EXPLANATION

Stream-flood hazard

SF — FEMA 100-year flood plain; possible shallow ground water

SF — Minor drainages not mapped by FEMA; may include debris flows

AF — **Alluvial-fan flood hazard and collapsible-soil potential**
Also, potential debris-flow hazard

Shallow ground-water flood hazard
Shallowest expected depth to water table 0-10 feet

Suspected Quaternary fault
Dashed where approximately located, dotted where concealed, ball on downthrown side

Surface-fault-rupture special-study zone

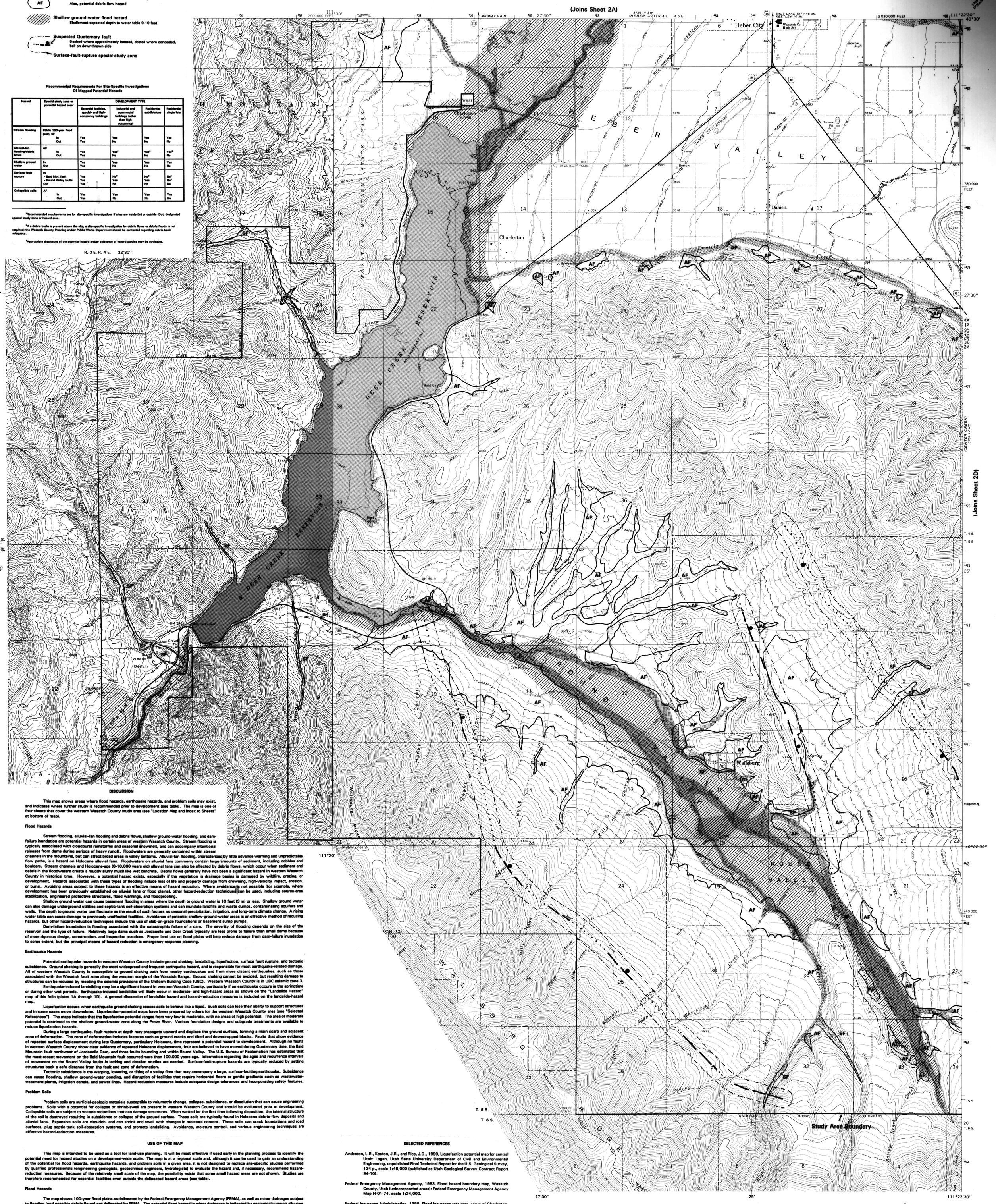
Recommended Requirements For Site-Specific Investigations Of Mapped Potential Hazards

Hazard	Special study zone or potential hazard area[1]	DEVELOPMENT TYPE			
		Essential facilities, special- and high-occupancy buildings	Industrial and commercial buildings (other than high-occupancy)	Residential subdivisions	Residential single lots
Stream flooding	FEMA 100-year flood plain, SF In Out	 Yes Yes	 Yes No	 Yes No	 Yes No
Alluvial-fan flooding/debris flows	AF In Out	 Yes Yes	 Yes[2] No	 Yes[2] No	 Yes[2] No
Shallow ground water	In Out	Yes Yes	Yes No	Yes No	Yes No
Surface fault rupture	In - Bald Mtn. fault - Round Valley faults Out	 Yes Yes Yes	 No[3] Yes No	 No[3] Yes No	 No[3] No[3] No
Collapsible soils	AF In Out	 Yes Yes	 Yes No	 Yes No	 Yes No

[1]Recommended requirements are for site-specific investigations if sites are inside (In) or outside (Out) designated special study zone or hazard area.

[2]If a debris basin is present above the site, a site-specific investigation for debris flows or debris floods is not required; the Wasatch County Planning and/or Public Works Department should be contacted regarding debris-basin adequacy.

[3]Appropriate disclosure of the potential hazard and/or existence of hazard studies may be advisable.



DISCUSSION

This map shows areas where flood hazards, earthquake hazards, and problem soils may exist, and indicates where further study is recommended prior to development (see table). The map is one of four sheets that cover the western Wasatch County study area (see "Location Map and Index to Sheets" at bottom of map).

Flood Hazards

Stream flooding, alluvial-fan flooding and debris flows, shallow ground-water flooding, and dam-failure inundation are potential hazards in certain areas of western Wasatch County. Stream flooding is typically associated with cloudburst rainstorms and seasonal snowmelt, and can accompany intentional releases from dams during periods of heavy runoff. Floodwaters are generally contained within stream channels in the mountains, but can affect broad areas in valley bottoms. Alluvial-fan flooding, characterized by little advance warning and unpredictable flow paths, is a hazard on Holocene alluvial fans. Floodwaters on alluvial fans commonly contain large amounts of sediment, including cobbles and boulders. Stream channels and Holocene-age (0-10,000 years old) alluvial fans can also be affected by debris flows, which occur when sediment and debris in the floodwaters create a muddy slurry much like wet concrete. Debris flows generally have not been a significant hazard in western Wasatch County in historical time. However, a potential hazard exists, especially if the vegetation in drainage basins is damaged by wildfire, grazing, or development. Hazards associated with these types of flooding include loss of life and property damage from drowning, high-velocity impact, erosion, or burial. Avoiding areas subject to these hazards is an effective means of hazard reduction. Where avoidance is not possible (for example, where development has been previously established on alluvial fans or flood plains), other hazard-reduction techniques can be used, including source-area stabilization, engineered protective structures, flood warnings, and floodproofing.

Shallow ground water can cause basement flooding in areas where the depth to ground water is 10 feet (3 m) or less. Shallow ground water can also damage underground utilities and septic-tank soil-absorption systems and can inundate landfills and waste dumps, contaminating aquifers and wells. The depth to ground water can fluctuate as the result of such factors as seasonal precipitation, irrigation, and long-term climate change. A rising water table can cause damage to previously unaffected facilities. Avoidance of potential shallow-ground-water areas is an effective method of reducing hazards, but other hazard-reduction techniques include the use of slab-on-grade foundations or basement sump pumps.

Dam-failure inundation is flooding associated with the catastrophic failure of a dam. The severity of flooding depends on the size of the reservoir and the type of failure. Relatively large dams such as Jordanelle and Deer Creek typically are less prone to failure than small dams because of more rigorous design, construction, and inspection practices. Proper land use on flood plains will help reduce damage from dam-failure inundation to some extent, but the principal means of hazard reduction is emergency response planning.

Earthquake Hazards

Potential earthquake hazards in western Wasatch County include ground shaking, landsliding, liquefaction, surface fault rupture, and tectonic subsidence. Ground shaking is generally the most widespread and frequent earthquake hazard, and is responsible for most earthquake-related damage. All of western Wasatch County is susceptible to ground shaking both from nearby earthquakes and from more distant earthquakes, such as those associated with the Wasatch fault zone along the western margin of the Wasatch Range. Ground shaking cannot be avoided, but resulting damage to structures can be reduced by meeting the seismic provisions of the Uniform Building Code (UBC). Western Wasatch County is in UBC seismic zone 3.

Earthquake-induced landsliding may be a significant hazard in western Wasatch County, particularly if an earthquake occurs in the springtime or during other wet periods. Earthquake-induced landslides will likely occur in moderate- and high-hazard areas as shown on the "Landslide Hazard" map of this folio (plates 1A through 1D). A general discussion of landslide hazard and hazard-reduction measures is included on the landslide-hazard map.

Liquefaction occurs when earthquake ground shaking causes soils to behave like a liquid. Such soils can lose their ability to support structures and in some cases move downslope. Liquefaction-potential maps have been prepared by others for the western Wasatch County area (see "Selected References"). The maps indicate that the liquefaction potential ranges from very low to moderate, with no areas of high potential. The area of moderate potential is restricted to the shallow ground-water zone along the Provo River. Various foundation designs and subgrade treatments are available to reduce liquefaction hazards.

During a large earthquake, fault rupture at depth may propagate upward and displace the ground surface, forming a main scarp and adjacent zone of deformation. The zone of deformation includes features such as ground cracks and tilted and downdropped blocks. Faults that show evidence of repeated surface displacement during late Quaternary, particulary Holocene, time represent a potential hazard to development. Although no faults in western Wasatch County show clear evidence of repeated Holocene displacement, four are believed to have moved during Quaternary time; the Bald Mountain fault northwest of Jordanelle Dam, and three faults bounding and within Round Valley. The U.S. Bureau of Reclamation has estimated that the most-recent movement on the Bald Mountain fault occurred more than 100,000 years ago. Information regarding the ages and recurrence intervals of movement on the Round Valley faults is lacking and detailed studies are needed. Surface-fault-rupture hazards are typically reduced by setting structures back a safe distance from the fault and zone of deformation.

Tectonic subsidence is the warping, lowering, or tilting of a valley floor that may accompany a large, surface-faulting earthquake. Subsidence can cause flooding, shallow ground-water ponding, and disruption of facilities that require horizontal floors or gentle gradients such as wastewater-treatment plants, irrigation canals, and sewer lines. Hazard-reduction measures include adequate design tolerances and incorporating safety features.

Problem Soils

Problem soils are surficial-geologic materials susceptible to volumetric change, collapse, subsidence, or dissolution that can cause engineering problems. Soils with a potential for collapse or shrink-swell are present in western Wasatch County and should be evaluated prior to development. Collapsible soils are subject to volume reductions that can damage structures. When wetted for the first time following deposition, the internal structure of the soil is destroyed resulting in subsidence or collapse of the ground surface. These soils are typically found in Holocene debris-flow deposits and alluvial fans. Expansive soils are clay-rich, and can shrink and swell with changes in moisture content. These soils can crack foundations and road surfaces, plug septic-tank soil-absorption systems, and promote landsliding. Avoidance, moisture control, and various engineering techniques are effective hazard-reduction measures.

USE OF THIS MAP

This map is intended to be used as a tool for land-use planning. It will be most effective if used early in the planning process to identify the potential need for hazard studies on a development-wide scale. The map is at a regional scale and, although it can be used to gain an understanding of the potential for flood hazards, earthquake hazards, and problem soils in a given area, it is not designed to replace site-specific studies performed by qualified professionals (engineering geologists, geotechnical engineers, hydrologists) to evaluate the hazard and, if necessary, recommend hazard-reduction measures. Because of the relatively small scale of the map, the possibility exists that some small hazard areas are not shown. Studies are therefore recommended for essential facilities even outside the delineated hazard areas (see table).

Flood Hazards

The map shows 100-year flood plains as delineated by the Federal Emergency Management Agency (FEMA), as well as minor drainages subject to flooding (and possibly debris flows) not delineated by FEMA. The potential flood hazard in minor drainages is indicated by geologically young alluvium deposited by floodwaters in the drainages. The Federal Insurance Administration's National Flood Insurance Program has established guidelines for development within the FEMA 100-year flood plains. Prior to development near minor drainages subject to flooding, studies should define the 100-year flood plain within which FEMA guidelines should be applied. Flooding may still occur in undesignated areas near drainages on the map during extreme rainstorms, but such events are infrequent.

The map shows boundaries of Holocene alluvial fans, which are areas where alluvial-fan flooding and debris flows may occur. Site-specific studies in these areas should address parts of the fan surface that would be subject to channelized flow versus sheet flow, the potential for debris flows based on slope and channel conditions above the fan, and the effect of existing upstream structures that might divert or contain floods or flows.

Where the map indicates shallow ground-water flooding is a potential hazard, site-specific investigations should be performed to characterize ground-water conditions prior to development. The studies should determine the shallowest expected water table as controlled by seasonal precipitation, irrigation, and long-term fluctuations.

The U.S. Bureau of Reclamation has prepared dam-failure inundation maps for Jordanelle and Deer Creek Dams (see "Selected References"), as well as emergency-action plans. The Utah Division of Water Rights, Dam Safety Section, maintains emergency-action-plan files for the smaller dams in the area. The information in these documents should be used for land-use and emergency-response planning.

Earthquake Hazards

Hazard zones associated with ground shaking, earthquake-induced landslides, and liquefaction are not shown on the map as noted in the "Discussion." Standard soil-foundation reports should provide data for UBC site coefficients used in seismic design. Recommendations for landslide-hazard investigations are included on the landslide-hazard map of this folio (plates 1A-1D). In the area of moderate liquefaction potential, site-specific studies should be performed for proposed essential facilities (for example, hospitals, police and fire stations) to evaluate the hazard and recommend hazard-reduction measures.

The map shows special-study zones associated with the Bald Mountain and Round Valley faults. The hazard associated with the Bald Mountain fault appears to be low and need only be considered if essential facilities are planned within the special-study zone. Because of the lack of information on activity of the Round Valley faults, site-specific studies to evaluate the earthquake history on these faults and characterize the zone of deformation are recommended prior to development within the associated special-study zones.

The extent and degree of tectonic-subsidence hazard is difficult to predict, and hazard areas have not been delineated on the map. The hazard is proportional to the potential for surface fault rupture, as well as the length and expected vertical displacment of the fault, and is therefore low in western Wasatch County. In general, the areas between the Bald Mountain fault and Jordanelle Reservoir and in Round Valley between the valley-bounding faults may experience tectonic subsidence during a surface-rupturing earthquake on one of these faults. Site-specific investigations (recommended for proposed essential and special-use facilities in these areas; see "Discussion") should address the likelihood of faulting and anticipated extent of tectonic-subsidence-related flooding and ground tilt.

Problem Soils

The map shows boundaries of Holocene alluvial fans where collapsible soils may be found. The location of expansive soils in western Wasatch County is more difficult to predict, and expansive-soil hazard areas are not shown on the map. U.S. Soil Conservation Service maps indicate that soils with a high shrink-swell potential may be widespread in western Wasatch County (see "Selected References"). The potential for collapse or shrink-swell, along with other soil-engineering properties, should be evaluated in a standard soil-foundation report prior to development.

SELECTED REFERENCES

Anderson, L.R., Keaton, J.R., and Rice, J.D., 1990, Liquefaction potential map for central Utah: Logan, Utah State University Department of Civil and Environmental Engineering, unpublished Final Technical Report for the U.S. Geological Survey, 134 p., scale 1:48,000 (published as Utah Geological Survey Contract Report 94-10).

Federal Emergency Management Agency, 1983, Flood hazard boundary map, Wasatch County, Utah (unincorporated areas): Federal Emergency Management Agency Map H-01-74, scale 1:24,000.

Federal Insurance Administration, 1980, Flood insurance rate map, town of Charleston, Utah, Wasatch County: U.S. Department of Housing and Urban Development, Community Panel No. 490165 0001 A, scale 1:7,200.

----1980, Flood insurance rate map, city of Midway, Utah, Wasatch County: U.S. Department of Housing and Urban Development, Community Panel No. 490167 0005 B, scale 1:9,600.

----1987, Flood insurance rate map, city of Heber City, Utah, Wasatch County: U.S. Department of Housing and Urban Development, Community Panel No. 490166 0001 B, scale 1:6,000.

Hecker, Suzanne, 1993, Quaternary tectonics of Utah with emphasis on earthquake-hazard characterization: Utah Geological Survey Bulletin 127, 157 p.

Hylland, M.D., and Lowe, Mike, in preparation, Geology and land-use planning, western Wasatch County, Utah: Utah Geological Survey Special Study.

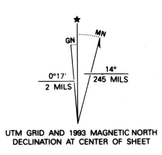
Kockelman, W.J., 1977, Flood-loss prevention and reduction measures, *in* Waananen, A.O., Limerinos, J.T., Kockelman, W.J., Spangle, W.E., and Blair, M.L., editors, Flood-prone areas and land-use planning - selected examples from the San Francisco Bay region, California: U.S. Geological Survey Professional Paper 942, 75 p.

Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1986, Regional seismotectonic study for the back valleys of the Wasatch Mountains in northeastern Utah: U.S. Bureau of Reclamation report, 317 p.

U.S. Bureau of Reclamation, 1985, Technical report on dam failure inundation study, Deer Creek Dam (Provo River Project, Utah): Unpublished report, 14 p.

----1993, Jordanelle Dam, Bonneville Unit, Central Utah Project, Utah, Upper Colorado Region: U.S. Department of the Interior, Emergency Preparedness Brief (with inundation map) from Standing Operating Procedures, 13 p.

Woodward, Lowell, Jensen, E.H., and Harvey, J.L., 1976, Soil Survey of Heber Valley area, Utah - parts of Wasatch and Utah Counties: U.S. Department of Agriculture, Soil Conservation Service and Forest Service in cooperation with Utah Agricultural Research Station, 124 p.



UTM GRID AND 1993 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Location Map and Index to Sheets

PLATE 2C
FLOOD HAZARDS, EARTHQUAKE HAZARDS, AND PROBLEM SOILS, WESTERN WASATCH COUNTY, UTAH

Michael D. Hylland and Charles E. Bishop

1995

Maps in this folio:
- Landslide Hazard (Plates 1A-1D)
- Flood Hazards, Earthquake Hazards, and Problem Soils (Plates 2A-2D)
- Suitability for Wastewater Disposal in Septic-Tank Soil-Absorption Systems (Plates 3A-3D)

Base from Aspen Grove, Charleston, and Wallsburg Ridge, Utah, USGS 7.5-minute topographic quadrangle maps.
Drafted by Noah P. Snyder