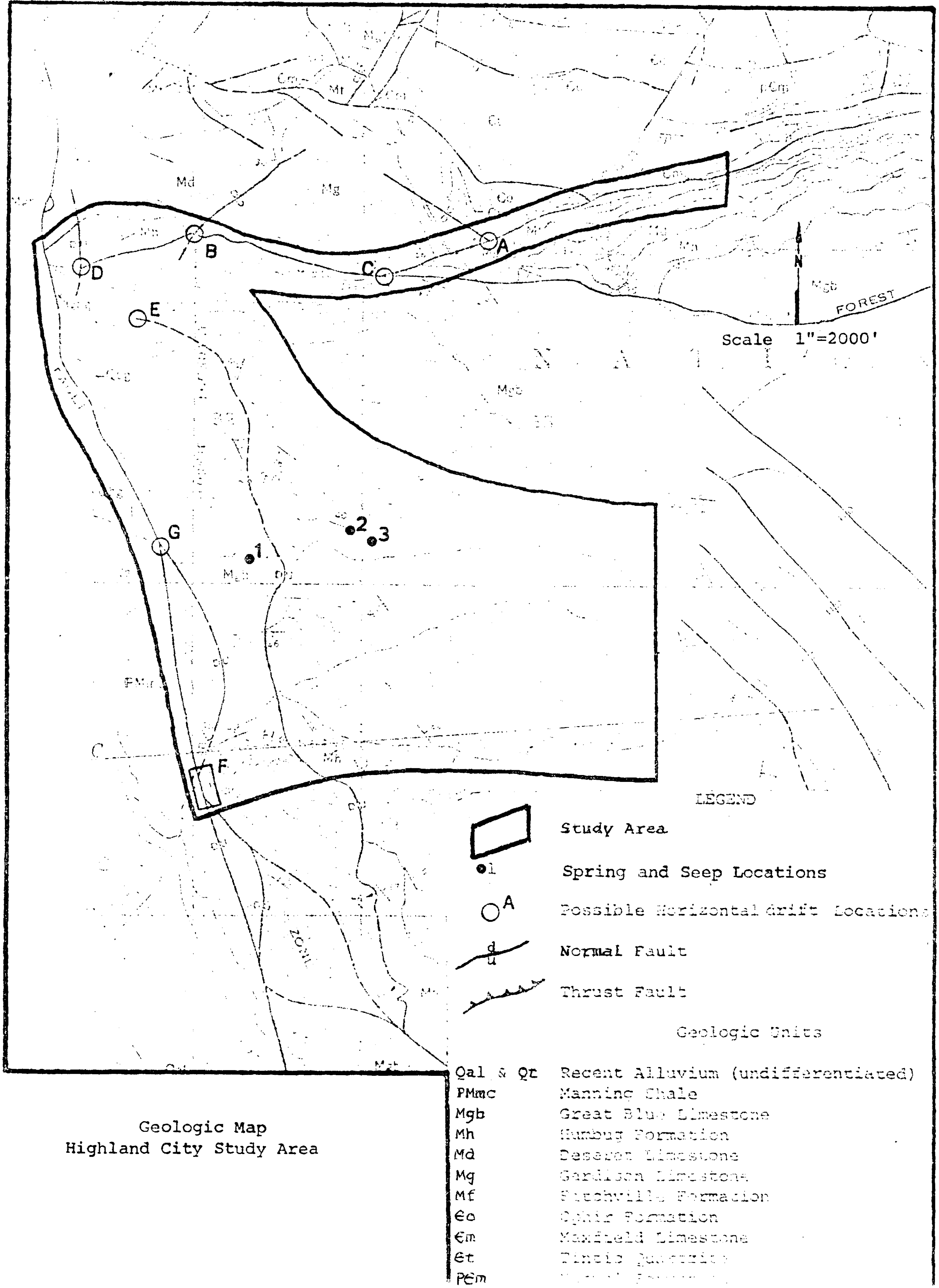
Baker, A.A., and Crittenden, M.D., Jr., 1961, Geology of the Timpanogos Cave Quadrangle, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ 132, scale 1: 24,000.

Klauk, R.H., 1979, Shallow ground water occurrence in northeastern Utah Valley, Utah: Utah Geological and Mineral Survey Report of Investigation 130, 12 p.

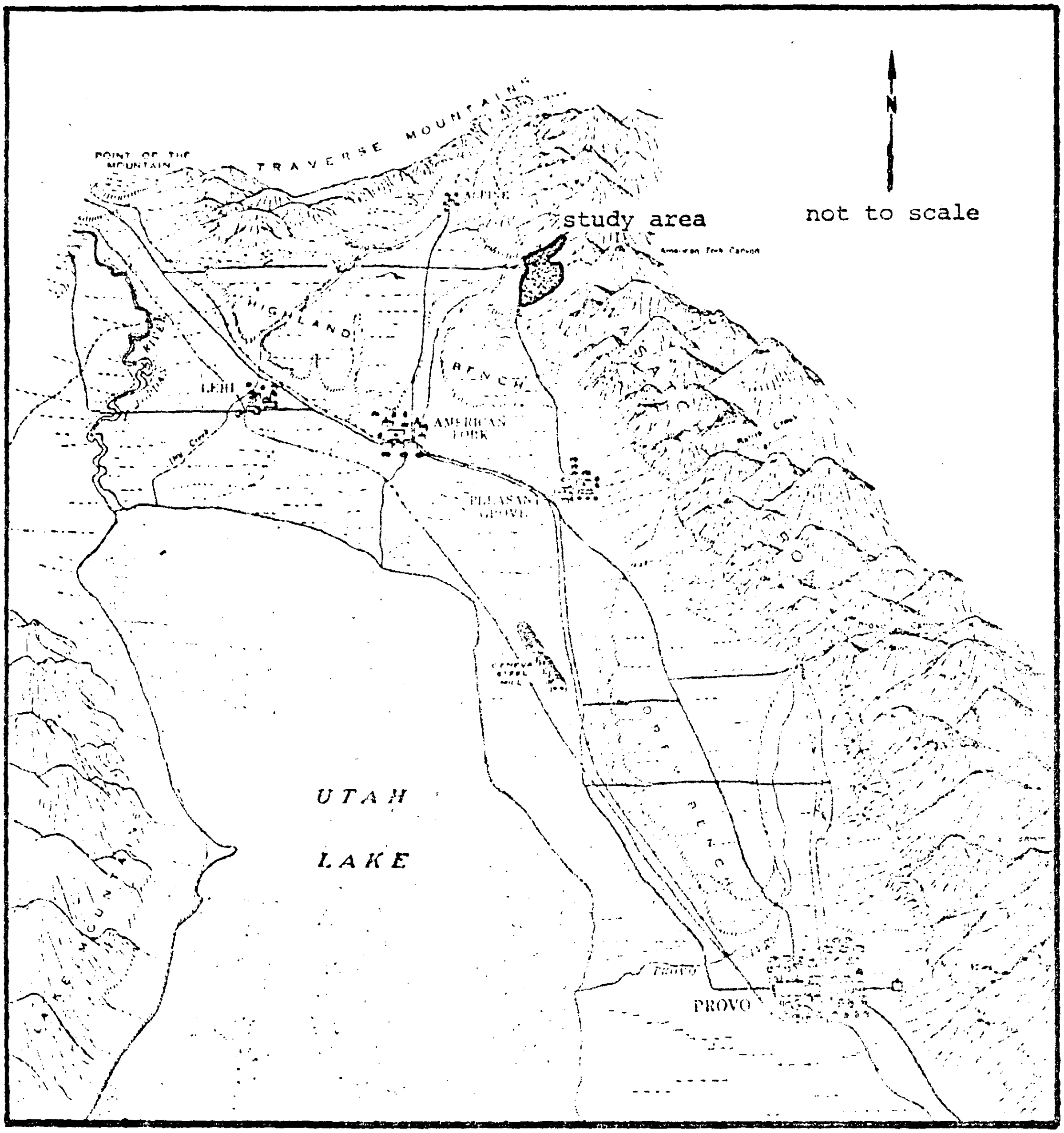
Gill, H.E., 1980, Preliminary geologic investigation to locate additional sources of culinary ground water for Highland City, Utah: Utah Geological and Mineral Survey Report of Investigation 159, 10 p.

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.

Attachment 2, memo of 9/20/83 to W. Lund



Geologic Map
Highland City Study Area



General Location Map

Highland City Study Area

Era	System	Geologic Unit	Composition*	Water-bearing properties **
Cenezoic	Quaternary	Recent Alluvium (undifferentiated)	Chiefly unconsolidated and colluvial deposits of gravel, cobbles & boulders forming alluvial fans & stream channel deposits of gravel along perennial streams	Permeability moderate to high. Yields generally adequate for stock & domestic supplies. Water contains less than about 250 Mg/L of dissolved solids.
Paleozoic	Miss-Penn	Manning Canyon	Mostly black to dark brown shale; some interbedded limestone and conglomerate sandstone; 1,600 feet thick.	Permeability low; minor water from horizontal shaft near Pleasant Grove, Utah; privately owned; approximately 6-10 GPM
	Mississippian	Great Blue Limestone	Chiefly calcitic thinbedded shaley limestone; dark gray to black; weathers into flakes or thin slabs that are light gray or pinkish tan. 2800 feet thick	Permeability low to moderate; rock highly fractured but moderate to high degree of healing was observed. Very minor water discharged from springs found in this unit.
		Humbug Formation	Fine to medium-grained limey sandstone with thin to thick bedded, fine to coarse-grained dolomite. 800 feet thick	Permeability moderate to high. Highly fractured with little or no healing. Joint sets on end providing good access for water. No water produced from this unit in study area.
		Deseret Limestone	Massive cliff forming unit; light to dark gray, fine to coarse-grained dolomite with abundant lenticular chert. 420 feet thick.	Permeability moderate to low; highly fractured but well healed; although well healed, large stream issues from alluvium at its base near fault zone in section 17, T4S, R2E.
		Gardison Limestone	Dark gray coarse-grained dolomite (30 feet); thin bedded blue-gray limestone (100 feet); dark gray massive limestone 400 feet thick.	Permeability low; highly fractured but well heated; very minor water produced from spring in study area.
		Fitchville Formation	Tan weathered dolomite sandstone (10 feet) light to dark gray massive dolomite 165 feet thick.	Permeability moderate; highly fractured moderately healed; numerous vugs present; no water sources found in study area in this unit.
	Cambrian	Maxfield Limestone	Dark Gray oolitic to pisolitic limestone; massive blue-gray mottled or speckled limestone & dolomite. 200 feet thick.	Permeability low; no water sources observed in study area.
		Ophir Formation	Flakey olive-green micaceous shale and siltstone (250' thick); pale gray limestone (90' thick); brown shale intergrading with fine-grained calcareous sandstone (170' thick)	Permeability moderate to high; highly fractured with low to medium healing; several good water sources from this unit in study area.
		Tintic Quartzite	Nearly pure pale pink, white quartzite; coarse to medium-grained; 1300 feet thick.	Permeability high; best source for water in study area; highly fractured; produces up to approximately 1300 GPM in study area.
Precambrian		Mutual Formation	Conglomerate; quartzite & shale; gray, tan or greenish-gray sandstones; grayish red shales; Conglomerates with boulders up to 5' in diameter; 1300 feet thick.	Permeability moderate to poor; no water issues from this unit in study area.
		Mineral Fork Tillite	Tough massive tillite & rounded pebbles, cobbles & boulders in angular sand-size grained matrix; cemented by rock flower; 1000 feet thick.	Permeability low; very minor water produced from this unit within study area.

*From Timpanogas Geologic Quadrangle Map GQ-132

**From Report of Investigation 159

Table 1. Geologic Units and Their General Hydrologic Characteristics Upper Utah Valley

Table 2. Potential Horizontal Drift Locations and Descriptions

Site	Location	Formation	Description
A	T. 4 S., R. 2 E. SE1/4, SW1/4 sec.28	Ophir Formation (Co)	Calcareous sandstone; highly fractured, unhealed; intersection of two faults.
B	T. 4 S., R. 2 E. SE1/4, SW1/4 sec. 29	Deseret Limestone (Md) Gardison Limestone (Mg) Humbug Formation (Mh) Great Blue Limestone (Mgb)	(Md): Cherty dolomite. (Ms): Cherty dolomite, fossiliferous limestone. (Mh): Dolomite limey sandstone. (Mgb): Shaley limestone. All highly fractured, slight to totally healed.
C	T. 4 S., R. 2 E. NW1/4, NW1/4 sec.33	Gardison Limestone (Mg) Great Blue Limestone (Mgb)	(Mgo): Cherty dolomite and fossiliferous limestone. (Mgb): Shaley limestone. Both highly fractured, moderate to totally healed; intersection of two major faults; intersection of two faults and four formations.
D	T. 4 S., R. 2 E. NW1/4, NW1/4 sec.32	Humbug Formation (Mh) Great Blue Limestone (Mgb)	(Mh): Dolomite and limey sandstone. (Mgb): Shaley limestone. Both highly fractured, slight to totally healed; intersection of two faults.
E	T. 4 S., R. 2 E. NE1/4, NW1/4 sec.32	Great Blue Limestone (Mgb)	Shaley limestone; highly fractured, moderate to totally healed; intersection of fault with American Fork Creek.
F	T. 5 S., R. 2 E. NW1/4, SE1/4 sec.5	Great Blue Limestone (Mgb)	Shaley limestone; highly fractured, moderate to totally healed; intersection of three faults.
G	T. 4 S., R. 2 E. SE1/4, SW1/4 sec.32	Great Blue Limestone (Mgb)	Shaley limestone; highly fractured, moderate to totally healed; intersection of two faults.

GEOLOGICAL HAZARDS

Project: Helicopter reconnaissance of slope failures in Cottonwood Canyon, Sanpete County			Requesting Agency: Dept. of Public Safety
By: W. R. Lund	Date: 6/2/83	County: Sanpete	Job No.: GH-1
USGS Quadrangle: Fairview Lakes (880), Fairview (881)			

June 2, 1983

MEMORANDUM

TO: Larry E. Lunnen, Commissioner, Department of Public Safety

FROM: William R. Lund, Utah Geological and Mineral Survey

SUBJECT: Helicopter reconnaissance of slope failures in Cottonwood Canyon, Sanpete County

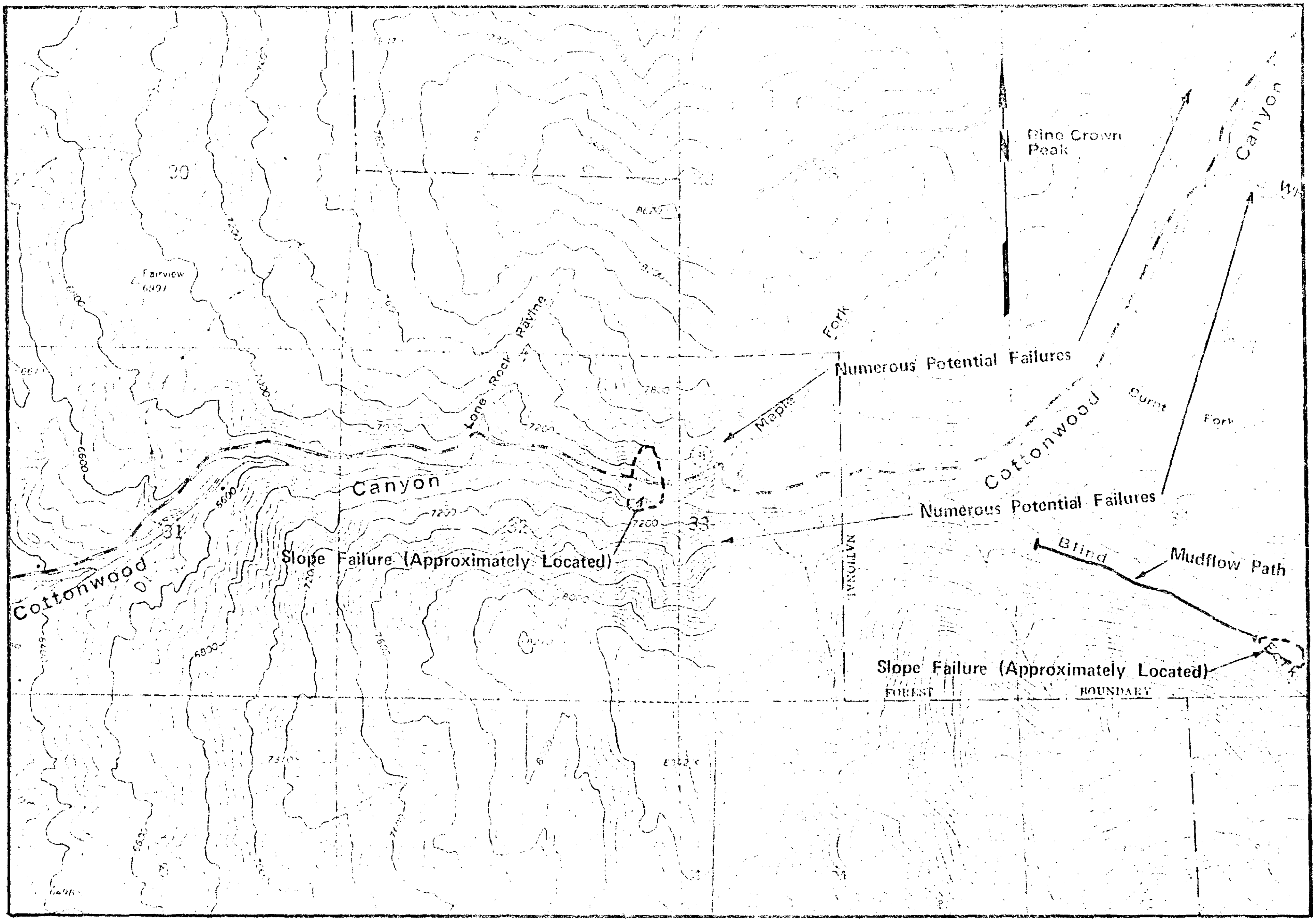
A helocopter reconnaissance was conducted on May 31, 1983, of slope failures in Cottonwood Canyon affecting State Route 31 and the flow of Cottonwood Creek. A large failure located on the north side of the canyon between Lone Rock Ravine and Maple Fork (see attachment) moved during the night of May 30 destroying approximately 300 feet of roadbed and damming the creek. The relatively small amount of poorly consolidated material reaching the creek was easily eroded and allowed the stream to re-establish its channel before a significant water impoundment could form.

Numerous other failures and potential failures were observed on both sides of the canyon upstream from the main slide. A landslide at the head of Blind Fork created a debris flow which was a minimum of 10 to 15 feet deep and moved at a high rate of speed for nearly a mile before its energy was dissipated by a dense stand of brush and timber located in its path. Based on the width and continuity of ground cracks seen on mountain slopes, there exists a high potential for additional large slope failures in the canyon.

The slope failures in Cottonwood Canyon are the result of saturated ground conditions combined with an inherently weak geologic formation. The majority of failures are located in that portion of the canyon underlain by the Tertiary-Cretaceous-age North Horn Formation which consists of poorly consolidated sandstone and mudstone. The North Horn Formation is the same unit that was involved in the sliding at Thistle.

Any attempt to reopen Route 31 should proceed with extreme caution. The headwall of the main slide is unstable and located above the former roadbed. Heavy equipment working on or near the slide may cause renewed movement which could damage the equipment and/or block the stream channel. Additional slope failures at other locations in the canyon are a certainty and if large enough, could result in a stream blockage. A particular concern is the possibility that landslides occurring on canyon walls may generate fast-moving mudflows along Cottonwood Creek. Such flows could exit the canyon before adequate evacuation measures could be taken in Fairview. UGMS concurs with the decision to maintain a 24-hour watch on the canyon and recommends that it be flown periodically (every one to two days) to monitor slide development.

WRL/co



General location map Cottonwood Canyon, Sanpete County   Scale 1:24,000

Project: Slope stability analysis of Southern Utah State College and Utah State University properties east of Cedar City, Iron County.			Requesting Agency: Southern Utah State College	
By: G.E. Christenson	Date: Nov. 23, 1983	County: Iron		Job No.: GH-2
USGS Quadrangle: Webster Flat (196), Flanigan Arch (237)				

November 23, 1983

MEMORANDUM

TO: William R. Lund, Chief, Site Investigations Section

FROM: Gary E. Christenson, Geologist

SUBJECT: Slope stability analysis of Southern Utah State College and Utah State University properties east of Cedar City, Iron County, Utah

BACKGROUND

In response to requests from Gerald R. Sherratt, president of Southern Utah State College, and Doyle J. Matthews, dean and director of the Utah State University College of Agriculture and Agricultural Experiment Station, an investigation was made of property owned by these institutions east of Cedar City. The property is being considered for lease for development of a ski area on the north slope of Black Mountain. This is a preliminary evaluation of only those parcels involved in the proposed ski area in sections 11, 12, 13, and 14, T. 37 S., R. 10 W., Salt Lake Baseline and Meridian (attachment 1). The investigation consisted of a review of pertinent literature, interpretation of aerial photographs, and field reconnaissance conducted October 19-20, 1983. This report discusses only general geologic conditions with emphasis on slope stability in the area. Soil conditions for construction, flood hazard, ground water, and seismic hazard are not addressed here except very briefly in the Conclusions and Recommendations section.

SETTING

The approximate boundaries of properties owned by Southern Utah State College (SUSC) and Utah State University (USU) covered in this study are shown in attachment 1. The area is in the Southern High Plateaus physiographic province of Utah on the south side of Cedar Canyon (Stokes, 1977). Cedar Mountain, Black Mountain, and the interconnecting flat-topped ridges (attachment 1) are remnants of the high plateau surface which had been dissected in this area by Crow Creek and its tributaries. The northeastern slope of Black Mountain on which the ski area is proposed is steepest near the top, becoming more gentle in lower portions. Most of the steepest terrain is south of the properties. Canyons draining the area are broad and shallow except for one steep-walled, deep canyon in the southeastern corner. This canyon traverses the southwestern corner of the USU property and then follows the north-south boundary between the two properties.

Elevations in the area studied range from about 7900 feet along Crow Creek in the northwestern corner up to about 9650 feet in the southwestern corner at the top of the ridge. Slopes are heavily forested with aspen, fir, spruce, and juniper trees. The top of Black Mountain, which would be the upper lift station of the proposed ski area, is at an elevation of 10,375 feet. The locations of lifts and access roads shown in attachment 1 are taken from a map submitted to the UGMS by President Sherratt of SUSC on May 19, 1983.

GENERAL GEOLOGY

The properties are underlain by generally flat-lying sedimentary rocks of the Cretaceous-age Straight Cliffs and Wahweap Sandstones (Gregory, 1950). These units are overlain by sandstone of the Cretaceous Kaiparowits Formation and Quaternary (?) basalt above about 9000 feet. Most exposures of these upper rock units are south of the property although talus accumulations of basalt boulders occur over much of it. Few exposures of the Straight Cliffs and Wahweap Sandstones are present, but where exposed they consist of massive to thick-bedded sandstone with thin interbedded shale units. Gregory (1950) reports that sandstone beds in these units are from 3 to 40 feet thick with interbedded lenticular conglomerate, shales, and limestone generally less than a few hundred feet in lateral extent and a few inches to a few feet in thickness.

The extensive boulder talus deposits covering slopes has accumulated as a result of intense frost-shattering of rock outcrops along the ridge from freezing and thawing of water in joints. The majority of these talus accumulations are probably remnants from the Pleistocene Epoch (more than 10,000 years ago) when the climate was colder and frost action more intense. An exposure in a canyon along the edge of one of the larger talus accumulations south of the property indicates a maximum thickness of 30-45 feet, and talus in the center of this accumulation is probably even thicker. At the surface, the talus appears to be composed of large blocks, locally up to 10 feet in diameter, with no matrix material. However, cross-sections of the talus exposed in the canyon indicate that below a depth of several feet, the deposit includes cobble- and gravel-sized clasts in a finer-grained matrix material with no large voids between blocks as seen at the surface.

SLOPE STABILITY

Slope movement of several types is either presently occurring or has occurred in the past on the property and in adjacent areas. The bedrock in the area consists of competent sandstone generally not subject to slope failures such as rock slumps. However, in areas of exposed sandstone cliffs such as along the canyon in the southeastern corner of the property, rock fall hazard is locally great (attachment 1). At the head of that canyon, erosional processes are very active on barren steep slopes cut into exposed friable sandstone and overlying basalt talus deposits. Active rock falls and slumps are found in basalt talus deposits in the upper canyon walls.

Colluvial deposits derived from sandstone bedrock also show evidence of instability. A slump, probably active last spring, occurs in colluvium on the south-facing slope of the ridge in the northeast corner of the property (attachment 1). The rock here is highly fractured and the slope is much steeper than most other slopes in colluvium on the property. Similar slumps in colluvium on more gentle south-facing slopes are present north of Highway 14 just north of the property. North-facing slopes in sandstone colluvium are more gentle and more heavily vegetated and appear generally stable except where undercut by roads or streams.

For the most part, accumulation of basalt boulder talus on lower slopes has ceased and deposits are being stabalized by development of soils and encroachment of forests. Forests now occur above these deposits and isolate them from their former source of boulder debris at the ridge crest. Active production and downslope movement of basalt talus is now occurring only along the ridge top and upper slopes, most of which are south of the property.

Although basalt talus moved downslope and accumulated principally by gravity movement of individual clasts (rock fall), the largest and presumably thickest talus accumulations show evidence of another form of downslope movement. Concentric, lobate structures with oversteepend fronts observed in these deposits may indicate either: (1) earthflow movement of talus and/or underlying rock, or (2) rock glacier movement of talus. Gregory (1950) considered these lobate features to be the result of intermittant downward creep as landslides, and notes that they are most noticeable where unjointed impervious beds underlie thick accumulations of talus allowing buildup of water in the talus. The type of slope movement required to produce the observed surface features would be an earthflow. Although underlying rock does not appear prone to earthflow-type failures, the talus accumulations themselves, when saturated, could fail in this manner and develop the flow structures seen on the surface. Instability of the talus is evidenced by slumps where deposits have been undercut and exposed in upper canyon walls in the southeastern corner of the property. The presence of water in the talus deposits is indicated by seeps at the talus-bedrock interface in this canyon wall.

As defined by Washburn (1973), rock glaciers are characterized by steep fronts at or near the angle of repose, concentric ridges, and finer debris at depth than at the surface. Interstitial ice, i.e. ice in voids between rock and soil particles, is apparently necessary for movement to occur. Modern active rock glaciers vary in thickness from 50 to 150 feet, although inactive rock glaciers at the same locality which are remnants from colder and/or wetter climates may be considerably thinner (Wahrhaftig and Cox, 1959). The features on this property have many of the characteristics of inactive rock glaciers. Freezing of water trapped in talus above less permeable underlying rock would promote development of rock glaciers in the same way saturation might cause earthflow movement. The presence of these features on northeast-facing slopes may also indicate rock glacier activity because such slopes are shielded from direct sunlight and are colder relative to south-or even northwest-facing slopes. Further work is needed to determine if movement resulted from rock glacier activity due to buildup of ice, or earthflow movement caused by saturation of talus on steep slopes. In either case, movement does not appear to be active at present. The lack of activity is indicated by the encroachment of forest vegetation and accumulation of soil material in voids between boulders. Also, the growth of lichen and development of patina (weathered coating or varnish on exposed surfaces) on boulders and the pitting by weathering of upper surfaces of boulders indicate that movement in the talus has not occurred in recent times.

CONCLUSIONS AND RECOMMENDATIONS

The principal areas of unstable slopes are in the steep canyon walls in the eastern part of the SUSC property and the western part of the USU property (attachment 1). These slopes show local evidence of rapid erosion, rock falls, and/or earth slumps. While all major facilities for the proposed ski area (lifts, lodges, access roads, parking lots) are in this zone, none are on observed unstable slopes. Except for local problems that may arise from undercutting of colluvial slopes for construction, no major slope stability problems are anticipated that will directly affect ski area structures.

Elsewhere, slopes are generally stable under present conditions although all slopes could be destabalized by undercutting, loading, wetting, or earthquake ground shaking. Formation of talus from basalt outcrops by frost action is still active at higher elevations (above 9200 feet), but zones of modern accumulation with greatest rock-fall hazard are generally south of the property. Although earthflow and/or rock glacier flow in talus accumulations appears to be inactive, dislodging of boulders on remnant flow fronts and steep upper slopes may pose a local rock-fall hazard.

This report is a general assessment of slope stability only. Potential hazards not addressed in this report which may be present include seismicity (earthquakes causing ground shaking with possible ground rupture and/or slope failure), flooding, shallow ground water, and adverse soils conditions. With regard to these hazards, the following preliminary observations can be made:

1) The site is not traversed by any known active faults (Anderson and Miller, 1979), but is in a zone of moderate earthquake risk requiring construction to comply at a minimum with specifications in the Uniform Building Code for seismic zone 2.

2) Major flood hazard areas are restricted to zones along streams in canyon bottoms and may affect access roads and parking areas for the proposed ski area.

3) Shallow ground water may be present along all streams and in hillside areas where springs or seeps occur. Many such springs and seeps are found in the steep canyon in the southeastern corner of the area.

4) Adverse soil conditions such as expansive clays or collapsible soils were not apparent from surface reconnaissance, although subsurface exploration is needed to confirm this. However, soil conditions in basalt talus may be poor for construction.

REFERENCES

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

Bjorklund, L. J., Sumsion, 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.

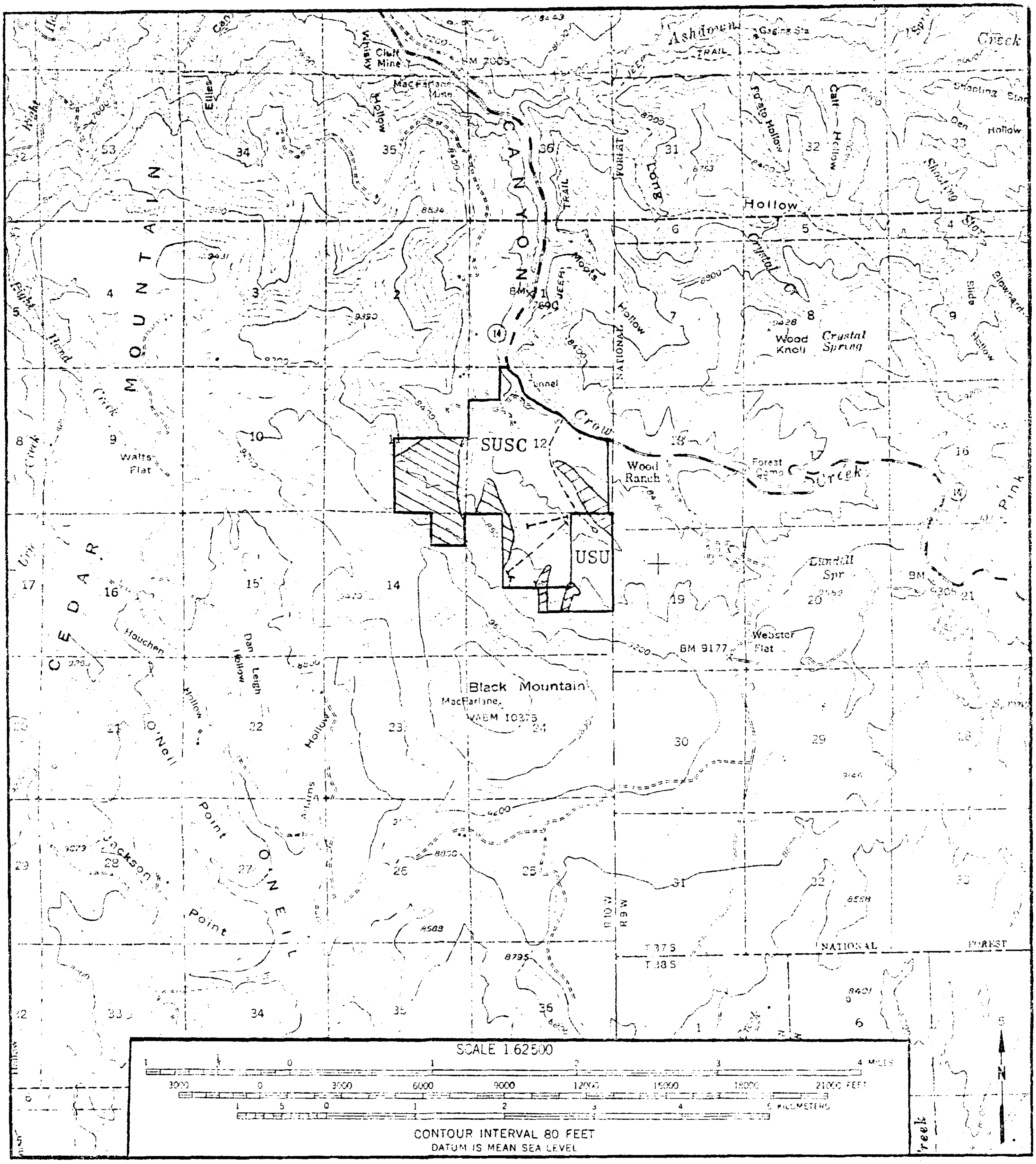
Gregory, H.E., 1950, Geology of eastern Iron County, Utah: Utah Geological and Mineral Survey Bulletin 37, 153 p.

Stokes, W.L., 1977, Subdivisions of the major physiographic provinces in Utah: Utah Geology, v. 4, no. 1, p. 1-17.

Washburn, A.L., 1973, Periglacial processes and environments: London, Edward Arnold (Publishers) Ltd., 320 p.

Wahrhaftig, C., and Cox, A., 1959, Rock glaciers in the Alaskan Range: Geological Society of American Bulletin, v. 70, p. 383-436.

Base map from: USGS 15' Topo Quad
Cedar Breaks, Utah 1958



Explanation

Principal zone of basalt talus accumulations

Zone of rockfall and earth slump hazard

Proposed ski lift

Proposed ski area access road

Generalized map showing property boundary, proposed development, and geologic features.

APPENDIX

List of Applied Geology Program Publications Current Through 1983

Bulletins

93. Geologic hazards in Morgan County with applications to planning, by B.N. Kaliser, 1972, 21 p.

96. Environmental geology of Bear Lake area, Rich County, Utah, by B.N. Kaliser, 1972, 32 p.

Special Studies

38. Engineering geology of the City and County Building, Salt Lake City, Utah, by B.N. Kaliser, 1971, 12 p.

51. Geology for assessment of seismic risk in the Tooele and Rush valleys, Tooele County, Utah, by B.L. Everitt and B.N. Kaliser, 1980, 33 p.

58. Engineering geology of the St. George area, Washington County, Utah, by G.E. Christenson and R.D. Deen, 1983, 32 p., 9 figs., 2 plates (in pocket), 3 tables, appendix.

Maps

27. Wasatch fault zone - Salt Lake City aqueduct system, City Creek Canyon to Provo River, Salt Lake and Utah Counties, Utah, approx. scale 1:140,000, 1969.

42. Earthquake fault map of a portion of Salt Lake County, Utah, by B. N. Kaliser, approx. scale 1:80,000, 1976.

Reports of Investigation

35. Bonneville Salt Flats hydrogeological study near Wendover, Utah, by B. N. Kaliser, 1967, 15 p., 7 figs., 7 tables.

38. Engineering geology of the Victory Road Reservoir site, Salt Lake City, Utah, by B. N. Kaliser, 1968, 12 p., photos, 11 figs., 1 pl.

40. Geology for planning, Bear Lake area, Rich County, Utah, by B. N. Kaliser, 1969, 84 p., 9 figs., 5 tables, 2 pls.

42. Hydrogeologic reconnaissance of Birch Spring, near Manila, Daggett County, Utah, by B. N. Kaliser, 1970, 5 p., 1 fig.

43. Preliminary reconnaissance of a landslide, Uintah, Weber County, by B. N. Kaliser, 1969, 4 p., 1 fig.

44. Pollution potential evaluation, Greater Aneth area oil field, by B. N. Kaliser, 1969, 3 p.

45. Preliminary reconnaissance of Patio Springs development, Weber County, by B. N. Kaliser, 1970, 2 p.

46. Sanitary landfill site reconnaissance evaluation, Cedar City, Utah, by B. N. Kaliser, 1970, 4 p.

47. Reconnaissance slope stability of Pine View Reservoir, Ogden Canyon, Weber County, by B. N. Kaliser, 1970, 7 p., 3 figs.

49. Preliminary reconnaissance of Kanab Creek Ranchos development, Kane County, by B. N. Kaliser, 1971, 2 p.

50. Preliminary reconnaissance of Buhler Estates development, west of St. George, Utah, by B. N. Kaliser, 1971, 3 p.

51. Preliminary reconnaissance of East Layton landslide, Davis County. Utah, by B. N. Kaliser, 1971, 4 p., 1 fig.

52. Preliminary reconnaissance of the Finch Trailer Court, Lake Point. Tooele County, Utah, by B. N. Kaliser, 1971, 3 p., 1 fig.

53. Suggested additions for subdivision ordinance for Morgan County, Utah, by B. N. Kaliser, 1971, 5 p.

54. Preliminary Geologic reconnaissance, Timber Lake subdivision, Wasatch County, Utah, by B. N. Kaliser, 1970, 3 p., 1 fig.

55. Hillside home evaluation in South Ogden, Utah, by B. N. Kaliser, 1971, 4 p., 1 fig.

57. Geologic hazards in Morgan County with applications to planning, by B. N. Kaliser, 1971, 95 p., 45 figs., 9 tables, 2 pls. (also available as Bulletin 93).

58. Bedrock aquifer exploration east of Bountiful, Utah-Phase I, by B. N. Kaliser, 1971, 13 p., 9 figs.

59. Retaining wall reconnaissance investigaton, Salt Lake City, by B. N. Kaliser, 1971, 3 p.

61. Investigation of building damage at 20 and 24 "O" Street, Salt Lake City, Utah, by H. Suekawa, 1972, 12 p., 3 figs.

62. Painted Hills Estates subdivision between St. George and Santa Clara. Utah, by B. N. Kaliser, 1972, 2 p.

63. Old Irontown subdivision, 22 Miles W., NW of Cedar City, Utah, by B. N. Kaliser, 1972, 2 p.

65. Contour mining proposal by North American Coal Corp., Clear Creek, Utah, by H. H. Doelling and B. N. Kaliser, 1972, 12 p., 4 figs., 3 tables.

66. Preliminary geologic reconnaissance of the Highland Estates subdivision, Summit County, by B. N. Kaliser, 1972, 3 p., 1 fig.

67. Inspection of cracks in home, Top of the World subdivision, Salt Lake County, by B. N. Kaliser, 1972, 3 p., 1 fig.

68. Preliminary geologic reconnaissance of the Forest Meadow Ranch recreation property, Summit County, by B. N. Kaliser, 1972, 4 p., 1 fig.

69. Geological reconnaissance of the proposed Park City/Summit County sanitary landfill site, by B. N. Kaliser, 1972, 5 p., 1 fig.

72. Slope stability - preliminary geologic reconnaissance for Kamas East subdivision, Summit County, Utah, by B. N. Kaliser, 1972, 3 p., 1 fig.

73. Preliminary geologic reconnaissance of proposed condominium property, mouth of Little Cottonwood Canyon, by B. N. Kaliser, 1972, 2 p.

75. Southern Utah subdivision inspections, Washington County, Utah, by B. N. Kaliser, 1973, 4 p.

76. Weathering of the Salt Lake City and County Building Dimension Stone, by B. N. Kaliser, 1973, 17 p., 5 figs., 1 table.

77. Preliminary reconnaissance of subdivisions near Alpine, Utah County. June 1973, by B. N. Kaliser, 1973, 3 p., map.

78. Preliminary reconnaissance of Bear Lake area subdivisions (Bridgerland Village and Sweetwater), Rich County, July 1972, by B. N. Kaliser, 1973, 3 p., 1 fig.

79. Basement crack evaluation, uncompleted home, Layton, Utah-Davis County, by B. N. Kaliser, 1973, 3 p.

80. Distressed homes, Club Heights section, South Ogden, Weber County, by B. N. Kaliser, 1973, 5 p., 1 fig.

81. Geologic reconnaissance in the Golden Hills subdivision (Salt Lake County) with conclusions relevant to subdivision practice elsewhere, by B. N. Kaliser, 1973, 6 p., 1 fig.

82. Preliminary geologic reconnaissance of proposed subdivision, Summit Park, Summit County, Utah, by B. N. Kaliser, 1973, 3 p.

86. Mt. Olympus Cove environmental geology study, by B. N. Kaliser, 1973, 50 p., 20 figs., 6 pls.

87. Reconnaissance of far west subdivision, Curlew Valley, Box Elder County, Utah, by B. N. Kaliser, 1973, 4 p., 1 fig.

89. Environmental geologic reconnaissance of the Starvation Lake State Park, Duchesne County, by B. N. Kaliser, 1974, 4 p., 1 fig.

90. Preliminary geologic reconnaissance of the Pleasant Creek Estates subdivision, Sanpete County, by B. N. Kaliser, 1974, 4 p., 1 fig.

92. Preliminary geologic reconnaissance of two Kane County subdivisions, by B. N. Kaliser, 1974, 13 p., 2 figs., 2 tables.

93. Preliminary geologic reconnaissance of Mt. Tabby Estates, Duchesne County, by B. N. Kaliser, 1974, 5 p., 1 fig.

94. Preliminary engineering geologic reconnaissance of the Capitol Study area, Salt Lake City, by B. N. Kaliser, 1974, 15 p., 8 figs., 1 pl.

95. Preliminary engineering geologic reconnaissance of the Spring Oaks subdivision, Utah County, by B. N. Kaliser, 1974, 4 p., 2 figs.

96. Environmental geologic reconnaissance, potential Recreation Lands in Provo River Drainage, Utah and Wasatch Counties, by B. N. Kaliser, 1974, 10 p., 4 figs.

97. Environmental geologic evaluation, Long Park Dam and Reservoir, Daggett County, Utah, by B. N. Kaliser, 1975, 6 p., 2 figs.

98. Preliminary geologic reconnaissance of Lower Kingston Canyon, Town of Kingston, Piute County, by B. N. Kaliser, 1975, 3 p., 1 fig.

99. Geologic evaluation from test holes of Lake Rockport Estates subdivision, Summit County, by B. N. Kaliser, 1975, 5 p., 1 fig.

101. Geotechnical suitability of lots as homesites in Highlands subdivision, Morgan County, by B. N. Kaliser, 1975, 3 p., 1 fig.

103. Geologic reconnaissance of the southern Utah Bicentennial Amphitheater, Springdale, Utah, by B. N. Kaliser, 1975, 5 p., 1 fig.

104. Preliminary geologic reconnaissance of the Summit Park subdivision, Smithfield, Cache County, Utah, by B. N. Kaliser, 1975, 5 p., 1 fig.

105. Preliminary geologic reconnaissance of Timber Lake subdivision, Plate No. 15, Wasatch County, Utah, by M. A. Raja, 1976, 8 p., 1 fig.

106. Preliminary geologic reconnaissance of six southern Utah subdivisions, by B. N. Kaliser, 1976, 17 p., 2 figs.

107. Geological reconnaissance of the site for the Sevier Valley Technical College with notes of archeological significance, by B. N. Kaliser, 1976, 6 p., 1 fig.

108. Final report to the U.S. Geological Survey Earthquake Hazard Reduction Program, USGS Grant No. 14-08-0001-G-166, by B. N. Kaliser, 1976, 231 p., 35 figs.

109. Exploration for fluid waste disposal site, Brighton, Salt Lake County, by B. N. Kaliser, 1976, 6 p., 1 fig.

110. Preliminary geologic reconnaissance for sanitary landfill sites for city of Moab, Grand County, by B. N. Kaliser, 1976, 5 p., 1 fig.

112. Preliminary geologic reconnaissance of Pioneer Trail subdivision, Morgan County, Utah, by M. A. Raja, 1976, 8 p., 1 fig.

113. Preliminary environmental geologic reconnaissance of Lost Creek State Park, by B. N. Kaliser, 1976, 3 p.

119. Report and recommendations for selected individual wastewater disposal systems in the Roosevelt and Vernal areas, Duchesne and Uintah counties, by James Rogers, 1977, 6 p., 12 figs.

121. Preliminary notes on alternate sites for a coal-fired plant in Utah, by B. N. Kaliser, 1977, 15 p., 6 figs.

122. Preliminary geologic reconnaissance of twelve proposed coal-fired power plant sites, eastern Uintah County, by J. L. Rogers and J. A. Campbell, 1978, 25 p., 12 figs.

123. Slope stability evaluation of the Logan River Bluff below Utah State University, Logan, Utah, by R. H. Klauk and B. N. Kaliser, 1978, 24 p., 3 figs., 2 tables.

126. Geology of urban development in the east bench area, Bountiful, Utah, by J. L. Rogers, 1978, 26 p., 8 figs.

127. Preliminary geotechnical reconnaissance, Old St. Benedict's Hospital site, Ogden, Utah, by B. N. Kaliser and R. Puri, 1978, 6 p., 1 fig.

130. Shallow ground water occurrences in northeastern Utah Valley, Utah, by R. H. Klauk, 1979, 12 p., 1 fig.

131. Preliminary geotechnical reconnaissance of a proposed new townsite in Cedar Valley, Utah County, Utah, by W. R. Lund and B. N. Kaliser, 1979, 22 p., 4 figs.

132. Investigation of three alternate sites for use as a sanitary landfill by the City of Price, Utah, by W. R. Lund and R. H. Klauk, 1979, 44 p., illus, 3 figs., 1 table.

133. Shallow groundwater occurrence west of Buchanon Avenue reservoirs, Ogden Ctiy, Utah, by B. N. Kaliser, 1979, 5 p., 2 figs.

134. Geotechnical reconnaissance of Sandy City fire station site, by B. N. Kaliser and W. R. Lund, 1979, 8 p., 2 figs., 2 pls.

135. Preliminary geotechnical reconnaissance of three prospective school sites for the Box Elder County school district, by B. N. Kaliser and W. R. Lund, 1979, 26 p., 4 figs., 1 table.

137. Geology for planning purposes of the Rockport State Park, Summit County, Utah, by R. H. Klauk, 1979, 20 p., 5 figs., 1 table, 1 pl.

144. Grand County sanitary landfill evaluation, by W. R. Lund, 1980, 23 p., 3 figs.

145. Ground surface subsidence, mouth of Weber Canyon, Weber County, by B. N. Kaliser, 1979, 6 p., 2 figs., 1 table.

146. Geotechnical reconnaissance of Kanab City's wastewater treatment, Lagoon site, by W. R. Lund, 1979, 18 p., 2 figs.

147. Geologic and topographic constraints to land use, Big Cottonwood Canyon, Salt Lake County, Utah, by W. R. Lund, 1980, 58 p., 1 fig.

148. Geologic evaluation of six sites for the disposal of vitro tailings, by F. D. Davis, 1980, 15 p., 4 figs.

149. Geology of some foundation excavations in northeastern Salt Lake City, by B. L. Everitt with contributions by B. N. Kaliser and D. T. McMillan, 1980, 24 p.

150. Distressed dwellings on First Avenue, Salt Lake City, by B. N. Kaliser, 1980, 15 p., 6 figs., 1 table.

151. Geology for planning purposes, Willard Bay State recreation area, by W. R. Lund, 1980, 30 p., 4 figs., 3 tables, 2 pls.

152. Geotechnical reconnaissance for Mapleton City water tank, by B. N. Kaliser, 1980, 9 p., 3 figs.

153. Geologic evaluations of potential low-level radioactive waste disposal sites between Crescent Junction and Cisco, Grand County, Utah, by F. D. Davis, 1980, 12 p., 3 figs.

154. Mount St. Helens, a report to Governor Scott M. Matheson, by L. Tempest, J. W. Southwick, and B. N. Kaliser, 1980, 75 p., 2 figs.

155. Geologic investigation of slope failures, Heber Creeper scenic railroad Right-of-Way, Wasatch County, Utah, by W. R. Lund, 1980, 24 p., 7 figs., 4 pls.

156. Comments on the geologic aspects of the MX base locations in western Utah, by F. D. Davis, 1980, 9 p., 5 figs.

158. Geotechnical reconnaissance of the Wasatch Hot Springs building site, by H. E. Gill, 1980, 12 p., 2 figs., 1 pl.

159. Preliminary geologic investigation to locate additional sources of culinary groundwater for Highland City, Utah, by H. E. Gill, 1980, 10 p., 2 figs., 2 tables.

160. Geologic investigation to locate potential sites for the new Riverside-North Garland culinary water well, by W. R. Lund, 1981, 12 p., 3 figs., 2 tables.

161. Summary report on the drilling and pump testing of a proposed water well in the bedrock Weber sandstone aquifer, Uintah County, Utah, by W. R. Lund, 1981, 9 p., 2 figs.

162. Geologic investigation to locate a culinary water well for Gunnison City, Sanpete County, Utah, by Harold E. Gill, 1981, 18 p., 4 figs., 1 table, 1 pl.

163. Geologic investigation of a major slope failure in the Washington terrace landslide complex near the mouth of Weber Canyon, Weber County, Utah, by H. E. Gill, 1981, 18 p., 2 figs., 1 table.

164. Preliminary feasibility study for proposed oil field waste water disposal sites east of Coalville, Summit County, Utah, by G. E. Christenson, 1981, 8 p., 2 figs., 1 table.

165. Engineering geology for land use planning, Perry, Utah, by W. R. Lund, 1981, 12 p., 7 plates.

166. Gasoline "spill" into alluvial aquifer, Monticello, San Juan County, Utah, by B. N. Kaliser, 1981, 17 p., 3 figs.

167. Engineering geology for land-use planning, Ballard, Utah, by G. E. Christenson, 1981, 13 p., 4 pls.

168. Investigation of basement flooding associated with shallow, unconfined ground water in Sandy City, Utah, by W. R. Lund, 1981, 45 p., 5 figs., 4 tables, 1 pl.

169. Geologic and hydrologic evaluation of Mt. Pleasant watershed, Sanpete County, Utah, by H. E. Gill, 1982, 18 p., 2 figs., 2 tables, 5 pls.

170. Analysis of geologic material furnished by mining interests relevant to the proposed Jordanelle reservoir site, USBR Central Utah Project, by B. N. Kaliser, 1981, 11 p.

172. Hydrologic investigation for possible contamination of the shallow unconfined aquifer and surface water in the vicinity of the Bay area refuse disposal site, Davis County, Utah, by H. E. Gill, 1982, 16 p., 4 figs., 2 tables.

173. Rapid earth flow of May 9, 1982, Salt Lake County, Utah, by B. N. Kaliser and W. F. Case, 1982, 33 p., 17 figs., 2 tables.

175. Geologic hazards evaluation of three canal alignments along Brush Creek near Jensen, Uintah County, Utah, by W. R. Lund, 1983, 12 p., 4 figs.

176. Geologic evaluation of septic tank and soil absorption system suitability, Dry Fork Canyon, Uintah County, Utah, by W. R. Lund, 1982, 31 p., 1 fig., 1 table, 3 pls.

177. Geologic review of proposed rail access alternatives, Gibson Dome nuclear waste terminal storage study area, Utah, by W. R. Lund, 1982, 9 p, 2 figs., 1 table.

181. Engineering geology for land-use planning, Smithfield, Utah, by G. E. Christenson, 1983, 37 p., 3 figs., 2 tables, 5 pls.

Open-File Reports

13. Environmental and Engineering Geology of the Lower Snow Basin Road Area, Weber County, by B. N. Kaliser, 1973.