Probabilistic Liquefaction Potential and Liquefaction-Induced Ground Failure Maps for the Urban Wasatch Front: Phase IV, Fiscal Year 2007: Collaborative Research with University of Utah and Brigham Young University
PHASE IV FY2007

Steven F. Bartlett, Ph.D., P.E.
Associate Professor
Department of Civil and Environmental Engineering
University of Utah
122 S. Central Campus Dr.
Salt Lake City, Utah 84112
801-587-7726 (voice)
801-585-5477 (fax)
e mail: bartlett@civil.utah.edu

Travis M. Gerber, Ph.D., P.E.
Assistant Professor
Department of Civil and Environmental Engineering
Brigham Young University
368P Clyde Building
Provo, Utah 84602
801-422-1349 (voice)
801-422-0159 (fax)
e mail: tgerber@byu.edu

Daniel Hinckley
Graduate Student
Department of Civil and Environmental Engineering
University of Utah
122 S. Central Campus Dr.
Salt Lake City, Utah 84112

Abstract

This report presents liquefaction-induced lateral spread and ground settlement maps for the Salt Lake Valley for a M7.0 scenario event on the Wasatch fault and for two probabilistic-based events: (1) peak ground acceleration associated with a 2 percent probability of exceedance in 50 years and (2) peak ground acceleration associated with a 10 percent probability of exceedance in 50 years. The maps presented herein are the first liquefaction-induced ground failure maps developed for Utah using both geotechnical and geological data in conjunction with deterministic and probabilistic estimates of strong motion. These maps have been developed to aid engineers, developers and city planners identify areas that may require additional geotechnical evaluations and/or liquefaction mitigation to reduce the liquefaction hazard. The maps were developed from an extensive geotechnical database, geologic mapping and hazard calculations. Estimates of lateral spread displacement were calculated from the Youd et al. (2002) regression model and ground settlement estimates were calculated from procedures developed by Tokimatsu and Seed (1987) and Yoshimine et al. (2006). Estimates from these methods were plotted within their respective surficial geologic units, and the mapped units were subsequently assigned an estimate of ground displacement based on statistical analysis. The mapped units for the scenario event were assigned a displacement hazard that has an 85 percent probability of non-exceedance for the M7.0 Wasatch fault characteristic earthquake while the probabilistic-based events were assigned the median displacement hazard for their respective probabilistic events. The maps show relatively high lateral spread and settlement hazards exist along and near the Jordan River and in recent alluvial/river/stream/lake deposits found in the northern part of the Salt Lake Valley.

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1 Introduction

Liquefaction induced ground failure causes considerable damage to the built environment. Types of ground failure include: flow failure, lateral spread, ground oscillation, differential settlement, loss of bearing capacity and ground fissures. Some locales along Utah's Wasatch Front have a considerable liquefaction hazard due the presence of loose, saturated granular soils and the proximity to sources of significant seismic ground shaking such as the Wasatch and West Valley fault zones.

The Utah Liquefaction Advisory Group (ULAG) was formed in 2003 under the auspices of the Utah Geological Survey to oversee the liquefaction mapping effort in Utah. ULAG includes representatives of government, academia, and industry with expertise in liquefaction mapping. The group establishes a consensus on societal needs and technical capabilities, identifies data needs and mapping techniques, and forms a partnership to propose programs to accomplish the goals of the group. The guiding objectives presented in this section were developed ULAG in meetings held in Salt Lake City, Utah during March and April of 2003 and are reviewed and updated on an annual basis.

The program objectives established by ULAG in 2003 and updated annually are:

- Create a liquefaction database of relevant geotechnical factors and develop Geographic Information System (GIS) methods for probabilistic liquefaction hazard assessment using the database, strong motion estimates from the USGS National Seismic Hazard Map Program and appropriate site amplification factors to modify the strong motion estimates for soil effects.
- Develop methods to perform uncertainty analyses and/or quantify the uncertainties associated with the liquefaction-hazard mapping project.
- Correlate the GIS geotechnical database and surficial geological mapping to estimate geotechnical and properties for similar geological units in areas with limited or no subsurface data. These correlations will be used to better understand the liquefaction susceptibility of a given geological unit or facies and improve the quality of the liquefaction assessment in areas that are under sampled. Initial correlations will be developed during the pilot project and will continue in future mapped areas, as the data from additional geologic units and geographic areas are compiled.
- Compile during FY2006-2009 the GIS database for other areas along the Wasatch Front using the pilot-project methods and complete the liquefaction triggering maps for these areas. The preliminary priority of data compilation and mapping is: Salt Lake County, Utah County, Weber-Davis Counties, Cache County and Box Elder County.
- Develop probabilistic methods to map the amount of liquefaction-induced horizontal ground displacement and liquefaction-induced settlement. These methods will use existing correlations that relate thickness of liquefiable layers and other soil factors to the potential for lateral spread displacement and settlement. This mapping will be done for the same areas as the probabilistic liquefaction-hazard maps.
- Study documented occurrences of deformed Quaternary soils to: 1) determine if deformation is liquefaction-induced or related to other mechanisms (for example, failure of underlying clay), which will help implement criteria similar to those of California for establishing liquefaction hazard zones based on the presence of historical liquefaction;

and 2) determine the age of failed soils to establish the liquefaction hazard posed by latest Pleistocene Lake Bonneville deposits.

2   Project Status

During FY 2004, ULAG was funded to gather subsurface data in northern Salt Lake County and to develop a probabilistic liquefaction-triggering map for that area. In conjunction with this effort, geotechnical and geological data were obtained and entered into a geographic information system (GIS) database by the University of Utah. The types of subsurface data gathered included: 1) standard penetration tests (SPT), 2) cone penetrometer tests (CPT), 3) shear wave velocity (V_s) measurements, 4) soil type, laboratory classification tests and Atterberg limits, 5) grain-size analysis and 6) correlations with geological surficial units. The GIS database for northern Salt Lake County has been completed and can be found at: www.civil.utah.edu\~bartlett\ulag.html

In addition during FY2004, the University of Utah developed ARC GIS code for lateral spread analysis (Bartlett et al. 2005). From the code, a lateral spread map for a M7.0 scenario earthquake northern Salt Lake Valley was developed (Bartlett et al. 2005).

In FY 2005, the University of Utah was solely funded to gather subsurface data in southern Salt Lake County. This task was completed in 2005 and the updated GIS database is found at the ULAG website given above.

The FY2006 tasks included: development of CPT and SPT correlations, correlation of subsurface geologic and geotechnical ArcGIS^{TM} database with surficial geologic mapping, mapped mean annual probability of triggering liquefaction for Salt Lake County, mapped probability of triggering liquefaction for a scenario earthquake for Salt Lake County, mapped mean annual probability of lateral spread exceeding displacement thresholds of 0.1, 0.3 and 1.0 meters for northern Salt Lake County, mapped lateral spread horizontal displacement for a scenario event for southern Salt Lake County, synthesis report of seismically induced ground displacement in Salt Lake County, and CPT subsurface investigations in downtown Salt Lake City.

In FY2007, ULAG members requested the development of scenario lateral spread displacement map for southern Salt Lake County. This map is developed herein using a M7.0 earthquake on the Salt Lake City segment of the Wasatch fault zone. In addition, to complete the suite of liquefaction-related hazard maps for Salt Lake County, liquefaction-induced settlement maps will be produced in this report. This task will use the previously ARC GIS database to produce probabilistic and deterministic lateral spread hazard maps and the associated ARC CIS code. A set of three maps will be produced: two "best-estimate" (i.e., median) settlement maps based on strong motion estimates from the national hazard maps for 2 and 10 percent probabilities of exceedance in 50 years, and one scenario map for a M7.0 earthquake on the Salt Lake City segment of the Wasatch fault.

3 Liquefaction

Liquefaction can occur when excess pore pressures are generated in relatively loose, saturated, granular soil deposits that are subjected to cyclic loading resulting from moderate to large earthquakes. In the liquefied state, the soil's shear resistance is significantly reduced and such loss of strength may cause ground failure (e.g., flow failure, lateral spread and ground oscillation). In addition, ground settlement may occur as excess pore pressure dissipates and the soil reconsolidates to a denser configuration. Infrastructure, embankments and retaining walls atop liquefied ground may suffer from bearing capacity and other types of failure due to liquefied conditions of the foundation soils.

Perhaps the most damaging type of liquefaction failure is lateral spread. During lateral spread, blocks of relatively intact surficial soil atop liquefied soil displace down slope or towards a free face. Lateral spreads generated by the 1906 San Francisco earthquake damaged or destroyed numerous buildings, bridges, roads and pipelines (Youd and Hoose, 1978). Most notably, lateral spread along Valencia Street between 17th and 18th Streets severed water lines to downtown San Francisco. The resulting interruption of water greatly hampered fire fighting during the ensuing fire and significantly added to the earthquake losses. Lateral spreads caused by the 1964 Alaska earthquake disrupted many bridges, buildings, pipelines and other lifelines in cities such as Anchorage, Homer, Kodiak, Valdez, Seward, Portage and Whittier, Alaska. Approximately $80 million of liquefaction damage (1964 value) was incurred by 266 bridges and numerous sections of embankment along the Alaska Railroad and Highway (McCulloch and Bonilla, 1970; Kachadoorian, 1968). In that same year, liquefaction caused widespread damage to buildings, roads and bridges in Niigata, Japan (Hamada et al., 1986). In addition, ground settlement associated with liquefaction has caused extensive damage (Yoshida et al., 2001; Kaneko et al., 1995).

4 Liquefaction Hazards Along the Wasatch Front

The Wasatch Front in Utah has a relatively high liquefaction hazard due to the presence of several nearby, active faults. The Salt Lake segment of the Wasatch fault is capable of producing a M7.0 or greater event (Machette et al., 1992) which could trigger liquefaction in several locales within the valley. In addition, the Salt Lake and other valleys along the Wasatch Front are relatively deep, sedimentary basins with shallow groundwater containing loose, saturated, potentially liquefiable soil deposits. With a 2.5 percent population increase from 2007 to 2008 (Bernstein, 2008), Utah is the nation's fastest growing state and its infrastructure is continually expanding in earthquake-prone areas. This requires continual assessment of geological hazards, urban planning and earthquake-resistant design to reduce Utah's seismic risk.

This paper focuses on the development of liquefaction-induced lateral spread and ground settlement maps for the Salt Lake Valley, Utah for three cases: (1) a characteristic M7.0 event on the Wasatch fault, (2) the peak ground acceleration (PGA) corresponding to 2 percent probability of exceedance in 50 years and (3) the PGA corresponding to 10 percent probability of exceedance in 50 years. Additionally, recommendations on the implementation and use of these maps in hazard ordinances are presented in the Geologic Setting section.

Quaternary unconsolidated sediments in the Salt Lake Valley are generally between 40 and 200 m thick, except for the northeastern part of the valley, where they may be as thick as 700 m (Arnow et al., 1970; Wong et al., 2002). Localized tilting caused by faulting and deepening of the sedimentary basin has produced the deeper section of unconsolidated sediments found in this part of the Salt Lake Valley.

Holocene sediments, deposited after the last regression of late-Pleistocene Lake Bonneville, and Lake Bonneville deposits dominate the surficial geology of this intermountain basin (Figure 4-1, Table 4-1). The northern part of the Salt Lake Valley is covered by Holocene lacustrine, marsh and alluvial sediments that were deposited after the last major regression of Lake Bonneville, some 10,000 years before present (Lund, 1990). The northward flowing Jordan River and its tributary streams that generally flow northwesterly across the Salt Lake Valley are the primary source of highly liquefiable sediments (Olsen et al., 2007).

In other parts of the valley, Holocene and late-Quaternary alluvium, alluvial fan, colluvial and glacial deposits have been deposited atop Lake Bonneville lacustrine, delta and terrace deposits (Wong et al., 2002). In the southern part of the valley and along its eastern margins, surficial deltaic deposits from Lake Bonneville and pre-Bonneville alluvial-fan deposits, late Tertiary/early Pleistocene fanglomerates are morphologically distinctive and generally thick in some areas (Wong et al., 2002).

The groundwater table is relatively shallow (generally less than 10 to 15 feet below the surface) in the northern part of the valley and along the Jordan River and its tributaries (Bartlett et al., 2005). The groundwater table is much deeper along the margins of the valley near the mountain fronts. Unfortunately, a reliable groundwater map does not exist for the Salt Lake Valley, thus the depth to groundwater recorded on the borehole logs from the geotechnical database was used in conjunction with an inverse distance square interpolation method to estimate the ground water level in the valley (Bartlett et al., 2005).
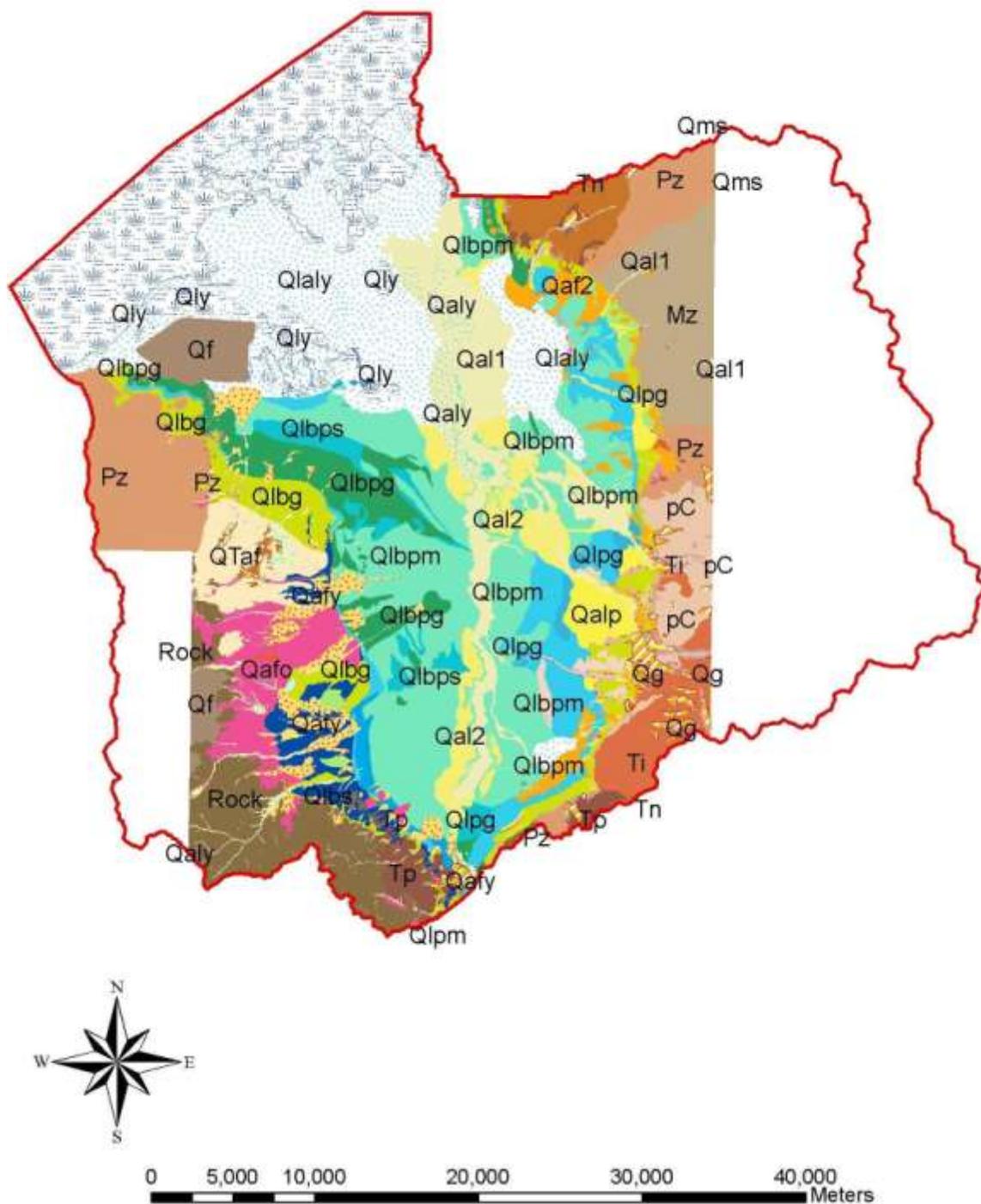
Figure 4-1 Surficial geology of the Salt Lake Valley, Utah (modified from Personius and Scott, 1992; Biek et al., 2004; and Miller, 1980). See Table 1 for descriptions of geologic units

Table 4-1
Name, description and age of major surficial geologic units in the Salt Lake Valley
(Personius and Scott, 1992; Biek et al., 2004; and Miller, 1980).

Name	Description	Age
Stream Alluvium		
Qal1	Modern stream alluvium 1	Upper Holocene
Qal2	Modern stream alluvium 2	Upper Holocene
Qalp	Stream alluvium related to the Provo (regressive) phase of Lake Bonneville	Upper Pleistocene
Qaly	Stream alluvial deposits, undivided	Holocene-Upper Pleistocene
Alluvial Fan Deposits		
Qaf2	Alluvial fan deposits 2	Holocene
Qafy	Alluvial fan deposits, undivided	Holocene-Upper Pleistocene
Qafb	Alluvial fan deposits of the Bonneville (transgressive) ph.	Upper Pleistocene
Qafo	Older alluvial fan deposits, undivided	Middle Pleistocene
QTaf	Oldest alluvial fan deposits	Upper Pleistocene
Young Lacustrine and Mixed-Environment Deposits		
Qly	Lacustrine and marsh deposits	Holocene
Qlaly	Lacustrine, marsh and alluvial deposits	Holocene-Upper Pleistocene
Lake Bonneville Lacustrine Deposits		
Qlpd	Deltaic gravel of the Provo (regressive) phase	Upper Pleistocene
Qlpg	Lac. gravel and sand of the Provo (regressive) phase	Upper Pleistocene
Qlps	Lac. sand and silt of the Provo (regressive) phase	Upper Pleistocene
Qlpm	Lac. clay and silt of the Provo (regressive) phase	Upper Pleistocene
Qlbg	Lac. gravel and sand of the Bonneville (transgressive) ph.	Upper Pleistocene
Qlbs	Lac. sand and silt of the Bonneville (transgressive) phase	Upper Pleistocene
Qlbm	Lac. clay and silt of the Bonneville (transgressive) phase	Upper Pleistocene
Qlbpg	Lac. gravel and sand of the Bonneville Lake cycle, undiv.	Upper Pleistocene
Qlbps	Lac. sand and silt of the Bonneville Lake cycle, undiv.	Upper Pleistocene
Qlbpm	Lac. silt and clay of the Bonneville Lake cycle, undivided	Upper Pleistocene
Colluvial Deposits		
Qclsp (Qmls)	Lateral spread deposits	Holocene-Upper Pleistocene
Qca	Colluvium and alluvium, undivided	Holocene-Mid. Pleistocene
Qes	Eolian sand	Holocene
Artificial Deposits		
Qf	Artificial fill	Historical
Bedrock (sometimes generalized as "Rock")		
Ti	Tertiary intrusive igneous rocks	Oligocene
Tn	Tertiary sedimentary and volcanic rocks	Neogene
Tp	Tertiary sedimentary and volcanic rocks	Paleogene
Mz	Mesozoic sedimentary rocks	Cretaceous - Triassic
Pz	Paleozoic sedimentary rocks	Permian - Cambrian
pC	Precambrian metamorphic rocks	Proterozoic and Archean
Rock	Limestone, shale, etc.	Pleistocene-Upper Mississippian

5   Faulting and Seismicity

The Salt Lake Valley is located in the central Wasatch Front part of the Intermountain Seismic Belt which is a series of active, Quaternary normal faults extending from southern Montana to northern Arizona (Smith and Arabasz, 1991). The Salt Lake segment of the Wasatch fault poses the primary seismic hazard to the Salt Lake Valley (Scott and Shroba, 1985; Machette et al., 1992; Personius and Scott, 1992). This segment extends approximately 46 km from the Traverse Mountains salient on the south to the Salt Lake salient on the north (Personius and Scott, 1992). It is a complex normal fault system consisting of several sections that include (from north to south): (1) the Warm Springs fault along the Salt Lake salient, (2) the East Bench fault, which is located just east of downtown Salt Lake City, (3) the Cottonwood section along the southern part of the Wasatch Front in the Salt Lake Valley and (4) the western part of the Fort Canyon fault near the Traverse Mountains salient. Other faults in the north central-part of the valley form the West Valley fault zone, which is antithetic to the Salt Lake segment and may co-rupture with this segment (e.g., Youngs et al., 1987; Keaton et al., 1993).

The average recurrence of faulting on the Salt Lake segment is approximately 1,300 years (Lund, 2005) with a scenario event of approximately M7.0 or larger (Machette et al., 1992). No historical events have occurred on this segment, but well-documented evidence of prehistoric faulting has been observed in numerous paleoseismological, geological and geotechnical investigations. Expected PGA values for surficial soil conditions vary from about 0.1 to 1.1 g according to soil conditions and distance from the fault (Wong et al., 2002). Ground acceleration of this amplitude will cause liquefaction-induced ground failure in parts of the central and northern valley, especially in the Holocene fluvial and alluvial deposits found in these areas. In addition, the strong ground motion may be amplified and prolonged due to basin effects within the valley (Olsen et al., 1995).

6   Previous Studies

Numerous paleoseismological, geologic and geotechnical investigations conducted in the Salt Lake Valley have documented prehistoric ground failures, which in part, are caused by liquefaction-induced lateral spread (e.g., Osmond et al., 1965; Keaton and Anderson, 1995; Simon and Bymaster, 1999; Kleinfelder Inc., 1999; Cotton, Shires and Associates, 1999; Korbay and McCormick, 1999; Black el al., 2003). The ground displacement features at the Salt Palace Convention Center have been extensively studied and their causal mechanism(s) are somewhat controversial (Simon and Bymaster, 1999; Kleinfelder, 1999; Cotton, Shires and Associates, 1999; Black et al., 2003; Korbay and McCormick, 1999). These studies are important to understand the origins of prehistoric ground failures mapped in the downtown area.

On a larger scale, subsurface information in combination with surficial geologic maps can be compiled and interpreted to create liquefaction county hazard maps for development, planning and natural disaster preparation. Liquefaction hazard maps have been classified into three general types: (1) liquefaction susceptibility, (2) liquefaction potential and (3) liquefaction ground failure maps (Youd and Perkins, 1978; Power and Holzer, 1996). Liquefaction susceptibility maps describe the relative vulnerability or susceptibility of the soil to liquefaction and are based on geological mapping of depositional environments and/or descriptions of the soil's texture and age. These maps do not consider the level or frequency of strong motion. In contrast,

liquefaction potential maps combine soil susceptibility information with the seismicity of the area to describe the likelihood or potential of liquefaction for deterministic or probabilistic events. Lastly, liquefaction ground failure maps show estimates of the expected amount of permanent ground displacement associated with an event or hazard level. These latter maps are considered the most useful type of map for assessment and mitigation of liquefaction-induced damage.

The first liquefaction potential map for the Salt Lake Valley was developed by Anderson et al. (1987) and later revised by Anderson et al. (1994) and digitized by Jarva (1994). The Anderson et al. (1994) map is currently adopted by most municipalities in Salt Lake County for hazard identification. This map was developed from geologic mapping, Standard Penetration Test (SPT) penetration resistance (blow count) N values and borehole soil descriptions using a relatively limited geotechnical database. From these data, estimates of the liquefaction potential were made and generalized to the mapped area. More recently, Solomon et al. (2004) have developed a liquefaction ground failure map that presents the Liquefaction Severity Index (LSI) (Youd and Perkins, 1987) for the Salt Lake Valley. However, this approach did not implement subsurface geotechnical data, but was based solely on surficial mapping. Recently, Erickson (2007) has completed a probabilistic liquefaction potential map for the Salt Lake Valley using subsurface geotechnical data and surficial mapping that combines the input from the United States Geological Survey (USGS) probabilistic seismic hazard maps (Frankel et al., 2002) with the probability of triggering liquefaction using probabilistic curves developed by Seed et al. (2003). Bartlett et al. (2005) and Olsen et al. (2007) have also produced a lateral spread displacement hazard map for a M7.0 Wasatch fault scenario earthquake for northern Salt Lake Valley.

This paper extends the work of Bartlett et al. (2005) and Olsen et al. (2007) and develops lateral spread displacement maps and liquefaction-induced ground settlement maps for the entire Salt Lake Valley based on a M7.0 Wasatch fault event (Wong et al., 2002) and for probabilistic estimates from the 2008 USGS National Seismic Hazard Mapping Project (Petersen et al., 2008). The selected PGA estimates correspond to a 2 percent probability of exceedance in 50 years and a 10 percent probability of exceedance in 50 years.

7 ArcGIS® Geotechnical Database

An extensive geotechnical database has been compiled in ArcGIS® for use in liquefaction analysis in the Salt Lake Valley (Bartlett et al., 2005; Olsen et al. 2007, Erickson, 2007). Efforts have been made to gather subsurface information for nearly all major geologic units (Figure 4-1, Table 7-1) and to document the quality of data of the borehole information. At the time of this study, the database contained subsurface information from 963 boreholes drilled in the valley since 1959 (Figure 7-1; see also Appendix A). Many of the boreholes are from recent Utah Department of Transportation (UDOT) projects where explorations generally extend to depths of 15 m or greater, especially near bridge structures. In other areas of the valley, the major contributors of subsurface data were Salt Lake County, city municipalities and geotechnical consultants.

The information compiled in the ArcGIS® geotechnical database includes borehole logs, soil descriptions, groundwater levels, SPT blow counts, fines content, mean grain size and soil unit weights. Additionally, shear wave velocity (V_s) data for Salt Lake Valley (Ashland and McDonald, 2003) for approximately 160 locations are contained in the database. The V_s dataset was reduced to representative site-response unit groups based on similar subsurface profile

characteristics (e.g., near-surface soil type, origin, deposition and age). Average V_s values (12 and 30 m) were determined for each site-response unit. Each surficial geologic unit was assigned to the best-paired site-response unit for use in the liquefaction analyses.

Because the subsurface information originated from a variety of sources and data quality varied, a system was developed to assign data quality indicators to each individual datum (Bartlett et al., 2005). In this system, a "1" was assigned to data where the supporting information was well documented in the original geotechnical report. (In total there were 2,261 fines content and 315 mean grain size measurements in the database that had data quality rankings of "1.") A data quality indicator of "2" was given to data that could be reasonably estimated from nearby borehole logs for the same site, and a "3" denoted data that were averaged from other nearby boreholes based on their soil type and geologic unit. Missing soil unit weight, fines content and mean grain size data that could not be estimated from nearby boreholes were averaged from high quality data within the entire database. For these averages, a "4" was assigned to data that represent averaged properties for the same soil type and geologic unit; and a "5" was assigned to data that represent averaged properties for the same soil type irrespective of the geologic unit. (No SPT penetration resistance data were averaged for this study; if such data were missing, the borehole information was not used.)

A groundwater depth map is required for liquefaction, lateral spread and ground settlement calculations. A comprehensive groundwater map did not exist for the mapped area, nor was there sufficient historical data to accurately model groundwater depths and fluctuations throughout the valley. Thus, the recorded groundwater depths from the borehole logs were used to generate a groundwater map using an inverse distance square interpolation method (Bartlett et al., 2005). To account for seasonal fluctuations, the depth to groundwater was conservatively decreased by 5 feet in all boreholes. In addition, if part of a soil layer was indicated on the borehole log to be saturated, the entire layer was assumed to be saturated in the analyses.

Surface slope and nearby topographical features are important factors in estimating lateral spread (Bartlett and Youd, 1992). A digital elevation model (DEM) from the USGS and free face features such as river channels and canals were used in ArcGIS® routines to approximate the surface slope and distance and height of a nearby free face, if present, for each borehole location (Bartlett et al., 2005, Olsen et al., 2007).

Table 7-1
Number of database boreholes in major surficial geologic units

Name	Description	Boreholes
Stream Alluvium		
Qal1	Modern stream alluvium 1	288
Qal2	Modern stream alluvium 2	111
Qalp	Stream alluvium related to the Provo (regressive) phase of Lake Bonneville	10
Qaly	Stream alluvial deposits, undivided	15
Alluvial Fan Deposits		
Qaf2	Alluvial fan deposits 2	28
Qafy	Alluvial fan deposits, undivided	6
Qafb	Alluvial fan deposits of the Bonneville (transgressive) ph.	3
Qafo	Older alluvial fan deposits, undivided	1
QTaf	Oldest alluvial fan deposits	1
Young Lacustrine and Mixed-Environment Deposits		
Qly	Lacustrine and marsh deposits	5
Qlaly	Lacustrine, marsh and alluvial deposits	136
Lake Bonneville Lacustrine Deposits		
Qlpd	Deltaic gravel of the Provo (regressive) phase	5
Qlpg	Lac. gravel and sand of the Provo (regressive) phase	40
Qlps	Lac. sand and silt of the Provo (regressive) phase	0
Qlpm	Lac. clay and silt of the Provo (regressive) phase	0
Qlbg	Lac. gravel and sand of the Bonneville (transgressive) ph.	14
Qlbs	Lac. sand and silt of the Bonneville (transgressive) phase	1
Qlbm	Lac. clay and silt of the Bonneville (transgressive) phase	5
Qlbpg	Lac. gravel and sand of the Bonneville Lake cycle, undiv.	12
Qlbps	Lac. sand and silt of the Bonneville Lake cycle, undiv.	5
Qlbpm	Lac. silt and clay of the Bonneville Lake cycle, undivided	269
Colluvial Deposits		
Qclsp (Qmls)	Lateral spread deposits	2
Qca	Colluvium and alluvium, undivided	1
Qes	Eolian sand	1
Artificial Deposits		
Qf	Artificial fill	0
Bedrock		
Ti	Tertiary intrusive igneous rocks	0
Tn	Tertiary sedimentary and volcanic rocks	0
Tp	Tertiary sedimentary and volcanic rocks	0
Mz	Mesozoic sedimentary rocks	1
Pz	Paleozoic sedimentary rocks	2
pC	Precambrian metamorphic rocks	0
Rock	Pleistocene-Upper Mississippian limestone, shale, etc.	1
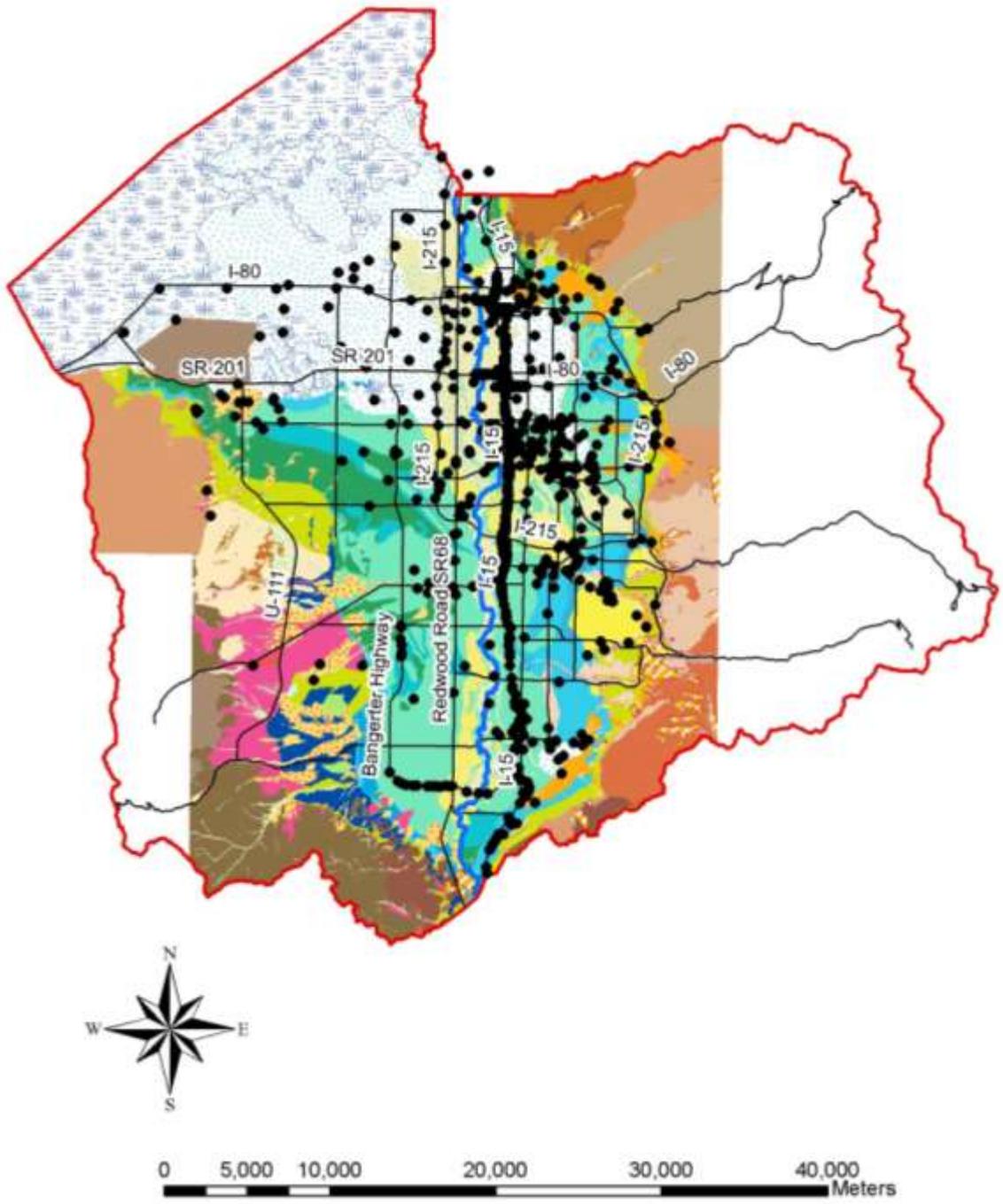
Figure 7-1 Locations of geotechnical boreholes contained in ArcGIS® geotechnical database, Salt Lake Valley, Utah

8 Liquefaction Hazard Mapping

Liquefaction ground failure maps were created for the Salt Lake Valley for lateral spread and liquefaction-induced ground settlement based on a scenario M7.0 Wasatch fault earthquake and for probabilistic events associated with PGA values corresponding to a 2 percent probability of exceedance in 50 years and a 10 percent probability of exceedance in 50 years. The PGA estimates for the M7.0 Wasatch fault scenario event were obtained from Wong et al. (2002) and the PGA estimates for the probabilistic events were obtained from the USGS National Strong Motion Hazard Mapping Project (Petersen et al., 2008). In accordance with the method and criteria proposed by Seed et al. (2001), the Petersen et al. (2008) rock-based PGA estimates were adjusted for surface soil effects based on the averaged shear wave velocities (V_s) assigned to the several site-response units, as previously described.

8.1 Lateral Spread Map Development

The lateral spread maps presented herein are a continuation of work completed for the northern part of the Salt Lake Valley by Bartlett et al. (2005) and Olsen et al. (2007). The methods used for this paper are consistent with the methods developed in those reports. In short, following the methods outlined in Youd et al. (2001), raw SPT blow count data were normalized and corrected to $(N_1)_{60}$ clean sand values and liquefaction triggering analyses were completed at each borehole location.

Lateral spread displacements were estimated by the Youd et al. (2002) regression model. The model requires the following input: earthquake magnitude, horizontal distance from the seismic source, distance to free face and height of free face (if applicable), ground slope (if applicable), and cumulative thickness, average fines content and mean grain size of all saturated granular layers with SPT $(N_1)_{60}$ blow counts less than 15. The scenario analysis was based on a M7.0 earthquake on the Wasatch fault (Wong et al., 2002) while input magnitudes and horizontal distances for the probabilistic analyses varied based on deaggregations of the data presented by Petersen et al. (2008). All other input variables were obtained from the ArcGIS® geotechnical database previously described.

Displacements were estimated at each borehole location having a factor of safety against liquefaction triggering less than or equal to 1.1. All boreholes with factors of safety against liquefaction triggering greater than 1.1 were assigned a lateral spread displacement of 0 m. The estimated horizontal displacements (D_H) were further categorized as "minimal" (0 m); "low" (0 to 0.1 m); "moderate" (0.1 to 0.3 m); "high" (0.3 to 1.0 m); and "very high" (greater than 1.0 m).

Hazard categories were assigned to the major surficial geologic units by statistical analysis of the estimated displacements from all boreholes located within each respective geologic unit or group of units representing similar characteristics (e.g., near-surface soil type, origin, deposition and age). Using the method discussed by Bartlett et al. (2005) and Olsen et al. (2007), cumulative histograms of increasing hazard severity were developed to determine an 85 percent non-exceedance threshold for the scenario event (Figures 16 through 21 in Appendix C). The 85 percent non-exceedance criterion means that no more than 15 percent of the estimated displacements exceed the upper bound of the hazard category that was assigned to the respective geologic unit or group of units and thus approximately represents a mean plus one standard

deviation criterion. For the probabilistic-based maps, the hazard category assigned to each geologic unit or group of units was based on the median estimated displacement for the respective unit.

In some areas, several clearly defined homogenous or nearly homogenous clusters of similar displacement that differed from the remaining estimates were represented in the same geologic unit. In these cases, the geologic units were subdivided prior to conducting statistical analysis, so that the displacement estimates were more homogenous locally. Several examples of statistical hazard category assessments are included in Appendix C.

The liquefaction-induced lateral spread ground displacement map for the scenario M7.0 Wasatch fault earthquake is presented in Figure 8-1 and the probabilistic-based maps are presented in Figures 8-2 and 8-3. These maps are useful in identifying areas of high ground displacement potential and areas where site-specific geotechnical investigation and/or liquefaction mitigation are warranted.

8.2 Ground Settlement Map Development

Liquefaction-induced ground settlements were estimated by averaging the results of Tokimatsu and Seed (1987) and the Yoshimine et al. (2006) method which is based on the methodology originally proposed by Ishihara and Yoshimine (1992). Both methods estimate ground settlement based on SPT N values, which conveniently suits the data available in the ArcGIS® geotechnical database. The following paragraphs describe each method and the input data required to estimate settlement.

Tokimatsu and Seed (1987) estimate volumetric strain in saturated clean sands based on cyclic stress ratio and SPT blow counts, $(N_1)_{60}$ (see Figure 8-4). The method is based on correlations of field and laboratory performance data to post-liquefaction settlements recorded after the Niigata 1964, Tokachioki 1968 and Miyagiken Oki 1968 earthquakes. For the purposes of our study, the curves presented in Figure 8-4 were digitized into over 1,400 interpolated data points (see Appendix B).

Yoshimine et al. (2006) present a series of equations to describe the liquefaction-induced volumetric strain prediction curves presented in Ishihara and Yoshimine (1992). The curves were derived from strains observed in cyclic laboratory testing performed by Nagase and Ishihara (1988) and correlate factor of safety against liquefaction triggering to the maximum single amplitude of shear strain (γ_{max}) based on relative density which is estimated from Japanese-normalized blow SPT blow counts, N_1 (Figure 8-5). The maximum single amplitude of shear strain is then used to estimate post-liquefaction volumetric strain due to reconsolidation (Figure 8-6). The Yoshimine et al. (2006) equations were used in the ArcGIS® routines to facilitate rapid calculations (see Appendix B).

To estimate liquefaction-induced settlement by Tokimatsu and Seed (1987), the raw blow count data contained in the ArcGIS® geotechnical database were normalized and corrected to $(N_1)_{60}$ clean sand values and liquefaction triggering analyses were completed at each borehole location following the methods outlined in Youd et al. (2001). A reference table created from the data points interpolated from Figure 8-4 was then used to estimate liquefaction-induced volumetric strains where the factor of safety against liquefaction triggering was less than or equal to 1.1. The required input variables consisted of $(N_1)_{60}$ values normalized and corrected to clean sands by

Youd et al. (2001) and cyclic stress ratios calculated in accordance with the guidelines presented in Tokimatsu and Seed (1987). Due to differences in event magnitude, the cyclic stress ratios were scaled based on the magnitude scaling factors presented in Tokimatsu and Seed (1987) which were taken from Seed et al. (1983). The scenario analysis was based on a M7.0 earthquake on the Wasatch fault while input magnitudes for the probabilistic analyses varied based on deaggregations of the data presented by Petersen et al. (2008). Settlements were calculated by multiplying the volumetric strains by the thickness of each respective liquefiable soil layer. A ground settlement value of 0 m was assigned to all locations with factors of safety for liquefaction triggering greater than 1.1.

To estimate liquefaction-induced settlement by Yoshimine et al. (2006), the raw blow count data contained in the ArcGIS® geotechnical database were normalized and corrected to $(N_1)_{60}$ clean sand values following the methods outlined in Youd et al. (2001). To account for traditional Japanese sampling practices and techniques, the $(N_1)_{60}$ clean sand blow count values were converted to N_1 values following the guidelines in Seed et al. (1985). Following the method outlined by Yoshimine et al. (2006), the N_1 values were converted to relative densities by Meyerhof (1957) and the likelihood of liquefaction triggering was calculated based on the Japanese Design Code for Highway Bridges (2000). Using the relative densities and the factors of safety against liquefaction triggering the maximum single amplitude of shear strain was calculated for all sites with a factor of safety against liquefaction triggering less than or equal to 1.1. Finally, liquefaction-induced volumetric strains were estimated by the relative densities and the maximum single amplitude of shear strains. Settlements were calculated by multiplying the volumetric strains by the thickness of each respective liquefiable soil layer. A ground settlement value of 0 m was assigned to all locations with factors of safety for liquefaction triggering greater than 1.1. Since earthquake magnitude was not a required input variable, no magnitude scaling factors were used in this method.

The results from each method were compared at each borehole to determine if there were significant differences in the settlement estimates. For example, the scenario M7.0 earthquake settlement data set showed an average difference between the two methods of 0.004 m, with a maximum difference of 0.083 m. Of the 963 boreholes, Tokimatsu and Seed (1987) predicted higher settlements than Yoshimine et al. (2006) in 232 boreholes and the opposite was true for 444 boreholes. Both methods predicted no settlement in 287 boreholes. A method-to-method comparison of the differences showed that 74 percent of the boreholes were within 0.01 m, 92 percent were within 0.025 m and 99 percent were within 0.05 m. Hence, it was concluded that the two methods produced relatively similar results when considering the quality of the input data and the ultimate use of the mapping. Subsequently, the average of the two methods was considered appropriate to estimate the ground settlement at each liquefiable borehole location.

The ground settlement estimates were categorized as "low" (0 to 0.05 m); "moderate" (0.05 to 0.1 m); "high" (0.1 to 0.3 m); and "very high" (greater than 0.3 m). Similar to the lateral spread displacement maps, hazard categories were assigned to the major geologic units by statistical analysis of the estimated displacements from all boreholes located within each respective geologic unit or group of units with similar subsurface characteristics (e.g., near-surface soil type, origin, deposition and age). In brief, the hazard category assignments for the M7.0 Wasatch fault scenario map were based on an 85 percent non-exceedance criterion while the hazard categories for the probabilistic maps were based on the median displacement within the respective geologic unit or group of units.
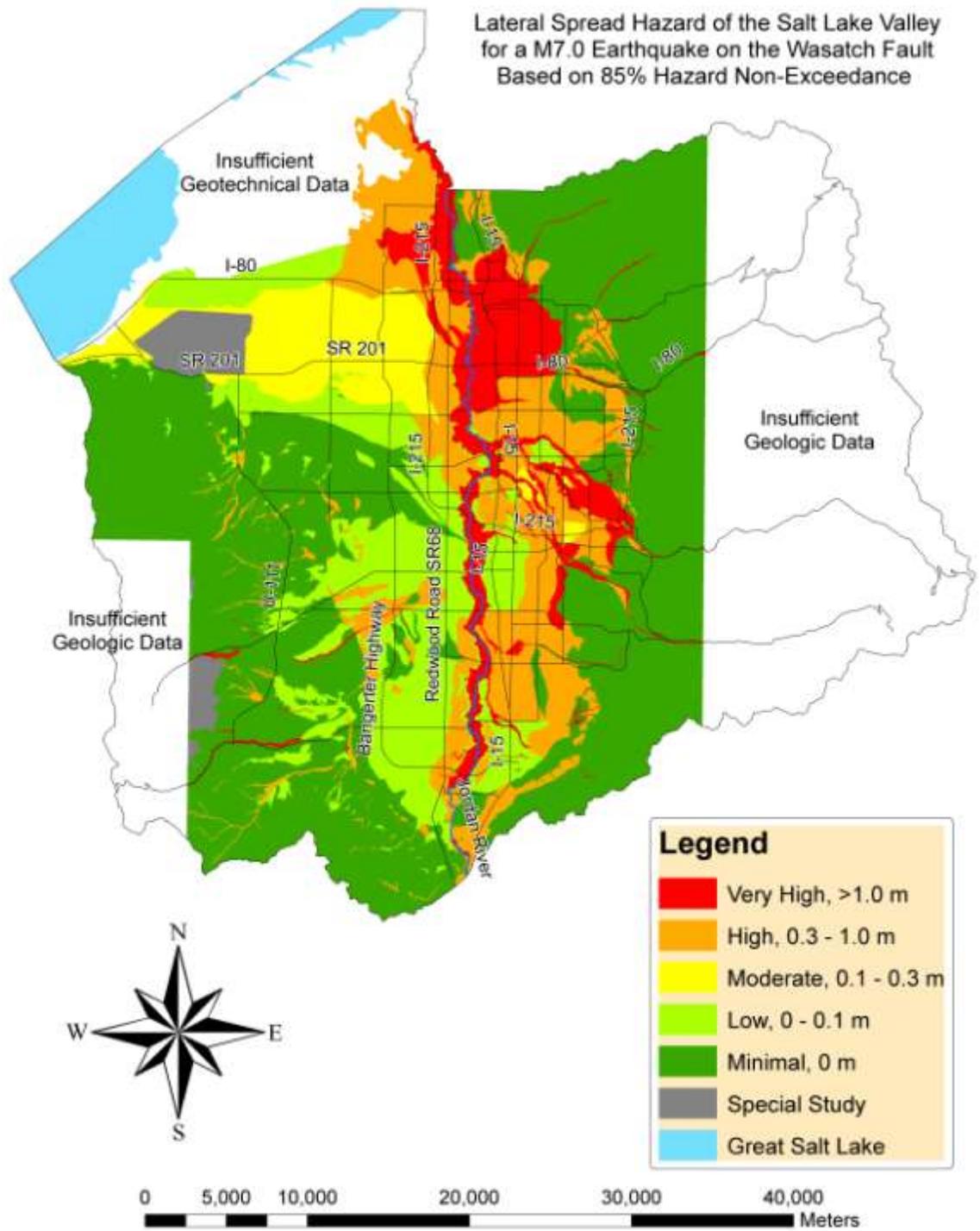
Figure 8-1 Lateral spread displacement hazard for the Salt Lake Valley, Utah based on M7.0 scenario earthquake on the Salt Lake segment of the Wasatch fault and an 85 percent non-exceedance probability threshold

Figure 8-2 Lateral spread displacement hazard for the Salt Lake Valley, Utah based on the PGA associated with a 2 percent probability of exceedance in 50 years
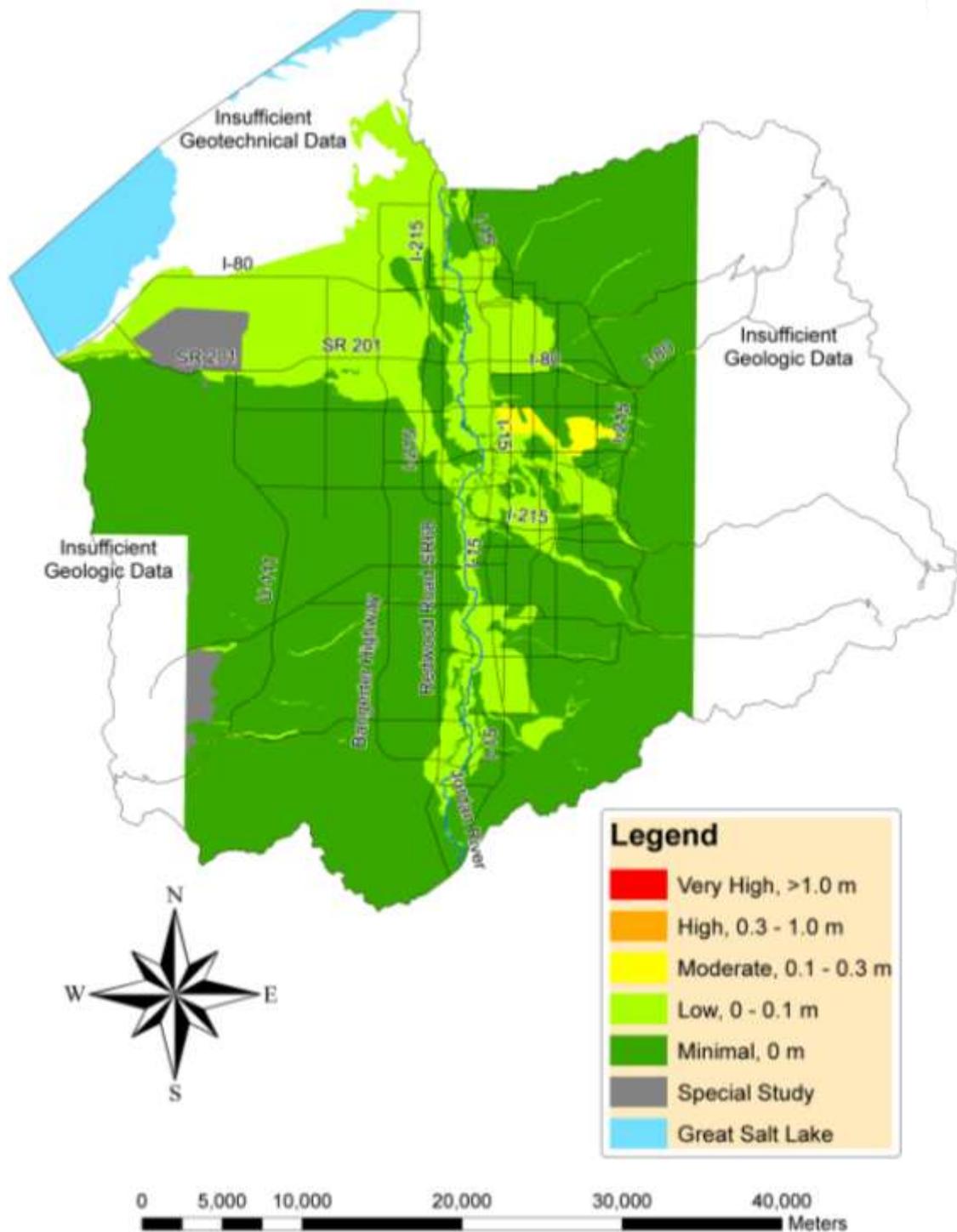
Figure 8-3 Lateral spread displacement hazard for the Salt Lake Valley, Utah based on the PGA associated with a 10 percent probability of exceedance in 50 years
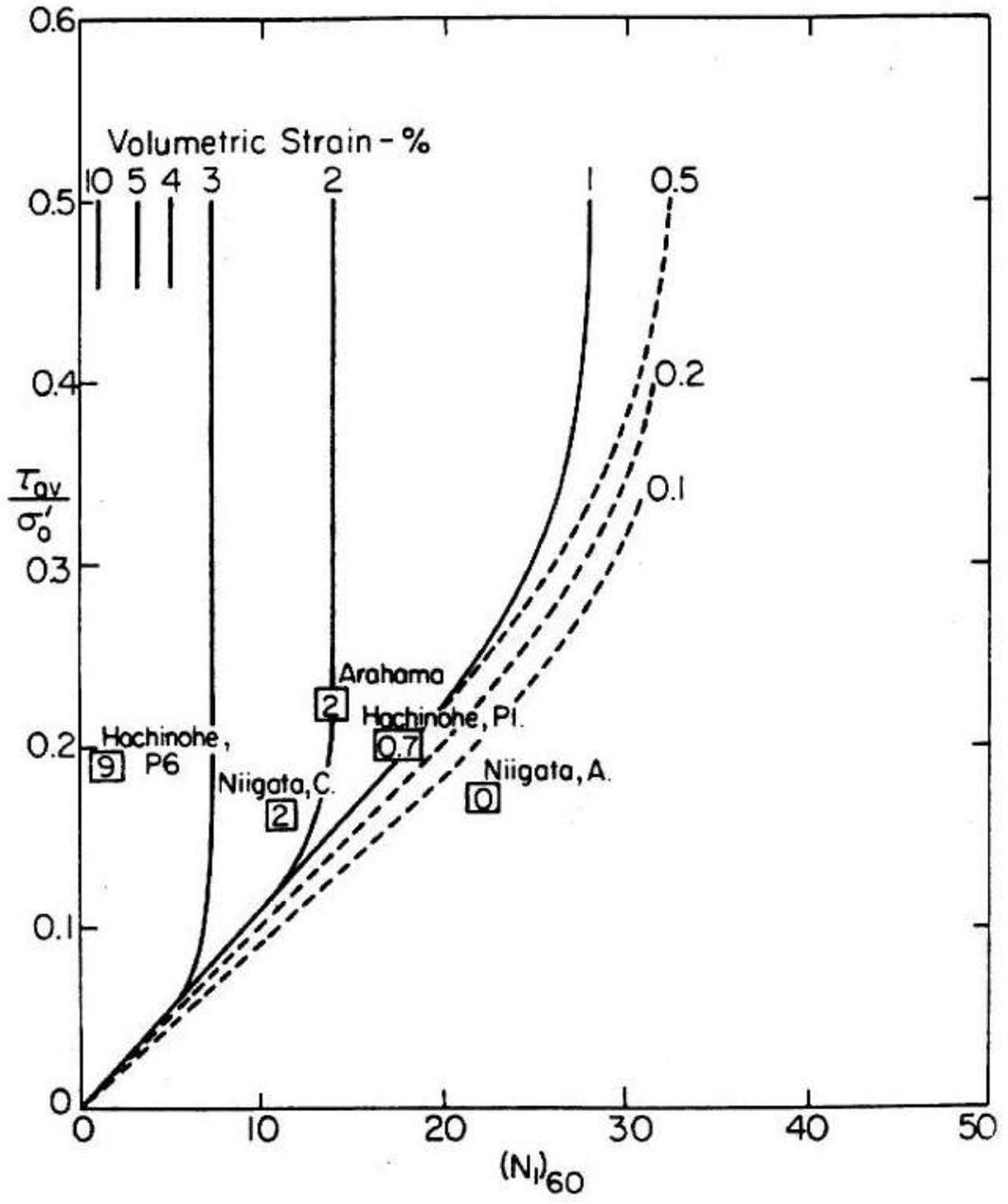
Figure 8-4 Relationships between $(N_1)_{60}$, Cyclic Stress Ratio and Volumetric Strain for Saturated Clean Sands (Tokimatsu and Seed, 1987).
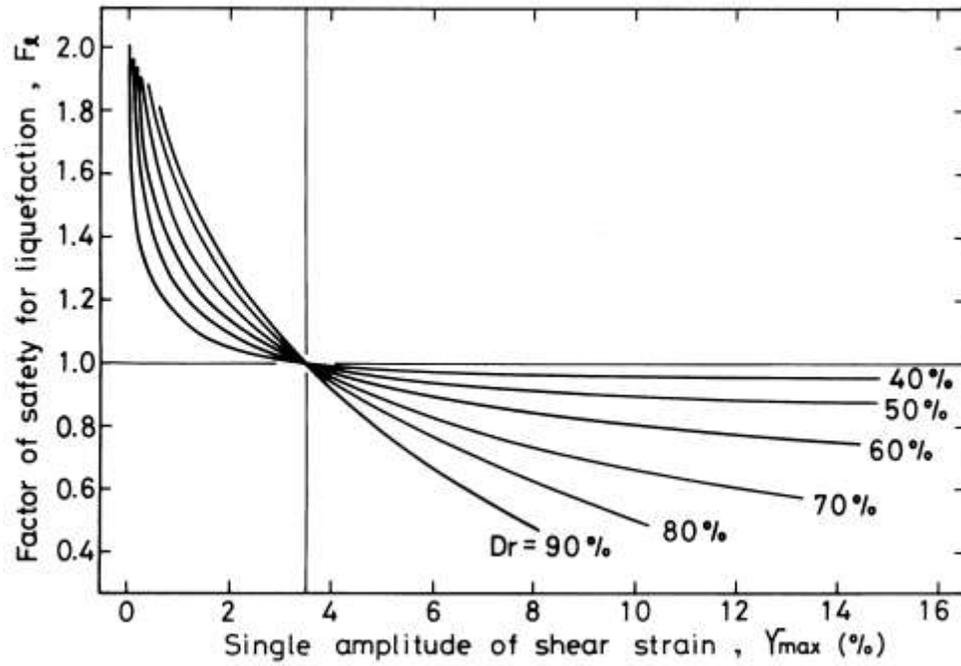
Figure 8-5 Relationships between liquefaction factor of safety and maximum shear strain (Ishihara and Yoshimine, 1992).
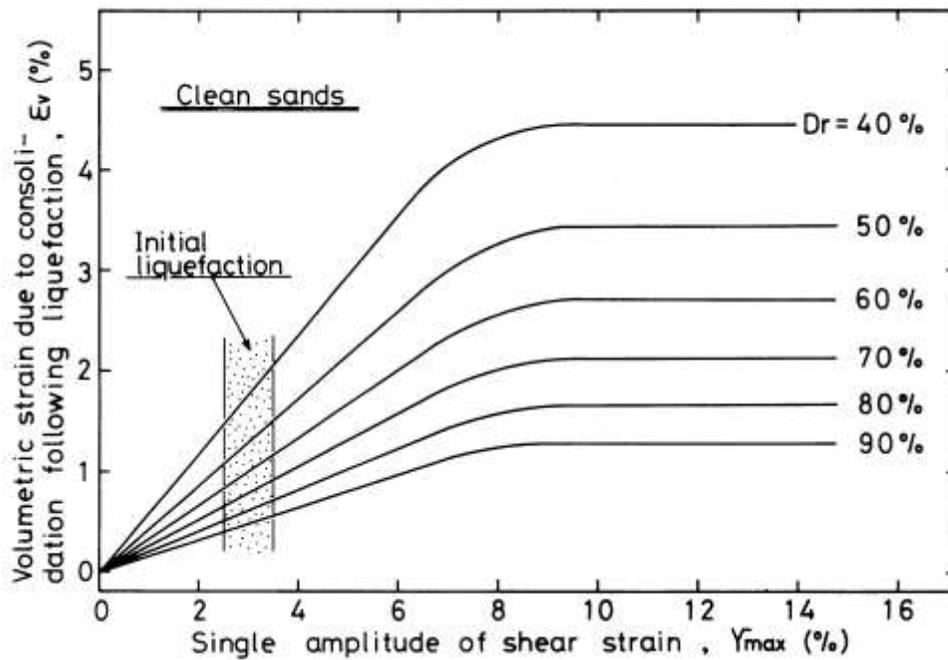
Figure 8-6 Relationships between re-consolidated volume change and shear strain (Ishihara and Yoshimine 1992).

The liquefaction-induced settlement ground displacement map for the scenario M7.0 Wasatch fault earthquake is presented in Figure 8-7 and the probabilistic-based maps are presented in Figures 8-8 and 8-9. These maps are useful in identifying areas of high ground displacement potential and areas where site-specific geotechnical investigation and/or liquefaction mitigation are warranted.

The 85 percent non-exceedance criterion used in the development of the scenario map and the median displacements considered in the development of the probabilistic maps represent the appropriate level of conservatism required for the proper implementation of the maps as recommended by consensus of the Utah Liquefaction Advisory Group (personal communications, February 11, 2009 and February 8, 2010). If a different degree of conservatism is requested by the end-user of a respective jurisdiction, the maps can be easily and quickly altered to reflect modified criteria. For example, a higher or lower non-exceedance criterion could be used to create a more-conservative or less-conservative map, respectively. However, it is recommended that the same map development methods be used for grouping and categorizing individual geologic units. As previously mentioned, additional details and examples of statistical hazard category assessments are included in Appendix C.
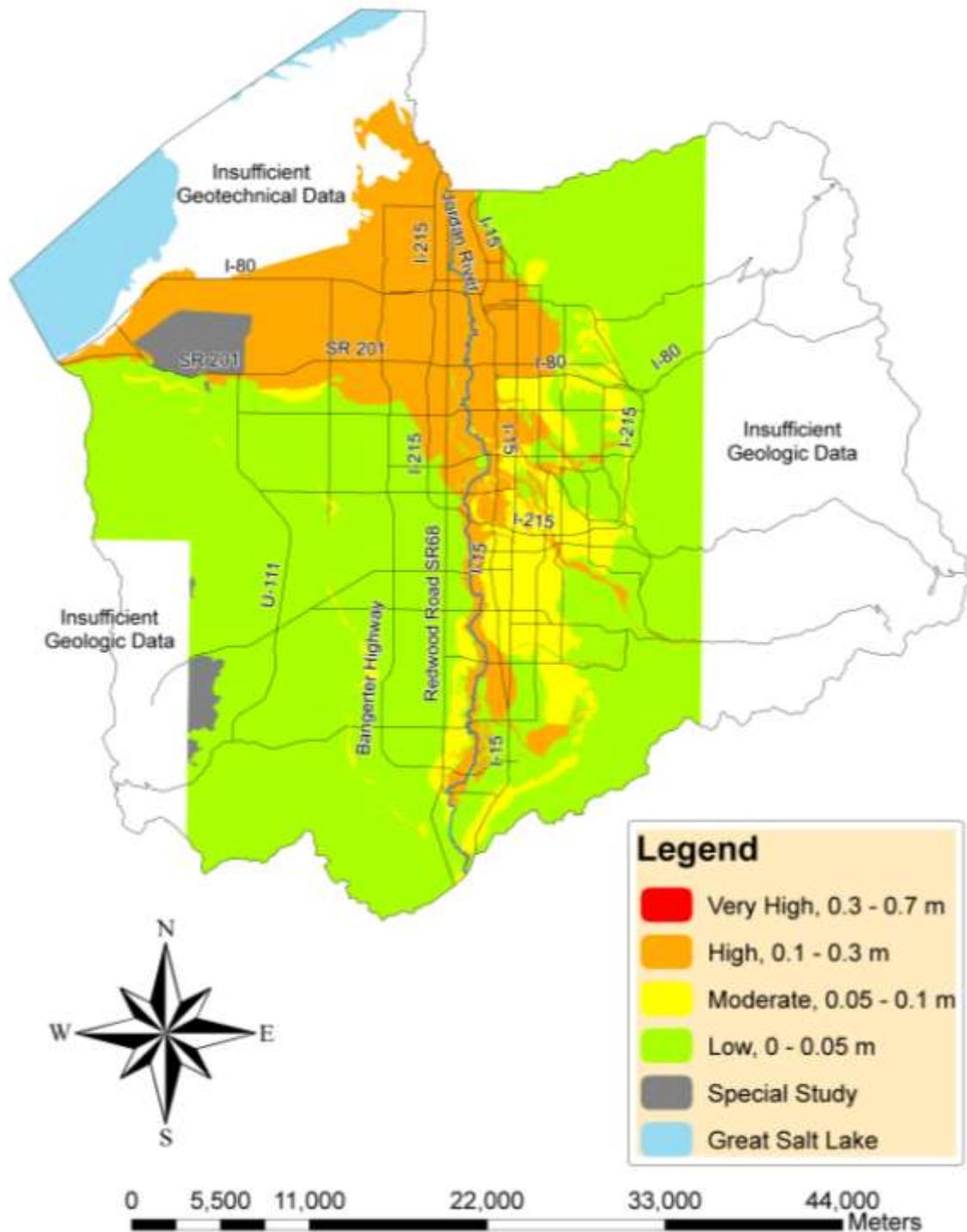
Figure 8-7 Liquefaction-induced ground settlement hazard for the Salt Lake Valley, Utah for a M7.0 scenario earthquake on the Salt Lake segment of the Wasatch fault and 85 percent non-exceedance probability threshold
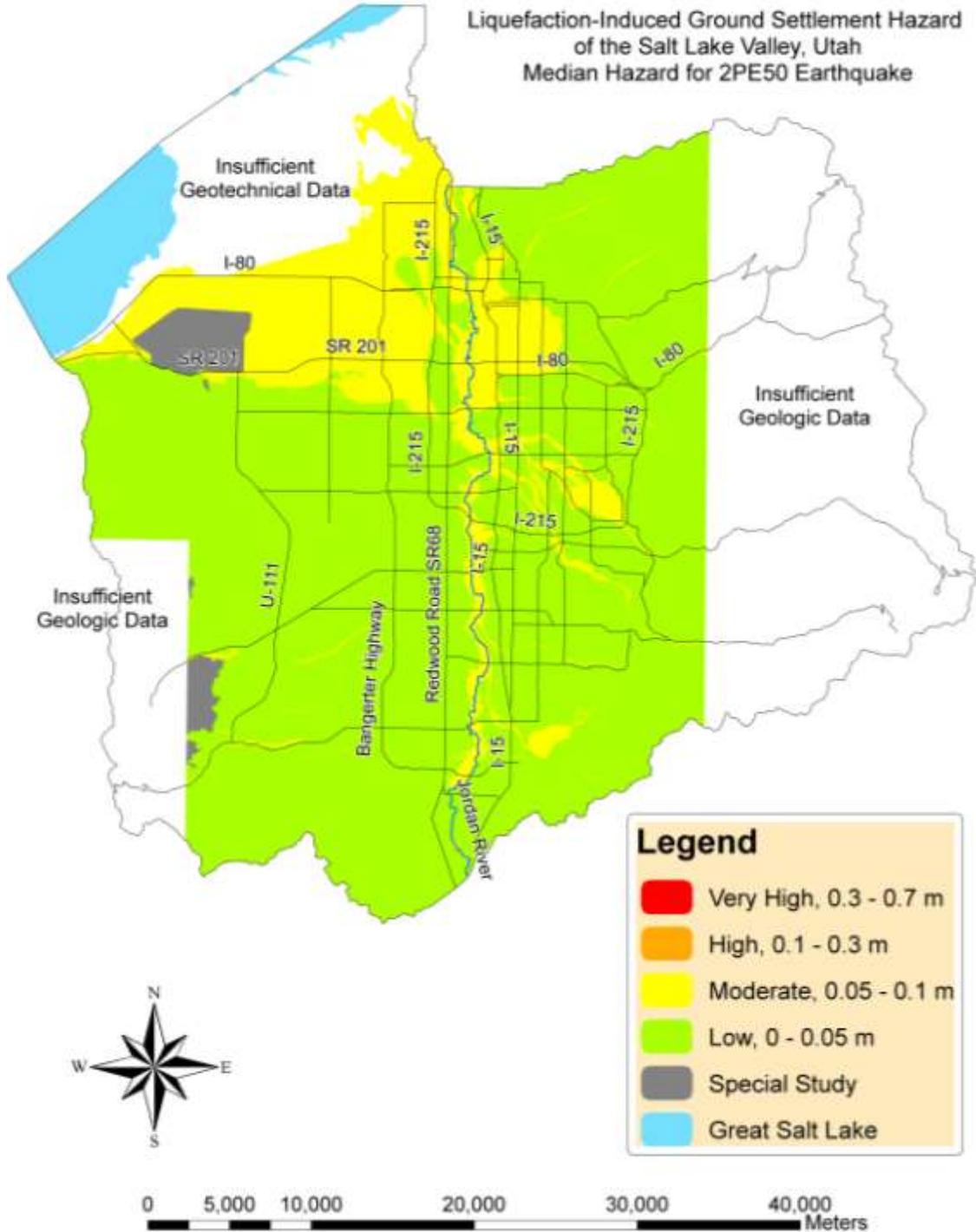
Figure 8-8 Liquefaction-induced ground settlement hazard in the Salt Lake Valley based on the PGA associated with a 2 percent probability of exceedance in 50 years
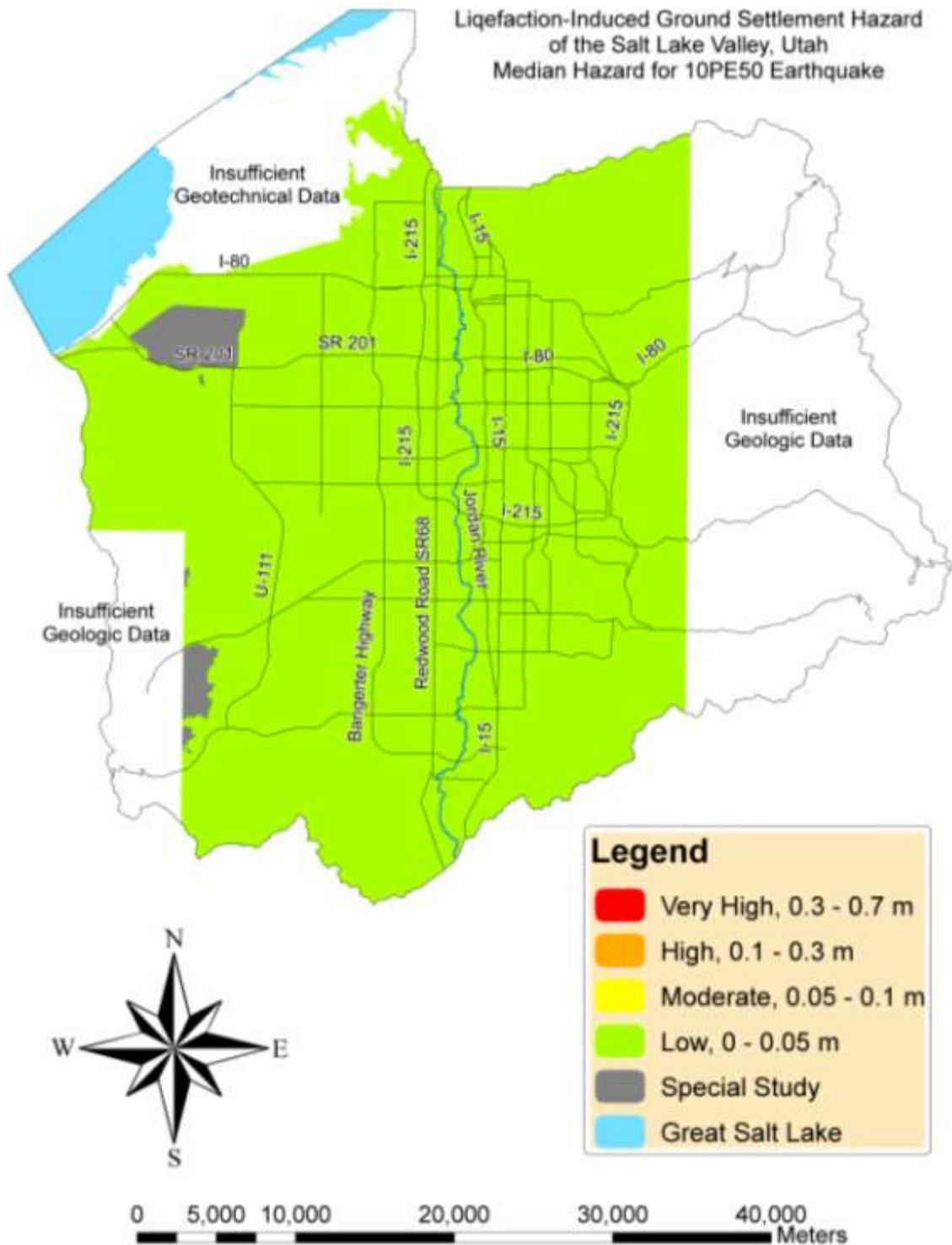
Figure 8-9 Liquefaction-induced ground settlement hazard in the Salt Lake Valley based on the PGA associated with a 10 percent probability of exceedance in 50 years

9 Conclusions

The maps presented herein are the first liquefaction-induced ground failure maps developed in Utah from an extensive geotechnical database that complements established geological mapping. The maps were developed for a M7.0 event on the Wasatch fault and two probabilistic-based events. The results of the hazard calculations suggest that increased lateral spread and ground settlement hazard exists in the central part of the valley along and near the Jordan River and in the northern eastern part of the valley. The increased hazard in these areas is due to the presence of young, relatively loose granular deposits and potentially shallow groundwater. The surficial geology in these areas predominantly consists of recent alluvial/river/stream/lake deposits.

In general, the M7.0 scenario maps, which are based on an approximate 15 percent exceedance probability for ground displacement, show higher hazard than the probabilistic-based scenario maps. In addition to non-exceedance criteria, other differences in the displacement estimates are attributed to variations in the PGA values used in developing the maps. Specifically, the M7.0 scenario event maps use PGA estimates from Wong et al. (2002) which are generally higher than the PGA estimates obtained from the USGS National Seismic Hazard Mapping Project (Petersen et al., 2008) for the 2 and 10 percent probabilities of exceedance in 50 years events.

The M7.0 scenario event maps are the preferred maps for preliminary planning purposes because they have been developed for the characteristic earthquake on the Salt Lake City segment of the Wasatch fault, and because they are conservative due to their approximate 15 percent exceedance probability for ground displacement when compared with the median displacement value used in developing the probabilistic-based maps.

However, some agencies such as UDOT, implement probabilistic-based events in their design procedures. For critical or essential UDOT structures (i.e., lifeline bridges, overpass structures and adjacent retaining walls), the 2 percent probability of exceedance in 50 years hazard maps are more useful because the input PGA values (which represent a 2,475-year return period) closely approximate the 3 percent probability of exceedance in 75 years (2,462-year return period) PGA required by UDOT (UDOT, 2009).

The two probabilistic events included in this report are for a 2,475-year return period and a 475-year return period (2 percent probability of exceedance in 50 years and 10 percent probability of exceedance in 50 years, respectively). However, for the design of normal structures (e.g., highway retaining walls that do not impact a critical or essential structure), UDOT has recently adopted the American Association of State Highway and Transportation Officials (AASHTO, 2009) seismic design provisions which are based on an approximate 1,000-year return period. Thus, it may be advantageous to develop additional probabilistic-based ground failure hazard maps. It is recommended that additional maps be developed following the analysis methods and map development methods for grouping and categorizing individual geologic units detailed herein.

Lastly, it is hoped that this series of displacement-based liquefaction ground failure maps will better aid in identifying seismic hazard and risk. Because the maps are displacement based, they better represent the potential damage to built-environment than previously published liquefaction maps.

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APPENDIX A - Database summary

The ArcGIS® geotechnical database used in this project contains 963 boreholes located in the Salt Lake Valley. Because the liquefaction hazard maps are based on established geological mapping, efforts were made to collect subsurface data from all major geological units within the valley. Table 3 shows the borehole identification number, project name, project location, date drilled (if available) and the respective surficial geologic unit for each borehole. This information can be cross-referenced to the tables in Appendix D (Tables 9 through 32) where the calculated liquefaction-induced ground displacements are listed by borehole identification number.

Table 3

ArcGIS® Database Borehole Identification Information

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1	SLCO- Sam Park Reservoir Improvements	3107 S 3300 E	3/11/1997	Qaf2
2	SLCO- Bennett Office	3362 S. Main St	3/17/1997	Qlbpm
3	SLCO- Bennett Office	3362 S. Main St	3/17/1997	Qlbpm
4	SLCO- Salt Lake County/Jail Complex	881 W 3300 S	2/28/1996	Qal2
5	SLCO- Granite School Dist-Magna Elementary	8500 W 3100 S	1/20/1997	Qafy
6	SLCO- White Farm Village Sub	8003 W 2700 S	4/1/1999	Qafy
7	SLCO- US West Magna Building Addition	2662 S 9040 W	6/28/2000	Qafy
8	SLCO- Albertson's A-Express No. 0363-11AI	890 E 3300 S	10/20/1998	Qlaly
9	SLCO- Magna Jiffy Lube	3444 S 7200 W	2/21/2000	Qlbpm
10	SLCO-Bud Bailey	3530 S Main St	3/27/1995	Qlbpm
11	SLCO- Michael Menlove Office/Warehouse Building	3555 S 700 W	12/18/1997	Qal2
12	SLCO- Alpha Trucking	1900 N Redwood Rd	6/10/1999	Qal1
13	SLCO-Proposed Building Addition	1805 W 500 S	3/12/1999	Qaly
14	SLCO-Sorensen Technology Park- Lots 20 and 21	1130 S 3800 W	6/26/1996	Qlaly
15	SLCO-Almond Street condominiums	255 N. Almond St	8/21/1996	Qaf2
16	SLCO-Union Pacific	100 S 400 W	5/1/6462	Qlaly
17	SLCO- Proposed Office Warehouse	1850 S Freemont Drive	10/6/1997	Qaly
18	SLCO- Praztek Partner	2100 S 4600 W	5/2/1991	Qlaly
19	SLCO- Praztek Partner	1300 S 5600 W	5/8/1991	Qlaly
20	SLCO- American Plaza	300 S Main St		Qaf2
21	SLCO- Proposed Warehouse	46 S 1900 W		Qaly
22	SLCO- SLC Public Utilities Water Tank	3875 S 3800 E	12/3/1991	Qafb
23	SLCO- SLC Cell Tower	2301 W 4805 S	12/18/1990	Qlbpm
24	SLCO- Dayna Office & Production Facility	4398 S Riverboat Dr	5/13/1992	Qlbpm
25	SLCO- Beckstrand & Associates	990 W Atherton Dr (4349 S)	11/18/1991	Qaly
26	SLCO- Park 'N Fly	1950 W 500 S	12/7/1998	Qaly
27	DATS Trucking Inc Freight Terminal	2800 W 500 S	4/22/1998	Qlaly
28	SLCO- Salt Lake Int Center Liquefaction Study	Plat 12 Lot 4	9/2/1997	Qlaly
29	SLCO- Westside Dixon Development	159 W 300 S	10/24/1997	Qlaly
30	SLCO- Hardman, Norman F Cell Comm. Facility	7462 W 2820 S	7/26/1991	Qlaly
31	SLCO- Proposed Subdivision	3411 S 700 E	5/7/1997	Qlbpm
32	SLCO- KESSLER, AL & SONS Dwelling Group	3454 S 500 E	11/18/1997	Qlbpg
33	SLCO- Joe Colosimo PUD	3362 S 1100 E	2/10/1999	Qlaly

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
34	SBI- Salt Palace Expansion	200 S West Temple	1/18/1999	Qaf2
35	SLCO- US West Communications Tower	2600 W 4700 S	5/1/1992	Qlbpg
36	SLCO- Superwash	4300 S Redwood Rd	8/19/1992	Qal2
37	SLCO-SLC Corp Water Tank	4500 S 2700 E	8/11/1998	Qaf2
38	SLCO- Robert Meyer Jay Sample PUD	7730 S. Forest Creek Lane	5/14/1999	Qlbg
39	SLCO- SLCO Fire Station	8295 S Wasatch Blvd (3680 E)	2/10/1998	Qea
40	SLCO- Kim Lamoreaux	2200 East 8200 South	8/5/1992	Qalp
41	SLCO- Hercules	4797 S 9170 W		QTaf
42	SLCO-Metropolitan Water District Generator Building	9000 S. Danish Rd	8/23/1996	Qaf2
43	SLCO-Duaine Rasmussen Apartment Units	7701 S Highland Dr		Qes
44	SLCO-Duaine Rasmussen Apartment Units	7701 S Highland Dr		Qlpg
45	SLCO-Duaine Rasmussen Apartment Units	7701 S Highland Dr		Qlbg
46	SLCO-Duaine Rasmussen Apartment Units	7701 S Highland Dr		Qlbg
47	SLCO- Granite Dist/Keith Bradshaw	3650 S. Montclaire St	12/17/1998	Qlbps
48	SLC0- Davencourt PUD	4100 S 2200 W	2/8/1996	Qal2
49	SLCO-Valley View Condominiums	1850 E 3900 S	3/15/1996	Qlbpm
50	UGS- East High School	840 S 1300 E	5/17/1990	Qlbpm
51	UGS- Highland High School	2166 S 1700 E	5/25/1990	Qlpg
52	UGS West High School	241 W 300 N	5/30/1990	Qaf2
53	UGS- Canyon View Park Subdivision	Kennedy Drive	3/19/1985	Qlbg
54	UGS- Downhole Seismic Shear Wave Survey at IHC WVC, UT	2800 S 4600 W	4/23/1997	Qly
55	UGS- Soils Investigation High Rise Elderly Complex	2100 S State St	9/19/1972	Qlaly
56	UGS-Soil Foundation Investigation for Emergency Op Center	400 N State Office Building	8/1/1982	Qlbpg
57	UGS-Soil Foundation Report South Temple Condos	550 E South Temple	10/19/1979	Qmls
58	UGS-Geotechnical Investigation-Granite Furniture Dist Cent	3200 W Parkway Blvd	3/2/1994	Qlaly
59	UGS- Foundation Inv. LDS Hospital Parking Lot (R-H)	B Street & 8th Ave	3/20/1987	Qlpg
60	UDOT- 33rd South Over I-415	33rd South and I-215	11/10/1966	Qlbm
61	UDOT- Saltair to Airport	5600 W I-80	6/1/1973	Qlaly
62	UDOT- Saltair to Airport	7200 W I-80	5/1/1972	Qlaly
63	UDOT- I-80 2nd West to Parley's Canyon	900 E I-80	5/21/1963	Qlaly
64	UDOT- Salt Lake City Belt Route	3500 S & I-215	11/27/1961	Qlaly
65	UDOT- Salt Lake City Belt Route	2700 S & I-215	12/1/1961	Qaly
66	UDOT- Salt Lake City Belt Route	California Ave & I-215	12/4/1961	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
67	UDOT- Salt Lake City Belt Route	6th N & I-215	10/5/1961	Qaly
68	UDOT- Salt Lake City Belt Route	17th N &I-215	10/16/1961	Qal1
69	UDOT- Salt Lake City Belt Route	I-215 close to county border	10/18/1961	Qlaly
72	UDOT- Salt Lake City Belt Route	I-215 North of 39th South	11/6/1961	Qalp
73	UDOT- Salt Lake City Belt Route	I-215 & 3900 S	11/1/1961	Qalp
74	UDOT- Salt Lake City Belt Route	I-215 & 4500 S	10/31/1961	Qlbg
75	UGS- Air Traffic Control Tower and Base Building	1200 N 4000 W	7/1/1994	Qal1
76	UGS-SLC Water Reclamation Plant	1700 N 900 W	1/1/1990	Qlbpm
77	UGS- Center Street Bridge Foundation Report	Cudnay Ave	11/25/1992	Qly
78	UGS-Reliance Warehouse & Office Building	1730 S 4370 W	5/17/1980	Qlaly
79	UGS- UEM 4 Property	1030 W 3110 S	9/25/1996	Qal1
80	UGS- Proposed Hotel Complex for Sinclair Oil Company	550 S Main Street	10/25/1995	Qlaly
81	UGS- Canyon Road Apartments Soil Investigation	2nd Ave Canyon Rd	1/1/1972	Qaf2
82	UGS-Fleming Foods Warehouse Addition	2205 W 1500 S	11/1/1994	Qaly
83	SLCO- Pleasant Green Subdivision	7306 W 3100 S		Qlbpm
84	SLCO- Copper Mountain Estates	8650 W 3500 S		Qlbpg
85	SLCO- 811 Housing Project	7986 W 3500 S	1/18/1996	Qlbps
86	SLCO- Lambert Auto	398 E 3300 S	8/12/1996	Qlbpm
87	SLCO- Michael's Mill Subdivision	900 E 3465 S	7/31/1997	Qlaly
88	SLCO- Ensign Development Inc	7451 W 2820 S	11/4/1996	Qlpg
89	SLCO- Ruseler Multi-Family Development	3504 S 300 E		Qlbpm
90	UGS- American Plaza 4&5	300 S Main St	9/24/1980	Qaf2
91	UDOT- 21rst So. Freeway 6th West to Pioneer Road	2100 S Redwood Rd		Qaly
92	UDOT-I-80 9th West to SL Airport Foundation Investigation	Jordan River I-80		Qal1
93	UDOT-I-80 9th West to SL Airport Foundation Investigation	34th West I-80		Qlaly
94	UDOT-I-80 9th West to SL Airport Foundation Investigation	Railroad I-80		Qal1
95	SLCO- Amen Exist Seminary	3328 S 500 E		Qlaly
96	UGS-Utah State Fairgrounds Foundation Investigation	1200 W 300 N	2/3/1981	Qal2
97	UGS- Soils Investigation for the Proposed College Inn SLC, U	100 S 1300 E	12/14/1996	Qaf2
98	UGS- Soil & Foundation Investigation Terra Tek Research Fac	Wakara Way	10/24/1974	Qlbm

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
99	UGS-Soils Investigation for Fuel Op Facility UT Air National	F and E St 8th and 9th Streets SL Airport		Qall
100	UGS- Soils & Foundation Investigation Artco High Rise Struct	146 S Lincoln Ave	7/21/1980	Qaf2
101	UGS- Earth Slide Investigation Ensign School	13th Ave M St	5/31/1977	Qlbg
102	UGS0 Grand Salt Lake Mall	5600 W 700 S		Qlaly
103	UGS- Foundation Investigation Tower Apartment Building No.2	Mouth of Emigration Canyon		Qafb
104	UGS- S&F Investigation for LDS Church Printing Building	1700 S Industrial Rd	2/13/1986	Qaly
105	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	11/13/1990	Qlaly
106	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	11/15/1990	Qlaly
107	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	11/27/1990	Qly
108	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	12/1/1990	Qlaly
109	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	1/21/1991	Qlaly
110	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	1/12/1991	Qlaly
111	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	12/17/1990	Qlaly
112	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	12/7/1990	Qly
113	Site Characterization Report for Tailings Impoundment	Kennecott Tailings Impoundment	1/29/1991	Qlaly
134	UDOT I15 13th South	I15 13th South	4/24/1996	Qall
135	UDOT I15 13th South	I15 13th South	4/23/1996	Qall
136	UDOT I15 13th South	I15 13th South	7/8/1996	Qall
137	UDOT I15 13th South	I15 13th South	4/25/1996	Qall
138	UDOT I15 13th South	I15 13th South	4/26/1996	Qall
139	UDOT I15 13th South	I15 13th South	5/2/1996	Qall
140	UDOT I15 13th South	I15 13th South	5/3/1996	Qall
141	UDOT I15 13th South	I15 13th South	5/6/1996	Qall
142	UDOT I15 13th South	I15 13th South	5/7/1996	Qall
143	UDOT I15 13th South	I15 13th South	5/7/1996	Qall
144	UDOT I15 13th South	I 15 13th South	4/28/1996	Qall
145	UDOT I15 13th South	I 15 13th South	4/23/1996	Qall
146	UDOT I15 13th South	I 15 13th South	3/29/1996	Qall
147	UDOT I15 13th South	I 15 13th South	4/30/1996	Qall
148	UDOT I15 13th South	I 15 13th South	4/25/1996	Qall
149	UDOT I15 13th South	I 15 13th South	4/30/1996	Qall
150	UDOT I15 13th South	I 15 13th South	5/1/1996	Qall
151	UDOT I15 13th South	I 15 13th South	5/2/1996	Qall
152	UDOT I15 13th South	I 15 13th South	5/2/1996	Qall

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
153	UDOT I15 13th South	I 15 13th South	4/26/1996	Qal1
154	UDOT I15 13th South	I 15 13th South	6/12/1996	Qal1
172	UDOT I15 24th South Section	I 15 2400 S	3/18/1996	Qal1
173	UDOT I15 24th South Section	I 15 2400 S	3/20/1996	Qal1
174	UDOT I15 24th South Section	I 15 2400 S	4/3/1996	Qal1
175	UDOT I15 24th South Section	I 15 2400 S	3/26/1996	Qlaly
176	UDOT I15 24th South Section	I 15 2400 S	3/29/1996	Qlaly
177	UDOT I15 24th South Section	I 15 2400 S	3/28/1996	Qlaly
178	UDOT I15 24th South Section	I 15 2400 S	3/25/1996	Qal1
179	UDOT I15 24th South Section	I 15 2400 S	3/25/1996	Qal1
180	UDOT I15 24th South Section	I 15 2400 S	3/22/1996	Qal1
181	UDOT I15 24th South Section	I 15 2400 S	5/9/1996	Qal1
182	UDOT I15 24th South Section	I 15 2400 S	5/7/1996	Qal1
183	UDOT I15 24th South Section	I 15 2400 S	4/2/1996	Qal1
184	UDOT I15 24th South Section	I 15 2400 S	5/6/1996	Qal1
185	UDOT I15 24th South Section	I 15 2400 S	4/1/1996	Qal1
186	UDOT I15 24th South Section	I 15 2400 S	4/2/1996	Qal1
187	UDOT I15 24th South Section	I 15 2400 S	4/4/1996	Qal1
188	UDOT I15 24th South Section	I 15 2400 S	4/3/1996	Qal1
189	UDOT I15 24th South Section	I 15 2400 S	4/9/1996	Qal1
190	UDOT I15 24th South Section	I 15 2400 S	4/10/1996	Qal1
191	UDOT I15 24th South Section	I 15 2400 S	4/12/1996	Qal1
192	UDOT I15 24th South Section	I 15 2400 S	4/11/1996	Qal1
193	UDOT I15 24th South Section	I 15 2400 S	4/15/1996	Qal1
194	UDOT I15 24th South Section	I 15 2400 S	4/18/1996	Qal1
195	UDOT I15 24th South Section	I 15 2400 S	3/26/1996	Qal1
196	UDOT I15 24th South Section	I 15 2400 S	3/20/1996	Qal1
197	UDOT I15 24th South Section	I 15 2400 S	5/8/1996	Qal1
198	UDOT I15 24th South Section	I 15 2400 S	3/28/1996	Qal1
199	UDOT I15 24th South Section	I 15 2400 S	3/27/1996	Qal1
200	UDOT I15 24th South Section	I 15 2400 S	3/21/1996	Qal1
201	UDOT I15 24th South Section	I 15 2400 S	4/24/1996	Qal1
202	UDOT I15 24th South Section	I 15 2400 S	4/24/1996	Qal1
203	UDOT I15 24th South Section	I 15 2400 S	3/18/1996	Qal1
204	UDOT I15 24th South Section	I 15 2400 S	5/13/1996	Qal1
205	UDOT I15 24th South Section	I 15 2400 S	3/25/1996	Qal1
206	UDOT I15 24th South Section	I 15 2400 S	3/26/1996	Qal1
207	UDOT I15 24th South Section	I 15 2400 S	3/22/1996	Qal1
208	UDOT I15 24th South Section	I 15 2400 S	3/26/1996	Qal1
209	UDOT I15 24th South Section	I 15 2400 S	4/9/1996	Qal1
210	UDOT I15 24th South Section	I 15 2400 S	4/9/1996	Qal1
211	UDOT I15 24th South Section	I 15 2400 S	4/9/1996	Qal1
212	UDOT I15 24th South Section	I 15 2400 S	4/5/1996	Qal1
213	UDOT I15 24th South Section	I 15 2400 S	4/8/1996	Qal1
214	UDOT I15 24th South Section	I 15 2400 S	4/22/1996	Qal1
215	UDOT I15 24th South Section	I 15 2400 S	4/16/1996	Qal1
216	UDOT I15 24th South Section	I 15 2400 S	4/15/1996	Qal1
217	UDOT I15 24th South Section	I 15 2400 S	4/16/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
218	UDOT I15 24th South Section	I 15 2400 S	4/19/1996	Qal1
219	UDOT I15 24th South Section	I 15 2400 S	4/16/1996	Qal1
220	UDOT I15 24th South Section	I 15 2400 S	4/18/1996	Qal1
221	UDOT I15 24th South Section	I 15 2400 S	5/10/1996	Qlaly
222	UDOT I15 24th South Section	I 15 2400 S	4/1/1996	Qal1
223	UDOT I15 24th South Section	I 15 2400 S	6/10/1996	Qal1
224	UDOT I15 24th South Section	I 15 2400 S	4/17/1996	Qal1
225	UDOT I15 24th South Section	I 15 2400 S	5/9/1996	Qal1
226	UDOT I15 24th South Section	I 15 2400 S	5/13/1996	Qal1
227	UDOT I15 24th South Section	I 15 2400 S	4/4/1996	Qal1
228	UDOT I15 24th South Section	I 15 2400 S	5/3/1996	Qal1
229	UDOT I15 24th South Section	I 15 2400 S	4/3/1996	Qal1
230	UDOT I15 24th South Section	I 15 2400 S	4/11/1996	Qal1
231	UDOT I15 24th South Section	I 15 2400 S	4/8/1996	Qal1
232	UDOT I15 24th South Section	I 15 2400 S	4/29/1996	Qal1
233	UDOT I15 24th South Section	I 15 2400 S	4/29/1996	Qal1
234	UDOT I15 24th South Section	I 15 2400 S	7/11/1996	Qal1
235	UDOT I15 24th South Section	I 15 2400 S	7/11/1996	Qal1
236	UDOT I15 24th South Section	I 15 2400 S	4/1/1996	Qal1
237	UDOT I15 24th South Section	I 15 2400 S	5/14/1996	Qal1
238	UDOT I15 24th South Section	I 15 2400 S	3/21/1996	Qlaly
239	UDOT I15 24th South Section	I 15 2400 S	5/6/1996	Qal1
240	UDOT I15 24th South Section	I 15 2400 S	4/22/1996	Qal1
241	UDOT I15 24th South Section	I 15 2400 S	4/16/1996	Qlaly
277	I-15 Corridor Reconstruction	I-15 4500 South	5/21/1996	Qal1
278	I-15 Corridor Reconstruction	I-15 4500 South	5/21/1996	Qlbpm
279	I-15 Corridor Reconstruction	I-15 4500 South	5/21/1996	Qal1
280	I-15 Corridor Reconstruction	I-15 4500 South	6/17/1996	Qal1
281	I-15 Corridor Reconstruction	I-15 4500 South	5/22/1996	Qal1
282	I-15 Corridor Reconstruction	I-15 4500 South	5/23/1996	Qal1
283	I-15 Corridor Reconstruction	I-15 4500 South	5/16/1996	Qal1
284	I-15 Corridor Reconstruction	I-15 4500 South	6/4/1996	Qal1
285	I-15 Corridor Reconstruction	I-15 4500 South	5/28/1996	Qal1
286	I-15 Corridor Reconstruction	I-15 4500 South	7/14/1996	Qal1
287	I-15 Corridor Reconstruction	I-15 4500 South	7/14/1996	Qal1
288	I-15 Corridor Reconstruction	I-15 4500 South	5/22/1996	Qlbpm
289	I-15 Corridor Reconstruction	I-15 4500 South	5/23/1996	Qal1
290	I-15 Corridor Reconstruction	I-15 4500 South	6/11/1996	Qal1
291	I-15 Corridor Reconstruction	I-15 4500 South	5/29/1996	Qal1
292	I-15 Corridor Reconstruction	I-15 4500 South	5/22/1996	Qlbpm
293	I-15 Corridor Reconstruction	I-15 4500 South	5/23/1996	Qal1
294	I-15 Corridor Reconstruction	I-15 4500 South	6/17/1996	Qlbpm
295	I-15 Corridor Reconstruction	I-15 4500 South	6/17/1996	Qal1
296	I-15 Corridor Reconstruction	I-15 4500 South	6/17/1996	Qal1
297	I-15 Corridor Reconstruction	I-15 4500 South	5/22/1996	Qal1
298	I-15 Corridor Reconstruction	I-15 4500 South	5/18/1996	Qal1
299	I-15 Corridor Reconstruction	I-15 4500 South	5/28/1996	Qal1
300	I-15 Corridor Reconstruction	I-15 4500 South	5/28/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
301	I-15 Corridor Reconstruction	I-15 4500 South	6/3/1996	Qal1
302	I-15 Corridor Reconstruction	I-15 4500 South	6/14/1996	Qlbpm
303	I-15 Corridor Reconstruction	I-15 4500 South	6/14/1996	Qal1
304	I-15 Corridor Reconstruction	I-15 4500 South	6/3/1996	Qal2
305	I-15 Corridor Reconstruction	I-15 4500 South	6/3/1996	Qal2
306	I-15 Corridor Reconstruction	I-15 4500 South	6/14/1996	Qal1
307	I-15 Corridor Reconstruction	I-15 4500 South	7/14/1996	Qal1
308	I-15 Corridor Reconstruction	I-15 4500 South	7/14/1996	Qal2
309	I-15 Corridor Reconstruction	I-15 7200 South	4/19/1996	Qlbpm
310	I-15 Corridor Reconstruction	I-15 7200 South	4/15/1996	Qlbpm
311	I-15 Corridor Reconstruction	I-15 7200 South	4/22/1996	Qlbpm
312	I-15 Corridor Reconstruction	I-15 7200 South	4/16/1996	Qlbpm
313	I-15 Corridor Reconstruction	I-15 7200 South	4/23/1996	Qlbpm
314	I-15 Corridor Reconstruction	I-15 7200 South	4/16/1996	Qlbpm
315	I-15 Corridor Reconstruction	I-15 7200 South	4/24/1996	Qlbpm
316	I-15 Corridor Reconstruction	I-15 7200 South	4/30/1996	Qlbpm
317	I-15 Corridor Reconstruction	I-15 7200 South	4/17/1996	Qlbpm
318	I-15 Corridor Reconstruction	I-15 7200 South	7/8/1996	Qlbpm
319	I-15 Corridor Reconstruction	I-15 7200 South	4/17/1996	Qlbpm
320	I-15 Corridor Reconstruction	I-15 7200 South	7/9/1996	Qlbpm
321	I-15 Corridor Reconstruction	I-15 7200 South	4/16/1996	Qlbpm
322	I-15 Corridor Reconstruction	I-15 7200 South	7/9/1996	Qlbpm
323	I-15 Corridor Reconstruction	I-15 7200 South	4/16/1996	Qlbpm
324	I-15 Corridor Reconstruction	I-15 7200 South	4/16/1996	Qlbpm
325	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qlbpm
326	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qlbpm
327	I-15 Corridor Reconstruction	I-15 7200 South	4/17/1996	Qlbpm
328	I-15 Corridor Reconstruction	I-15 7200 South	4/17/1996	Qlbpm
329	I-15 Corridor Reconstruction	I-15 7200 South	4/30/1996	Qlbpm
330	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qal1
331	I-15 Corridor Reconstruction	I-15 7200 South	4/30/1996	Qlbpm
332	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qlbpm
333	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qlbpm
334	I-15 Corridor Reconstruction	I-15 7200 South	4/18/1996	Qlbpm
335	I-15 Corridor Reconstruction	I-15 7200 South	5/6/1996	Qlbpm
336	I-15 Corridor Reconstruction	I-15 7200 South	5/3/1996	Qlbpm
337	I-15 Corridor Reconstruction	I-15 7200 South	5/3/1996	Qlbpm
338	I-15 Corridor Reconstruction	I-15 7200 South	5/6/1996	Qlbpm
339	I-15 Corridor Reconstruction	I-15 7200 South	5/7/1996	Qlbpm
340	I-15 Corridor Reconstruction	I-15 7200 South	5/8/1996	Qlbpm
341	I-15 Corridor Reconstruction	I-15 7200 South	5/8/1996	Qlbpm
342	I-15 Corridor Reconstruction	I-15 7200 South	5/8/1996	Qlbpm
343	I-15 Corridor Reconstruction	I-15 7200 South	5/10/1996	Qlbpm
344	I-15 Corridor Reconstruction	I-15 7200 South	5/9/1996	Qlbpm
345	I-15 Corridor Reconstruction	I-15 7200 South	5/10/1996	Qlbpm
346	I-15 Corridor Reconstruction	I-15 7200 South	5/6/1996	Qlbpm
347	I-15 Corridor Reconstruction	I-15 7200 South	5/2/1996	Qal2
348	I-15 Corridor Reconstruction	I-15 7200 South	5/2/1996	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
349	I-15 Corridor Reconstruction	I-15 7200 South	5/3/1996	Qal2
350	I-15 Corridor Reconstruction	I-15 7200 South	5/2/1996	Qal2
351	I-15 Corridor Reconstruction	I-15 7200 South	5/1/1996	Qal2
352	I-15 Corridor Reconstruction	I-15 7200 South	5/1/1996	Qal2
353	I-15 Corridor Reconstruction	I-15 7200 South	5/1/1996	Qal2
354	I-15 Corridor Reconstruction	7200 South Interstate 15	5/12/1996	Qlbpm
355	I-15 Corridor Reconstruction	7200 South Interstate 15	5/11/1996	Qlbpm
356	I-15 Corridor Reconstruction	7200 South Interstate 15	5/13/1996	Qlbpm
357	I-15 Corridor Reconstruction	7200 South Interstate 15	5/15/1996	Qlbpm
358	I-15 Corridor Reconstruction	7200 South Interstate 15	5/16/1996	Qlbpm
359	I-15 Corridor Reconstruction	7200 South Interstate 15	7/22/1996	Qlbpm
360	I-15 Corridor Reconstruction	7200 South Interstate 15	7/16/1996	Qlbpm
361	I-15 Corridor Reconstruction	7200 South Interstate 15	7/16/1996	Qlbpm
362	I-15 Corridor Reconstruction	7200 South Interstate 15	6/20/1996	Qlbpm
363	I-15 Corridor Reconstruction	7200 South Interstate 15	7/16/1996	Qlbpm
364	I-15 Corridor Reconstruction	7200 South Interstate 15	7/17/1996	Qlbpm
365	I-15 Corridor Reconstruction	7200 South Interstate 15	6/13/1996	Qlbpm
366	I-15 Corridor Reconstruction	7200 South Interstate 15	6/12/1996	Qlbpm
367	I-15 Corridor Reconstruction	7200 South Interstate 15	6/8/1996	Qal1
368	I-15 Corridor Reconstruction	7200 South Interstate 15	6/10/1996	Qal1
369	I-15 Corridor Reconstruction	7200 South Interstate 15	6/11/1996	Qal1
370	I-15 Corridor Reconstruction	7200 South Interstate 15	6/19/1996	Qlbpm
371	I-15 Corridor Reconstruction	7200 South Interstate 15	6/20/1996	Qal2
372	I-15 Corridor Reconstruction	7200 South Interstate 15	6/14/1996	Qal1
373	I-15 Corridor Reconstruction	7200 South Interstate 15	7/23/1996	Qal1
374	I-15 Corridor Reconstruction	7200 South Interstate 15	6/17/1996	Qal1
375	I-15 Corridor Reconstruction	7200 South Interstate 15	6/15/1996	Qal1
376	I-15 Corridor Reconstruction	7200 South Interstate 15	6/15/1996	Qal1
377	I-15 Corridor Reconstruction	7200 South Interstate 15	6/19/1996	Qlbpm
378	I-15 Corridor Reconstruction	7200 South Interstate 15	6/18/1996	Qlbpm
379	I-15 Corridor Reconstruction	7200 South Interstate 15	5/20/1996	Qal2
380	I-15 Corridor Reconstruction	7200 South Interstate 15	5/21/1996	Qal2
381	I-15 Corridor Reconstruction	7200 South Interstate 15	7/13/1996	Qlbpm
382	I-15 Corridor Reconstruction	7200 South Interstate 15	7/14/1996	Qlbpm
383	I-15 Corridor Reconstruction	7200 South Interstate 15	6/6/1996	Qlbpm
384	I-15 Corridor Reconstruction	7200 South Interstate 15	6/6/1996	Qal1
385	I-15 Corridor Reconstruction	7200 South Interstate 15	6/25/1996	Qal1
386	I-15 Corridor Reconstruction	7200 South Interstate 15	7/9/1996	Qal1
387	I-15 Corridor Reconstruction	7200 South Interstate 15	7/10/1996	Qal1
388	I-15 Corridor Reconstruction	7200 South Interstate 15	6/25/1996	Qal1
389	I-15 Corridor Reconstruction	7200 South Interstate 15	7/10/1996	Qlbpm
390	I-15 Corridor Reconstruction	7200 South Interstate 15	7/11/1996	Qlbpm
391	I-15 Corridor Reconstruction	7200 South Interstate 15	6/26/1996	Qlbpm
392	I-15 Corridor Reconstruction	7200 South Interstate 15	6/27/1996	Qlbpm
393	I-15 Corridor Reconstruction	7200 South Interstate 15	7/5/1996	Qlbpm
394	I-15 Corridor Reconstruction	7200 South Interstate 15	7/3/1996	Qlbpm
395	I-15 Corridor Reconstruction	7200 South Interstate 15	7/6/1996	Qlbpm

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
396	I-15 Corridor Reconstruction	7200 South Interstate 15	7/1/1996	Qlbpm
397	I-15 Corridor Reconstruction	7200 South Interstate 15	7/5/1996	Qlbpm
398	I-15 Corridor Reconstruction	7200 South Interstate 15	6/29/1996	Qlbpm
399	I-15 Corridor Reconstruction	7200 South Interstate 15	6/29/1996	Qlbpm
400	I-15 Corridor Reconstruction	7200 South Interstate 15	6/28/1996	Qlbpm
401	I-15 Corridor Reconstruction	7200 South Interstate 15	6/28/1996	Qlbpm
402	I-15 Corridor Reconstruction	7200 South Interstate 15	6/28/1996	Qlbpm
403	I-15 Corridor Reconstruction	7200 South Interstate 15	7/3/1996	Qlbpm
404	I-15 Corridor Reconstruction	7200 South Interstate 15	7/25/1996	Qlbpm
405	I-15 Corridor Reconstruction	7200 South Interstate 15	4/19/1996	Qlbpm
406	I-15 Corridor Reconstruction	7200 South Interstate 15	4/22/1996	Qlbpm
407	I-15 Corridor Reconstruction	7200 South Interstate 15	4/23/1996	Qlbpm
408	I-15 Corridor Reconstruction	7200 South Interstate 15	4/24/1996	Qlbpm
409	I-15 Corridor Reconstruction	7200 South Interstate 15	4/25/1996	Qlbpm
410	I-15 Corridor Reconstruction	7200 South Interstate 15	7/23/1996	Qlbpm
411	I-15 Corridor Reconstruction	7200 South Interstate 15	4/29/1996	Qlbpm
412	I-15 Corridor Reconstruction	7200 South Interstate 15	4/27/1996	Qlbpm
413	I-15 Corridor Reconstruction	7200 South Interstate 15	7/24/1996	Qlbpm
414	I-15 Corridor Reconstruction	7200 South Interstate 15	4/26/1996	Qlbpm
415	I-15 Corridor Reconstruction	7200 South Interstate 15	5/17/1996	Qlbpm
416	I-15 Corridor Reconstruction	7200 South Interstate 15	5/29/1996	Qlbpm
417	I-15 Corridor Reconstruction	7200 South Interstate 15	5/27/1996	Qlbpm
418	I-15 Corridor Reconstruction	7200 South Interstate 15	5/18/1996	Qlbpm
419	I-15 Corridor Reconstruction	7200 South Interstate 15	7/2/1996	Qlbpm
420	I-15 Corridor Reconstruction	7200 South Interstate 15	7/1/1996	Qlbpm
421	I-15 Corridor Reconstruction	7200 South Interstate 15	7/6/1996	Qlbpm
422	I-15 Corridor Reconstruction	7200 South Interstate 15	7/22/1996	Qlbpm
423	I-15 Corridor Reconstruction	7200 South Interstate 15	6/26/1996	Qlbpm
424	I-15 Corridor Reconstruction	7200 South Interstate 15	7/2/1996	Qlbpm
425	I-15 Corridor Reconstruction	7200 South Interstate 15	7/1/1996	Qlbpm
426	I-15 Corridor Reconstruction	7200 South Interstate 15	7/11/1996	Qlbpm
427	I-15 Corridor Reconstruction	7200 South Interstate 15	7/25/1996	Qlbpm
428	I-15 Corridor Reconstruction	7200 South Interstate 15	7/8/1996	Qlbpm
429	I-15 Corridor Reconstruction	7200 South Interstate 15	7/12/1996	Qal1
430	I-15 Corridor Reconstruction	7200 South Interstate 15	7/28/1996	Qal1
431	I-15 Corridor Reconstruction	7200 South Interstate 15	6/24/1996	Qal1
432	I-15 Corridor Reconstruction	7200 South Interstate 15	6/11/1996	Qal1
433	I-15 Corridor Reconstruction	7200 South Interstate 15	7/20/1996	Qal1
434	I-15 Corridor Reconstruction	7200 South Interstate 15	7/21/1996	Qal1
435	I-15 Corridor Reconstruction	7200 South Interstate 15	5/31/1996	Qal1
436	I-15 Corridor Reconstruction	7200 South Interstate 15	5/29/1996	Qal1
437	I-15 Corridor Reconstruction	7200 South Interstate 15	6/1/1996	Qlbpm
438	I-15 Corridor Reconstruction	7200 South Interstate 15	5/25/1996	Qlbpm
439	I-15 Corridor Reconstruction	7200 South Interstate 15	7/26/1996	Qal1
440	I-15 Corridor Reconstruction	7200 South Interstate 15	5/22/1996	Qlbpm
441	I-15 Corridor Reconstruction	7200 South Interstate 15	5/24/1996	Qlbpm
442	I-15 Corridor Reconstruction	7200 South Interstate 15	6/4/1996	Qlbpm
443	I-15 Corridor Reconstruction	7200 South Interstate 15	6/1/1996	Qlbpm

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
444	I-15 Corridor Reconstruction	7200 South Interstate 15	6/3/1996	Qlbpm
445	I-15 Corridor Reconstruction	7200 South Interstate 15	6/8/1996	Qlbpm
446	I-15 Corridor Reconstruction	7200 South Interstate 15	6/5/1996	Qlbpm
447	I-15 Corridor Reconstruction	7200 South Interstate 15	5/23/1996	Qlbpm
448	I-15 Corridor Reconstruction	7200 South Interstate 15	6/19/1996	Qal1
459	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/2/1996	Qal1
460	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/2/1996	Qal1
461	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/3/1996	Qlaly
462	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/30/1996	Qlaly
463	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/12/1996	Qlaly
464	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/1/1996	Qlaly
465	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/15/1996	Qal1
466	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/15/1996	Qal1
467	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/13/1996	Qal1
468	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/29/1996	Qlaly
470	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/18/1996	Qlaly
471	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/19/1996	Qlaly
472	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/5/1996	Qlaly
473	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/8/1996	Qlaly
474	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/10/1996	Qal1
475	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/16/1996	Qlaly
476	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/15/1996	Qlaly
477	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/11/1996	Qlaly
478	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/17/1996	Qal1
479	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/18/1996	Qal1
480	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/10/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
481	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/22/1996	Qal1
482	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/19/1996	Qal1
483	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/22/1996	Qlaly
484	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/23/1996	Qlaly
485	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/29/1996	Qal1
486	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/19/1996	Qal1
487	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/23/1996	Qal1
488	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/23/1996	Qal1
489	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/3/1996	Qal1
490	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/24/1996	Qal1
491	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/2/1996	Qlaly
492	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/30/1996	Qlaly
493	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/25/1996	Qlaly
494	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/6/1996	Qal1
495	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/7/1996	Qal1
496	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/9/1996	Qal1
497	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/8/1996	Qal1
498	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/9/1996	Qal1
499	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/22/1996	Qal1
500	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/11/1996	Qal1
501	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/11/1996	Qal1
502	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
503	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/12/1996	Qal1
504	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/13/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
505	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/30/1996	Qal1
506	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/20/1996	Qlaly
507	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/21/1996	Qlaly
508	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/19/1996	Qlaly
509	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/19/1996	Qlaly
510	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/16/1996	Qlaly
511	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/8/1996	Qlaly
512	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/18/1996	Qlaly
513	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/13/1996	Qlaly
514	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/29/1996	Qal1
515	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/14/1996	Qal1
516	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/19/1996	Qal1
517	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/17/1996	Qal1
518	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/22/1996	Qal1
519	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/26/1996	Qal1
520	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/25/1996	Qal1
521	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
522	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/24/1996	Qal1
523	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/30/1996	Qal1
524	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/27/1996	Qal1
525	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/26/1996	Qal1
526	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/27/1996	Qal1
527	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/1/1996	Qal1
528	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/21/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
529	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	7/2/1996	Qal1
530	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/23/1996	Qal1
531	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/30/1996	Qlaly
532	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/18/1996	Qlaly
533	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	4/29/1996	Qlaly
534	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
535	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/25/1996	Qal1
536	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/13/1996	Qal1
537	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/13/1996	Qal1
538	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/25/1996	Qlaly
539	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/25/1996	Qlaly
540	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/29/1996	Qal1
541	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
542	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
543	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/27/1996	Qal1
544	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/25/1996	Qal1
545	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/26/1996	Qal1
546	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
547	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/27/1996	Qal1
548	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/27/1996	Qal1
549	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/26/1996	Qal1
550	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/26/1996	Qal1
551	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/10/1996	Qal1
552	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/6/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
553	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/8/1996	Qlaly
554	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/10/1996	Qlaly
555	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/10/1996	Qal1
556	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/22/1996	Qal1
557	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/22/1996	Qal1
558	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/8/1996	Qal1
559	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/8/1996	Qal1
560	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	5/8/1996	Qal1
561	I-15 Corridor Reconstruction Section 4: 600 South Interchange	600 South Interstate 15	6/28/1996	Qal1
562	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-01	SR 201	5/4/1996	Qal1
563	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-02	SR 201	5/4/1996	Qal1
564	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-03	SR 201	5/5/1996	Qal1
565	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-04	SR 201	4/29/1996	Qal1
566	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-05	900WC	5/13/1996	Qal1
567	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-06	21S 201W	6/6/1996	Qal1
568	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-07	900 WE	6/2/1996	Qal1
570	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-09	700W	6/2/1996	Qal1
571	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-10	SR 201	6/16/1996	Qal1
572	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-11	SR 201	6/16/1996	Qal1
573	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-12	SR 201	5/5/1996	Qal1
574	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-13	SR 201	5/1/1996	Qal1
575	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-14	SR 201	5/2/1996	Qal1
576	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-15	21S 201W	5/8/1996	Qal1
577	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-16	SR 201	5/7/1996	Qal1

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
578	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-17	201E 15N	6/1/1996	Qal1
579	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-18	SR 201	5/6/1996	Qal1
580	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-19	21S 201W	5/11/1996	Qal1
581	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-20	900 WA	4/30/1996	Qal1
582	I-15 Corridor Reconstruction Section 10: SR 201 35-8163-21	900WB	4/30/1996	Qal1
585	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/5/1996	Qlaly
586	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/5/1996	Qlaly
587	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/16/1996	Qlaly
588	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/20/1996	Qlaly
589	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	5/28/1996	Qlaly
590	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
591	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	5/14/1996	Qlaly
592	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
593	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/30/1996	Qlaly
594	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/2/1996	Qlaly
595	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-80W15N	6/17/1996	Qlaly
596	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	6/2/1996	Qlaly
597	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	5/16/1996	Qlaly
598	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	6/24/1996	Qlaly
599	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	6/17/1996	Qlaly
600	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/13/1996	Qlaly
601	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
602	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/28/1996	Qlaly
603	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/14/1996	Qlaly

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
604	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/30/1996	Qlaly
605	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
606	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/21/1996	Qlaly
607	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/2/1996	Qlaly
608	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/3/1996	Qlaly
609	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/4/1996	Qlaly
610	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/17/1996	Qlaly
611	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-80W15N	5/14/1996	Qlaly
612	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-15S80E	5/14/1996	Qlaly
613	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/16/1996	Qlaly
614	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/13/1996	Qlaly
615	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/14/1996	Qlaly
616	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
617	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/15/1996	Qlaly
618	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/30/1996	Qlaly
619	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-80W15N	5/30/1996	Qlaly
620	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/14/1996	Qlaly
621	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	6/29/1996	Qlaly
622	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-80W15N	5/22/1996	Qlaly
623	I-15 Corridor Reconstruction Section 9: State Street 35-8160	SS-I80	5/13/1996	Qlaly
624	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/9/1996	Qal2
625	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/23/1996	Qal2
626	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/8/1996	Qal2
627	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/30/1996	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
628	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/22/1996	Qal2
629	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/6/1996	Qal2
630	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/16/1996	Qal1
631	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/21/1996	Qal1
632	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/15/1996	Qal1
633	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/17/1996	Qal1
634	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/4/1996	Qal1
635	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/7/1996	Qal1
636	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/3/1996	Qal1
638	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/29/1996	Qal2
639	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/6/1996	Qal2
640	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	7/11/1996	Qal2
641	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/31/1996	Qal2
642	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/20/1996	Qal2
643	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/19/1996	Qal2
644	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/19/1996	Qal2
645	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/25/1996	Qal2
646	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/18/1996	Qal2
647	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/18/1996	Qal2
648	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/19/1996	Qal2
649	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	6/9/1996	Qal2
650	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/18/1996	Qal2
651	I-15 Corridor Reconstruction Section 8: 3300 South Interchange	I-15	5/22/1996	Qal2
652	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/4/1996	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
654	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/3/1996	Qal2
655	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/1/1996	Qal2
656	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/6/1996	Qal2
657	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/11/1996	Qal2
658	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	5/31/1996	Qal2
659	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/1/1996	Qal2
660	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/11/1996	Qal2
661	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/10/1996	Qal2
662	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/11/1996	Qal2
663	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/5/1996	Qal2
664	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/11/1996	Qlbpm
665	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	5/30/1996	Qal1
666	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/13/1996	Qal1
667	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/12/1996	Qal1
668	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/12/1996	Qal2
669	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/16/1996	Qal2
670	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/4/1996	Qal2
671	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/4/1996	Qal2
672	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	5/29/1996	Qal2
673	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	5/30/1996	Qal2
674	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/12/1996	Qal2
675	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/3/1996	Qal2
676	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/5/1996	Qal2
677	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/1/1996	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
678	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/1/1996	Qal2
679	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	5/30/1996	Qal1
680	I-15 Corridor Reconstruction Section 6: 5300 South Interchange	I-15	6/2/1996	Qal2
681	Industrial Center	1925 W. Indiana Ave	10/15/2001	Qaly
682	Industrial Center	1925 W. Indiana Ave	10/15/2001	Qaly
683	Stream Lane Subdivision	3518 S. 2000 E	12/23/2003	Qaf2
684	Bolton Place Subdivision	1465 W 500 N	2/9/2004	Qlbpm
685	Fast Movers Warehouse	3651 S 700 W	4/20/2001	Qal2
686	Proposed Water Transmission Line	app 2200E 1700S	4/23/1982	Qlbpm
687	Proposed Water Transmission Line	app 2200E 1700S	4/23/1982	Qlbpm
688	Foothill Stake Center	2100 S Between Hollywood and Westminster	4/23/1982	Qlbpm
689	Safeway Store	1638 S 900 E	12/12/1972	Qlaly
690	Irving Commons Parking Structure	1200 E 2100 S		Qlpg
691	1700 S State St	1700 S State St	4/27/1970	Qlaly
692	St. Joseph Home	app 1900 S 500 E	3/18/1982	Qlaly
693	First Security Bank	2100 S 1100 E		Qaf2
694	Foothill Drive over I-80 Structure 17	Foothill Drive I-80	1/1/1960	Mz
695	I80 and 17th East	17th East I-80		Qlbm
696	Imperial 1st and 2nd Wards, Highland Stake	2700 S Fillmore St		Qlbpm
697	Rosslyn School	2291 S 2000 E		Qlpg
698		app 2800 E Parley's Way	7/20/1979	Qlpg
699	I-80 2300 E Ramp	2300 E I-80	1/1/1960	Qaf2
700	Skipper Fish and Chips	3086 East 3300 S		Qalp
701	Proposed Bank	2163 E 3300 S	11/4/1975	Qlbpm
702		3175 S State Street	7/20/1959	Qlaly
703	Skyline High School Swimming Pool	3251 E 3760 S		Qalp
704	Fort Douglas	Fort Douglas	9/20/1978	Qaf2
705	Trolley Corners Facility	500 S 700 E		Qaf2
706	KSL Building	200 E Social Hall Ave		Qaf2
707	Salt Lake Valley Ward for the Deaf	700 S 800 E		Qlaly
708	Donner Crest Condominiums	850 S. Donner Way (Mouth of Emigration Canyon)		Qafb
709	Report of Foundation investigation Gibbons and Reed Batch Pl	Gibbons and Reed Batch Plant, North Salt Lake	2/11/1977	Qly
710	Tischner-Busch warehouse	1800 N 3600 W		Qlaly
711	Tischner-Busch warehouse	1800 N 3600 W		Qlaly
712	Dames and Moore Job no. 5471-001-06	1674 N Beck Street		Qlbpg
713	Dames and Moore AMACO report	Beck Street		Qaf2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
714	Dames and Moore		6/16/1981	Qlbpm
715	RBG	Sandrun Drive and Dorchester Drive		Qlbm
716	Dames and Moore	South Temple and E street	8/21/1978	Qlpg
717	21st Wards Emigration Stake	2nd Avenue 700 E		Qaf2
718	Proposed 11th Avenue Extension	11th Avenue	8/21/1974	Qlbg
719	Proposed 11th Avenue Extension	11th Avenue	8/21/1974	Qaf2
720	Proposed 11th Avenue Extension	11th Avenue	8/21/1974	Qlbm
721			12/6/1966	Qlaly
722	International - 2.5	North of I-80	12/18/1979	Qlaly
723	SL International Center- Easton Aluminum	Donald Douglas Road and Harold Gatty Drive (575 N)		Qlaly
724	Skagg's Office Building	Charles Lindberg Dr and Amelia Earhart Drive		Qlaly
725	Mervyns Brickyard Plaza	3250 S between 11th and 13th East	8/9/1979	Qlbpm
726	Standard Optical	1901 W Parkway BLVD		Qaly
727	Bradshaw Condominiums	app 10 E 400 S to 500 S		Qaf2
728	2100 S 1300 E	2100 S 1300 E		Qlpg
729	Chen and Associates Job No. 301 U	300 W North Temple	4/16/1980	Qaf2
730	East Redwood Subdivision	3405 S Redwood Rd		Qall
731	Dura Crete Building	1475 W 3500 S		Qall
732	Chevron Gas Station	4400 W 3500 S	8/26/1981	Qlbpm
733	Jordan North 5 and 12 Wards Chapel	Hawkeye West Drive (app 3800 W) 4100 S		Qlbpm
734	Buehner Block	2800 S 200 W	7/18/1979	Qlaly
735	West Lake Apartments	3600 W 3100 S		Qlaly
736	McDonald's Facility	3450 W 3500 S		Qlbpm
737	Glendale Park School Addition	1455 W. California Ave		Qall
738	Transmission Line			Qlaly
739	Liberty School	1092 S 200 E		Qlaly
740	Parkview Elementary School	1250 W. Mead Ave (970 S)		Qaly
741	Bonneville Concentrator	Kennecott, West of Magna, South of Tailings Pond		Qlbg
742	Bonneville Concentrator	Kennecott, West of Magna, South of Tailings Pond		Qlbg
743	Bonneville Concentrator	Kennecott, West of Magna, South of Tailings Pond		Qlbg

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
744	Redwood 1st and 3rd Wards LDS Chapel	1265 W 2320 S		Qal1
745	KV Transmission Line		3/10/1976	Qlaly
746	Prest O Lite Warehouse	1000 S Redwood Rd	10/2/1972	Qaly
747	LDS Welfare Square Dairy Addition	770 S 800 W. app		Qal1
748	I-215 over 3100 S	3100 S I-215	11/28/1961	Qlaly
749	1525 W Cheyenne Street	466 S Cheyenne St (1525 W)		Qal1
750	Geotechnical Investigation MHJ Block 37 City Library	200 E 400 S		Qmls
1000	Tapp Family Trust Office Building	6200 S Wasatch Blvd, Holladay UT	4/1/1998	Qaf2
1001	Alan Kruckenberg	6776 South 1300 East	8/26/1998	Qal2
1002	Terry Anderton	4445 South 1025 East	5/5/1997	Qlbpm
1003	Hampton Development LLC	447 East Greenwood Avenue (7500 South)	6/2/1997	Qlpg
1004	Hamblin Kasco	4573 South Highland Drive (1800 East)	5/4/1999	Qlbpm
1005	Joe Colosimo	4381 South Highland Drive (1730 East)	4/9/1997	Qlbpm
1006	Richard Bennion	1039 East 3900 South	4/16/1997	Qlbpm
1007	ROE Oaks	6400 South 1500 East	7/11/1996	Qlbpm
1008	Meyer, Robert & Sample, Jay	8071 South Highland Drive (2070 East)	2/3/1998	Qal1
1009	Clark Ivory	5101 South 1000 East	10/30/1997	Qlbpm
1010	Willow Park LLC/Victor j. Salm	3281 South 200 East	11/14/1997	Qlbpm
1011	Contempo Tile	3746 South 300 West		Qal2
1012	Menlove Construction	3464 South Main Street	11/4/1997	Qlbpm
1013	Ben Logue	693 West Fine Drive (3720 South)	3/26/1998	Qal2
1014	Granite Credit Union	3679 South 900 East		Qlaly
1015	Excel Investment Corporation	3738 South 900 East	3/21/1998	Qlbpm
1016	Andy Seppi	579 West 3900 South	3/28/1997	Qal2
1017	Royal Heritage Home Care	3201 South 900 E	8/7/1997	Qlaly
1018	Arlington Association LLc	5089 South 900 East	1/15/1999	Qlbpm
1019	Gary Machan	622 East 4500 South	3/8/1999	Qlbpm
1020	J. McDonald Brubaker	6727 South 1300 East	3/31/1999	Qal2
1021	E. Duff Ellsworth	4049 South Howick Street (210 West)	2/15/1999	Qal1
1022	St. Marks Hospital	1100 East 3900 South	4/21/1999	Qlaly
1023	Colosimo Ent.	5499 South 1300 East	8/10/1999	Qlbpm
1024	Robert J DeBry	5105 South 900 East	4/20/1999	Qlbpm
1025	Kirk Nielson	4041 South Commerce Drive (300 West)	11/18/1999	Qal1
1026	Mountain States Business Park	3950 South 300 West	2/3/2000	Qal2
1027	34th Street LLC	4062 South 500 East	4/17/2000	Qal1
1028	Cambridge Square Associates	900 East 3700 South	2/24/2000	Qlbpm

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1029	Roland Webb	33 East Columbia Avenue (4160 South)	4/24/2000	Qal1
1030	WEBCO, Inc	7364 South Creek Road (1125 East)	2/9/2000	Qal2
1031	IDG Development	4916 South Highland Circle (1800 East)	6/21/2000	Qal2
1032	Dave O' Bagy	4252 South Highland Drive (1700 East)	3/28/2000	Qlaly
1033	C3 Investments LLC	3949 South 200 East	3/8/2000	Qlbpm
1034	Willow Park LLC	4525 South 1300 East	2/11/2000	Qal1
1035	Pacifi Corp	87 West 3900 South	10/13/1998	Qal2
1036	Brad Reynolds Construction	1075 East 4800 South	2/11/1999	Qlbpm
1037	Timmons Properties LLC	1601 East 4500 South	9/10/1998	Qlbpm
1038	Whitney Lane LLC	3721 South 1300 East	1/4/1999	Qlaly
1039	Regent Assisted Living Inc	7220 South Union Park Avenue (1320 East)	6/25/1998	Qal1
1040	Josephine J Platt	4645 South Highland Drive (1800 East)	12/9/1998	Qaf2
1041	Tom Sdrales	5600 South 1300 East	5/21/1998	Qlbpm
1042	SLCO Parks and Recreation	1661 East Murray Holladay Blvd (4705 South)	5/13/1998	Qal1
1043	Silverwood Estates II	855 East 3900 South	3/8/1999	Qal1
1044	Arthur L Flangas	2910 South 8400 West	10/1/1999	Qafy
1045	Thomas R. Kendrick	242 West 3620 South	6/29/1995	Qal2
1046	Michael Menlove	6235 South Redwood Road (1700 West)	4/18/1996	Qlbpm
1047	JM Dev.	4596 South 785 East	2/2/1998	Qal1
1048	Sunstone Corporation	802 East 7800 South	8/21/1997	Qlpg
1049	Troy Spencer	465 East 3900 South	10/13/1997	Qlbpm
1050	Village Communities LC	6996 South 700 East	4/3/1996	Qal2
1051	Utah Non Profit Housing	8923 West 2700 South	1/28/1997	Qafy
1052	Daplco Builders L.C.	3860 South McCall Street (250 East)	1/10/1997	Qlbpm
1053	Candlewood Hotel Corporation	7030 South Park Centre Drive (1435 East)	10/22/1996	Qlpd
1054	Bushness Wells Construction	4060 South 300 East	7/11/1997	Qal1
1055	Enterprise Car Rental	4139 South State Street	12/4/1997	Qal1
1056	Hampton Development Company	1159 East 4500 South	6/3/1997	Qlbpm
1057	Herms Assoc.	7269 South Union Park Avenue (1200 East)	8/17/1996	Qal1
1058	SLCO Board of Commissioners	1500 East Murray Holladay Road (4705 South)	4/1/1996	Qal1
1059	Boyer - Old Mill LC	6200 South 3000 East	10/4/1994	Qaf2
1060	CLC Associates Inc.	6600 South Union Park Avenue (975 East)	8/26/1996	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1061	Homestead Village	5770 South 1650 West	10/2/1995	Qlbpm
1062	David Platt	1935 East Siesta Drive (7485 South)	2/6/1997	Qalp
1063	Ivory Homes	790 East 4400 South	7/26/1996	Qlbpm
1064	Spectrum Development Corporation	4141 South 700 East	6/27/1996	Qlbpm
1065	William Steve Perry	328 East 3900 South		Qlbpm
1066	Kim Jooms	315 West 3300 South	8/27/1991	Qal2
1067	Kim Anderson	7155 South 540 East	11/13/1995	Qlpg
1068	Sorenson Associates	815 West 4500 South	1/12/1995	Qal1
1069	Arlene Carlson	4099 South Highland Drive (1710 East)	11/20/1995	Qlaly
1070	Prime Commercial Partners LLC	7351 South Union Park Avenue (1145 East)		Qal2
1071	Jaren L Davis	1282 East 4500 South	6/9/1997	Qal2
1072	West America Finance Corp	4605 South 900 East		Qlbpm
1073	Sigma Corp	777 East 3900 South		Qlbpm
1074	American Housing Development	4561 South 900 East	8/1/1995	Qlbpm
1075	Ron Halpern	846 East North Union Avenue (7130 South)	5/15/1995	Qal2
1076	Patricia Adams	4745 South 3200 West	7/7/1995	Qlbpm
1077	Trammell Crow Residential Co.	6714 South 1300 East	4/20/1995	Qal2
1078	ORD Properties Inc.	910 West 3900 South	3/8/1995	Qlbpm
1079	Mark Eldredge	1860 East 5600 South	4/26/1995	Qal1
1080	Housing Authority	290 East 4050 South		Qal1
1081	Smith Brubaker	351 East 7500 South	10/25/1996	Qlpg
1082	Village Communities	7351 South 300 East	6/26/1995	Qlbpm
1083	Hamlet Development	4771 South 600 East	2/21/1995	Qal1
1084	Salt Lake County	177 West 3600 South	6/27/1995	Qal2
1085	Fourels Investment Co.	7000 South 1435 East		Qlpd
1086	Jim Theusch	7025 South 1435 East		Qlbpm
1087	Wallnet Investments LLC	2755 East 6580 South	2/4/1998	Qlpd
1088	William Oswald	1075 West 3725 South	11/14/1994	Qal2
1089	McDonald's Corporation	3890 South 1100 East	6/7/1994	Qlaly
1090	Salt Lake County	3638 South West Temple Street	3/21/1994	Qlbpm
1091	Kent Alred	1349 East 4500 South		Qal2
1092	Asset Network of America	1582 West 5400 South	8/9/1990	Qlbpm
1093	American Equity Corporation	1052 East 7220 South		Qal2
1094	Neal Hammond	3535 South 500 West	10/28/1994	Qal2
1095	Western River Expeditions	1180 East 6600 South	6/17/1994	Qal2
1096	Hercules Aerospace	9400 West 5050 South		Qlbg
1097	Salt Lake County	1820 East 6965 South	9/6/1995	Qlpg
1098	Opportunity Development	7765 South 300 East	1/5/1995	Qlpg
1099	Richard Sorenson	5400 South 1300 West	9/2/1994	Qlbpm
1100	Sussex Group	4168 South 900 East	6/10/1994	Qlbpm
1101	Locus	4805 South 2350 West		Qlbpm
1102	T & Z Corporation	3960 South 300 West		Qal2
1103	Colorado Land Consultants, Inc.	7100 South 1400 East	10/27/1993	Qlpd

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1104	Civil Land Consultants	7100 South 1300 East	10/25/1993	Qlpd
1105	PGAW Architects	2145 East Creek Road (8200 South)		Qalp
1106	Mountain America Credit Union	1298 East Murray Holladay Road (4785 South)	12/6/1993	Qal1
1107	Triton Investments	1355 West 4070 South		Qal1
1108	McDonala	6280 South Redwood Road (1700 West)	6/17/1993	Qlbpm
1109	Holladay Hills II imited Partnership	3714 South Highland Drive	3/18/1993	Qlaly
1110	River Point Associates	925 West 3900 South	3/4/1993	Qal2
1111	Gordon Gygi Architects	6728 South 1300 East		Qal2
1112	Triton Investments	4500 South 465 East		Qal2
1113	Triton Investments	4070 South 1355 West		Qlbpm
1114	E BA Berger Inc.	5400 South 2510 West	7/21/1993	Qlbpm
1115	S-Deveorp	4365 South State Street	12/13/2004	Qal2
1116	Mike Polich	3518 South 2000 East	12/23/2003	Qaf2
1117	Steven T. Hunt	5814 Haven Lane	7/27/1998	Qal1
1118	Frank Perri	3651 South 700 West	4/20/2001	Qal2
1119	Prince Development	1712 East 9800 South	7/22/2004	Qlpg
1120	Bill Berg	791 West Kolten Road	7/15/2002	Qlbpm
1121	SLC Cellular Tower	3699 South 300 West	5/26/1992	Qal2
1122	Kelly Sheppard	7112 South 700 East	1/25/1993	Qal2
1123	Duane Wright	4411 South 1300 East	10/29/1992	Qal1
1124	Mark McDougal	4360 South Redwood Road (1700 West)		Qal2
1125	US West SAL - Midvale	910 East 6600 South	7/28/1992	Qal2
1126	William Hafeman	1200 West 5100 South	2/10/1993	Qlbpm
1127	First Security Mortgage	358 East 3900 South	10/9/1992	Qlbpm
1128	Utah Power and Light	1287 East 6465 South	2/28/1992	Qal2
1129	Mark Blair	771 East 4345 South	10/29/1992	Qlbpm
1130	Hawk Park 2	1150 East 4780 South	3/19/1992	Qal1
1131	State of Utah DFCM	5709 South 1500 West		Qlbpm
1132	American Equity Corporation	1677 East 4500 South		Qlbpm
1133	LDS Church	2365 West 4945 South		Qlbpm
1134	Val Shelley	5205 South Highland Drive	4/22/1992	Qal1
1135	Pheasant Lane Estates	7660 South Caballero Drive	8/14/1991	Qalp
1136	Brent Moon	4115 South Main Street	3/6/1992	Qal1
1137	Mancini & Groesbeck	194 East 3900 South	11/21/1990	Qlbpm
1138	Light Touch Inc.	3550 South 700 West	4/5/1991	Qal2
1139	Salt Lake City	184 East Gordon Lane (4190 South)	12/18/1990	Qal1
1140	George Brushke	7817 South 2000 East	2/12/1991	Qal1
1141	Nanolia Investments	725 West 3300 South	7/27/1990	Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1142	Cottonwood Estates Corporation	2250 East Creek Road (8200 South)	2/12/1991	Qalp
1143	Esther's Cove Subdivision	1400 East Siesta Drive	10/17/1989	Qal1
1144	Sorenson Associates	860 West Levoy Drive (4380 South)	10/16/1995	Qal1
1145	Wal-Mart Stores Inc.	5400 South Redwood Road	8/9/1990	Qlbpm
1146	Guy Mendenhall	1009 East 4800 South	9/9/1992	Qal1
1147	Westech Engineering	3639 South West Temple	5/1/1996	Qal2
1148	Edinburgh Condos	1105 East 4800 South	5/16/1985	Qal1
1149	Security Capital Pacific Trust	700 West 3727 South	5/3/1996	Qal2
1150	Learning Tree Day Care	860 East 4500 South	2/25/1985	Qlbpm
1151	Chadd Ford Partnership	837 East 7440 South		Qlpg
1152	Bonneville Inn	315 West 3300 South	8/27/1991	Qal2
1153	Aramark Uniform Service	3679 South 700 West		Qal2
1154	US West	3900 South 450 West	6/18/1992	Qlaly
1155	Salt Lake Medical Investors LDT	1201 East 4500 South	1/27/1987	Qal2
1156		9500 South 700 West		Qlbpm
1157	LDS Institute @ SLCC	2200 West 4600 South		Qlbpm
1158	Bangerter Highway	SPTC Railroad over Bangerter Highway	3/11/1996	Qal2
1159	Bangerter Highway	1300 West S.R. 154	10/28/1996	Qal1
1160	Bangerter Highway	Jordan River S.R. 154	10/17/1996	Qal1
1161	Bangerter Highway	Interstate 15, S.R. 154	10/10/1996	Qlbpm
1162	LDS Church	10200 South 1300 West	5/31/1978	Qlbps
1163	Civil Land Consultants	11000 South Interstate 15	3/6/1995	Qlbpm
1164	Bingham Canyon Reservoir	10200 South 7200 West	5/22/1960	Qafo
1165	Ballard Medical Products	12300 South Lone Peak Parkway	4/15/1992	Qlbpm
1166	South Towne Office Park Partnership	10600 South Tower Boulevard	1/7/1990	Qal1
1167	Oak Financial Properties	7800 South 1275 West	5/30/1997	Qlbpm
1168	Metropolitan Water District of Salt Lake and Sandy	Interstate 15 Bluffdale Interchange	10/28/2002	Qlpg
1169	Metropolitan Water District of Salt Lake and Sandy	9000 South Danish Road (3000 East)	11/29/1999	Qal2
1170	Metropolitan Water District of Salt Lake and Sandy	Interstate 15 Bluffdale Interchange	10/30/2002	Qlpg
1171	Metropolitan Water District of Salt Lake and Sandy	Interstate 15 Bluffdale Interchange	10/30/2002	Qlpg
1172	UDOT Bangerter Highway	SR-154 4100 South	3/16/1999	Qlbpm
1173	UDOT Bangerter Highway	SR-154 4100 South	3/19/1999	Qlbpm
1174	UDOT Bangerter Highway	SR-154 4100 South	4/15/1999	Qlbpm
1175	UDOT Bangerter Highway	SR-154 9000 South	6/30/1995	Qlbpg

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1176	UDOT Bangerter Highway	SR-154 9000 South	6/30/1995	Qlbpg
1177	UDOT Bangerter Highway	SR-154 9000 South	6/30/1995	Qlbpm
1178	UDOT Bangerter Highway	SR-154 9000 South	7/3/1995	Qlbps
1179	UDOT Bangerter Highway	S.R. 154 9800 South	7/6/1995	Qlbpm
1180	UDOT Bangerter Highway	S.R. 154 9800 South	7/6/1995	Qlbpm
1181	UDOT Bangerter Highway Segment 8	SR-154 3600 West	8/1/1996	Qlbpm
1182	UDOT Bangerter Highway Segment 8	SR-154 3600 West	8/2/1996	Qlbpm
1183	UDOT Bangerter Highway Segment 8	SR-154 3600 West	8/2/1996	Qlbpm
1184	UDOT Bangerter Highway Segment 8	SR-154 3000 West	7/30/1996	Qlbpm
1185	UDOT Bangerter Highway Segment 8	SR-154 3000 West	7/31/1996	Qlbpm
1186	UDOT Bangerter Highway Segment 8	SR-154 2700 West	7/21/1996	Qlbpm
1187	UDOT Bangerter Highway Segment 8	SR-154 2500 West	7/31/1996	Qlbpm
1188	UDOT Bangerter Highway Segment 8	SR-154 2200 West	8/5/1996	Qlbpm
1189	UDOT Bangerter Highway Segment 8	SR-154 2200 West	8/5/1996	Qal2
1190	UDOT Bangerter Highway Segment 8	SR-154 2000 West	8/1/1996	Qal2
1191	UDOT Bangerter Highway Segment 8	SR-154 2000 West	8/6/1996	Qal2
1192	UDOT Bangerter Highway Segment 8	SR-154 Redwood Road	8/6/1996	Qal2
1193	UDOT Bangerter Highway Segment 8	SR-154 13400 South	10/20/1998	Qlbpm
1194	UDOT Bangerter Highway Segment 8	SR-154 13400 South	10/28/1998	Qlbpm
1195	UDOT I-15 Utah County Line to 10600 South	I-15 14600 South	1/15/2003	Qlpg
1196	UDOT I-15 Utah County Line to 10600 South	I-15 14600 South	1/22/2003	Qlpg
1197	UDOT I-15 Utah County Line to 10600 South	I-15 11400 South	3/15/2000	Qlbpm
1198	UDOT I-15 Utah County Line to 10600 South	I-15 11400 South	3/15/2000	Qlbpm
1199	UDOT I-15 Utah County Line to 10600 South	I-15 Salt Lake/Utah County Line	8/20/2003	Qlbpg
1200	UDOT I-15 Utah County Line to 10600 South	I-15 Salt Lake/Utah County Line	8/20/2003	Qlpg
1201	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/19/2003	Qlpg
1202	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/19/2003	Qlpg
1203	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/20/2003	Qlpg
1204	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/20/2003	Qlpg
1205	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/20/2003	Qlpg
1206	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/20/2003	Qlpg
1207	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	10/21/2003	Qlpg
1208	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	10/21/2003	Qlpg

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1209	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	10/21/2003	Qlpg
1210	UDOT I-15 Utah County Line to 10600 South	I-15 Point of the Mountain	8/27/2003	Qlpg
1211	UDOT I-15 Utah County Line to 10600 South	I-15 Bangerter Highway	9/5/2003	Qlbpm
1212	UDOT I-15 Utah County Line to 10600 South	I-15 Bangerter Highway	8/28/2003	Qlbpm
1213	UDOT I-15 Utah County Line to 10600 South	I-15 10800 South	10/22/2003	Qlbpm
1214	UDOT I-15 Utah County Line to 10600 South	I-15 10800 South	10/23/2003	Qlbpm
1215	UDOT I-15 Utah County Line to 10600 South	I-15 11400 South	8/26/2003	Qlbpm
1216	UDOT I-15 Utah County Line to 10600 South	I-15 11400 South	8/27/2003	Qlbpm
1217	Proposed Carwash	1300 East Pioneer Road	3/29/2005	Qlpg
1218	Draper Commercial Property	1400 East Draper Parkway	7/29/2004	Qlpg
1219	Draper Retail Center	300 East 12450 South	2/24/2005	Qlbpm
1220	Proposed Office Building	11650 South State Street	5/16/2004	Qlbpm
1221	Southfork Estates	300 East 14200 South	4/16/2003	Qaf2
1222	Proposed Office Complex	13975 South Minuteman Drive	6/29/1999	Qlbpm
1223	U.S. Post Office	700 East Locust Street (8500 South)		Qlpg
1224	LDS Church	4800 West 4170 South		Qlbps
1225	Kearns District	4015 West 4775 South	1/19/1977	Qlbpg
1226	LDS Church	5255 South 3200 West		Qlbpm
1227	LDS Church	5415 South 4575 West		Qlbpg
1228	Playworld	7200 South State Street		Qlbpm
1229	The Redwood Village Shopping Center	7000 South Redwood Road		Qlbpm
1230	LDS Church	7510 South 2700 West		Qlbpm
1231	LDS Church	7325 South 3200 West		Qlbpm
1232	LDS Church	8000 South 2700 West		Qlbpm
1233	Skaggs Super Center	7800 South Redwood Road		Qlbpm
1234	Hart Brothers Music	8131 South Redwood		Qlbpm
1235	Granite Elementary School	4350 South 5400 West		Qlbpg
1236	Arlington School	5025 South State Street		Qal1
1237	Murray High School Gymnasium Addition	5440 South State Street		Qlbpm
1238	Arby's Restaurant	5830 South State Street		Qal2
1239	Proposed Cashway Store	6000 South State Street		Qal2

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1240	Water Tank #3	10200 South 4450 West	10/8/2003	Qlbs
1241	Water Tank #1	11400 South 3200 West	11/11/2003	Qlbpm
1242	Water Tank #5	10200 South 6000 West	10/13/2003	Qafy
1243	4.5 MG Reservoir	10500 South 6300 West	6/27/2005	Qlbg
1244	I-15 Corridor Reconstruction	10600 South Interstate 15	6/20/1996	Qlbpm
1245	I-15 Corridor Reconstruction	10200 South Interstate 15	6/20/1996	Qal1
1246	I-15 Corridor Reconstruction	10000 South Interstate 15	6/21/1996	Qlbpm
1247	I-15 Corridor Reconstruction	9800 South Interstate 15	6/21/1996	Qlpg
1248	I-15 Corridor Reconstruction	9400 South Interstate 15	6/27/1996	Qlpg
1249	I-15 Corridor Reconstruction	9400 South Interstate 15	6/26/1996	Qlbpm
1250	I-15 Corridor Reconstruction	9400 South Interstate 15	6/24/1996	Qlbpm
1251	I-15 Corridor Reconstruction	9000 South Interstate 15	6/26/1996	Qlbpm
1252	I-15 Corridor Reconstruction	9000 South Interstate 15	6/24/1996	Qlbpm
1253	I-15 Corridor Reconstruction	9000 South Interstate 15	6/25/1996	Qlbpm
1254	I-15 Corridor Reconstruction	9000 South Interstate 15	7/8/1996	Qlbpm
1255	I-15 Corridor Reconstruction	9000 South Interstate 15	7/3/1996	Qlbpm
1256	I-15 Corridor Reconstruction	9000 South Interstate 15	6/27/1996	Qlbpm
1257	I-15 Corridor Reconstruction	8600 South Interstate 15	6/27/1996	Qlbpm
1258	I-15 Corridor Reconstruction	8600 South Interstate 15	7/1/1996	Qlbpm
1259	I-15 Corridor Reconstruction	8200 South Interstate 15	7/1/1996	Qlbpm
1260	I-15 Corridor Reconstruction	8100 South Interstate 15	7/1/1996	Qlbpm
1261	Blessed Sacrament Catholic Church	9800 South 1745 East	3/16/2004	Qlbg
1262	Proposed Residence	2813 Ksel Drive	8/3/2004	Qlbg
1263	South Jordan Recreation Center	10800 South Redwood Road	3/4/2003	Qlbpm
1264	Best Buy Facility	11400 South State Street	6/27/2001	Qlbpm

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1265	Dimple Dell	10600 South 1000 East	5/11/1998	Qlpg
1266	Albertson's	9400 South 2000 East	2/25/1997	Qalp
1267	Jordan Common's	9400 South State Street	6/24/1997	Qlpg
1268	Associated Food Stores	7800 South 3200 West	2/23/1998	Qlbpm
1269	Smith's Food and Drug	9000 South 4000 West	3/19/1997	Qlbpg
1270	In-N_Out Burger Draper	12200 South Factory Outlet Drive	12/16/2008	Qlbpm
1271	Sainsbury-Simmons I Sub.	12980 South Fort Street, Draper, Utah	12/1/2008	Qlaly
1272	Burger King Draper	SW Corner of Bangerter Parkway and 150 East	10/30/2008	Qlbpm
1273	Cowabunga Bay Project	12101 South Factory Outlet Dr.	9/10/2008	Qlbpm
1274	Proposed Residence	1709 East Pioneer Road	6/17/2008	Qal1
1275	Proposed Draper Office Building	12325 South 900 East, Draper, Utah	5/28/2008	Qlbpm
1276	Proposed Residence	12483 South Relation Street, Draper, Utah	4/11/2008	Qal1
1277	Proposed Residence	1035 East 13400 South, Draper, Utah	5/12/2008	Qaf2
1278	Proposed Commercial Development	12047 Lone Peak Parkway	3/12/2008	Qlbpm
1279	Proposed Commercial Development	12047 Lone Peak Parkway	9/10/2007	Qlbpm
1280	Office Buildings	11980 South 700 East, Draper, Ut	5/1/2008	Qlbpm
1281	Beehive Assisted Living	700 East 12400 South	4/7/2008	Qlbpm
1282	Proposed Addition Capital Premium Facility	12235 South 800 East, Draper, Utah	2/21/2008	Qlbpm
1283	Chase Bank-Bangerter Crossing	150 East and Bangerter Parkway	2/4/2008	Qlbpm
1284	Intermountain Plantings	11623 South State, Draper, Utah	5/20/2008	Qlbpm
1285	Cypress Credit Union	183 East 13800 South, Draper, Utah	5/1/2008	Qlbpm
1286	Auto Owners Insurance Building	190 East 14000 South, Draper, Utah	4/30/2008	Qlbpm
1287	Proposed Walgreens Store	SWC 13800 Street and Bangerter Parkway, Draper, Ut	6/27/2008	Pz
1288	Proposed Subdivision Lot	730 East 12690 South, Draper, Utah	3/11/2008	Qlaly
1289	Derbyshire Estates	1050 East 12800 South, Draper, Utah	3/6/2008	Qlaly
1290	Proposed America First Credit Union	13866 South Bangerter Parkway, Draper, Utah	2/11/2008	Rock

Table 3 Continued

Borehole ID Number	Project Name	Project Location/Address	Date of Exploration	Geologic Unit
1291	Proposed Exchange at 140th	SW Corner of 14000 South and Bangerter Pkwy	6/2/2008	Qlbpm
1292	Proposed New Building	12607 South Minuteman Drive, Draper, Utah	7/9/2007	Qlbpm
1293	Proposed Retail Building	136 East 13800 South, Draper, Utah	7/6/2007	Pz
1294	Furniture Row	IKEA Way, Draper, Utah	6/5/2007	Qlbpm
1295	Lone Peak Industrial Park	12865 South 225 West, Draper, Utah	11/10/2005	Qlbpm
1296	Proposed Residential Subdivision	12091 South 700 West	8/6/2007	Qlbpm
1297	Townhouse Development	150 East 11800 South, Draper, Utah	5/17/2006	Qlbpm
1298	Corner Creek Plaza	13420 Pony Express Road, Draper, Utah	5/1/2007	Qal1
1299	South Willow Business Park	150 West 12300 South, Draper, Utah	1/22/2007	Qal1
1300	Quest Office And Training Center	12300 South Galena Park Drive, Draper, Utah	12/8/2006	Qlbpm
1301	Proposed Draper Industrial Park	125 West 12650 South, Draper, Utah	10/16/2007	Qlbpm
1302	Tegra Health Building	11800 South State, Draper, Utah	5/11/2009	Qlbpm

APPENDIX B - Development of ArcGIS® Ground Settlement Routines

Liquefaction-induced ground settlements were estimated by averaging the calculated results of Tokimatsu and Seed (1987) and Yoshimine et al. (2006) for all liquefiable layers in the top 30 m of each borehole ($FS_{liq} \leq 1.1$). Both methods estimate ground settlement based on SPT N values, which conveniently suits the data available in the ArcGIS® geotechnical database. Additional parameters from the geotechnical database such as fines content, soil unit weight and depth to groundwater were also used in the settlement calculations.

The PGA estimates for the M7.0 Wasatch fault scenario event were obtained from Wong et al. (2002) and the PGA estimates for the probabilistic events were obtained from the USGS National Strong Motion Hazard Mapping Project (Petersen et al., 2008). In accordance with the method and criteria proposed by Seed et al. (2001), the Petersen et al. (2008) rock-based PGA estimates were adjusted for surface soil effects based on the averaged shear wave velocities assigned to the several site-response units previously described. The groundwater location and soil unit weight profiles contained in the geotechnical database were used to calculate the overburden pressures.

Tokimatsu and Seed

Tokimatsu and Seed (1987) estimate volumetric strain in saturated clean sands based on cyclic stress ratio (CSR) and normalized SPT blow counts, $(N_1)_{60}$. In accordance with the guidelines presented in Tokimatsu and Seed (1987), CSR values were calculated by:

$$CSR = 0.65 \left(\frac{a_{max}}{g} \right) \left(\frac{\sigma_o}{\sigma'_o} \right) r_d \qquad \text{(Equation 1)}$$

where a_{max} is the maximum horizontal acceleration at the ground surface (PGA); g is the acceleration of gravity (9.81 m/s^2); σ_o is the total overburden pressure at the depth considered; σ'_o is the effective overburden pressure at the depth considered; and r_d is a stress reduction factor that varies from 1 at the ground surface to about 0.9 at a depth of approximately 9 m.

Following procedures recommended by Youd et al. (2001), the raw blow count data contained in the ArcGIS® geotechnical database were normalized and corrected to $(N_1)_{60}$ values by:

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S \qquad \text{(Equation 2)}$$

where N_m is the measured standard penetration resistance (blow count); C_N is used to normalize N_m to a common reference effective overburden stress (σ'_o) of approximately 100 kPa (1 atm); C_E varies from 0.5 to 1.3 depending on the type and efficiency of the hammer used in the SPT testing; C_B ranges from 1.0 for a 65-mm diameter hole to 1.15 for a 200-mm diameter hole; C_R ranges from 0.75 for less than 3 m of rod to 1.0 for 10 to 30 m of rod; and C_S varies from 1.0 for samplers with liners to a value of 1.1 to 1.3 for samplers without liners. The data required to

determine these factors was typically included on the borehole logs used to create the ArcGIS® geotechnical database. In the event that borehole diameter, hammer energy or sampler liner data was missing from a particular borehole log, estimates were obtained from a table of typical values for each drilling company. The typical-value tables were created based on actual data included on other borehole logs.

As previously mentioned, the geotechnical database contains the amount of material finer than the standard No. 200 sieve (FC). This data was used to correct the $(N_1)_{60}$ values to clean sand values based on (Youd et al., 2001):

$$(N_1)_{60-CS} = \alpha + \beta (N_1)_{60} \qquad \text{(Equation 3)}$$

where the α and β coefficients are determined by:

$$\alpha = 0 \qquad \text{for FC} \le 5\% \qquad \text{(Equation 4a)}$$

$$\alpha = \exp[1.76 - (190/FC^2)] \qquad \text{for } 5\% < FC < 35\% \qquad \text{(Equation 4b)}$$

$$\alpha = 5.0 \qquad \text{for FC} \ge 35\% \qquad \text{(Equation 4c)}$$

$$\beta = 1.0 \qquad \text{for FC} \le 5\% \qquad \text{(Equation 5a)}$$

$$\beta = [0.99 + (FC^{1.5}/1,000)] \qquad \text{for } 5\% < FC < 35\% \qquad \text{(Equation 5b)}$$

$$\beta = 1.2 \qquad \text{for FC} \ge 35\% \qquad \text{(Equation 5c)}$$

The soil profiles for each borehole location were screened for liquefaction triggering using Youd et al. (2001). A ground settlement value of 0 m was assigned to all soils layers with factors of safety against liquefaction triggering greater than 1.1. Triggering analysis was completed as follows:

$$FS_{liq} = \frac{CRR_{7.5}}{CSR} MSF \qquad \text{(Equation 6)}$$

where CSR is determined by Equation 1 above; $CRR_{7.5}$ is the minimum cyclic resistance ratio for liquefaction as defined by the SPT clean-sand base curve which is approximated by (Youd et al., 2001):

$$CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10 \bullet (N_1)_{60} + 45]^2} - \frac{1}{200} \qquad \text{(Equation 7)}$$

and MSF is a magnitude scaling factor used to adjust for magnitudes other than M7.5 (Seed et al., 1983). The scenario analysis was based on a M7.0 earthquake on the Wasatch fault while input magnitudes for the probabilistic analyses varied based on deaggregations of the data presented by Petersen et al. (2008). The MSF's used in the Tokimatsu and Seed analysis were interpolated from the data presented in Table 4 (Seed et al., 1983).

A reference table with approximately 1,400 data points was created from the volumetric strain curves presented in Figure 12 (see Table 5). The table allowed volumetric strains to be rapidly determined based on the $(N_1)_{60}$ clean sand blow counts and CSR values. To account for the M7.5 calibration of the curves in Figure 12, the MSF's shown in Table 4 were used to adjust the CSR values to $CSR_{7.5}$ by Tokimatsu and Seed (1987):

$$CSR_{7.5} = \frac{CSR}{MSF} \qquad \text{(Equation 8)}$$

The estimated settlement, Δ_{TS}, at each borehole was the summation of the thickness of each liquefiable soil layer, t, times the respective estimated volumetric strain, ε_{vo}:

$$\Delta_{TS} = \sum_{i=1}^{n} t_i \times \varepsilon_{vo,i} \qquad \text{(Equation 9)}$$

An estimate of zero settlement was assigned to soils with clean sand $(N_1)_{60}$ values greater than 30 ($CSR_{7.5} \leq 0.3$) or 32 ($CSR_{7.5} > 0.3$). The volumetric strain curves trend approximately vertical for $CSR_{7.5}$ values greater than or equal to 0.46. Therefore, the estimated volumetric strains at $CSR_{7.5}$ equal to 0.46 were used for all $CSR_{7.5}$ values greater than or equal to 0.46.

Table 4
Magnitude Scaling Factors presented by Seed et al. (1983)

Earthquake Magnitude	Magnitude Scaling Factor, MSF
8.25	0.91
7.5	1.0
6.75	1.13
6.0	1.33
5.25	1.5
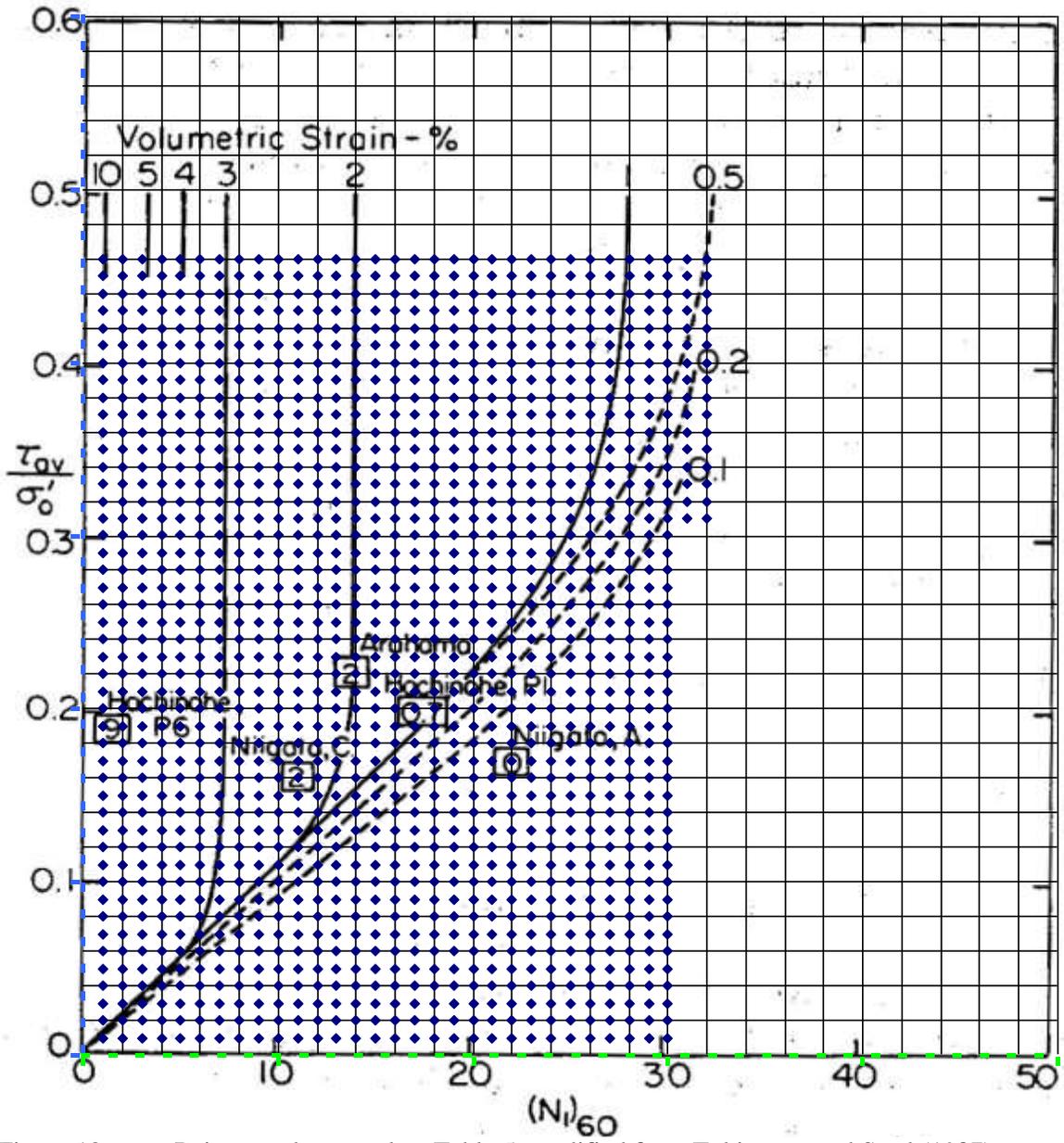
Figure 12.   Points used to populate Table 5, modified from Tokimatsu and Seed (1987)

Table 5

Digitized Settlement Curves Presented in Tokimatsu and Seed (1987)

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.01	1	5.00	0.02	22	0.00
0.01	2	0.05	0.02	23	0.00
0.01	3	0.00	0.02	24	0.00
0.01	4	0.00	0.02	25	0.00
0.01	5	0.00	0.02	26	0.00
0.01	6	0.00	0.02	27	0.00
0.01	7	0.00	0.02	28	0.00
0.01	8	0.00	0.02	29	0.00
0.01	9	0.00	0.02	30	0.00
0.01	10	0.00	0.03	1	10.00
0.01	11	0.00	0.03	2	5.50
0.01	12	0.00	0.03	3	0.50
0.01	13	0.00	0.03	4	0.08
0.01	14	0.00	0.03	5	0.06
0.01	15	0.00	0.03	6	0.05
0.01	16	0.00	0.03	7	0.00
0.01	17	0.00	0.03	8	0.00
0.01	18	0.00	0.03	9	0.00
0.01	19	0.00	0.03	10	0.00
0.01	20	0.00	0.03	11	0.00
0.01	21	0.00	0.03	12	0.00
0.01	22	0.00	0.03	13	0.00
0.01	23	0.00	0.03	14	0.00
0.01	24	0.00	0.03	15	0.00
0.01	25	0.00	0.03	16	0.00
0.01	26	0.00	0.03	17	0.00
0.01	27	0.00	0.03	18	0.00
0.01	28	0.00	0.03	19	0.00
0.01	29	0.00	0.03	20	0.00
0.01	30	0.00	0.03	21	0.00
0.02	1	10.00	0.03	22	0.00
0.02	2	1.00	0.03	23	0.00
0.02	3	0.07	0.03	24	0.00
0.02	4	0.05	0.03	25	0.00
0.02	5	0.05	0.03	26	0.00
0.02	6	0.00	0.03	27	0.00
0.02	7	0.00	0.03	28	0.00
0.02	8	0.00	0.03	29	0.00
0.02	9	0.00	0.03	30	0.00
0.02	10	0.00	0.04	1	10.00
0.02	11	0.00	0.04	2	7.00
0.02	12	0.00	0.04	3	4.80
0.02	13	0.00	0.04	4	0.30
0.02	14	0.00	0.04	5	0.08
0.02	15	0.00	0.04	6	0.06
0.02	16	0.00	0.04	7	0.05
0.02	17	0.00	0.04	8	0.05
0.02	18	0.00	0.04	9	0.05
0.02	19	0.00	0.04	10	0.00
0.02	20	0.00	0.04	11	0.00
0.02	21	0.00	0.04	12	0.00

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.04	13	0.00	0.06	7	0.09
0.04	14	0.00	0.06	8	0.07
0.04	15	0.00	0.06	9	0.07
0.04	16	0.00	0.06	10	0.06
0.04	17	0.00	0.06	11	0.05
0.04	18	0.00	0.06	12	0.05
0.04	19	0.00	0.06	13	0.00
0.04	20	0.00	0.06	14	0.00
0.04	21	0.00	0.06	15	0.00
0.04	22	0.00	0.06	16	0.00
0.04	23	0.00	0.06	17	0.00
0.04	24	0.00	0.06	18	0.00
0.04	25	0.00	0.06	19	0.00
0.04	26	0.00	0.06	20	0.00
0.04	27	0.00	0.06	21	0.00
0.04	28	0.00	0.06	22	0.00
0.04	29	0.00	0.06	23	0.00
0.04	30	0.00	0.06	24	0.00
0.05	1	10.00	0.06	25	0.00
0.05	2	7.00	0.06	26	0.00
0.05	3	5.00	0.06	27	0.00
0.05	4	4.00	0.06	28	0.00
0.05	5	0.40	0.06	29	0.00
0.05	6	0.09	0.06	30	0.00
0.05	7	0.07	0.07	1	10.00
0.05	8	0.06	0.07	2	7.00
0.05	9	0.06	0.07	3	5.00
0.05	10	0.05	0.07	4	4.40
0.05	11	0.00	0.07	5	3.90
0.05	12	0.00	0.07	6	3.00
0.05	13	0.00	0.07	7	0.20
0.05	14	0.00	0.07	8	0.10
0.05	15	0.00	0.07	9	0.08
0.05	16	0.00	0.07	10	0.07
0.05	17	0.00	0.07	11	0.06
0.05	18	0.00	0.07	12	0.06
0.05	19	0.00	0.07	13	0.05
0.05	20	0.00	0.07	14	0.05
0.05	21	0.00	0.07	15	0.00
0.05	22	0.00	0.07	16	0.00
0.05	23	0.00	0.07	17	0.00
0.05	24	0.00	0.07	18	0.00
0.05	25	0.00	0.07	19	0.00
0.05	26	0.00	0.07	20	0.00
0.05	27	0.00	0.07	21	0.00
0.05	28	0.00	0.07	22	0.00
0.05	29	0.00	0.07	23	0.00
0.05	30	0.00	0.07	24	0.00
0.06	1	10.00	0.07	25	0.00
0.06	2	7.00	0.07	26	0.00
0.06	3	5.00	0.07	27	0.00
0.06	4	4.30	0.07	28	0.00
0.06	5	3.50	0.07	29	0.00
0.06	6	0.20	0.07	30	0.00

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.08	1	10.00	0.09	25	0.00
0.08	2	7.00	0.09	26	0.00
0.08	3	5.00	0.09	27	0.00
0.08	4	4.40	0.09	28	0.00
0.08	5	4.00	0.09	29	0.00
0.08	6	3.20	0.09	30	0.00
0.08	7	2.10	0.10	1	10.00
0.08	8	0.20	0.10	2	7.00
0.08	9	0.10	0.10	3	5.00
0.08	10	0.08	0.10	4	4.40
0.08	11	0.07	0.10	5	4.00
0.08	12	0.06	0.10	6	3.40
0.08	13	0.06	0.10	7	2.80
0.08	14	0.05	0.10	8	2.40
0.08	15	0.05	0.10	9	2.10
0.08	16	0.05	0.10	10	0.20
0.08	17	0.00	0.10	11	0.10
0.08	18	0.00	0.10	12	0.08
0.08	19	0.00	0.10	13	0.07
0.08	20	0.00	0.10	14	0.07
0.08	21	0.00	0.10	15	0.06
0.08	22	0.00	0.10	16	0.06
0.08	23	0.00	0.10	17	0.05
0.08	24	0.00	0.10	18	0.05
0.08	25	0.00	0.10	19	0.05
0.08	26	0.00	0.10	20	0.00
0.08	27	0.00	0.10	21	0.00
0.08	28	0.00	0.10	22	0.00
0.08	29	0.00	0.10	23	0.00
0.08	30	0.00	0.10	24	0.00
0.09	1	10.00	0.10	25	0.00
0.09	2	7.00	0.10	26	0.00
0.09	3	5.00	0.10	27	0.00
0.09	4	4.40	0.10	28	0.00
0.09	5	4.00	0.10	29	0.00
0.09	6	3.30	0.10	30	0.00
0.09	7	2.60	0.11	1	10.00
0.09	8	2.00	0.11	2	7.00
0.09	9	0.20	0.11	3	5.00
0.09	10	0.09	0.11	4	4.40
0.09	11	0.09	0.11	5	4.00
0.09	12	0.07	0.11	6	3.50
0.09	13	0.06	0.11	7	2.90
0.09	14	0.06	0.11	8	2.70
0.09	15	0.05	0.11	9	2.30
0.09	16	0.05	0.11	10	2.00
0.09	17	0.05	0.11	11	0.20
0.09	18	0.00	0.11	12	0.10
0.09	19	0.00	0.11	13	0.08
0.09	20	0.00	0.11	14	0.08
0.09	21	0.00	0.11	15	0.07
0.09	22	0.00	0.11	16	0.06
0.09	23	0.00	0.11	17	0.06
0.09	24	0.00	0.11	18	0.06

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.11	19	0.05	0.13	13	0.20
0.11	20	0.05	0.13	14	0.10
0.11	21	0.05	0.13	15	0.09
0.11	22	0.00	0.13	16	0.08
0.11	23	0.00	0.13	17	0.07
0.11	24	0.00	0.13	18	0.07
0.11	25	0.00	0.13	19	0.06
0.11	26	0.00	0.13	20	0.06
0.11	27	0.00	0.13	21	0.06
0.11	28	0.00	0.13	22	0.05
0.11	29	0.00	0.13	23	0.05
0.11	30	0.00	0.13	24	0.05
0.12	1	10.00	0.13	25	0.05
0.12	2	7.00	0.13	26	0.00
0.12	3	5.00	0.13	27	0.00
0.12	4	4.40	0.13	28	0.00
0.12	5	4.00	0.13	29	0.00
0.12	6	3.50	0.13	30	0.00
0.12	7	3.00	0.14	1	10.00
0.12	8	2.80	0.14	2	7.00
0.12	9	2.50	0.14	3	5.00
0.12	10	2.20	0.14	4	4.40
0.12	11	1.00	0.14	5	4.00
0.12	12	0.20	0.14	6	3.50
0.12	13	0.10	0.14	7	3.00
0.12	14	0.09	0.14	8	2.90
0.12	15	0.08	0.14	9	2.80
0.12	16	0.07	0.14	10	2.40
0.12	17	0.07	0.14	11	2.20
0.12	18	0.06	0.14	12	2.00
0.12	19	0.06	0.14	13	0.40
0.12	20	0.05	0.14	14	0.20
0.12	21	0.05	0.14	15	0.10
0.12	22	0.05	0.14	16	0.09
0.12	23	0.05	0.14	17	0.08
0.12	24	0.00	0.14	18	0.07
0.12	25	0.00	0.14	19	0.07
0.12	26	0.00	0.14	20	0.06
0.12	27	0.00	0.14	21	0.06
0.12	28	0.00	0.14	22	0.06
0.12	29	0.00	0.14	23	0.05
0.12	30	0.00	0.14	24	0.05
0.13	1	10.00	0.14	25	0.05
0.13	2	7.00	0.14	26	0.05
0.13	3	5.00	0.14	27	0.05
0.13	4	4.40	0.14	28	0.00
0.13	5	4.00	0.14	29	0.00
0.13	6	3.50	0.14	30	0.00
0.13	7	3.00	0.15	1	10.00
0.13	8	2.90	0.15	2	7.00
0.13	9	2.70	0.15	3	5.00
0.13	10	2.30	0.15	4	4.40
0.13	11	2.10	0.15	5	4.00
0.13	12	0.50	0.15	6	3.50

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.15	7	3.00	0.17	1	10.00
0.15	8	2.90	0.17	2	7.00
0.15	9	2.80	0.17	3	5.00
0.15	10	2.50	0.17	4	4.40
0.15	11	2.30	0.17	5	4.00
0.15	12	2.10	0.17	6	3.50
0.15	13	1.50	0.17	7	3.00
0.15	14	0.50	0.17	8	2.90
0.15	15	0.20	0.17	9	2.80
0.15	16	0.10	0.17	10	2.70
0.15	17	0.09	0.17	11	2.40
0.15	18	0.08	0.17	12	2.20
0.15	19	0.07	0.17	13	2.10
0.15	20	0.07	0.17	14	1.80
0.15	21	0.07	0.17	15	1.10
0.15	22	0.06	0.17	16	0.50
0.15	23	0.06	0.17	17	0.20
0.15	24	0.06	0.17	18	0.15
0.15	25	0.05	0.17	19	0.09
0.15	26	0.05	0.17	20	0.08
0.15	27	0.05	0.17	21	0.08
0.15	28	0.05	0.17	22	0.07
0.15	29	0.00	0.17	23	0.07
0.15	30	0.00	0.17	24	0.06
0.16	1	10.00	0.17	25	0.06
0.16	2	7.00	0.17	26	0.06
0.16	3	5.00	0.17	27	0.06
0.16	4	4.40	0.17	28	0.05
0.16	5	4.00	0.17	29	0.05
0.16	6	3.50	0.17	30	0.05
0.16	7	3.00	0.18	1	10.00
0.16	8	2.90	0.18	2	7.00
0.16	9	2.80	0.18	3	5.00
0.16	10	2.60	0.18	4	4.40
0.16	11	2.30	0.18	5	4.00
0.16	12	2.20	0.18	6	3.50
0.16	13	2.00	0.18	7	3.00
0.16	14	1.50	0.18	8	2.90
0.16	15	0.50	0.18	9	2.80
0.16	16	0.20	0.18	10	2.70
0.16	17	0.15	0.18	11	2.40
0.16	18	0.09	0.18	12	2.20
0.16	19	0.08	0.18	13	2.10
0.16	20	0.07	0.18	14	1.90
0.16	21	0.07	0.18	15	1.50
0.16	22	0.07	0.18	16	1.10
0.16	23	0.06	0.18	17	0.40
0.16	24	0.06	0.18	18	0.20
0.16	25	0.06	0.18	19	0.15
0.16	26	0.06	0.18	20	0.10
0.16	27	0.05	0.18	21	0.08
0.16	28	0.05	0.18	22	0.08
0.16	29	0.05	0.18	23	0.07
0.16	30	0.05	0.18	24	0.07

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.18	25	0.07	0.20	19	0.40
0.18	26	0.06	0.20	20	0.20
0.18	27	0.06	0.20	21	0.15
0.18	28	0.06	0.20	22	0.10
0.18	29	0.06	0.20	23	0.09
0.18	30	0.05	0.20	24	0.08
0.19	1	10.00	0.20	25	0.07
0.19	2	7.00	0.20	26	0.07
0.19	3	5.00	0.20	27	0.07
0.19	4	4.40	0.20	28	0.07
0.19	5	4.00	0.20	29	0.06
0.19	6	3.50	0.20	30	0.06
0.19	7	3.00	0.21	1	10.00
0.19	8	2.90	0.21	2	7.00
0.19	9	2.80	0.21	3	5.00
0.19	10	2.70	0.21	4	4.40
0.19	11	2.40	0.21	5	4.00
0.19	12	2.30	0.21	6	3.50
0.19	13	2.10	0.21	7	3.00
0.19	14	1.90	0.21	8	2.90
0.19	15	1.70	0.21	9	2.80
0.19	16	1.50	0.21	10	2.70
0.19	17	1.10	0.21	11	2.40
0.19	18	0.40	0.21	12	2.30
0.19	19	0.20	0.21	13	2.10
0.19	20	0.15	0.21	14	2.00
0.19	21	0.10	0.21	15	1.80
0.19	22	0.09	0.21	16	1.60
0.19	23	0.08	0.21	17	1.50
0.19	24	0.07	0.21	18	1.20
0.19	25	0.07	0.21	19	1.00
0.19	26	0.07	0.21	20	0.30
0.19	27	0.06	0.21	21	0.20
0.19	28	0.06	0.21	22	0.15
0.19	29	0.06	0.21	23	0.10
0.19	30	0.06	0.21	24	0.09
0.20	1	10.00	0.21	25	0.08
0.20	2	7.00	0.21	26	0.07
0.20	3	5.00	0.21	27	0.07
0.20	4	4.40	0.21	28	0.07
0.20	5	4.00	0.21	29	0.07
0.20	6	3.50	0.21	30	0.06
0.20	7	3.00	0.22	1	10.00
0.20	8	2.90	0.22	2	7.00
0.20	9	2.80	0.22	3	5.00
0.20	10	2.70	0.22	4	4.40
0.20	11	2.40	0.22	5	4.00
0.20	12	2.30	0.22	6	3.50
0.20	13	2.10	0.22	7	3.00
0.20	14	2.00	0.22	8	2.90
0.20	15	1.80	0.22	9	2.80
0.20	16	1.60	0.22	10	2.70
0.20	17	1.30	0.22	11	2.40
0.20	18	1.10	0.22	12	2.30

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.22	13	2.10	0.24	7	3.00
0.22	14	2.00	0.24	8	2.90
0.22	15	1.90	0.24	9	2.80
0.22	16	1.70	0.24	10	2.70
0.22	17	1.60	0.24	11	2.40
0.22	18	1.40	0.24	12	2.30
0.22	19	1.10	0.24	13	2.10
0.22	20	0.50	0.24	14	2.00
0.22	21	0.30	0.24	15	1.90
0.22	22	0.20	0.24	16	1.80
0.22	23	0.10	0.24	17	1.60
0.22	24	0.10	0.24	18	1.50
0.22	25	0.09	0.24	19	1.40
0.22	26	0.08	0.24	20	1.20
0.22	27	0.08	0.24	21	1.10
0.22	28	0.07	0.24	22	0.40
0.22	29	0.07	0.24	23	0.20
0.22	30	0.07	0.24	24	0.15
0.23	1	10.00	0.24	25	0.10
0.23	2	7.00	0.24	26	0.09
0.23	3	5.00	0.24	27	0.08
0.23	4	4.40	0.24	28	0.08
0.23	5	4.00	0.24	29	0.08
0.23	6	3.50	0.24	30	0.07
0.23	7	3.00	0.25	1	10.00
0.23	8	2.90	0.25	2	7.00
0.23	9	2.80	0.25	3	5.00
0.23	10	2.70	0.25	4	4.40
0.23	11	2.40	0.25	5	4.00
0.23	12	2.30	0.25	6	3.50
0.23	13	2.10	0.25	7	3.00
0.23	14	2.00	0.25	8	2.90
0.23	15	1.90	0.25	9	2.80
0.23	16	1.70	0.25	10	2.70
0.23	17	1.60	0.25	11	2.40
0.23	18	1.50	0.25	12	2.30
0.23	19	1.30	0.25	13	2.10
0.23	20	1.10	0.25	14	2.00
0.23	21	0.50	0.25	15	1.90
0.23	22	0.30	0.25	16	1.80
0.23	23	0.15	0.25	17	1.70
0.23	24	0.10	0.25	18	1.60
0.23	25	0.09	0.25	19	1.50
0.23	26	0.09	0.25	20	1.30
0.23	27	0.08	0.25	21	1.20
0.23	28	0.08	0.25	22	1.00
0.23	29	0.07	0.25	23	0.40
0.23	30	0.07	0.25	24	0.20
0.24	1	10.00	0.25	25	0.15
0.24	2	7.00	0.25	26	0.10
0.24	3	5.00	0.25	27	0.09
0.24	4	4.40	0.25	28	0.08
0.24	5	4.00	0.25	29	0.08
0.24	6	3.50	0.25	30	0.08

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.26	1	10.00	0.27	25	0.30
0.26	2	7.00	0.27	26	0.20
0.26	3	5.00	0.27	27	0.10
0.26	4	4.40	0.27	28	0.09
0.26	5	4.00	0.27	29	0.09
0.26	6	3.50	0.27	30	0.08
0.26	7	3.00	0.28	1	10.00
0.26	8	2.90	0.28	2	7.00
0.26	9	2.80	0.28	3	5.00
0.26	10	2.70	0.28	4	4.40
0.26	11	2.40	0.28	5	4.00
0.26	12	2.30	0.28	6	3.50
0.26	13	2.10	0.28	7	3.00
0.26	14	2.00	0.28	8	2.90
0.26	15	1.90	0.28	9	2.80
0.26	16	1.80	0.28	10	2.70
0.26	17	1.70	0.28	11	2.40
0.26	18	1.60	0.28	12	2.30
0.26	19	1.50	0.28	13	2.10
0.26	20	1.40	0.28	14	2.00
0.26	21	1.20	0.28	15	1.90
0.26	22	1.10	0.28	16	1.80
0.26	23	0.60	0.28	17	1.70
0.26	24	0.30	0.28	18	1.65
0.26	25	0.20	0.28	19	1.60
0.26	26	0.15	0.28	20	1.40
0.26	27	0.10	0.28	21	1.30
0.26	28	0.09	0.28	22	1.20
0.26	29	0.08	0.28	23	1.10
0.26	30	0.08	0.28	24	0.90
0.27	1	10.00	0.28	25	0.40
0.27	2	7.00	0.28	26	0.20
0.27	3	5.00	0.28	27	0.15
0.27	4	4.40	0.28	28	0.10
0.27	5	4.00	0.28	29	0.09
0.27	6	3.50	0.28	30	0.09
0.27	7	3.00	0.29	1	10.00
0.27	8	2.90	0.29	2	7.00
0.27	9	2.80	0.29	3	5.00
0.27	10	2.70	0.29	4	4.40
0.27	11	2.40	0.29	5	4.00
0.27	12	2.30	0.29	6	3.50
0.27	13	2.10	0.29	7	3.00
0.27	14	2.00	0.29	8	2.90
0.27	15	1.90	0.29	9	2.80
0.27	16	1.80	0.29	10	2.70
0.27	17	1.70	0.29	11	2.40
0.27	18	1.65	0.29	12	2.30
0.27	19	1.50	0.29	13	2.10
0.27	20	1.40	0.29	14	2.00
0.27	21	1.30	0.29	15	1.90
0.27	22	1.20	0.29	16	1.80
0.27	23	1.00	0.29	17	1.70
0.27	24	0.50	0.29	18	1.65

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.29	19	1.60	0.31	13	2.10
0.29	20	1.50	0.31	14	2.00
0.29	21	1.40	0.31	15	1.91
0.29	22	1.30	0.31	16	1.82
0.29	23	1.20	0.31	17	1.73
0.29	24	1.00	0.31	18	1.64
0.29	25	0.60	0.31	19	1.55
0.29	26	0.40	0.31	20	1.46
0.29	27	0.20	0.31	21	1.36
0.29	28	0.15	0.31	22	1.27
0.29	29	0.10	0.31	23	1.18
0.29	30	0.09	0.31	24	1.09
0.30	1	10.00	0.31	25	1.02
0.30	2	7.00	0.31	26	0.80
0.30	3	5.00	0.31	27	0.45
0.30	4	4.40	0.31	28	0.25
0.30	5	4.00	0.31	29	0.16
0.30	6	3.50	0.31	30	0.10
0.30	7	3.00	0.31	31	0.05
0.30	8	2.90	0.31	32	0.00
0.30	9	2.80	0.32	1	10.00
0.30	10	2.70	0.32	2	7.00
0.30	11	2.40	0.32	3	5.00
0.30	12	2.30	0.32	4	4.40
0.30	13	2.10	0.32	5	4.00
0.30	14	2.00	0.32	6	3.50
0.30	15	1.90	0.32	7	3.00
0.30	16	1.80	0.32	8	2.90
0.30	17	1.70	0.32	9	2.80
0.30	18	1.65	0.32	10	2.70
0.30	19	1.60	0.32	11	2.40
0.30	20	1.50	0.32	12	2.30
0.30	21	1.40	0.32	13	2.10
0.30	22	1.30	0.32	14	2.00
0.30	23	1.20	0.32	15	1.92
0.30	24	1.10	0.32	16	1.83
0.30	25	0.90	0.32	17	1.75
0.30	26	0.50	0.32	18	1.66
0.30	27	0.30	0.32	19	1.57
0.30	28	0.20	0.32	20	1.49
0.30	29	0.10	0.32	21	1.40
0.30	30	0.10	0.32	22	1.32
0.31	1	10.00	0.32	23	1.23
0.31	2	7.00	0.32	24	1.15
0.31	3	5.00	0.32	25	1.06
0.31	4	4.40	0.32	26	0.90
0.31	5	4.00	0.32	27	0.60
0.31	6	3.50	0.32	28	0.40
0.31	7	3.00	0.32	29	0.20
0.31	8	2.90	0.32	30	0.12
0.31	9	2.80	0.32	31	0.05
0.31	10	2.70	0.32	32	0.00
0.31	11	2.40	0.33	1	10.00
0.31	12	2.30	0.33	2	7.00

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.33	3	5.00	0.34	25	1.12
0.33	4	4.40	0.34	26	1.04
0.33	5	4.00	0.34	27	0.80
0.33	6	3.50	0.34	28	0.60
0.33	7	3.00	0.34	29	0.35
0.33	8	2.90	0.34	30	0.20
0.33	9	2.80	0.34	31	0.10
0.33	10	2.70	0.34	32	0.00
0.33	11	2.40	0.35	1	10.00
0.33	12	2.30	0.35	2	7.00
0.33	13	2.10	0.35	3	5.00
0.33	14	2.00	0.35	4	4.40
0.33	15	1.92	0.35	5	4.00
0.33	16	1.83	0.35	6	3.50
0.33	17	1.75	0.35	7	3.00
0.33	18	1.67	0.35	8	2.90
0.33	19	1.58	0.35	9	2.80
0.33	20	1.50	0.35	10	2.70
0.33	21	1.42	0.35	11	2.40
0.33	22	1.33	0.35	12	2.30
0.33	23	1.25	0.35	13	2.10
0.33	24	1.17	0.35	14	2.00
0.33	25	1.08	0.35	15	1.92
0.33	26	1.00	0.35	16	1.84
0.33	27	0.75	0.35	17	1.77
0.33	28	0.50	0.35	18	1.69
0.33	29	0.25	0.35	19	1.61
0.33	30	0.17	0.35	20	1.53
0.33	31	0.75	0.35	21	1.45
0.33	32	0.00	0.35	22	1.37
0.34	1	10.00	0.35	23	1.29
0.34	2	7.00	0.35	24	1.22
0.34	3	5.00	0.35	25	1.14
0.34	4	4.40	0.35	26	1.06
0.34	5	4.00	0.35	27	0.90
0.34	6	3.50	0.35	28	0.60
0.34	7	3.00	0.35	29	0.40
0.34	8	2.90	0.35	30	0.20
0.34	9	2.80	0.35	31	0.10
0.34	10	2.70	0.35	32	0.00
0.34	11	2.40	0.36	1	10.00
0.34	12	2.30	0.36	2	7.00
0.34	13	2.10	0.36	3	5.00
0.34	14	2.00	0.36	4	4.40
0.34	15	1.92	0.36	5	4.00
0.34	16	1.84	0.36	6	3.50
0.34	17	1.76	0.36	7	3.00
0.34	18	1.68	0.36	8	2.90
0.34	19	1.60	0.36	9	2.80
0.34	20	1.52	0.36	10	2.70
0.34	21	1.44	0.36	11	2.40
0.34	22	1.36	0.36	12	2.30
0.34	23	1.28	0.36	13	2.10
0.34	24	1.20	0.36	14	2.00

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.36	15	1.92	0.38	5	4.00
0.36	16	1.85	0.38	6	3.50
0.36	17	1.77	0.38	7	3.00
0.36	18	1.69	0.38	8	2.90
0.36	19	1.61	0.38	9	2.80
0.36	20	1.54	0.38	10	2.70
0.36	21	1.46	0.38	11	2.40
0.36	22	1.38	0.38	12	2.30
0.36	23	1.30	0.38	13	2.10
0.36	24	1.23	0.38	14	2.00
0.36	25	1.15	0.38	15	1.92
0.36	26	1.07	0.38	16	1.85
0.36	27	0.95	0.38	17	1.77
0.36	28	0.75	0.38	18	1.70
0.36	29	0.51	0.38	19	1.62
0.36	30	0.30	0.38	20	1.54
0.36	31	0.16	0.38	21	1.47
0.36	32	0.00	0.38	22	1.39
0.37	1	10.00	0.38	23	1.32
0.37	2	7.00	0.38	24	1.24
0.37	3	5.00	0.38	25	1.16
0.37	4	4.40	0.38	26	1.09
0.37	5	4.00	0.38	27	1.01
0.37	6	3.50	0.38	28	0.83
0.37	7	3.00	0.38	29	0.65
0.37	8	2.90	0.38	30	0.50
0.37	9	2.80	0.38	31	0.20
0.37	10	2.70	0.38	32	0.00
0.37	11	2.40	0.39	1	10.00
0.37	12	2.30	0.39	2	7.00
0.37	13	2.10	0.39	3	5.00
0.37	14	2.00	0.39	4	4.40
0.37	15	1.92	0.39	5	4.00
0.37	16	1.85	0.39	6	3.50
0.37	17	1.77	0.39	7	3.00
0.37	18	1.69	0.39	8	2.90
0.37	19	1.62	0.39	9	2.80
0.37	20	1.54	0.39	10	2.70
0.37	21	1.46	0.39	11	2.40
0.37	22	1.39	0.39	12	2.30
0.37	23	1.31	0.39	13	2.10
0.37	24	1.23	0.39	14	2.00
0.37	25	1.15	0.39	15	1.93
0.37	26	1.08	0.39	16	1.85
0.37	27	1.00	0.39	17	1.77
0.37	28	0.80	0.39	18	1.70
0.37	29	0.60	0.39	19	1.62
0.37	30	0.40	0.39	20	1.55
0.37	31	0.18	0.39	21	1.47
0.37	32	0.00	0.39	22	1.40
0.38	1	10.00	0.39	23	1.32
0.38	2	7.00	0.39	24	1.25
0.38	3	5.00	0.39	25	1.17
0.38	4	4.40	0.39	26	1.10

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.39	27	1.02	0.41	17	1.78
0.39	28	0.85	0.41	18	1.71
0.39	29	0.70	0.41	19	1.63
0.39	30	0.54	0.41	20	1.56
0.39	31	0.23	0.41	21	1.48
0.39	32	0.00	0.41	22	1.41
0.40	1	10.00	0.41	23	1.34
0.40	2	7.00	0.41	24	1.26
0.40	3	5.00	0.41	25	1.19
0.40	4	4.40	0.41	26	1.12
0.40	5	4.00	0.41	27	1.04
0.40	6	3.50	0.41	28	0.90
0.40	7	3.00	0.41	29	0.78
0.40	8	2.90	0.41	30	0.63
0.40	9	2.80	0.41	31	0.45
0.40	10	2.70	0.41	32	0.00
0.40	11	2.40	0.42	1	10.00
0.40	12	2.30	0.42	2	7.00
0.40	13	2.10	0.42	3	5.00
0.40	14	2.00	0.42	4	4.40
0.40	15	1.93	0.42	5	4.00
0.40	16	1.85	0.42	6	3.50
0.40	17	1.78	0.42	7	3.00
0.40	18	1.70	0.42	8	2.90
0.40	19	1.63	0.42	9	2.80
0.40	20	1.55	0.42	10	2.70
0.40	21	1.48	0.42	11	2.40
0.40	22	1.40	0.42	12	2.30
0.40	23	1.33	0.42	13	2.10
0.40	24	1.26	0.42	14	2.00
0.40	25	1.18	0.42	15	1.93
0.40	26	1.11	0.42	16	1.85
0.40	27	1.03	0.42	17	1.78
0.40	28	0.90	0.42	18	1.71
0.40	29	0.72	0.42	19	1.64
0.40	30	0.60	0.42	20	1.56
0.40	31	0.40	0.42	21	1.49
0.40	32	0.00	0.42	22	1.42
0.41	1	10.00	0.42	23	1.34
0.41	2	7.00	0.42	24	1.27
0.41	3	5.00	0.42	25	1.98
0.41	4	4.40	0.42	26	1.13
0.41	5	4.00	0.42	27	1.05
0.41	6	3.50	0.42	28	0.95
0.41	7	3.00	0.42	29	0.75
0.41	8	2.90	0.42	30	0.65
0.41	9	2.80	0.42	31	0.51
0.41	10	2.70	0.42	32	0.00
0.41	11	2.40	0.43	1	10.00
0.41	12	2.30	0.43	2	7.00
0.41	13	2.10	0.43	3	5.00
0.41	14	2.00	0.43	4	4.40
0.41	15	1.93	0.43	5	4.00
0.41	16	1.85	0.43	6	3.50

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.43	7	3.00	0.44	29	0.88
0.43	8	2.90	0.44	30	0.75
0.43	9	2.80	0.44	31	0.63
0.43	10	2.70	0.44	32	0.00
0.43	11	2.40	0.45	1	10.00
0.43	12	2.30	0.45	2	7.00
0.43	13	2.10	0.45	3	5.00
0.43	14	2.00	0.45	4	4.40
0.43	15	1.93	0.45	5	4.00
0.43	16	1.86	0.45	6	3.50
0.43	17	1.78	0.45	7	3.00
0.43	18	1.71	0.45	8	2.90
0.43	19	1.64	0.45	9	2.80
0.43	20	1.57	0.45	10	2.70
0.43	21	1.50	0.45	11	2.40
0.43	22	1.42	0.45	12	2.30
0.43	23	1.35	0.45	13	2.10
0.43	24	1.28	0.45	14	2.00
0.43	25	1.21	0.45	15	1.92
0.43	26	1.13	0.45	16	1.86
0.43	27	1.06	0.45	17	1.79
0.43	28	0.97	0.45	18	1.71
0.43	29	0.80	0.45	19	1.64
0.43	30	0.65	0.45	20	1.57
0.43	31	0.54	0.45	21	1.50
0.43	32	0.00	0.45	22	1.43
0.44	1	10.00	0.45	23	1.36
0.44	2	7.00	0.45	24	1.29
0.44	3	5.00	0.45	25	1.21
0.44	4	4.40	0.45	26	1.14
0.44	5	4.00	0.45	27	1.07
0.44	6	3.50	0.45	28	1.00
0.44	7	3.00	0.45	29	0.88
0.44	8	2.90	0.45	30	0.75
0.44	9	2.80	0.45	31	0.63
0.44	10	2.70	0.45	32	0.00
0.44	11	2.40	0.46	1	10.00
0.44	12	2.30	0.46	2	7.00
0.44	13	2.10	0.46	3	5.00
0.44	14	2.00	0.46	4	4.40
0.44	15	1.92	0.46	5	4.00
0.44	16	1.86	0.46	6	3.50
0.44	17	1.79	0.46	7	3.00
0.44	18	1.71	0.46	8	2.90
0.44	19	1.64	0.46	9	2.80
0.44	20	1.57	0.46	10	2.70
0.44	21	1.50	0.46	11	2.40
0.44	22	1.43	0.46	12	2.30
0.44	23	1.36	0.46	13	2.10
0.44	24	1.29	0.46	14	2.00
0.44	25	1.21	0.46	15	1.92
0.44	26	1.14	0.46	16	1.86
0.44	27	1.07	0.46	17	1.79
0.44	28	1.00	0.46	18	1.71

Table 5 Continued

Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %	Cyclic Stress Ratio, CSR	Normalized and Corrected SPT Blow Count, $(N_1)_{60}$	Liquefaction-Induced Volumetric Strain, %
0.46	19	1.64	0.46	26	1.14
0.46	20	1.57	0.46	27	1.07
0.46	21	1.50	0.46	28	1.00
0.46	22	1.43	0.46	29	0.90
0.46	23	1.36	0.46	30	0.78
0.46	24	1.29	0.46	31	0.65
0.46	25	1.21	0.46	32	0.00

Yoshimine et al.

Yoshimine et al. (2006) published a series of functions that describe the settlement curves presented by Ishihara and Yoshimine (1992). The Ishihara and Yoshimine (1992) curves (Figures 13 and 14) relate volumetric strain in clean sands to relative density (via normalized SPT blow counts, N_1) and factor of safety against liquefaction triggering (FS).

The raw blow count data contained in the ArcGIS® geotechnical database were normalized and corrected to $(N_1)_{60}$ clean sand values by Equations 2 and 3 (Youd et al., 2001). The soil profiles for each borehole location were then screened for liquefaction triggering using Equations 1, 6 and 7 as previously described. A ground settlement value of 0 m was assigned to all soils layers with factors of safety against liquefaction triggering greater than 1.1.

To implement Yoshimine et al. (2006), the $(N_1)_{60}$ clean sand blow count values were converted to N_1 values using Seed et al. (1985) to account for traditional Japanese sampling practices and techniques:

$$N_1 = \frac{(N_1)_{60}}{0.9} \quad \text{for } (N_1)_{60} < 20 \qquad \text{(Equation 10a)}$$

$$N_1 = (N_1)_{60} \quad \text{for } (N_1)_{60} \geq 20 \qquad \text{(Equation 10b)}$$

Following the method outlined by Yoshimine et al. (2006), the N_1 values were converted to relative densities, D_r, by (Meyerhof, 1957):

$$D_r = 21\sqrt{\frac{N_1}{1.7}} \qquad \text{(Equation 11)}$$

and the likelihood of liquefaction triggering, FS, was calculated according to the Japanese Design Code for Highway Bridges (2000):

$$FS = \frac{R}{L} \qquad \text{(Equation 12)}$$

$$R = 0.0882\sqrt{\frac{N_1}{1.7}} \qquad \text{for } N_1 < 14 \qquad \text{(Equation 13a)}$$

$$R = 0.0882\sqrt{\frac{N_1}{1.7}} + 1.6E^{-6}\left(\frac{N_1}{1.7}\right)^{4.5} \qquad \text{for } N_1 \geq 14 \qquad \text{(Equation 13b)}$$

$$L = r_d\left(\frac{\sigma_v}{\sigma'_v}\right)\left(\frac{\alpha}{g}\right) \qquad \text{(Equation 14)}$$

$$r_d = 1.0 - 0.015D \qquad \text{(Equation 15)}$$

where N_1 is the normalized and corrected Japanese-modified SPT blow count, σ_v and σ'_v are the total and effective overburden pressures, respectively, α is the PGA for the analysis, D is the depth from ground surface and r_d is a stress reduction factor.
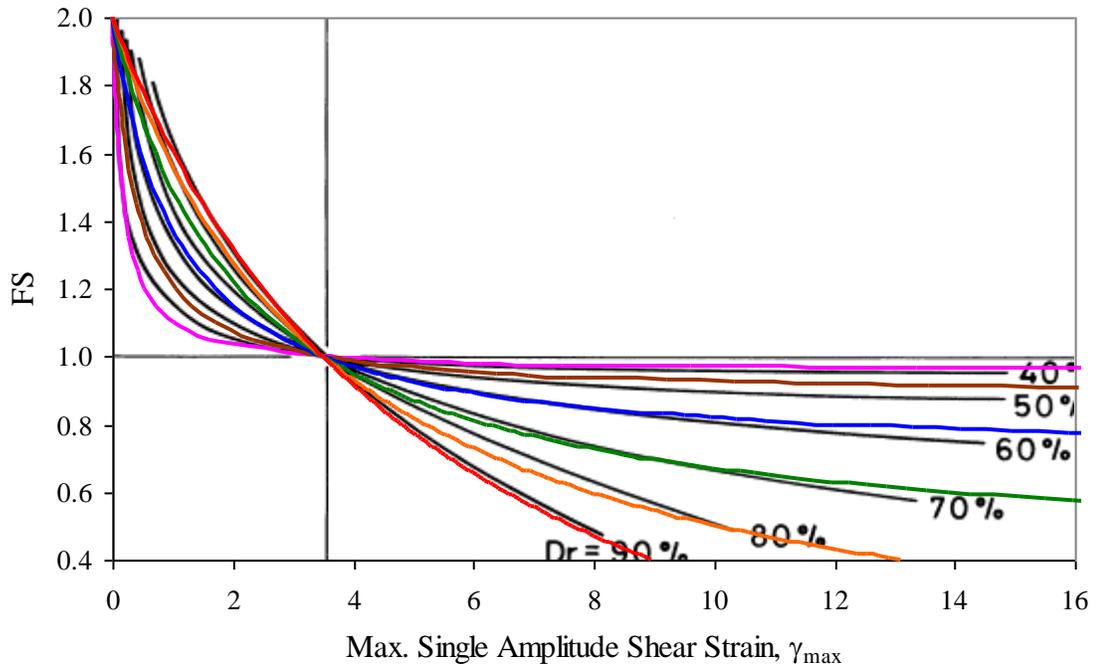
Figure 13.   Curves used to correlate single amplitude shear strain (γ_{max}) to factor of safety against liquefaction (relative density, D_r, calculated from N_1)
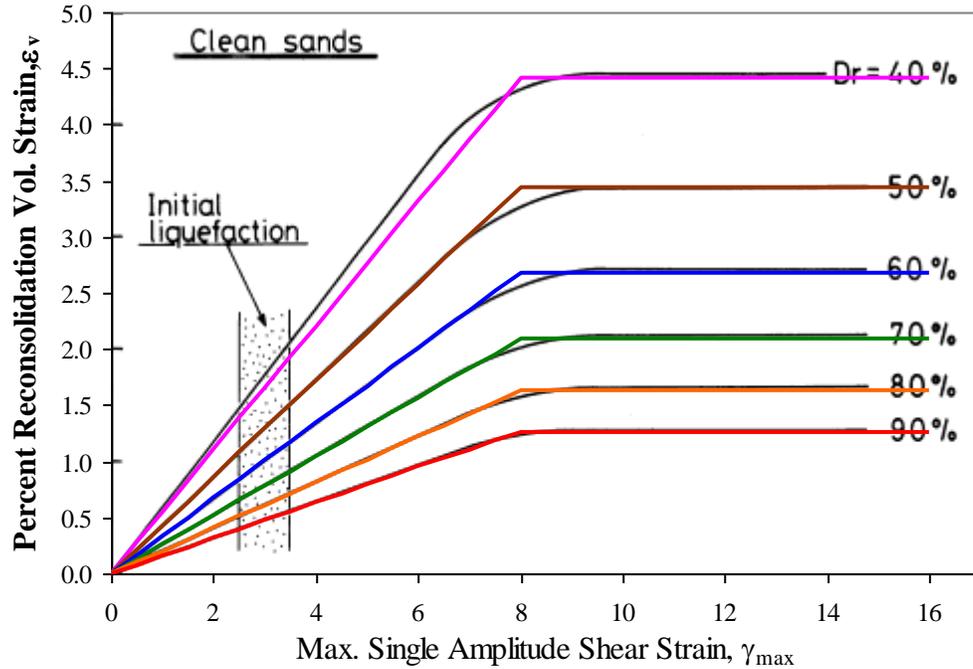
Figure 14. Curves used to correlate single amplitude of shear strain (γ_{max}) to post-liquefaction settlement

The maximum single amplitude of shear strain, γ_{max}, for all sites with a factor of safety against liquefaction triggering, FS, less than or equal to 1.1 was calculated by Yoshimine et al. (2006). In the following equations F_{ult} is a nameless intermediate variable and the relative density prior to liquefaction, $D_{r,ini}$, is expressed as an integer (i.e., 65 percent is expressed as 65):

$$\gamma_{max} = 3.5(2 - FS)\frac{1 - F_{ult}}{FS - F_{ult}} \quad \text{if } F_{ult} \leq FS \leq 2.0 \qquad \text{(Equation 16a)}$$

$$\gamma_{max} = 0 \qquad \text{if } FS \geq 2.0 \qquad \text{(Equation 16b)}$$

$$\gamma_{max} = \infty \qquad \text{if } F_{ult} \leq FS \qquad \text{(Equation 16c)}$$

where

$$F_{ult} = -0.0006 D_{r,ini}^2 + 0.047 D_{r,ini} + 0.032 \quad \text{if } D_{r,ini} \geq 39.2\% \qquad \text{(Equation 17a)}$$

$$F_{ult} = 0.9524 \qquad \text{if } D_{r,ini} < 39.2\% \qquad \text{(Equation 17b)}$$

Finally, using the initial relative densities, $D_{r,ini}$, and the maximum single amplitude of shear strains, γ_{max}, percent liquefaction-induced volumetric strains, ε_v, were estimated by (Yoshimine et al., 2006):

$$\varepsilon_v = 1.5[\exp(-0.025D_{r,ini})]\gamma_{max} \qquad \text{if } \gamma_{max} \leq 8\% \qquad \text{(Equation 18a)}$$

$$\varepsilon_v = 12\exp(-0.025D_{r,ini}) \quad \text{if } \gamma_{max} > 8\% \qquad \text{(Equation 18b)}$$

The estimated settlement, Δ_Y, at each borehole was the summation of the thickness of each liquefiable soil layer, t, times the respective estimated volumetric strain, ε_v:

$$\Delta_Y = \sum_{i=1}^{n} t_i \times \varepsilon_{v,i} \qquad \text{(Equation 19)}$$

As previously mentioned, ground settlement value of 0 m was assigned to all locations with factors of safety for liquefaction triggering greater than 1.1. Since earthquake magnitude was not a required input variable, no magnitude scaling factors were used in this method.

Comparison of Methods

The calculated settlements (Δ_{TS} and Δ_Y) were compared at each borehole to assess the resultant similarities and differences between the two methodologies. The results for the three analysis events are shown in Table 6. For example, the scenario M7.0 earthquake settlement data set showed an average difference between the two methods of 0.004 m, with a maximum difference of 0.083 m. Of the 963 boreholes, Tokimatsu and Seed (1987) predicted higher settlements than Yoshimine et al. (2006) in 232 boreholes and the opposite was true for 444 boreholes. Both methods predicted no settlement in 287 boreholes. A method-to-method comparison of the differences showed that 74 percent of the boreholes were within 0.01 m, 92 percent were within 0.025 m and 99 percent were within 0.05 m.

It was concluded that the two methods produced relatively similar results when considering the quality of the input data and the ultimate use of the mapping. Subsequently, the average of the two methods was considered appropriate to estimate the ground settlement, Δ_{liq}, at each liquefiable borehole location:

$$\Delta_{liq} = \frac{\Delta_{TS} + \Delta_Y}{2} \qquad \text{(Equation 20)}$$

Table 6
Comparison of Δ_{TS} and Δ_Y at each Borehole for the Three Analysis Events

	Wasatch Fault M7.0 Event	2 percent Prob. of Exceedance in 50 yrs	10 percent Prob. of Exceedance in 50 yrs
Average Difference, m	0.004	0.006	0.002
Maximum Difference, m	0.083	0.083	0.076
Number of Boreholes where $\Delta_{TS} > \Delta_Y$	232	189	313
Number of Boreholes where $\Delta_Y > \Delta_{TS}$	444	487	352
Number of Boreholes where $\Delta_{TS} = \Delta_Y = 0$	287	287	298
Percent of Boreholes where Δ_{TS} and Δ_Y are within 0.010 m	73.9	73.7	78.4
Percent of Boreholes where Δ_{TS} and Δ_Y are within 0.025 m	92.3	91.4	94.3
Percent of Boreholes where Δ_{TS} and Δ_Y are within 0.050 m	99.0	98.8	99.3

APPENDIX C - Hazard Class Identification

This report presents the first liquefaction-induced ground displacement maps developed for Utah using both geotechnical and geological data in conjunction with deterministic and probabilistic estimates of strong motion.

Methods and Classifications

The lateral spread maps are a continuation of work completed for the northern part of the Salt Lake Valley by Bartlett et al. (2005) and Olsen et al. (2007). The methods used for this paper are consistent with the methods developed in those reports; the reader is referred to those reports for a detailed explanation of the analysis methodology. In short, lateral spread displacements were estimated by the Youd et al. (2002) regression model for all borehole locations having a factor of safety against liquefaction triggering less than or equal to 1.1. The estimated horizontal displacements (D_H) were further categorized as "minimal" (0 m); "low" (0 to 0.1 m); "moderate" (0.1 to 0.3 m); "high" (0.3 to 1.0 m); and "very high" (greater than 1.0 m). All boreholes with factors of safety against liquefaction triggering greater than 1.1 were assigned a lateral spread displacement of 0 m.

The methods used to estimate liquefaction-induced settlement are exhaustively explained in Appendix B. Briefly, settlement estimates were averaged from settlements estimated by Tokimatsu and Seed (1987) and Yoshimine et al. (2006). The ground settlement estimates were categorized as "low" (0 to 0.05 m); "moderate" (0.05 to 0.1 m); "high" (0.1 to 0.3 m); and "very high" (greater than 0.3 m). All soil layers with factors of safety against liquefaction triggering greater than 1.1 were assigned a settlement of 0 m.

In the six ground displacement maps (see Figures 3 through 5 and 9 through 11), a hazard category was assigned to each geologic unit shown in Figure 1 by statistical analysis of the estimated displacements from all boreholes located within the respective geologic unit or group of units with similar subsurface characteristics (e.g., near-surface soil type, origin, deposition and age). A total of 24 geologic groups were assessed and assigned a hazard classification for each map. All 963 boreholes from the ArcGIS® database are contained within the 24 geologic groups.

To assess the localized hazard, the estimated displacement at each borehole location was shown as a dot that was colored according to the hazard categories previously mentioned. The dot coloring was consistent with the classification shading shown in Figures 3 through 5 and 9 through 11. In some areas, several clearly defined homogenous or nearly homogenous dot clusters representing varying hazard categories existed in the same geologic unit. In these cases, the geologic units were subdivided prior to conducting statistical analysis.

An example of a "dot map" is included as Figure 15. The geologic unit shown highlighted in the middle of the figure is the Qlaly unit (lacustrine, marsh and alluvium deposits) located in the northeast quadrant of the valley. Due to the concentration of increased hazards in the northern

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(upper) part and inferior hazards in the southern (lower) part, this geologic unit was subdivided along the roadway that extends across the lower-third of the unit (Interstate 80).

Figure 15.　　"Dot map" showing boreholes in Qlaly unit in northeast valley quadrant

Deterministic Maps

Using the method discussed by Bartlett et al. (2005) and Olsen et al. (2007), cumulative histograms of increasing hazard severity were developed to determine an 85 percent non-exceedance ground displacement threshold for the M7.0 Wasatch fault scenario event maps. The 85 percent non-exceedance criterion means that no more than 15 percent of the estimated displacements exceed the hazard category assigned to the respective geologic unit or group of units and thus approximates a mean plus one standard deviation criterion. A sample histogram is shown in Figure 16. This histogram corresponds to the lateral spread hazard estimated for the northern part of the Qlaly geologic unit shown in Figure 15. Based on the 85 percent criterion, the lateral spread hazard associated with this geologic unit was classified as "very high." As shown by the solid horizontal line at 85 percent, no more than 15 percent of the displacement results exceed the assigned hazard category. Several additional histograms included as Figures 17 through 21 further illustrate the 85 percent criterion and subsequent hazard classification. The analysis type and assigned hazard category are listed in the figure description.

Probabilistic Maps

When the natural log of the probabilistic-based data was taken, it was observed that the datasets from well-sampled units generally demonstrated a log-normal distribution. Figure 22 shows the log-normal distribution of the natural log of the ground settlement estimates based on a 2 percent probability of exceedance in 50 years (2PE50) for the boreholes located in the northern part of the Qlaly unit shown in Figure 15. To account for 0-meter displacement estimates, 0.01 m (1 cm) was added to all settlement estimates prior to taking the natural log.

Due to the log-normal distribution, the hazard category assigned to each geologic unit or group of units for the probabilistic analyses was most appropriately indicated by the median of all estimated displacements within the respective dataset. The median means that no more than 50 percent of the estimated displacements exceed the hazard category assigned to the respective geologic unit or group of units. For the data presented in Figure 22, a median displacement of 0.054 m was used to classify the geologic unit as having a "moderate" liquefaction-induced ground settlement hazard. Figures 23 through 26 further illustrate the log-normal distributions.

**Qlaly unit located between I-15 and 1300 East from 600
North to 4500 South, data north of I-80 only, 87 boreholes**
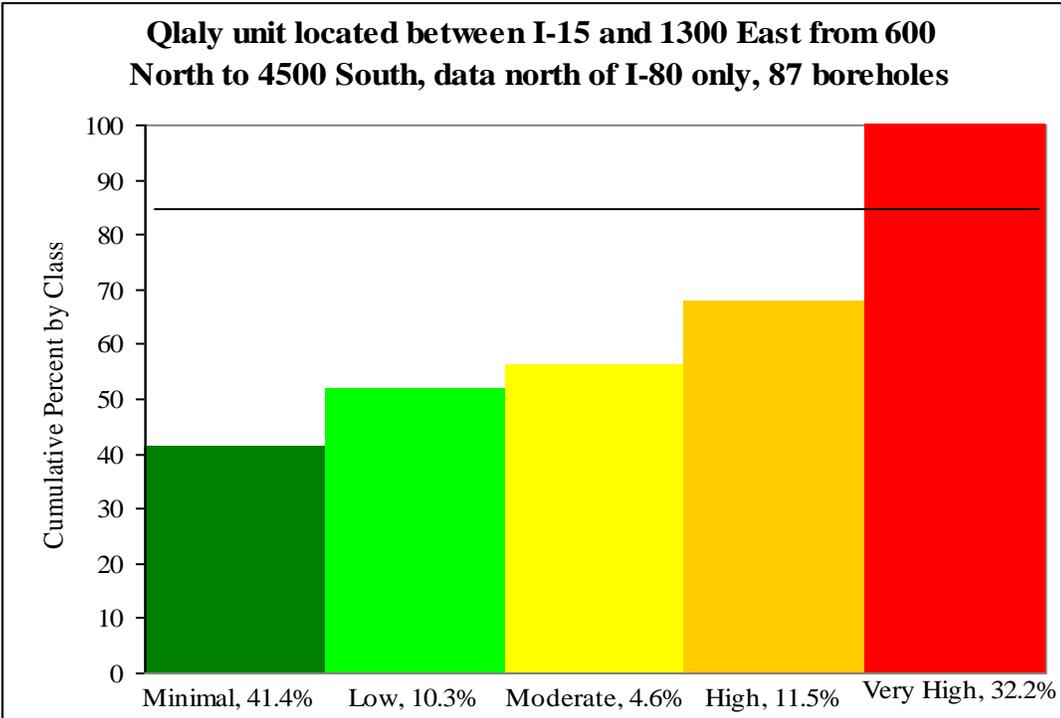
Figure 16.   Histogram showing "very high" hazard classification for lateral spread caused by a M7.0 event on the Wasatch fault for the northern part of Qlaly unit located in northeast valley quadrant.
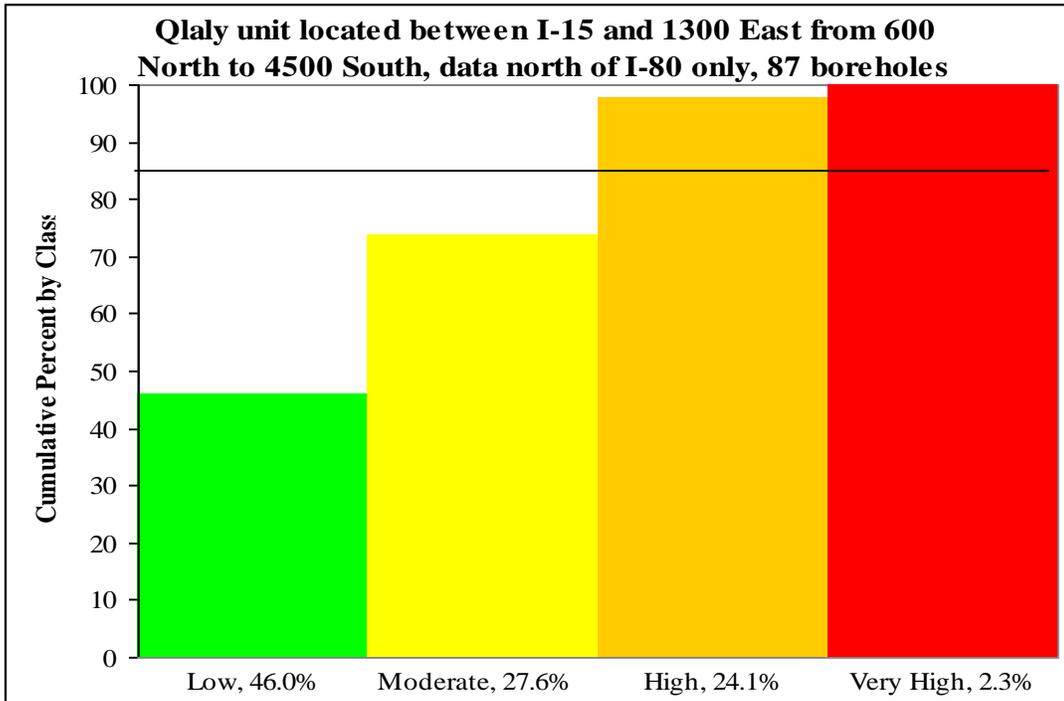
Figure 17.   Histogram showing "high" hazard classification for ground settlement caused by a M7.0 event on the Wasatch fault

Qal2 deposit located alongside Qal1 unit in center of valley, branches to Little and Big Cottonwood Canyons, 111 boreholes

Cumulative Percent by Class

Minimal, 45.0%   Low, 22.5%   Moderate, 9.0%   High, 13.5%   Very High, 9.9%
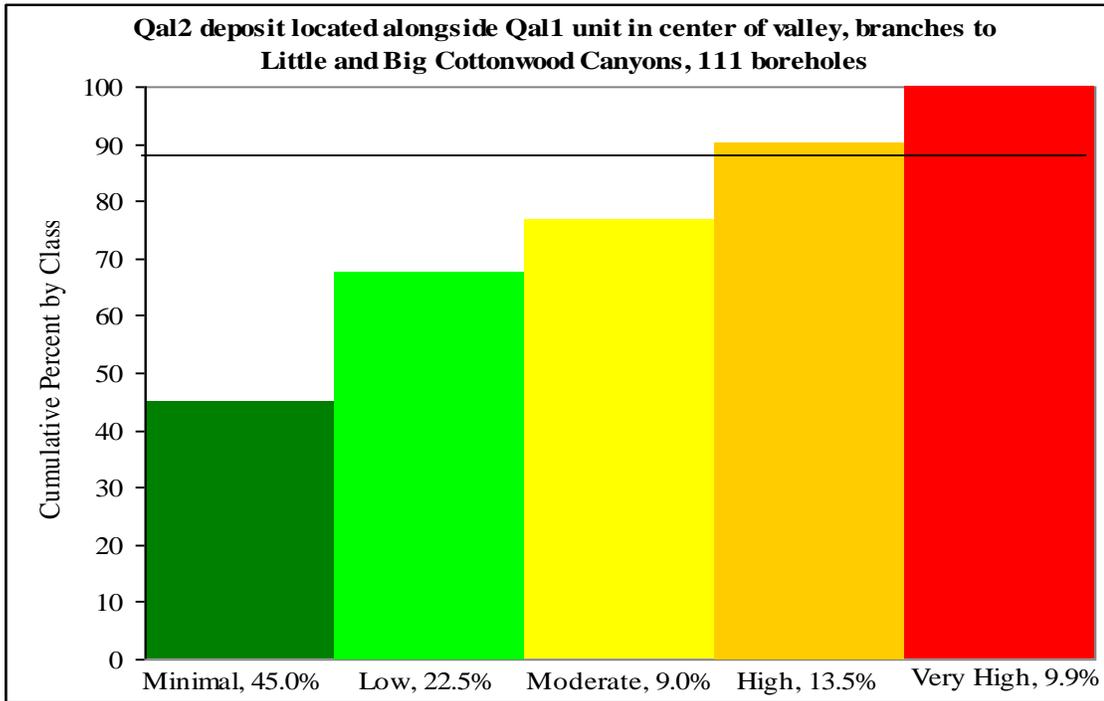
Figure 18.   Histogram showing "high" hazard classification for lateral spread caused by a M7.0 event on the Wasatch fault

Qal2 deposit located alongside Qal1 unit in center of valley, branches to Little and Big Cottonwood Canyons, 111 boreholes
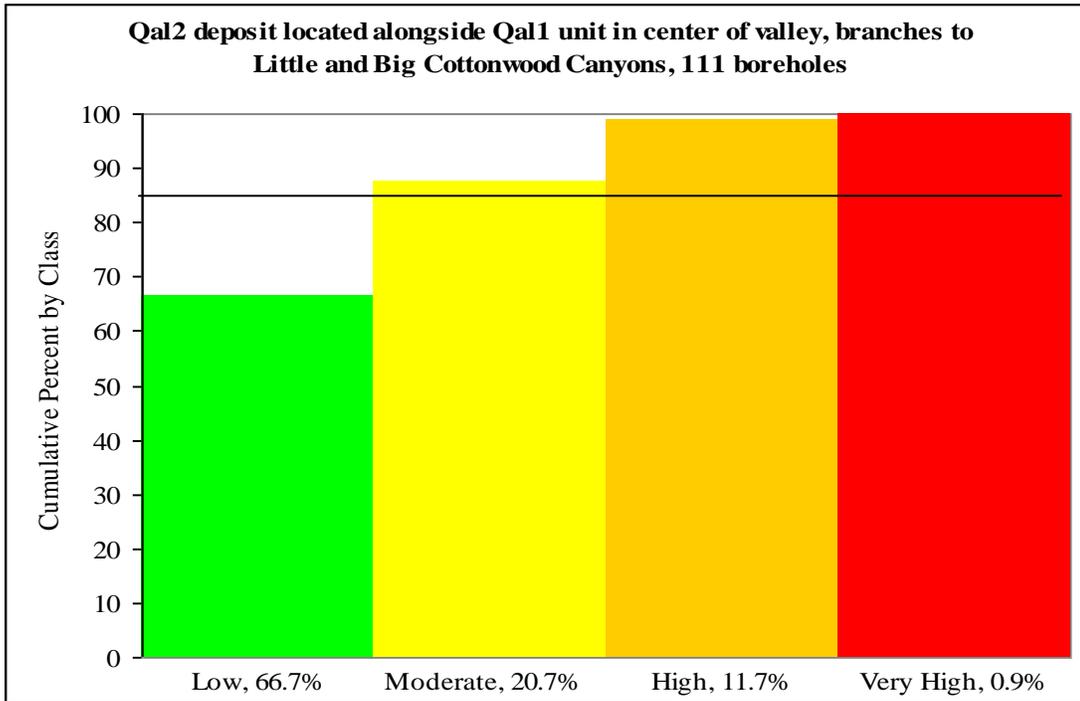
Figure 19.   Histogram showing "moderate" hazard classification for ground settlement corresponding to a M7.0 event on the Wasatch fault

Qlbpm units along I-15 corridor located between 3900 South and 9000 South, 123 boreholes
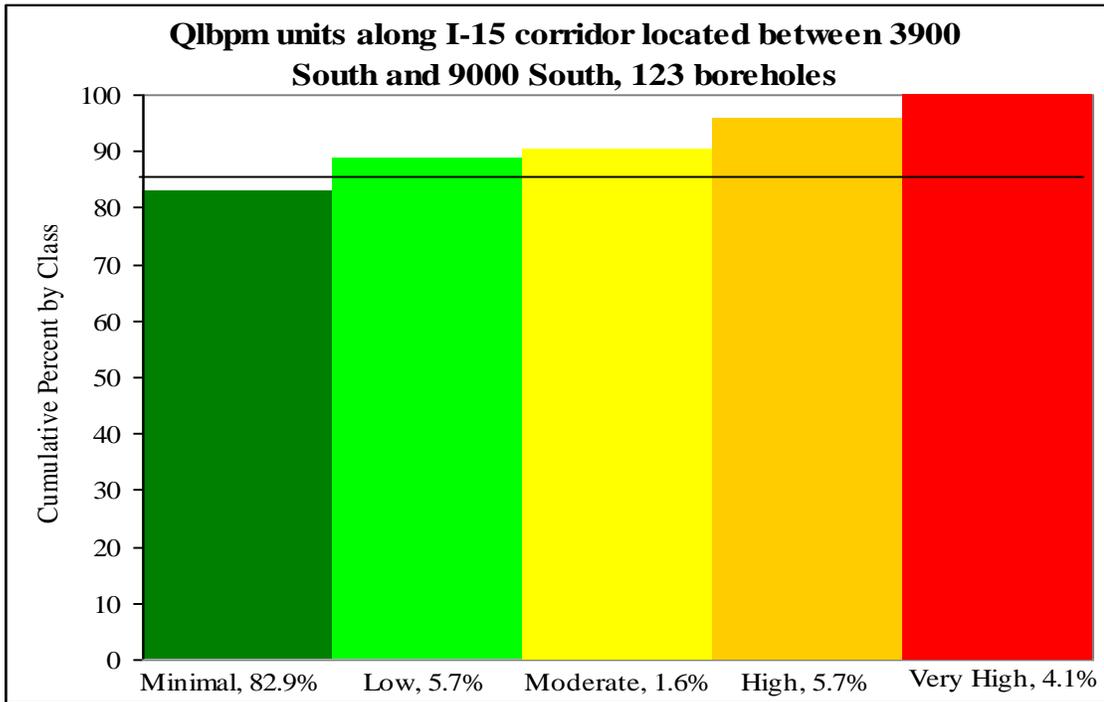
Figure 20.   Histogram showing "low" hazard classification for lateral spread caused by a M7.0 event on the Wasatch fault.
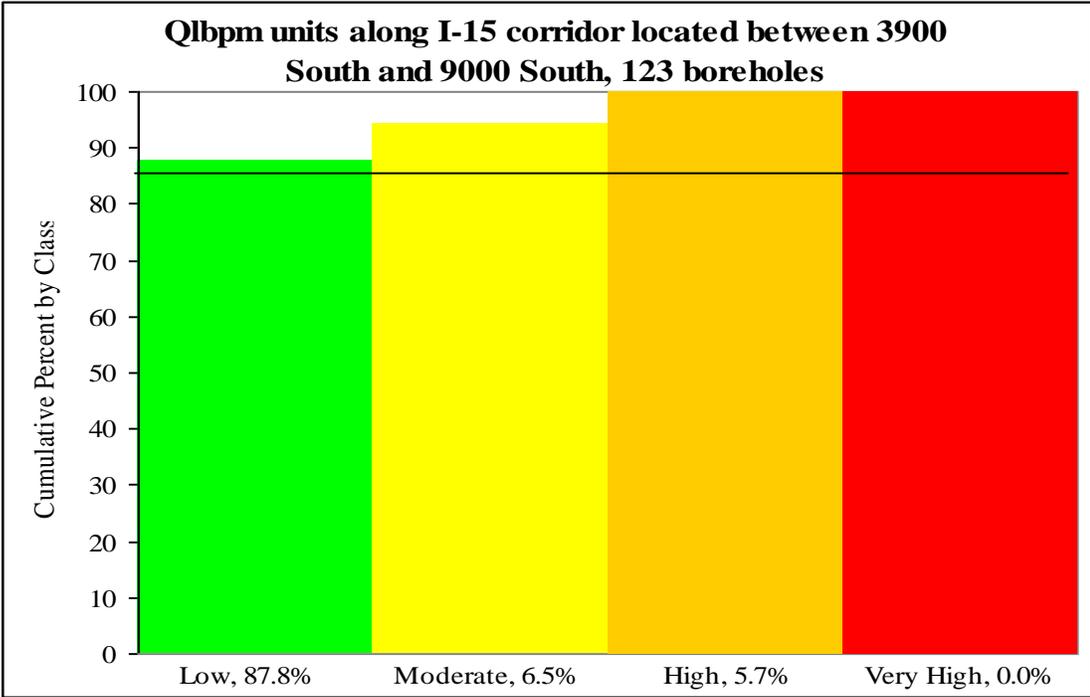
Figure 21.   Histogram showing "moderate" hazard classification for ground settlement corresponding to a M7.0 event on the Wasatch fault.
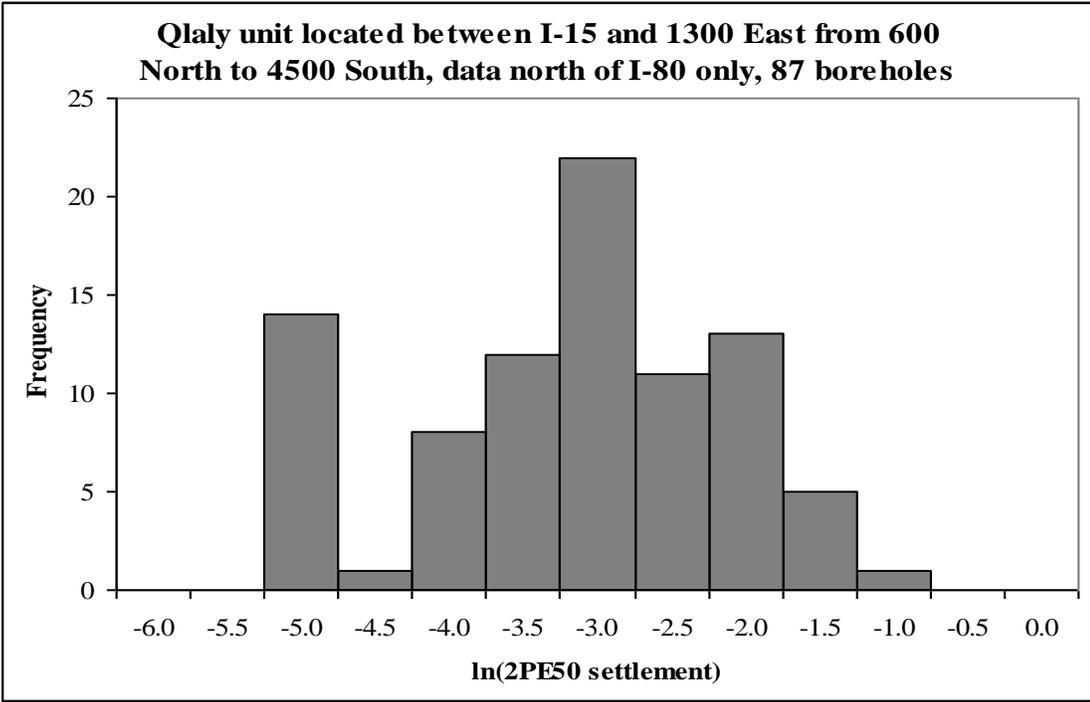
Figure 22.　　　Histogram showing ground settlement displacement distribution for 2PE50. A "moderate" ground settlement hazard was assigned to this unit

Qlaly unit located between I-15 and 1300 East from 600 North to 4500 South, data north of I-80 only, 87 boreholes
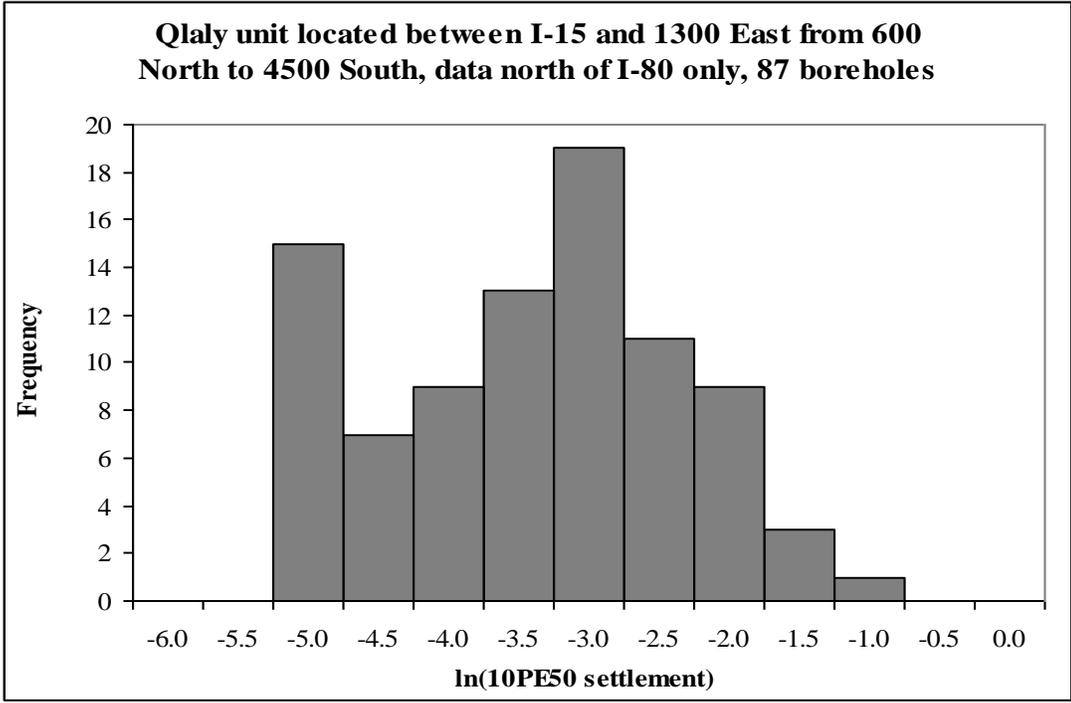
Figure 23.   Histogram showing ground settlement displacement distribution for 10PE50. A "low" ground settlement hazard was assigned to this unit.

Qlaly unit located between I-15 and 1300 East from 600 North to 4500 South, data north of I-80 only, 87 boreholes
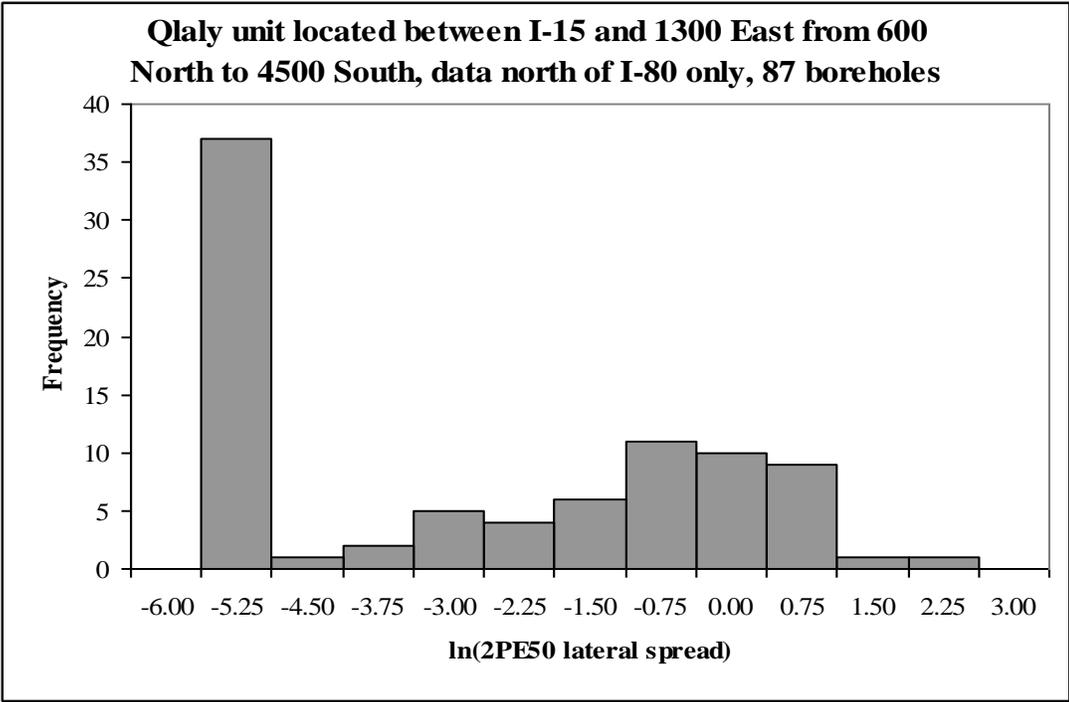
Figure 24.   Histogram showing lateral spread displacement distribution for 2PE50. A "low" lateral spread hazard was assigned to this unit

Qlaly unit located between I-15 and 1300 East from 600 North to 4500 South, data north of I-80 only, 87 boreholes
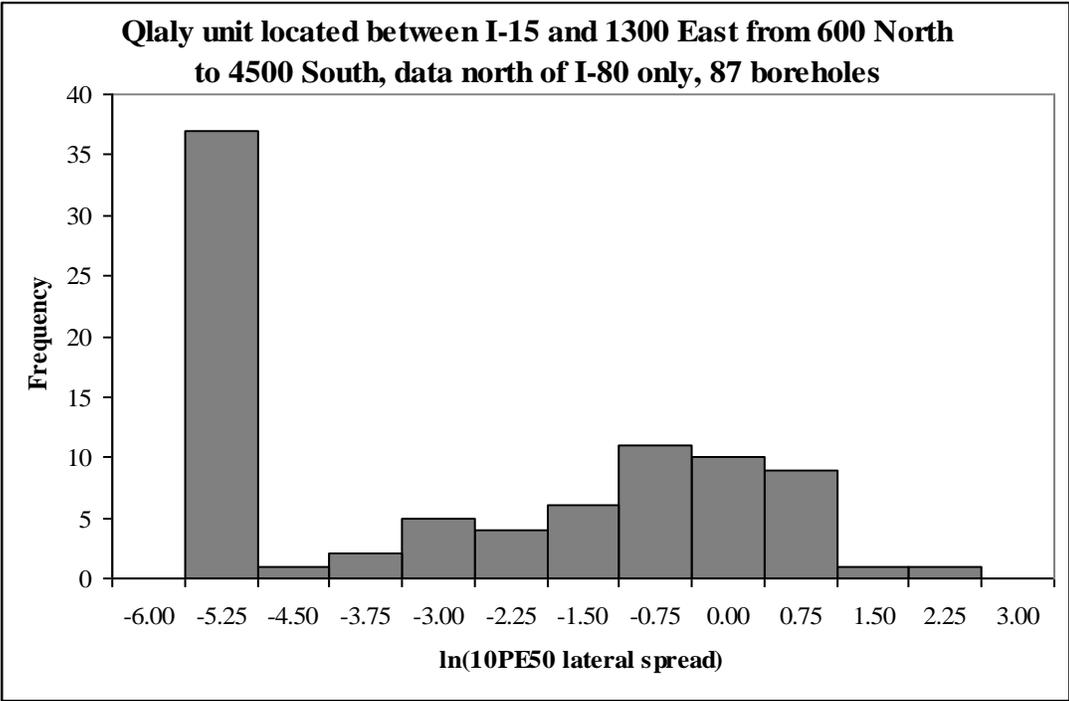
Figure 25.   Histogram showing lateral spread displacement distribution for 10PE50.   A "low" lateral spread hazard was assigned to this unit

Qal2 deposit located alongside Qal1 unit in center of valley, branches to Little and Big Cottonwood Canyons, 111 boreholes
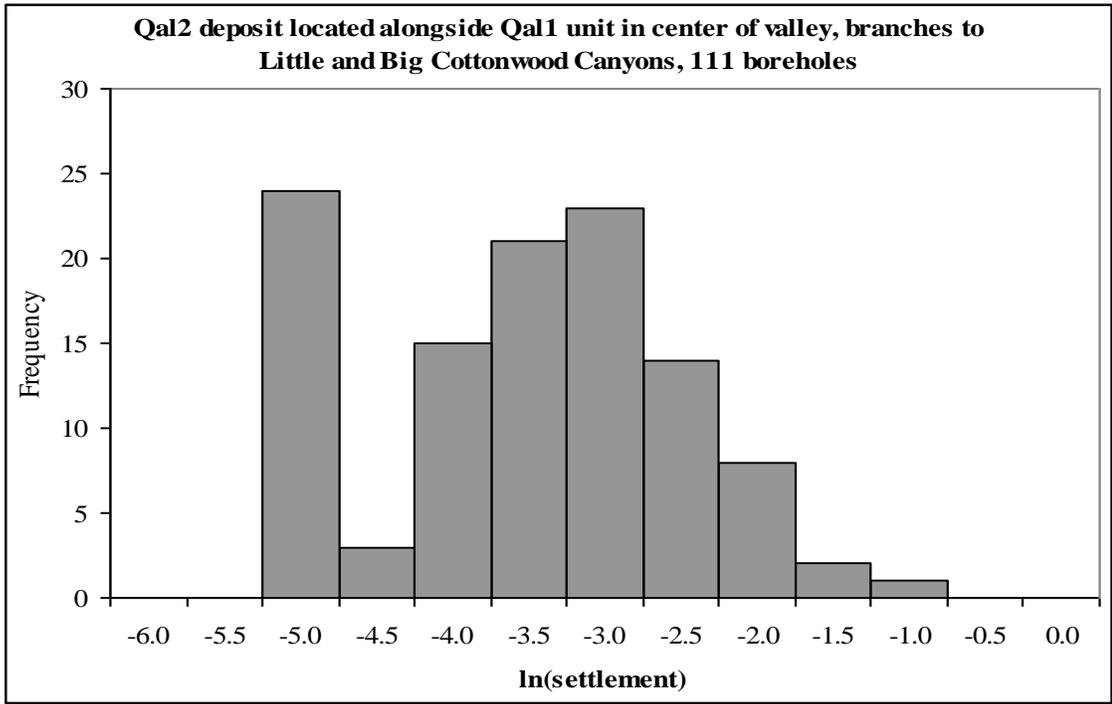
Figure 26.   Histogram showing ground settlement displacement distribution for 10PE50. A "moderate" ground settlement hazard was assigned to this unit.

<u>Summary Tables</u>

A hazard classification summary table for the three lateral spread maps for the 24 geologic groups is shown in Table 7. Table 8 summarizes the hazard classifications for the three ground settlement maps for the 24 geologic groups. To complement Tables 7 and 8, Appendix D contains tables of the estimated displacements in each of the 24 geologic groups. As previously mentioned, all 963 boreholes within the ArcGIS® database are contained within the 24 geologic groups. The tables in Appendix D may be cross-referenced with Table 3 in Appendix A for a description of approximate borehole location and date drilled.

Table 7

A Summary of Liquefaction-Induced Lateral Spread for the Salt Lake Valley

Unit Number	Surficial Geologic Unit/Group Description	Wasatch Fault M7.0 Scenario Event						Probabilistic 2%E-50		Probabilistic 10%E-50	
		% Min.	% Low	% Mod.	% High	% V. High	Hazard Class	Median, m	Hazard Class	Median, m	Hazard Class
1	Qaly and Qly units located in NW part of valley and Draper, 39 boreholes	41.0	25.6	15.4	10.3	7.7	High	0.01	Low	0.01	Low
2	Qaly between I-215 and I-15 from 600 N to 4700 S, 15 boreholes	20.0	26.7	6.7	40.0	6.7	High	0.11	Mod.	0.06	Low
3	Qal1 deposit in center of valley along entire length, branches to Little and Big Cottonwood Canyons, 288 boreholes	35.4	12.8	7.6	12.8	31.3	V. High	0.12	Mod.	0.09	Low
4	Qal2 deposit located alongside Qal1 units in center of valley, branches to Little and Big Cottonwood Canyons, 111 boreholes	45.0	22.5	9.0	13.5	9.9	High	0.01	Low	0.01	Low
5	Qaly unit located between I-15 and 1300 East from 600 North to 4500 South, data north of 180 only, 87 boreholes	41.4	10.3	4.6	11.5	32.2	V. High	0.07	Low	0.07	Low
6	Qaly unit located between I-15 and 1300 East from 600 North to 4600 South, data south of I-80 only, 15 boreholes	60.0	0.0	13.3	20.0	6.7	High	0.00	Min.	0.00	Min.
7	Qbpm unit located between State Street and 2700 East from 3900 South to 4500 South, 24 boreholes	29.2	12.5	25.0	20.8	12.5	High	0.14	Mod.	0.13	Mod.
8	Qbpm unit located between 300 East and 1100 East from 4200 South to 4700 South, 10 boreholes	60.0	20.0	10.0	0.0	10.0	Mod.	0.00	Min.	0.00	Min.
9	Qbpm units located between 900 East and Van Winkle Expressway from 4700 South to 7000 South, 8 boreholes	62.5	25.0	0.0	12.5	0.0	Low	0.00	Min.	0.00	Min.
10	Qbpm units along I-15 between 3900 S and 9000 S, 123 boreholes	82.9	5.7	1.6	5.7	4.1	Low	0.00	Min.	0.00	Min.
11	Qbpm units along I-15 between 9000 S and 12300 S, 27 boreholes	48.1	18.5	11.1	22.2	0.0	High	0.00	Low	0.00	Low
12	Qbpm units near I-15 between 600 N and 2300 N, 3 boreholes	100.0	0.0	0.0	0.0	0.0	Min.	0.00	Min.	0.00	Min.
13	Qbpm units east of 1300 E from S Temple to 5300 S, 7 boreholes	100.0	0.0	0.0	0.0	0.0	Min.	0.00	Min.	0.00	Min.
14	Qbpm units west of I-15 and units south of 12300 S, 67 boreholes	73.1	16.4	3.0	3.0	4.5	Low	0.00	Min.	0.00	Min.
15	Qal2 and Qmlz units/City Creek fan, 10 boreholes	60.0	0.0	0.0	0.0	40.0	V. High	0.00	Min.	0.00	Min.
16	All Qal2 units except City Creek fan, 20 boreholes	85.0	0.0	0.0	0.0	15.0	Min.	0.00	Min.	0.00	Min.
17	All Qalp units in the valley, 10 boreholes	90.0	0.0	0.0	0.0	10.0	Min.	0.00	Min.	0.00	Min.
18	All Qpg units in the valley, 40 boreholes	70.0	2.5	7.5	5.0	15.0	High	0.00	Min.	0.00	Min.
19	All Qfag units in the valley, 12 boreholes	83.3	0.0	0.0	8.3	8.3	High	0.00	Min.	0.00	Min.
20	All Qlbp units in the valley, 3 boreholes	100.0	0.0	0.0	0.0	0.0	Min.	0.00	Min.	0.00	Min.
21	All Qaly units in the valley, 6 boreholes	83.3	16.7	0.0	0.0	0.0	Low	0.00	Min.	0.00	Min.
22	All Qlpd units in the valley, 5 boreholes	80.0	0.0	0.0	0.0	20.0	V. High	0.00	Min.	0.00	Min.
23	All Qlbg units in the valley, 14 boreholes	100.0	0.0	0.0	0.0	0.0	Min.	0.00	Min.	0.00	Min.
24	Various smaller units in foothills, 17 boreholes (Qafb, Qca, QTaf, Qes, Qlbm, Mz, Qafo, Qlbr, Pz and Rock)	100.0	0.0	0.0	0.0	0.0	Min.	0.00	Min.	0.00	Min.

Table 8

A Summary of Liquefaction-Induced Ground Settlement for the Salt Lake Valley

Unit Number	Surficial Geologic Unit/Group Description	Wasatch Fault M7.0 Scenario Event					Probabilistic 2%/50		Probabilistic 10%/50	
		% Low	% Mod.	% High	% V. High	Hazard Class	Median, m	Hazard Class	Median, m	Hazard Class
1	Qaly and Qly units located in NW part of valley and Draper, 39 boreholes	48.7	25.6	25.6	0.0	High	0.05	Mod.	0.04	Low
2	Qaly between I-215 and I-15 from 600 N to 4700 S, 15 boreholes	53.3	20.0	26.7	0.0	High	0.05	Low	0.04	Low
3	Qal1 deposit in center of valley along entire length, branches to Little and Big Cottonwood Canyons, 288 boreholes	49.7	26.4	22.6	1.4	High	0.05	Mod.	0.03	Low
4	Qal2 deposit located alongside Qal1 unit in center of valley, branches to Little and Big Cottonwood Canyons, 111 boreholes	66.7	20.7	11.7	0.9	Mod.	0.03	Low	0.01	Low
5	Qaly unit located between I-15 and 1300 East from 600 North to 4500 South, data north of I-80 only, 87 boreholes	46.0	27.6	24.1	2.3	High	0.05	Mod.	0.04	Low
6	Qaly unit located between I-15 and 1300 East from 600 North to 4500 South, data south of I-80 only, 15 boreholes	80.0	13.3	6.7	0.0	Mod.	0.01	Low	0.01	Low
7	Qbpm unit located between State Street and 2700 East from 3900 South to 4500 South, 24 boreholes	58.3	16.7	25.0	0.0	High	0.04	Low	0.03	Low
8	Qbpm unit located between 500 East and 1100 East from 4300 South to 4700 South, 10 boreholes	90.0	10.0	0.0	0.0	Low	0.02	Low	0.01	Low
9	Qbpm units located between 900 East and Van Winkle Expressway from 4700 South to 7000 South, 8 boreholes	75.0	12.5	12.5	0.0	Mod.	0.01	Low	0.01	Low
10	Qbpm units along I-15 between 3900 S and 9000 S, 123 boreholes	87.8	6.5	5.7	0.0	Low	0.00	Low	0.00	Low
11	Qbpm units along I-15 between 9000 S and 12300 S, 27 boreholes	51.9	14.8	33.3	0.0	High	0.05	Low	0.02	Low
12	Qbpm units near I-15 between 600 N and 2300 N, 3 boreholes	66.7	0.0	33.3	0.0	High	0.02	Low	0.00	Low
13	Qbpm units east of 1300 E from S Temple to 5300 S, 7 boreholes	100.0	0.0	0.0	0.0	Low	0.00	Low	0.00	Low
14	Qbpm units west of I-15 and units south of 12300 S, 67 boreholes	88.6	11.9	0.0	1.5	Low	0.00	Low	0.00	Low
15	Qcf2 and Qmls units City Creek fan, 10 boreholes	60.0	0.0	40.0	0.0	High	0.04	Low	0.00	Low
16	All Qcf2 units except City Creek fan, 20 boreholes	95.0	5.0	0.0	0.0	Low	0.00	Low	0.00	Low
17	All Qafp units in the valley, 10 boreholes	90.0	0.0	10.0	0.0	Low	0.00	Low	0.00	Low
18	All Qafy units in the valley, 40 boreholes	80.0	15.0	5.0	0.0	Mod.	0.01	Low	0.00	Low
19	All Qlbpg units in the valley, 12 boreholes	91.7	0.0	8.3	0.0	Low	0.00	Low	0.00	Low
20	All Qbpg units in the valley, 3 boreholes	100.0	0.0	0.0	0.0	Low	0.00	Low	0.00	Low
21	All Qafy units in the valley, 6 boreholes	100.0	0.0	0.0	0.0	Low	0.01	Low	0.00	Low
22	All Qpd units in the valley, 5 boreholes	80.0	20.0	0.0	0.0	Mod.	0.02	Low	0.00	Low
23	All Qlbg units in the valley, 14 boreholes	92.9	7.1	0.0	0.0	Low	0.00	Low	0.00	Low
24	Various smaller units in foothills, 17 boreholes (Qafb, Qca, QTaf, Qes, Qlbm, Mc, Qaf6, Qlbs, Pz and Rock)	100.0	0.0	0.0	0.0	Low	0.00	Low	0.00	Low

APPENDIX D - Tabulated Ground Displacements

This appendix contains tables of the ground displacement values used in assigning the hazard categories shown in the lateral spread and ground settlement maps. The tables are organized according to the 24 geologic groups that are briefly described in Appendix C. The tables indicate the borehole ID number of each borehole so that the displacement estimates may be cross-referenced with Table 3 in Appendix A for a description of approximate borehole location and date drilled.

Table 9

Qlaly and Qly units located in northwest part of valley and Draper, 39 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
14	0.00	0.00	0.00	0.01	0.01	0.01
18	0.23	0.19	0.18	0.02	0.02	0.01
19	0.00	0.00	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.13	0.13	0.13
28	0.63	0.51	0.50	0.12	0.12	0.12
30	0.00	0.00	0.00	0.01	0.01	0.01
54	0.02	0.07	0.07	0.07	0.07	0.06
58	0.00	0.00	0.00	0.04	0.04	0.04
61	0.45	0.44	0.43	0.24	0.25	0.22
62	0.00	0.00	0.00	0.18	0.19	0.17
64	0.00	0.00	0.00	0.01	0.02	0.01
69	4.94	4.91	4.88	0.06	0.07	0.05
77	2.04	1.78	1.76	0.18	0.19	0.17
78	0.00	0.00	0.00	0.01	0.02	0.01
93	0.03	0.02	0.02	0.07	0.08	0.05
102	0.00	0.00	0.00	0.01	0.01	0.01
105	0.00	0.00	0.00	0.03	0.03	0.01
106	0.00	0.00	0.00	0.05	0.07	0.02
107	0.06	0.05	0.05	0.04	0.04	0.04
108	0.01	0.01	0.01	0.15	0.16	0.13
109	0.00	0.00	0.00	0.10	0.12	0.08
110	0.13	0.84	0.83	0.08	0.09	0.07
111	0.23	2.60	2.58	0.08	0.09	0.08
112	0.21	0.19	0.19	0.01	0.01	0.01
113	0.00	0.00	0.00	0.11	0.13	0.06
709	0.18	0.14	0.14	0.10	0.10	0.09
710	0.00	0.00	0.00	0.00	0.00	0.00
711	0.85	0.71	0.71	0.03	0.03	0.03
721	0.02	0.15	0.15	0.05	0.05	0.05
722	0.02	0.02	0.02	0.01	0.01	0.01
723	0.10	0.09	0.09	0.02	0.02	0.02
724	0.49	0.43	0.43	0.07	0.07	0.07
735	0.00	0.00	0.00	0.00	0.00	0.00
738	0.00	0.00	0.00	0.02	0.03	0.01
745	0.18	0.15	0.14	0.06	0.06	0.05
748	0.00	0.00	0.00	0.00	0.00	0.00

Table 10

Qaly units between I-215 and I-15 from 600 North to 4700 South, 15 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
13	1.01	0.77	0.76	0.08	0.08	0.07
17	0.00	0.00	0.00	0.00	0.00	0.00
21	0.04	0.04	0.00	0.02	0.02	0.01
25	0.00	0.00	0.00	0.01	0.01	0.00
26	0.00	0.00	0.00	0.00	0.00	0.00
65	0.28	0.17	0.17	0.20	0.21	0.19
67	0.35	0.31	0.31	0.20	0.22	0.14
82	0.38	0.30	0.30	0.03	0.03	0.03
91	0.34	0.27	0.26	0.16	0.17	0.15
104	0.08	0.06	0.06	0.05	0.06	0.04
681	0.61	0.51	0.00	0.04	0.04	0.02
682	0.03	0.03	0.03	0.08	0.08	0.05
726	0.05	0.06	0.05	0.03	0.03	0.02
740	0.79	0.56	0.56	0.05	0.05	0.04
746	0.37	0.11	0.11	0.14	0.14	0.13

Table 11

Qal1 deposit in center of valley along entire length, branches to Little and Big
Cottonwood Canyons, 288 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
12	3.06	2.54	2.53	0.16	0.16	0.16
66	0.00	0.00	0.00	0.03	0.04	0.02
68	0.78	0.71	0.71	0.15	0.17	0.13
75	0.00	0.00	0.00	0.03	0.04	0.02
79	0.00	0.00	0.00	0.03	0.04	0.01
92	0.00	0.00	0.00	0.02	0.02	0.02
94	1.71	1.39	1.38	0.15	0.16	0.11
99	0.24	0.21	0.21	0.08	0.10	0.05
134	0.00	0.00	0.00	0.08	0.10	0.02
135	0.01	0.00	0.00	0.11	0.12	0.09
136	0.02	0.02	0.02	0.05	0.06	0.04
137	0.96	0.75	0.74	0.06	0.06	0.04
138	0.00	0.00	0.00	0.03	0.03	0.02
139	0.00	0.00	0.00	0.05	0.07	0.01
140	0.01	0.01	0.01	0.16	0.17	0.11
141	0.00	0.00	0.00	0.03	0.03	0.00
142	0.00	0.00	0.00	0.01	0.01	0.00
143	0.01	0.00	0.00	0.03	0.03	0.02
144	4.33	3.75	3.73	0.03	0.03	0.03
145	0.01	0.00	0.00	0.03	0.03	0.03
146	0.00	0.00	0.00	0.00	0.00	0.00
147	0.00	0.00	0.00	0.00	0.00	0.00
148	0.00	0.00	0.00	0.06	0.06	0.05
149	0.00	0.00	0.00	0.06	0.06	0.05
150	0.00	0.00	0.00	0.00	0.00	0.00
151	0.03	0.02	0.02	0.05	0.05	0.04
152	0.20	0.15	0.15	0.11	0.11	0.09
153	0.20	0.14	0.14	0.16	0.16	0.13
154	0.00	0.00	0.00	0.04	0.04	0.01
172	0.13	0.11	0.11	0.13	0.13	0.12
173	0.00	0.00	0.00	0.03	0.03	0.00
174	0.00	0.00	0.00	0.05	0.05	0.03
178	0.00	0.00	0.00	0.11	0.11	0.11
179	0.00	0.00	0.00	0.02	0.02	0.02
180	0.00	0.00	0.00	0.02	0.02	0.01
181	0.27	0.24	0.24	0.10	0.10	0.06
182	0.05	0.04	0.04	0.11	0.12	0.08
183	0.00	0.00	0.00	0.10	0.12	0.03
184	0.11	0.10	0.10	0.06	0.06	0.04
185	0.00	0.00	0.00	0.00	0.00	0.00
186	0.00	0.00	0.00	0.06	0.07	0.04
187	0.41	0.38	0.38	0.06	0.07	0.03
188	0.00	0.00	0.00	0.01	0.01	0.00
189	0.00	0.00	0.00	0.04	0.04	0.02
190	0.00	0.00	0.00	0.00	0.00	0.00
191	0.29	0.22	0.22	0.06	0.06	0.03

Table 11 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
192	0.00	0.00	0.00	0.10	0.11	0.03
193	0.00	0.00	0.00	0.01	0.02	0.00
194	0.00	0.00	0.00	0.06	0.07	0.01
195	5.24	4.44	4.40	0.17	0.17	0.14
196	0.14	0.13	0.13	0.14	0.14	0.11
197	0.27	0.25	0.24	0.18	0.19	0.16
198	1.42	1.33	1.32	0.19	0.19	0.17
199	0.14	0.13	0.13	0.09	0.09	0.07
200	0.00	0.00	0.00	0.01	0.01	0.00
201	0.00	0.00	0.00	0.00	0.00	0.00
202	0.00	0.00	0.00	0.01	0.02	0.00
203	2.14	1.91	1.89	0.06	0.06	0.05
204	0.06	0.05	0.05	0.07	0.08	0.06
205	0.14	0.13	0.13	0.04	0.04	0.04
206	0.00	0.00	0.00	0.02	0.03	0.00
207	0.01	0.01	0.01	0.07	0.08	0.03
208	0.00	0.00	0.00	0.02	0.02	0.00
209	0.00	0.00	0.00	0.08	0.09	0.07
210	0.26	0.25	0.24	0.05	0.06	0.03
211	0.09	0.08	0.08	0.13	0.14	0.07
212	1.13	1.02	1.01	0.07	0.08	0.03
213	0.64	0.59	0.59	0.08	0.08	0.07
214	0.00	0.00	0.00	0.00	0.00	0.00
215	0.00	0.00	0.00	0.00	0.00	0.00
216	0.00	0.00	0.00	0.00	0.00	0.00
217	0.00	0.00	0.00	0.03	0.03	0.02
218	0.97	0.92	0.91	0.05	0.05	0.05
219	0.00	0.00	0.00	0.00	0.00	0.00
220	0.00	0.00	0.00	0.03	0.03	0.01
222	0.07	0.06	0.06	0.10	0.10	0.07
223	0.00	0.00	0.00	0.00	0.00	0.00
224	0.00	0.00	0.00	0.01	0.02	0.01
225	0.43	0.39	0.38	0.16	0.16	0.12
226	0.02	0.02	0.02	0.17	0.17	0.15
227	1.07	1.00	0.99	0.13	0.15	0.07
228	0.00	0.00	0.00	0.00	0.00	0.00
229	0.13	0.12	0.12	0.08	0.09	0.06
230	1.78	1.69	1.68	0.17	0.17	0.13
231	0.91	0.86	0.85	0.10	0.11	0.07
232	1.03	1.01	1.00	0.11	0.12	0.10
233	1.33	1.25	1.24	0.04	0.04	0.04
234	0.03	0.03	0.03	0.10	0.10	0.08
235	0.24	0.21	0.21	0.08	0.10	0.04
236	1.51	1.39	1.38	0.08	0.08	0.07
237	0.00	0.00	0.00	0.00	0.00	0.00
239	0.00	0.00	0.00	0.01	0.02	0.00
240	1.37	1.17	1.16	0.11	0.11	0.10
277	0.08	0.07	0.07	0.04	0.05	0.04
279	1.11	0.90	0.89	0.02	0.02	0.01
280	0.28	0.23	0.22	0.03	0.03	0.01

Table 11 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
281	2.48	2.13	2.11	0.09	0.10	0.05
282	1.89	1.59	1.57	0.12	0.12	0.11
283	1.37	1.14	1.12	0.07	0.07	0.06
284	0.29	0.24	0.24	0.31	0.32	0.25
285	0.03	0.03	0.03	0.03	0.03	0.02
286	0.04	0.04	0.04	0.03	0.04	0.01
287	0.00	0.00	0.00	0.00	0.00	0.00
289	3.32	2.90	2.86	0.20	0.20	0.19
290	0.91	0.77	0.76	0.18	0.20	0.13
291	1.30	1.07	1.06	0.19	0.21	0.13
293	1.08	0.87	0.86	0.04	0.04	0.04
295	2.46	2.14	2.12	0.06	0.07	0.05
296	0.33	0.28	0.28	0.06	0.06	0.02
297	1.34	1.16	1.15	0.03	0.03	0.03
298	0.00	0.00	0.00	0.02	0.03	0.00
299	0.69	0.58	0.57	0.05	0.05	0.04
300	1.12	0.94	0.93	0.04	0.04	0.04
301	1.28	1.05	1.04	0.04	0.04	0.04
303	2.90	2.35	2.33	0.07	0.07	0.07
306	1.07	0.84	0.83	0.03	0.03	0.01
307	0.06	0.06	0.06	0.02	0.02	0.01
330	0.00	0.00	0.00	0.00	0.00	0.00
367	0.00	0.00	0.00	0.05	0.05	0.00
368	2.23	1.87	1.84	0.03	0.03	0.02
369	0.00	0.00	0.00	0.00	0.00	0.00
372	0.00	0.00	0.00	0.03	0.03	0.01
373	0.00	0.00	0.00	0.04	0.03	0.00
374	0.52	0.43	0.00	0.09	0.09	0.01
375	0.00	0.00	0.00	0.02	0.02	0.00
376	0.00	0.00	0.00	0.00	0.00	0.00
384	0.00	0.00	0.00	0.00	0.00	0.00
385	0.00	0.00	0.00	0.02	0.02	0.00
386	0.00	0.00	0.00	0.00	0.00	0.00
387	0.00	0.00	0.00	0.00	0.00	0.00
388	0.61	0.52	0.51	0.10	0.10	0.01
429	1.13	0.97	0.00	0.09	0.09	0.07
430	0.00	0.00	0.00	0.02	0.01	0.00
431	0.00	0.00	0.00	0.07	0.07	0.02
432	0.92	0.78	0.77	0.06	0.06	0.03
433	0.00	0.00	0.00	0.02	0.01	0.00
434	0.00	0.00	0.00	0.01	0.01	0.00
435	0.00	0.00	0.00	0.06	0.06	0.03
436	0.00	0.00	0.00	0.00	0.00	0.00
439	0.00	0.00	0.00	0.02	0.02	0.00
448	0.00	0.00	0.00	0.02	0.02	0.00
459	3.55	2.37	2.36	0.08	0.08	0.05
460	1.13	0.76	0.76	0.03	0.04	0.01
465	0.00	0.00	0.00	0.00	0.00	0.00
466	1.71	1.39	1.38	0.17	0.19	0.16
467	0.50	0.39	0.39	0.04	0.04	0.03

Table 11 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
474	2.69	2.04	2.03	0.15	0.15	0.13
478	2.12	1.79	1.78	0.14	0.15	0.13
479	2.96	1.80	1.79	0.28	0.28	0.26
480	3.23	2.19	2.18	0.11	0.11	0.08
481	0.00	0.00	0.00	0.10	0.10	0.05
482	1.19	0.75	0.75	0.04	0.04	0.02
485	3.50	2.49	2.48	0.11	0.11	0.09
486	1.70	1.18	1.17	0.23	0.24	0.19
487	2.30	1.88	1.87	0.04	0.04	0.04
488	0.09	0.07	0.07	0.13	0.13	0.08
489	0.73	0.57	0.57	0.06	0.06	0.06
490	2.46	1.89	1.89	0.18	0.18	0.09
494	3.35	2.27	2.26	0.19	0.20	0.17
495	7.29	4.77	4.74	0.08	0.08	0.08
496	1.49	1.20	1.19	0.04	0.04	0.04
497	0.00	0.00	0.00	0.03	0.03	0.02
498	3.11	2.09	0.09	0.21	0.23	0.13
499	2.99	1.90	1.89	0.17	0.18	0.13
500	0.00	0.00	0.00	0.14	0.14	0.08
501	1.18	0.96	0.96	0.13	0.14	0.11
502	4.05	3.10	3.08	0.13	0.13	0.12
503	3.24	2.47	2.45	0.24	0.24	0.23
504	0.64	0.49	0.49	0.08	0.09	0.05
505	2.91	2.26	2.25	0.05	0.06	0.03
514	0.56	0.42	0.42	0.06	0.08	0.02
515	0.00	0.00	0.00	0.00	0.00	0.00
516	1.58	1.14	1.14	0.05	0.06	0.04
517	2.48	1.82	1.81	0.07	0.07	0.07
518	0.00	0.00	0.00	0.13	0.14	0.08
519	0.00	0.00	0.00	0.00	0.01	0.00
520	0.00	0.00	0.00	0.10	0.11	0.08
521	1.03	0.79	0.79	0.03	0.04	0.01
522	0.00	0.00	0.00	0.02	0.03	0.00
523	1.73	1.18	1.17	0.12	0.15	0.04
524	1.55	1.22	0.00	0.02	0.03	0.00
525	1.92	1.49	1.48	0.07	0.08	0.06
526	2.14	1.70	1.69	0.26	0.26	0.25
527	1.52	1.21	1.20	0.03	0.04	0.01
528	1.07	0.83	0.83	0.06	0.07	0.04
529	0.00	0.00	0.00	0.03	0.04	0.01
530	1.44	1.18	1.18	0.04	0.04	0.03
534	0.00	0.00	0.00	0.00	0.00	0.00
535	0.00	0.00	0.00	0.01	0.01	0.00
536	0.00	0.00	0.00	0.00	0.00	0.00
537	0.00	0.00	0.00	0.03	0.03	0.02
540	0.00	0.00	0.00	0.00	0.00	0.00
541	1.24	0.91	0.91	0.04	0.04	0.02
542	0.06	0.04	0.04	0.03	0.04	0.02
543	0.00	0.00	0.00	0.00	0.00	0.00
544	0.00	0.00	0.00	0.00	0.00	0.00

Table 11 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
545	0.00	0.00	0.00	0.00	0.00	0.00
546	0.03	0.03	0.03	0.01	0.01	0.01
547	0.00	0.00	0.00	0.00	0.00	0.00
548	0.09	0.07	0.07	0.01	0.01	0.01
549	0.00	0.00	0.00	0.00	0.00	0.00
550	0.00	0.00	0.00	0.00	0.00	0.00
551	4.35	2.88	2.86	0.12	0.12	0.11
552	0.85	0.67	0.67	0.01	0.01	0.00
555	2.93	2.40	2.39	0.02	0.02	0.01
556	1.97	1.58	1.57	0.03	0.03	0.02
557	1.48	1.16	1.15	0.04	0.04	0.04
558	0.00	0.00	0.00	0.00	0.00	0.00
559	1.54	1.30	1.29	0.05	0.05	0.04
560	0.43	0.32	0.32	0.01	0.01	0.00
561	0.00	0.00	0.00	0.02	0.02	0.00
562	0.10	0.09	0.00	0.03	0.04	0.01
563	5.15	4.34	4.29	0.13	0.13	0.12
564	1.35	1.13	1.11	0.04	0.04	0.04
565	0.52	0.49	0.49	0.18	0.18	0.16
566	0.46	0.43	0.42	0.19	0.20	0.16
567	0.41	0.38	0.37	0.11	0.12	0.09
568	0.00	0.00	0.00	0.07	0.07	0.07
570	0.00	0.00	0.00	0.04	0.04	0.03
571	0.01	0.01	0.01	0.03	0.03	0.03
572	0.47	0.41	0.40	0.05	0.08	0.02
573	2.74	2.33	2.31	0.31	0.31	0.25
574	0.00	0.00	0.00	0.18	0.19	0.15
575	0.61	0.53	0.53	0.06	0.06	0.04
576	0.00	0.00	0.00	0.18	0.19	0.12
577	0.07	0.07	0.07	0.09	0.11	0.05
578	0.70	0.63	0.62	0.11	0.12	0.07
579	1.22	1.04	1.03	0.32	0.34	0.27
580	0.00	0.00	0.00	0.00	0.01	0.00
581	0.16	0.13	0.13	0.05	0.05	0.04
582	2.05	1.72	1.70	0.05	0.05	0.05
630	0.03	0.03	0.03	0.50	0.52	0.48
631	1.60	1.33	1.32	0.07	0.07	0.02
632	1.51	1.28	1.27	0.17	0.17	0.16
633	0.55	0.46	0.46	0.13	0.13	0.09
634	1.10	0.91	0.91	0.11	0.12	0.10
635	1.08	0.91	0.90	0.11	0.11	0.07
636	2.24	1.88	1.86	0.13	0.13	0.11
665	0.66	0.55	0.54	0.04	0.04	0.03
666	0.38	0.31	0.30	0.05	0.06	0.02
667	0.67	0.55	0.55	0.07	0.07	0.03
679	1.17	0.98	0.97	0.06	0.07	0.03
730	0.06	0.05	0.05	0.02	0.03	0.01
731	0.44	0.37	0.37	0.02	0.02	0.02
737	0.05	0.03	0.03	0.02	0.02	0.02
744	0.74	0.70	0.69	0.09	0.09	0.08

Table 11 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Ishihara and Yoshimine (1992)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
747	0.59	0.44	0.44	0.08	0.08	0.04
749	0.00	0.00	0.00	0.00	0.00	0.00
1008	0.00	0.00	0.00	0.02	0.01	0.00
1021	0.98	0.82	0.81	0.06	0.06	0.04
1025	0.00	0.00	0.00	0.05	0.05	0.02
1027	1.94	1.76	1.75	0.02	0.02	0.02
1029	0.37	0.35	0.34	0.09	0.09	0.08
1034	2.59	1.78	1.78	0.02	0.02	0.02
1039	2.99	2.66	2.64	0.06	0.06	0.05
1042	0.24	0.13	0.13	0.07	0.07	0.05
1043	4.93	4.40	4.38	0.20	0.21	0.17
1047	0.50	0.44	0.43	0.05	0.05	0.04
1054	0.10	0.08	0.08	0.10	0.11	0.06
1055	1.12	1.00	0.99	0.06	0.07	0.05
1057	0.00	0.00	0.00	0.00	0.01	0.00
1058	7.60	4.58	4.57	0.15	0.16	0.11
1068	1.55	1.23	1.22	0.13	0.14	0.10
1079	0.00	0.00	0.00	0.00	0.00	0.00
1080	2.33	1.90	1.89	0.06	0.06	0.06
1083	0.00	0.00	0.00	0.00	0.00	0.00
1106	0.17	0.12	0.12	0.09	0.09	0.06
1107	0.00	0.00	0.00	0.01	0.02	0.01
1117	0.00	0.00	0.00	0.00	0.00	0.00
1123	2.00	1.41	1.40	0.07	0.07	0.05
1130	2.04	1.46	1.45	0.02	0.02	0.02
1134	0.00	0.00	0.00	0.00	0.00	0.00
1136	1.01	0.81	0.80	0.06	0.06	0.04
1139	0.00	0.00	0.00	0.02	0.02	0.00
1140	0.00	0.00	0.00	0.00	0.00	0.00
1143	1.00	0.85	0.85	0.07	0.07	0.03
1144	0.00	0.00	0.00	0.01	0.02	0.00
1146	0.00	0.00	0.00	0.01	0.01	0.00
1148	0.16	0.11	0.11	0.02	0.02	0.01
1159	0.00	0.00	0.00	0.00	0.00	0.00
1160	0.03	0.03	0.03	0.07	0.07	0.03
1166	0.00	0.00	0.00	0.04	0.04	0.00
1236	0.87	0.76	0.75	0.01	0.02	0.00
1245	1.12	1.17	1.16	0.09	0.09	0.08
1274	0.00	0.00	0.00	0.07	0.06	0.01
1276	7.94	7.44	7.42	0.21	0.21	0.12
1298	0.00	0.00	0.00	0.00	0.00	0.00
1299	1.29	1.19	1.18	0.07	0.07	0.07

Table 12

Qal2 deposit located alongside Qal1 unit in center of valley, branches to Little and
Big Cottonwood Canyons, 111 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
4	0.95	0.78	0.77	0.08	0.08	0.05
11	0.00	0.00	0.00	0.02	0.02	0.00
36	2.01	1.56	1.54	0.23	0.23	0.21
48	0.02	0.02	0.02	0.04	0.04	0.02
96	0.00	0.00	0.00	0.00	0.01	0.00
304	0.00	0.00	0.00	0.00	0.00	0.00
305	0.68	0.53	0.52	0.07	0.07	0.07
308	0.20	0.15	0.15	0.05	0.05	0.04
347	0.00	0.00	0.00	0.04	0.04	0.02
348	0.00	0.00	0.00	0.00	0.00	0.00
349	0.00	0.00	0.00	0.00	0.00	0.00
350	0.32	0.26	0.26	0.03	0.03	0.03
351	0.00	0.00	0.00	0.00	0.00	0.00
352	0.19	0.14	0.14	0.07	0.07	0.06
353	0.00	0.00	0.00	0.00	0.00	0.00
371	0.00	0.00	0.00	0.00	0.00	0.00
379	0.00	0.00	0.00	0.01	0.01	0.00
380	0.00	0.00	0.00	0.05	0.04	0.01
624	1.27	0.96	0.95	0.09	0.10	0.06
625	0.00	0.00	0.00	0.03	0.04	0.00
626	0.00	0.00	0.00	0.05	0.05	0.04
627	0.00	0.00	0.00	0.12	0.13	0.07
628	0.00	0.00	0.00	0.09	0.11	0.05
629	0.01	0.01	0.00	0.04	0.04	0.02
638	1.68	1.34	1.33	0.11	0.13	0.05
639	0.46	0.35	0.35	0.04	0.04	0.04
640	0.00	0.00	0.00	0.09	0.09	0.01
641	0.00	0.00	0.00	0.02	0.02	0.01
642	1.12	0.92	0.91	0.16	0.16	0.14
643	0.00	0.00	0.00	0.00	0.00	0.00
644	0.00	0.00	0.00	0.00	0.00	0.00
645	0.16	0.12	0.12	0.03	0.03	0.02
646	0.29	0.22	0.22	0.03	0.03	0.02
647	0.35	0.29	0.28	0.07	0.07	0.07
648	1.32	1.07	1.06	0.13	0.13	0.12
649	0.87	0.69	0.68	0.03	0.04	0.03
650	0.07	0.04	0.04	0.05	0.05	0.02
651	0.87	0.63	0.63	0.07	0.07	0.06
652	0.02	0.02	0.02	0.11	0.11	0.07
654	0.04	0.03	0.03	0.13	0.15	0.05
655	0.00	0.00	0.00	0.01	0.02	0.00
656	1.92	1.54	1.52	0.06	0.07	0.05
657	0.00	0.00	0.00	0.01	0.01	0.00
658	0.75	0.62	0.62	0.11	0.11	0.09
659	0.24	0.19	0.19	0.06	0.07	0.02
660	0.05	0.03	0.03	0.05	0.06	0.03

Table 12 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
661	0.05	0.04	0.04	0.16	0.17	0.14
662	0.00	0.00	0.00	0.00	0.00	0.00
663	0.21	0.17	0.17	0.11	0.12	0.08
668	0.00	0.00	0.00	0.03	0.03	0.03
669	0.00	0.00	0.00	0.02	0.02	0.00
670	0.00	0.00	0.00	0.00	0.00	0.00
671	0.87	0.72	0.71	0.27	0.28	0.15
672	1.86	1.51	1.49	0.05	0.05	0.05
673	0.03	0.02	0.02	0.04	0.04	0.03
674	0.03	0.02	0.02	0.06	0.09	0.01
675	0.00	0.00	0.00	0.01	0.01	0.00
676	0.00	0.00	0.00	0.00	0.00	0.00
677	0.50	0.39	0.38	0.03	0.03	0.03
678	0.00	0.00	0.00	0.02	0.03	0.01
680	0.00	0.00	0.00	0.00	0.00	0.00
685	0.01	0.01	0.01	0.37	0.37	0.35
1001	0.05	0.04	0.04	0.01	0.01	0.01
1011	0.01	0.00	0.00	0.07	0.08	0.04
1013	1.80	1.54	1.53	0.02	0.02	0.02
1016	0.16	0.10	0.10	0.07	0.08	0.02
1020	0.02	0.02	0.02	0.08	0.09	0.06
1026	0.00	0.00	0.00	0.00	0.00	0.00
1030	0.01	0.01	0.01	0.03	0.03	0.01
1031	0.00	0.00	0.00	0.03	0.03	0.01
1035	0.00	0.00	0.00	0.00	0.00	0.00
1045	0.29	0.13	0.12	0.05	0.05	0.05
1050	0.00	0.00	0.00	0.01	0.01	0.00
1060	2.00	1.49	1.48	0.05	0.05	0.04
1066	1.60	1.19	1.18	0.02	0.02	0.02
1070	0.00	0.00	0.00	0.00	0.00	0.00
1071	0.19	0.11	0.11	0.06	0.06	0.05
1075	0.00	0.00	0.00	0.00	0.00	0.00
1077	0.00	0.00	0.00	0.01	0.01	0.00
1084	0.09	0.06	0.06	0.09	0.09	0.09
1088	0.00	0.00	0.00	0.02	0.02	0.00
1091	0.24	0.13	0.13	0.06	0.06	0.06
1093	0.04	0.03	0.03	0.05	0.06	0.02
1094	0.01	0.01	0.01	0.04	0.04	0.03
1095	0.00	0.00	0.00	0.02	0.02	0.00
1102	0.00	0.00	0.00	0.02	0.03	0.00
1110	0.05	0.04	0.04	0.03	0.03	0.01
1111	1.02	0.87	0.87	0.03	0.03	0.01
1112	0.00	0.00	0.00	0.00	0.00	0.00
1115	0.04	0.03	0.00	0.02	0.02	0.00
1118	0.03	0.02	0.02	0.15	0.15	0.14
1121	0.02	0.02	0.02	0.05	0.06	0.02
1122	0.00	0.00	0.00	0.00	0.01	0.00
1124	0.57	0.51	0.50	0.01	0.01	0.01
1125	0.39	0.34	0.33	0.01	0.01	0.00
1128	0.03	0.03	0.03	0.09	0.09	0.02

Table 12 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1138	0.00	0.00	0.00	0.00	0.00	0.00
1141	0.06	0.04	0.04	0.06	0.06	0.06
1147	0.02	0.01	0.01	0.04	0.04	0.03
1149	0.00	0.00	0.00	0.00	0.00	0.00
1152	0.00	0.00	0.00	0.00	0.00	0.00
1153	0.53	0.44	0.00	0.01	0.02	0.00
1155	0.00	0.00	0.00	0.03	0.04	0.01
1158	0.53	0.48	0.48	0.17	0.17	0.14
1169	0.00	0.00	0.00	0.01	0.01	0.00
1189	0.00	0.00	0.00	0.00	0.00	0.00
1190	0.00	0.00	0.00	0.00	0.00	0.00
1191	0.00	0.00	0.00	0.00	0.00	0.00
1192	0.00	0.00	0.00	0.00	0.00	0.00
1238	0.63	0.50	0.50	0.03	0.03	0.01
1239	0.00	0.00	0.00	0.00	0.00	0.00

Table 13

Qlaly unit located between I-15 and 1300 East from 600 North to 4500 South, data
north of I-80 only, 87 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
16	0.19	0.13	0.13	0.12	0.12	0.07
29	2.93	1.92	1.92	0.13	0.14	0.07
55	0.09	0.08	0.08	0.05	0.05	0.05
63	3.88	3.36	3.35	0.42	0.42	0.41
80	0.00	0.00	0.00	0.06	0.06	0.05
175	0.00	0.00	0.00	0.01	0.02	0.00
176	0.00	0.00	0.00	0.01	0.02	0.00
177	0.00	0.00	0.00	0.01	0.02	0.00
221	0.44	0.37	0.37	0.08	0.08	0.06
238	0.02	0.01	0.01	0.02	0.02	0.02
241	0.00	0.00	0.00	0.05	0.05	0.03
461	1.44	1.09	1.09	0.03	0.03	0.03
462	0.52	0.40	0.39	0.10	0.10	0.08
463	5.61	4.07	4.05	0.23	0.23	0.23
464	1.25	0.87	0.86	0.26	0.27	0.21
468	1.26	0.96	0.96	0.12	0.12	0.09
470	0.00	0.00	0.00	0.00	0.00	0.00
471	0.00	0.00	0.00	0.00	0.00	0.00
472	1.23	0.89	0.88	0.20	0.20	0.17
473	0.00	0.00	0.00	0.06	0.06	0.03
475	3.73	2.89	2.88	0.06	0.06	0.05
476	0.06	0.04	0.04	0.11	0.11	0.10
477	3.39	2.39	2.39	0.08	0.08	0.05
483	1.37	0.82	0.81	0.07	0.07	0.07
484	0.00	0.00	0.00	0.01	0.01	0.00
491	0.76	0.55	0.55	0.06	0.06	0.04
492	0.09	0.06	0.06	0.28	0.28	0.27
493	1.33	0.87	0.87	0.17	0.17	0.16
506	1.15	0.86	0.86	0.17	0.17	0.16
507	0.00	0.00	0.00	0.08	0.08	0.07
508	0.13	0.10	0.10	0.02	0.02	0.02
509	10.13	7.45	7.41	0.33	0.33	0.29
510	0.00	0.00	0.00	0.00	0.00	0.00
511	3.94	3.04	3.02	0.06	0.06	0.05
512	3.82	2.90	2.88	0.05	0.05	0.05
513	4.10	3.09	3.08	0.15	0.16	0.12
531	0.05	0.03	0.03	0.05	0.06	0.03
532	19.39	13.74	13.69	0.18	0.18	0.15
533	4.62	3.51	3.50	0.06	0.06	0.04
538	0.00	0.00	0.00	0.00	0.00	0.00
539	0.07	0.05	0.05	0.04	0.04	0.03
553	2.30	1.93	1.92	0.04	0.04	0.02
554	0.31	0.23	0.23	0.08	0.08	0.08
585	0.00	0.00	0.00	0.03	0.03	0.01
586	0.00	0.00	0.00	0.09	0.09	0.08
587	0.00	0.00	0.00	0.05	0.05	0.01

Table 13 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
588	4.21	3.63	3.61	0.15	0.15	0.14
589	0.00	0.00	0.00	0.00	0.00	0.00
590	1.44	1.28	1.28	0.06	0.06	0.05
591	0.00	0.00	0.00	0.00	0.00	0.00
592	0.92	0.85	0.85	0.06	0.06	0.06
593	0.00	0.00	0.00	0.00	0.00	0.00
594	0.00	0.00	0.00	0.00	0.00	0.00
595	0.11	0.10	0.10	0.13	0.13	0.13
596	0.49	0.46	0.45	0.15	0.16	0.07
597	0.00	0.00	0.00	0.15	0.16	0.09
598	0.08	0.07	0.07	0.08	0.09	0.07
599	0.00	0.00	0.00	0.21	0.21	0.17
600	0.34	0.30	0.30	0.07	0.07	0.06
601	1.43	1.28	1.27	0.02	0.02	0.02
602	0.00	0.00	0.00	0.16	0.17	0.13
603	0.00	0.00	0.00	0.05	0.05	0.05
604	0.00	0.00	0.00	0.03	0.04	0.01
605	0.02	0.01	0.01	0.10	0.12	0.08
606	1.34	1.11	1.10	0.14	0.15	0.12
607	0.00	0.00	0.00	0.05	0.06	0.03
608	0.00	0.00	0.00	0.04	0.06	0.01
609	0.00	0.00	0.00	0.05	0.05	0.04
610	0.00	0.00	0.00	0.05	0.05	0.04
611	0.00	0.00	0.00	0.00	0.00	0.00
612	0.00	0.00	0.00	0.01	0.01	0.00
613	0.80	0.70	0.70	0.02	0.02	0.01
614	0.21	0.19	0.19	0.01	0.01	0.01
615	0.00	0.00	0.00	0.00	0.00	0.00
616	0.00	0.00	0.00	0.00	0.00	0.00
617	0.00	0.00	0.00	0.00	0.00	0.00
618	1.21	1.03	1.03	0.03	0.03	0.03
619	0.00	0.00	0.00	0.01	0.01	0.00
620	1.01	0.96	0.96	0.04	0.04	0.02
621	1.95	1.67	1.66	0.03	0.03	0.03
622	0.00	0.00	0.00	0.01	0.01	0.00
623	1.42	1.17	1.17	0.02	0.02	0.02
689	1.10	1.00	1.00	0.14	0.15	0.11
691	0.44	0.42	0.42	0.03	0.04	0.02
692	0.00	0.00	0.00	0.00	0.00	0.00
707	0.00	0.00	0.00	0.00	0.00	0.00
739	0.77	0.63	0.63	0.05	0.05	0.05

Table 14

Qlaly unit located between I-15 and 1300 East from 600 North to 4500 South, data
south of I-80 only, 15 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
8	0.00	0.00	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00	0.00	0.00
87	0.00	0.00	0.00	0.00	0.00	0.00
95	0.35	0.25	0.24	0.06	0.06	0.06
702	1.16	0.96	0.96	0.07	0.07	0.05
734	0.37	0.33	0.33	0.03	0.03	0.03
1014	0.00	0.00	0.00	0.00	0.00	0.00
1017	0.00	0.00	0.00	0.00	0.00	0.00
1022	0.28	0.25	0.25	0.03	0.03	0.02
1032	0.00	0.00	0.00	0.00	0.00	0.00
1038	0.00	0.00	0.00	0.02	0.02	0.00
1069	0.00	0.00	0.00	0.01	0.01	0.00
1089	0.00	0.00	0.00	0.00	0.00	0.00
1109	0.33	0.31	0.00	0.01	0.02	0.00
1154	0.11	0.09	0.09	0.16	0.16	0.16

Table 15

Qlbpm unit located between State Street and 2700 East from 3300 South to 4500 South, 24 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
2	0.00	0.00	0.00	0.04	0.04	0.02
3	0.22	0.15	0.15	0.09	0.09	0.08
10	0.20	0.15	0.15	0.10	0.10	0.08
31	0.00	0.00	0.00	0.12	0.12	0.11
49	0.00	0.00	0.00	0.01	0.01	0.00
86	1.25	0.79	0.79	0.04	0.04	0.04
89	1.90	1.35	1.34	0.06	0.06	0.05
1004	0.83	0.48	0.48	0.13	0.13	0.11
1005	0.21	0.14	0.13	0.04	0.04	0.02
1006	0.00	0.00	0.00	0.01	0.01	0.00
1010	0.68	0.52	0.52	0.01	0.01	0.01
1012	0.57	0.41	0.40	0.20	0.20	0.18
1015	0.00	0.00	0.00	0.00	0.00	0.00
1028	1.11	0.96	0.95	0.06	0.06	0.03
1033	0.00	0.00	0.00	0.00	0.00	0.00
1037	0.00	0.00	0.00	0.00	0.00	0.00
1049	0.49	0.39	0.39	0.02	0.02	0.02
1052	0.20	0.15	0.15	0.18	0.18	0.18
1065	0.32	0.23	0.00	0.01	0.01	0.00
1073	0.17	0.13	0.13	0.05	0.05	0.05
1090	0.26	0.21	0.20	0.14	0.14	0.11
1127	0.04	0.03	0.03	0.10	0.11	0.09
1132	0.00	0.00	0.00	0.00	0.00	0.00
1137	0.02	0.02	0.02	0.02	0.02	0.02

Table 16

Qlbpm unit located between 500 East and 1100 East from 4200 South to 4700 South, 10 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1002	0.00	0.00	0.00	0.01	0.01	0.00
1019	0.02	0.01	0.01	0.05	0.05	0.03
1056	0.00	0.00	0.00	0.00	0.00	0.00
1063	0.00	0.00	0.00	0.00	0.00	0.00
1064	0.00	0.00	0.00	0.00	0.00	0.00
1072	0.00	0.00	0.00	0.00	0.00	0.00
1074	0.11	0.07	0.07	0.04	0.05	0.03
1100	1.49	1.38	1.38	0.02	0.03	0.01
1129	0.08	0.06	0.06	0.09	0.09	0.06
1150	0.00	0.00	0.00	0.02	0.02	0.01

Table 17

Qlbpm units located between 900 East and Van Winkle Expressway from 4700
South to 7000 South, 8 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1007	0.00	0.00	0.00	0.00	0.00	0.00
1009	0.34	0.26	0.26	0.07	0.08	0.03
1018	0.02	0.01	0.01	0.12	0.11	0.09
1023	0.00	0.00	0.00	0.00	0.00	0.00
1024	0.04	0.03	0.03	0.03	0.04	0.02
1036	0.00	0.00	0.00	0.00	0.00	0.00
1041	0.00	0.00	0.00	0.00	0.00	0.00
1086	0.00	0.00	0.00	0.03	0.04	0.02

Table 18

Qlbpm units along I-15 corridor located between 3900 South and 9000 South, 123 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
278	0.00	0.00	0.00	0.16	0.16	0.16
288	1.76	1.52	1.51	0.15	0.15	0.14
292	0.85	0.68	0.67	0.02	0.03	0.01
294	0.59	0.45	0.46	0.15	0.15	0.15
302	3.22	2.63	2.60	0.07	0.07	0.07
309	0.00	0.00	0.00	0.00	0.00	0.00
310	0.00	0.00	0.00	0.00	0.00	0.00
311	0.00	0.00	0.00	0.00	0.00	0.00
312	0.00	0.00	0.00	0.00	0.00	0.00
313	0.00	0.00	0.00	0.00	0.00	0.00
314	0.00	0.00	0.00	0.00	0.00	0.00
315	0.58	0.50	0.49	0.06	0.06	0.05
316	0.00	0.00	0.00	0.01	0.00	0.00
317	0.00	0.00	0.00	0.00	0.00	0.00
318	0.00	0.00	0.00	0.04	0.04	0.01
319	0.00	0.00	0.00	0.00	0.00	0.00
320	0.00	0.00	0.00	0.00	0.00	0.00
321	0.00	0.00	0.00	0.00	0.00	0.00
322	0.68	0.58	0.57	0.07	0.06	0.02
323	0.00	0.00	0.00	0.00	0.00	0.00
324	0.00	0.00	0.00	0.00	0.00	0.00
325	0.00	0.00	0.00	0.00	0.00	0.00
326	0.00	0.00	0.00	0.00	0.00	0.00
327	0.00	0.00	0.00	0.00	0.00	0.00
328	0.00	0.00	0.00	0.00	0.00	0.00
329	0.00	0.00	0.00	0.00	0.00	0.00
331	0.00	0.00	0.00	0.00	0.00	0.00
332	0.00	0.00	0.00	0.00	0.00	0.00
333	0.00	0.00	0.00	0.00	0.00	0.00
334	0.00	0.00	0.00	0.00	0.00	0.00
335	0.00	0.00	0.00	0.00	0.00	0.00
336	0.00	0.00	0.00	0.00	0.00	0.00
337	0.00	0.00	0.00	0.00	0.00	0.00
338	0.00	0.00	0.00	0.00	0.00	0.00
339	0.00	0.00	0.00	0.01	0.01	0.00
340	0.00	0.00	0.00	0.00	0.00	0.00
341	0.00	0.00	0.00	0.00	0.00	0.00
342	0.00	0.00	0.00	0.00	0.00	0.00
343	0.00	0.00	0.00	0.00	0.00	0.00
344	0.00	0.00	0.00	0.01	0.00	0.00
345	0.00	0.00	0.00	0.00	0.00	0.00
346	0.00	0.00	0.00	0.01	0.00	0.00
354	0.00	0.00	0.00	0.00	0.00	0.00
355	0.00	0.00	0.00	0.00	0.00	0.00
356	0.00	0.00	0.00	0.00	0.00	0.00
357	0.00	0.00	0.00	0.00	0.00	0.00

Table 18 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
358	0.00	0.00	0.00	0.00	0.00	0.00
359	0.00	0.00	0.00	0.00	0.00	0.00
360	0.00	0.00	0.00	0.00	0.00	0.00
361	0.00	0.00	0.00	0.00	0.00	0.00
362	0.00	0.00	0.00	0.08	0.07	0.01
363	0.00	0.00	0.00	0.00	0.00	0.00
364	0.00	0.00	0.00	0.03	0.03	0.00
365	1.36	1.15	1.14	0.10	0.10	0.03
366	0.00	0.00	0.00	0.00	0.00	0.00
370	0.00	0.00	0.00	0.02	0.02	0.00
377	0.00	0.00	0.00	0.00	0.00	0.00
378	0.00	0.00	0.00	0.01	0.00	0.00
381	0.00	0.00	0.00	0.00	0.00	0.00
382	0.00	0.00	0.00	0.00	0.00	0.00
383	0.00	0.00	0.00	0.01	0.01	0.00
389	0.00	0.00	0.00	0.01	0.01	0.00
390	0.00	0.00	0.00	0.00	0.00	0.00
391	0.00	0.00	0.00	0.00	0.00	0.00
392	0.00	0.00	0.00	0.00	0.00	0.00
393	0.00	0.00	0.00	0.00	0.00	0.00
394	0.00	0.00	0.00	0.00	0.00	0.00
395	0.00	0.00	0.00	0.00	0.00	0.00
396	0.00	0.00	0.00	0.01	0.00	0.00
397	0.00	0.00	0.00	0.02	0.01	0.00
398	0.00	0.00	0.00	0.00	0.00	0.00
399	0.00	0.00	0.00	0.00	0.00	0.00
400	0.00	0.00	0.00	0.00	0.00	0.00
401	0.00	0.00	0.00	0.00	0.00	0.00
402	0.00	0.00	0.00	0.00	0.00	0.00
403	0.00	0.00	0.00	0.01	0.01	0.00
404	0.00	0.00	0.00	0.00	0.00	0.00
405	0.00	0.00	0.00	0.04	0.04	0.00
406	0.00	0.00	0.00	0.11	0.11	0.09
407	0.59	0.53	0.52	0.06	0.06	0.04
408	0.00	0.00	0.00	0.00	0.00	0.00
409	0.00	0.00	0.00	0.03	0.02	0.00
410	0.00	0.00	0.00	0.00	0.00	0.00
411	0.00	0.00	0.00	0.00	0.00	0.00
412	0.00	0.00	0.00	0.00	0.00	0.00
413	0.00	0.00	0.00	0.00	0.00	0.00
414	0.00	0.00	0.00	0.00	0.00	0.00
415	0.00	0.00	0.00	0.00	0.00	0.00
416	0.00	0.00	0.00	0.00	0.00	0.00
417	0.00	0.00	0.00	0.00	0.00	0.00
418	0.00	0.00	0.00	0.00	0.00	0.00
419	0.00	0.00	0.00	0.07	0.07	0.04
420	0.55	0.43	0.43	0.02	0.02	0.00
421	0.00	0.00	0.00	0.05	0.04	0.00
422	0.00	0.00	0.00	0.00	0.00	0.00
423	0.01	0.00	0.00	0.04	0.04	0.00

Table 18 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
424	1.03	0.80	0.00	0.03	0.02	0.00
425	0.29	0.22	0.00	0.04	0.03	0.00
426	0.70	0.54	0.00	0.02	0.02	0.00
427	0.00	0.00	0.00	0.00	0.00	0.00
428	0.27	0.20	0.20	0.18	0.17	0.14
437	0.00	0.00	0.00	0.00	0.00	0.00
438	1.54	1.30	1.28	0.08	0.07	0.05
440	0.00	0.00	0.00	0.03	0.03	0.03
441	0.00	0.00	0.00	0.00	0.00	0.00
442	0.05	0.04	0.04	0.02	0.03	0.01
443	0.00	0.00	0.00	0.00	0.00	0.00
444	0.00	0.00	0.00	0.01	0.02	0.00
445	0.00	0.00	0.00	0.03	0.06	0.01
446	0.00	0.00	0.00	0.00	0.00	0.00
447	0.00	0.00	0.00	0.01	0.01	0.00
664	0.00	0.00	0.00	0.03	0.03	0.03
1078	0.00	0.00	0.00	0.04	0.04	0.03
1082	0.01	0.01	0.01	0.04	0.04	0.03
1228	0.00	0.00	0.00	0.00	0.00	0.00
1237	0.06	0.05	0.05	0.03	0.03	0.02
1254	0.00	0.00	0.00	0.00	0.00	0.00
1255	0.00	0.00	0.00	0.00	0.00	0.00
1256	0.00	0.00	0.00	0.00	0.00	0.00
1257	0.00	0.00	0.00	0.18	0.18	0.18
1258	0.00	0.00	0.00	0.00	0.00	0.00
1259	0.00	0.00	0.00	0.00	0.00	0.00
1260	0.00	0.00	0.00	0.00	0.00	0.00

Table 19

Qlbpm units along I-15 corridor located between 9000 South and 12300 South, 27 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1156	0.03	0.03	0.03	0.04	0.03	0.02
1163	0.65	0.60	0.59	0.11	0.11	0.11
1165	0.83	0.79	0.79	0.11	0.11	0.10
1197	0.00	0.00	0.00	0.01	0.01	0.00
1198	0.00	0.00	0.00	0.05	0.05	0.01
1212	0.00	0.00	0.00	0.00	0.00	0.00
1213	0.27	0.27	0.27	0.05	0.05	0.05
1214	0.26	0.25	0.25	0.24	0.24	0.23
1215	0.00	0.00	0.00	0.00	0.00	0.00
1216	0.00	0.00	0.00	0.01	0.01	0.00
1220	0.00	0.00	0.00	0.00	0.00	0.00
1244	0.00	0.00	0.00	0.00	0.00	0.00
1246	0.32	0.32	0.32	0.15	0.15	0.15
1249	0.08	0.07	0.07	0.14	0.14	0.14
1250	0.37	0.37	0.37	0.12	0.12	0.09
1251	0.69	0.65	0.64	0.18	0.18	0.14
1252	0.00	0.00	0.00	0.08	0.08	0.08
1253	0.00	0.00	0.00	0.13	0.13	0.13
1264	0.00	0.00	0.00	0.00	0.00	0.00
1270	0.44	0.45	0.44	0.05	0.05	0.03
1273	0.00	0.00	0.00	0.00	0.00	0.00
1278	0.00	0.00	0.00	0.04	0.04	0.02
1279	0.02	0.02	0.02	0.12	0.12	0.11
1280	0.15	0.13	0.13	0.08	0.08	0.06
1284	0.00	0.00	0.00	0.00	0.00	0.00
1297	0.00	0.00	0.00	0.00	0.00	0.00
1302	0.00	0.00	0.00	0.00	0.00	0.00

Table 20

Qlbpm units near I-15 corridor located between 600 North and 2300 North, 3 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
76	0.00	0.00	0.00	0.16	0.16	0.16
684	0.00	0.00	0.00	0.00	0.00	0.00
714	0.00	0.00	0.00	0.02	0.02	0.00

Table 21

Qlbpm units located along east bench (east of 1300 East) from South Temple to 5300 South, 7 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
50	0.00	0.00	0.00	0.00	0.00	0.00
686	0.00	0.00	0.00	0.00	0.00	0.00
687	0.00	0.00	0.00	0.00	0.00	0.00
688	0.00	0.00	0.00	0.00	0.00	0.00
696	0.00	0.00	0.00	0.00	0.00	0.00
701	0.00	0.00	0.00	0.00	0.00	0.00
725	0.00	0.00	0.00	0.00	0.00	0.00

Table 22

Qlbpm units located west of I-15 corridor and units located south of 12300 South, 67 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
9	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00
83	0.00	0.00	0.00	0.00	0.00	0.00
732	0.00	0.00	0.00	0.01	0.01	0.01
733	0.00	0.00	0.00	0.00	0.00	0.00
736	0.00	0.00	0.00	0.01	0.01	0.01
1046	0.02	0.02	0.02	0.03	0.03	0.01
1061	0.00	0.00	0.00	0.00	0.00	0.00
1076	0.00	0.00	0.00	0.00	0.00	0.00
1092	0.00	0.00	0.00	0.00	0.00	0.00
1099	0.00	0.00	0.00	0.00	0.00	0.00
1101	0.00	0.00	0.00	0.00	0.00	0.00
1108	0.57	0.46	0.45	0.08	0.08	0.03
1113	0.00	0.00	0.00	0.00	0.00	0.00
1114	0.02	0.01	0.00	0.03	0.03	0.00
1120	0.00	0.00	0.00	0.00	0.00	0.00
1126	0.00	0.00	0.00	0.00	0.00	0.00
1131	0.00	0.00	0.00	0.01	0.01	0.00
1133	0.00	0.00	0.00	0.05	0.05	0.03
1145	0.00	0.00	0.00	0.00	0.00	0.00
1157	0.00	0.00	0.00	0.00	0.00	0.00
1161	0.02	0.01	0.01	0.05	0.05	0.04
1167	0.00	0.00	0.00	0.00	0.00	0.00
1172	0.00	0.00	0.00	0.00	0.00	0.00
1173	0.00	0.00	0.00	0.02	0.02	0.00
1174	0.02	0.02	0.02	0.04	0.03	0.01
1177	0.02	0.02	0.02	0.06	0.06	0.06
1179	0.00	0.00	0.00	0.00	0.00	0.00
1180	0.00	0.00	0.00	0.00	0.00	0.00
1181	0.00	0.00	0.00	0.00	0.00	0.00
1182	0.00	0.00	0.00	0.00	0.00	0.00
1183	0.00	0.00	0.00	0.00	0.00	0.00
1184	0.00	0.00	0.00	0.00	0.00	0.00
1185	0.00	0.00	0.00	0.00	0.00	0.00
1186	0.00	0.00	0.00	0.00	0.00	0.00
1187	0.00	0.00	0.00	0.00	0.00	0.00
1188	0.00	0.00	0.00	0.00	0.00	0.00
1193	0.00	0.00	0.00	0.00	0.00	0.00
1194	0.00	0.00	0.00	0.00	0.00	0.00
1211	0.97	0.84	0.83	0.03	0.03	0.02
1219	0.02	0.01	0.01	0.04	0.04	0.04
1222	0.00	0.00	0.00	0.00	0.00	0.00
1226	0.00	0.00	0.00	0.00	0.00	0.00
1229	0.02	0.02	0.02	0.05	0.05	0.04
1230	0.00	0.00	0.00	0.00	0.00	0.00

Table 22 Continued

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1231	0.00	0.00	0.00	0.00	0.00	0.00
1232	0.00	0.00	0.00	0.00	0.00	0.00
1233	0.00	0.00	0.00	0.00	0.00	0.00
1234	0.00	0.00	0.00	0.00	0.00	0.00
1241	0.03	0.03	0.03	0.02	0.02	0.01
1263	0.00	0.00	0.00	0.03	0.03	0.00
1268	0.00	0.00	0.00	0.00	0.00	0.00
1272	0.02	0.02	0.02	0.34	0.34	0.32
1275	0.00	0.00	0.00	0.03	0.03	0.01
1281	0.00	0.00	0.00	0.04	0.04	0.02
1282	0.00	0.00	0.00	0.00	0.00	0.00
1283	0.00	0.00	0.00	0.02	0.02	0.00
1285	0.00	0.00	0.00	0.01	0.01	0.00
1286	2.70	2.44	0.00	0.01	0.01	0.00
1291	0.00	0.00	0.00	0.00	0.00	0.00
1292	0.00	0.00	0.00	0.00	0.00	0.00
1294	0.28	0.25	0.25	0.09	0.09	0.05
1295	0.02	0.02	0.02	0.06	0.06	0.02
1296	1.73	1.70	1.68	0.08	0.08	0.04
1300	0.10	0.10	0.10	0.04	0.04	0.02
1301	1.42	1.34	1.33	0.07	0.07	0.06

Table 23

Qaf2 and Qmls units located between North Temple and 400 South from 400 West to 300 East (City Creek fan), 10 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
15	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.17	0.17	0.06
52	1.96	1.66	1.65	0.14	0.13	0.06
57	0.00	0.00	0.00	0.00	0.00	0.00
81	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.04	0.04	0.00
706	2.33	2.21	2.21	0.04	0.04	0.00
729	1.14	0.82	0.82	0.15	0.15	0.13
750	2.01	1.69	1.68	0.13	0.12	0.05

Table 24

All Qaf2 units except City Creek fan, 20 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1	0.00	0.00	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.02	0.02	0.01
42	0.00	0.00	0.00	0.00	0.00	0.00
97	0.00	0.00	0.00	0.07	0.06	0.00
100	0.00	0.00	0.00	0.00	0.00	0.00
683	0.00	0.00	0.00	0.00	0.00	0.00
693	1.64	1.60	0.00	0.02	0.02	0.00
699	0.00	0.00	0.00	0.02	0.02	0.00
704	0.00	0.00	0.00	0.00	0.00	0.00
705	0.00	0.00	0.00	0.02	0.02	0.00
713	0.00	0.00	0.00	0.00	0.00	0.00
717	0.00	0.00	0.00	0.00	0.00	0.00
719	0.00	0.00	0.00	0.00	0.00	0.00
727	0.00	0.00	0.00	0.00	0.00	0.00
1000	4.39	4.28	0.00	0.04	0.04	0.00
1040	0.00	0.00	0.00	0.00	0.00	0.00
1059	0.00	0.00	0.00	0.00	0.00	0.00
1116	0.00	0.00	0.00	0.00	0.00	0.00
1221	0.00	0.00	0.00	0.00	0.00	0.00
1277	4.62	3.76	0.00	0.05	0.04	0.00

Table 25

All Qalp units located along east bench from 6th Avenue to 10600 South, 10 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
40	0.00	0.00	0.00	0.00	0.00	0.00
72	0.00	0.00	0.00	0.00	0.00	0.00
73	0.00	0.00	0.00	0.00	0.00	0.00
700	0.00	0.00	0.00	0.00	0.00	0.00
703	0.00	0.00	0.00	0.00	0.00	0.00
1062	0.00	0.00	0.00	0.01	0.01	0.00
1105	0.00	0.00	0.00	0.00	0.00	0.00
1135	1.44	1.23	1.22	0.12	0.12	0.10
1142	0.00	0.00	0.00	0.00	0.00	0.00
1266	0.00	0.00	0.00	0.00	0.00	0.00

Table 26

All Qlpg units in the valley, 40 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
44	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.06	0.03	0.00
59	3.37	4.46	4.46	0.05	0.04	0.00
88	0.14	0.12	0.12	0.03	0.03	0.02
690	0.00	0.00	0.00	0.02	0.01	0.00
697	0.00	0.00	0.00	0.00	0.00	0.00
698	0.00	0.00	0.00	0.00	0.00	0.00
716	0.16	0.18	0.18	0.04	0.04	0.02
728	0.66	0.75	0.75	0.05	0.05	0.01
1003	0.04	0.03	0.03	0.16	0.16	0.13
1048	0.00	0.00	0.00	0.00	0.00	0.00
1067	0.00	0.00	0.00	0.01	0.01	0.00
1081	0.00	0.00	0.00	0.08	0.07	0.03
1097	2.53	2.13	2.11	0.03	0.03	0.01
1098	0.00	0.00	0.00	0.01	0.01	0.00
1119	0.00	0.00	0.00	0.00	0.00	0.00
1151	0.00	0.00	0.00	0.03	0.03	0.01
1168	0.00	0.00	0.00	0.00	0.00	0.00
1170	0.00	0.00	0.00	0.00	0.00	0.00
1171	0.00	0.00	0.00	0.00	0.00	0.00
1195	0.00	0.00	0.00	0.00	0.00	0.00
1196	0.00	0.00	0.00	0.00	0.00	0.00
1200	0.00	0.00	0.00	0.00	0.00	0.00
1201	0.00	0.00	0.00	0.00	0.00	0.00
1202	0.00	0.00	0.00	0.00	0.00	0.00
1203	0.00	0.00	0.00	0.00	0.00	0.00
1204	0.17	0.09	0.09	0.01	0.01	0.00
1205	1.81	1.14	1.12	0.04	0.04	0.03
1206	0.00	0.00	0.00	0.01	0.01	0.00
1207	0.00	0.00	0.00	0.02	0.02	0.01
1208	0.00	0.00	0.00	0.01	0.01	0.01
1209	0.99	0.92	0.91	0.02	0.02	0.01
1210	0.00	0.00	0.00	0.00	0.00	0.00
1217	3.16	2.71	2.70	0.14	0.14	0.12
1218	0.00	0.00	0.00	0.06	0.06	0.02
1223	0.00	0.00	0.00	0.00	0.00	0.00
1247	2.63	2.69	2.65	0.08	0.07	0.03
1248	1.49	1.44	1.42	0.06	0.06	0.04
1265	0.00	0.00	0.00	0.02	0.02	0.00
1267	0.00	0.00	0.00	0.01	0.01	0.00

Table 27

All Qlbpg units in the valley, 12 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
32	0.00	0.00	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.04	0.04	0.02
56	0.00	0.00	0.00	0.03	0.02	0.00
84	0.00	0.00	0.00	0.00	0.00	0.00
712	0.00	0.00	0.00	0.00	0.00	0.00
1175	0.00	0.00	0.00	0.00	0.00	0.00
1176	0.33	0.34	0.33	0.03	0.03	0.01
1199	3.82	3.58	3.51	0.21	0.21	0.20
1225	0.00	0.00	0.00	0.00	0.00	0.00
1227	0.00	0.00	0.00	0.00	0.00	0.00
1235	0.00	0.00	0.00	0.00	0.00	0.00
1269	0.00	0.00	0.00	0.00	0.00	0.00

Table 28

All Qlbps units in the valley, 5 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
47	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00
1162	0.00	0.00	0.00	0.00	0.00	0.00
1178	0.00	0.00	0.00	0.00	0.00	0.00
1224	0.00	0.00	0.00	0.02	0.02	0.00

Table 29

All Qafy units in the valley, 6 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
5	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.00	0.00	0.02	0.02	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00
1044	0.00	0.00	0.00	0.00	0.00	0.00
1051	0.01	0.01	0.00	0.01	0.01	0.00
1242	0.00	0.00	0.00	0.02	0.01	0.00

Table 30

All Qlpd units in the valley, 5 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
1053	2.03	1.78	0.06	0.07	0.07	0.03
1085	0.00	0.00	0.00	0.04	0.04	0.01
1087	0.00	0.00	0.00	0.02	0.02	0.00
1103	0.00	0.00	0.00	0.00	0.00	0.00
1104	0.00	0.00	0.00	0.00	0.00	0.00

Table 31

All Qlbg units in the valley, 14 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
38	0.00	0.00	0.00	0.00	0.00	0.00
45	0.00	0.00	0.00	0.00	0.00	0.00
46	0.00	0.00	0.00	0.00	0.00	0.00
53	0.00	0.00	0.00	0.02	0.01	0.00
74	0.00	0.00	0.00	0.01	0.01	0.00
101	0.00	0.00	0.00	0.00	0.00	0.00
718	0.00	0.00	0.00	0.00	0.00	0.00
741	0.00	0.00	0.00	0.02	0.02	0.01
742	0.00	0.00	0.00	0.00	0.00	0.00
743	0.00	0.00	0.00	0.06	0.06	0.01
1096	0.00	0.00	0.00	0.00	0.00	0.00
1243	0.00	0.00	0.00	0.00	0.00	0.00
1261	0.00	0.00	0.00	0.00	0.00	0.00
1262	0.00	0.00	0.00	0.00	0.00	0.00

Table 32

Various smaller units* in foothills, 17 boreholes

Borehole ID Number	Lateral Spread Horizontal Displacement, m Youd and others (2002)			Ground Settlement Displacement, m Average of Tokimatsu and Seed (1987) and Yoshimine and others (2006)		
	M7.0 Scenario	2PE50	10PE50	M7.0 Scenario	2PE50	10PE50
22	0.00	0.00	0.00	0.00	0.00	0.00
39	0.00	0.00	0.00	0.00	0.00	0.00
41	0.00	0.00	0.00	0.00	0.00	0.00
43	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
98	0.00	0.00	0.00	0.00	0.00	0.00
103	0.00	0.00	0.00	0.01	0.00	0.00
694	0.00	0.00	0.00	0.04	0.03	0.00
695	0.00	0.00	0.00	0.04	0.03	0.02
708	0.00	0.00	0.00	0.00	0.00	0.00
715	0.00	0.00	0.00	0.00	0.00	0.00
720	0.00	0.00	0.00	0.00	0.00	0.00
1164	0.00	0.00	0.00	0.03	0.03	0.00
1240	0.00	0.00	0.00	0.01	0.00	0.00
1287	0.00	0.00	0.00	0.00	0.00	0.00
1290	0.00	0.00	0.00	0.00	0.00	0.00
1293	0.00	0.00	0.00	0.00	0.00	0.00

*Geologic units include: Qafb, Qca, QTaf, Qes, Qlbm, Mz, Qafo, Qlbs, Pz and Rock

Bibliography

This report has not lead to any publications beyond this technical report.