

WESTERN GEOLOGIC, LLC

CRAIG V. NELSON, P.G., C.E.G., C.E.M.

Title	Principal Engineering Geologist
Expertise	Engineering Geology Groundwater Geology Environmental Due Diligence Environmental Geology Geologic Hazards Litigation Support
Academic Background	M.B.A., Eccles School of Business, University of Utah, 1991 M.S., Geology, Utah State University, 1986 B.S., Geology, Utah State University, 1982
Registration	Professional Geologist - Utah No. 5251804, California No. 4806, Wyoming No. PG-3766 Certified Engineering Geologist - California No. 1585 Certified Environmental Manager - Nevada No. 1975
Experience	<p>Mr. Nelson has over 32 years of experience managing a wide variety of projects in engineering, groundwater, and environmental geology. His expertise in geologic hazards mapping, analysis and mitigation stem from successful completion of numerous geologic hazard studies, fault and seismic investigations, rockfall probability assessments, landslide and debris flow studies, soil liquefaction analysis, and slope stability projects. He has completed geologic studies and risk analysis for engineered structures, public facilities, subdivisions, dams, highways, and corridors throughout the western U.S. and Canada.</p> <p>Mr. Nelson also has experience in engineering geology for surface and underground mining as well as economic evaluation of mineral deposits including metallic minerals, coal, sand and gravel, and other industrial minerals.</p> <p>His environmental and hydrogeology work has included subsurface site characterizations, soil-gas surveys, Phase I Environmental Site Assessments, Transaction Screen analyses, and soil and groundwater remediation projects involving a variety of contaminants and remediation technologies. He has provided expert witness and third-party review services in a number of geology related cases.</p> <p>Mr. Nelson has conducted hydrogeologic evaluations for locating water wells and constructing dewatering systems. He has groundwater modeling experience and the ability to characterize complex groundwater conditions. He has also provided expert witness and third-party review services for groundwater related cases.</p> <p>Environmental Site Assessments</p> <ul style="list-style-type: none">Directed, reviewed, or conducted several thousand Phase I Environmental Site Assessments and Environmental Transaction Screen process projects for a variety of commercial and industrial facilities throughout the western U.S. (Alaska, Arizona, California, Colorado, Hawaii, Idaho, Nebraska, New Mexico, North Dakota, Montana, Oregon, Texas, Utah, Washington, Wyoming), as well as Ireland, Scotland, Great Britain, and Singapore. <p>Geologic Hazards - Comprehensive</p> <ul style="list-style-type: none">Co-author of Salt Lake County's Natural Hazards Ordinance, which required developers to conduct special studies to address soil liquefaction and surface fault rupture in potential hazard areas.Conducted geologic hazard assessments and geoseismic evaluations for a many public facilities, residential subdivisions, dams, highways, and industrial facilities.

Groundwater Studies & Phase II Site Characterizations

- Managed and directed numerous Phase II environmental site characterizations to determine extent and magnitude of soil and ground water contamination for a variety of commercial and industrial facilities across the western U.S.
- Project manager for environmental site assessment of property down gradient from chemical leach ponds at a Salt Lake City chemical company.
- Conducted soil-gas screening surveys to determine if there was evidence of soil/groundwater contamination on site with evidence of historic underground storage tanks.

Geologic Hazards – Regulatory Review Services

- Mr. Nelson has provided geologic review services for Salt Lake County, Salt Lake City, West Valley City, Sandy City, and North Ogden City. Services included: holding pre-development coordinating meetings with developers and their geologic/geotechnical consultants to discuss potential geologic hazards and the scope of needed information to support the proposed development; field review and verification field data exposed in trenches, borings, test pits, etc.; review of technical reports and preparation of recommendations; attending planning commission and community meetings to discuss geologic hazards and development issues.

Geologic Hazards - Land Use Planning

- Prepared the geologic hazards analysis and land use overlays for Salt Lake County Planning Division's Foothill Area Master Plan. Geologic hazards of prime consideration in this land use plan include: surface fault rupture, earthquake ground shaking, liquefaction, landslides, rockfall, debris flow, mine and tunnel ground collapse, and avalanche.
- Prepared the geologic hazards analysis and land use overlays for Salt Lake County Planning Division's Holladay/Cottonwood Master Plan. Geologic hazards of prime consideration in this land use plan include: surface fault rupture, earthquake ground shaking, unstable slopes, and liquefaction.
- Prepared the geologic hazards analysis and land use overlays for Salt Lake County Planning Division's Magna Area Master Plan. Geologic hazards of prime consideration in this land use plan include: surface fault rupture, earthquake ground shaking, unstable slopes, and liquefaction.
- Prepared the geologic hazards analysis and land use overlays for Salt Lake County Planning Division's Taylorsville-Bennion Master Plan. Geologic hazards of prime consideration in this land use plan include: surface fault rupture, earthquake ground shaking, and liquefaction.
- Prepared the geologic hazards analysis and land use overlays for Salt Lake County Planning Division's Herriman Area Master Plan. Geologic hazards of prime consideration in this land use plan include: earthquake ground shaking, landslides, rockfall, debris flow, and liquefaction.

Expert Witness and Litigation Support

- Provided expert witness testimony, litigation support, and third-party review on a variety of geology and hydrogeology cases.

Dam Projects

- Provided engineering geology analysis for the seismic stability evaluation of Twin Lakes (concrete arch) and Lake Mary (concrete gravity) dams. Project included detailed bedrock mapping of abutments, seismic refraction survey, and slope stability analysis.
- Performed the geologic site reconnaissance and seismic design criteria for the reconstruction and enlargement of an earthfill dam in Payson Canyon, Utah.

Geologic Hazards - Surface Fault Rupture

- Completed a surface fault rupture hazard study for a proposed pipeline compressor station facility south of Salt Lake International Airport and north of the suspected trace of the active Granger Fault. Excavated and logged an exploratory trench (total 185m in length) to expose an unfaulted and undeformed marker bed identified at the pre-Holocene pre-Gilbert “red beds” used to demonstrate the low surface fault hazard at the site.
- Conducted a surface fault rupture hazard study for a proposed multi-lot subdivision/apartment complex adjacent to the active East Bench portion of the Wasatch Fault. Performed aerial photography analysis and fault mapping. Excavated and logged 4 exploratory trenches (total 120m in length) to locate the fault and determine rupture history (min. of 2.1m displacement observed). Provided recommendations for building set-backs, grading and footing placement in areas of rubble fill.
- Project manager for a combination fault and geotechnical investigation involving trenching a 59m long, 3.2m deep exploratory trench through Holocene alluvium and debris flow deposits into Pleistocene Lake Bonneville sediments. No active faults were delineated. The trench was logged using standard level-line techniques and a video log was also made to document the stratigraphy. Five test pits were also excavated, logged, and sampled for geotechnical testing.
- Conducted a fault investigation for a proposed residential development in a very structurally complex area within the active Wasatch Fault Zone. This project consisted of aerial photography analysis, fault and surficial geologic mapping, and excavating and logging a 77m long, 3m deep exploratory trench to delineate faulting and determine rupture history (nine active faults splays were documented). Provided recommendations for buildable areas to avoid future rupture hazard. Presentation of seismic techniques and risks to Planning Commission.
- Logs from geotechnical boreholes across this site indicated significant change in stratigraphy from east to west across the site. Analysis of aerial photographs proved inconclusive because of surficial disturbance from development in the earliest available photos (1938). Because the active East Bench portion of the Wasatch Fault has been mapped about 90m east of the site, an exploratory trench was excavated across the building pad to determine if the discontinuous stratigraphy was the result of past surface fault rupture. The 40m long trench was excavated 12m deep into Pleistocene Lake Bonneville sediments and revealed a silty clay lens interfingering with silty clay and gravel deposits. No evidence of faulting or liquefaction was observed; the contacts appeared to be depositional. No surface fault rupture-related constraints were recommended.
- Conducted surface fault rupture hazards evaluation for a proposed Salt Lake County Fire Station near the mouth of Little Cottonwood Canyon. Determined the location of the active Wasatch Fault in the vicinity of the site and provided recommendations to the structural engineer and architect for seismic design values for this critical structure. An exploratory trench 71.5m in length was excavated across the site to investigate the presence of recent fault activity. Recommendations were provided for earthquake ground shaking acceleration, ground tilting and deformation, surface fault rupture, and other geologic hazards. An earthquake probability analysis was prepared and recommendations for a risk assessment of the structure were provided.
- Project manager for a fault study conducted on a steep hillside lot (suspected fault scarp) in a subdivision approved in the mid 1970's before the Natural Hazards Ordinance prohibited placing structures over active faults. A 14.6m long, 5.2m deep trench was excavated into Pleistocene Lake Bonneville deposits. Three faults displacing sediment layers dated at 15,000-16,000 years old were logged. Recommendations were provided for siting the structure to avoid future surface fault rupture.

- Served as project manager and principal geologist for a fault hazard analysis for a proposed development located on 40 acres straddling a wide graben located within the active Wasatch Fault Zone. Project goals were to determine the potential buildable areas in this geologically complex parcel. Prepared a detailed aerial photo-based fault and surficial geology map. Three parallel exploratory trenches were excavated across the site perpendicular to the trend of the faults for a total distance of 733m. A detailed fault map was created based on the fault locations observed in the trenches and air photos. Other geologic hazards were also addressed including: rockfall, debris flow and set-back from steep slopes.
- Conducted a fault investigation for a subdivision approved in the mid-1970's based on work performed by another consultant. The previous work was questioned by the County Geologist because no subsurface exploration was performed to accurately locate the faults. A 22m long exploratory trench was excavated through about 2.5m of Holocene fill and alluvium into Pleistocene sediments. No evidence of faulting was observed, however deformation at the east end of the trench (at the base of the suspected 15m high fault scarp) displayed evidence of drag deformation. A slope stability analysis was performed to determine an appropriate building set-back distance from the base of the slope, should the slope fail during a rupture event.
- This fault study was prepared for a large addition to an industrial building located about 100m northeast of the Granger Fault in the West Valley Fault Zone. Because of the shallow groundwater (about 1.5m) and the amount of fill on the site it was doubtful that any meaningful information would be gained from exploratory trenching. Given these factors and the distance from the proposed structure to the surficial expression of the scarp in the air photo mapping, I was successful in lobbying for development of the site without subsurface exploration.

Geologic Hazards - Debris Flow/Sediment Yield

- Evaluation of debris flow potential and recommendations for emergency watershed protection following the September 1988 Affleck Park wild fire which burned over 5600 acres (22.7 km²) across several drainages in "suburbanized" Emigration Canyon, Utah. Analysis of the burned drainage indicated a 700 percent increase in potential sediment yield over the pre-fire conditions. Based on the recommendations of this study an emergency watershed restoration project was initiated to help mitigate erosion hazards. Erosion control structures consisting of 24 gabion baskets and 84 wire silt fences were installed across the upland slopes and a debris basin was constructed at the base of one major intermittent channel. The following spring a localized, intense rainstorm (estimated to be in excess of the 100 year event) triggered a large mobilization of sediment across a portion of the not-yet-revegetated burn area. Silt fences and gabions helped collect sediment and reduce peak debris flow volumes (although the force of the flows toppled several of the gabion structures). Two homes near the base of one drainage suffered some mud-related basement damage. The debris-basin protected drainage was not impacted by the localized storm. Estimates of the debris generated closely matched the predicted sediment yield for a post-fire event.
- A 6-lot Planned Unit Development (PUD) located within a steep drainage on the northern slope of Mt. Olympus, near Salt Lake City, Utah may be subject to periodic storm flooding and debris flow deposition. The purpose of this study was to determine the risk to the proposed homes from these hazards and to quantify the flow rates for three scenarios: 1) runoff confined to pre-existing drainage channels, 2) runoff as pure sheet flow, and 3) a combination of sheetflow and channel flow. Runoff rates were calculated using the SCS runoff model for 24 hour duration storms with return periods of 2, 10, and 24 years and precipitation of 45, 65, and 94mm respectively. Recommendations were provided for locating the building pads and grading to minimize the risks from storm water and debris.

- An engineering geology report was required the Pleasant View (Utah) City Engineer prior to development of an approximately 200 acre hillside north of Ogden, Utah. The site was located near the apex of an active alluvial fan at the mouth of an intermittent stream drainage. City ordinance required that the runoff from the 10- year storm be addressed. An analysis was performed on the drainage basin to determine the channel size requirements for both the 10 and 100 year storm and associated debris flow events. A probability risk assessment was also provided to help characterize the large-scale debris flow return interval and relative risk to the site.
- Conducted a debris flow hazard assessment for a proposed residential subdivision and golf course in Carbondale, Colorado. Developed a debris flow model based on evidence from prehistoric debris flows observed in alluvial fan test pits and evidence from a large historic debris flood/flow. Provided recommendations for hazard avoidance and reduction.

Mining and Underground Openings

- Served as project geologist on over twenty mining engineering projects including: highwall slope stability analysis; subsidence evaluation; pilot shaft evaluation; portal and main entry stability analyses; ground control assessment; and geotechnical logging/testing studies.

Corridor and Transportation Projects

- Project geologist conducting the geologic hazards analysis for the Independent Review of the Yellowstone Pipeline on Lolo National Forest in Montana and Idaho. Prepared a reconnaissance-level geologic hazards characterization of the pipeline corridor for hazards including: surface fault rupture, liquefaction, seismic ground acceleration, landslide, debris flow, rock fall, avalanche, and other hazards such as acid ground water corrosion.
- Project manager for the geotechnical exploration, testing, analysis and preliminary design recommendations for roadway embankment settlement, bridge abutments, pile design, and retaining walls for the redesign of the complex I-15/I-80 Junction at 2400 South in Salt Lake County. This major reconstruction project involved exploration of over 200 borings and CPT soundings, many in areas of soil and groundwater contamination from heavy metals, hydrocarbons, PCBs, solvents, and low-level radioactive fill material.
- Project manager for exploration and analysis to provide pavement design parameters to UDOT at over 80 sites along existing and planned surface roads adjacent to the I-15 corridor.
- Project manager for geologic and geotechnical exploration of the realignment of U.S. 189 in upper Provo Canyon, Utah. This section included routing through the infamous Hoover landslide complex as well as rock cuts ranging to 75m in height. Coordinated drilling, inclinometer installation and monitoring, downhole geophysics, and soil and rock mechanics testing. Provided detailed geologic maps, cross sections, and geologic hazards analysis including discontinuity and seismic parameters for the transportation design engineers.
- Project manager for the seismic hazard analysis of the I-15 corridor through Salt Lake County. This project involved exploration of 200 and 300 foot borings for downhole shear wave velocity and gamma and EM logging; seismic source characterization; ground-motion analysis; probabilistic and deterministic seismic hazards analyses; site response analyses; and seismic design spectra for more than 50 bridge sites along the corridor.
- Project manager for the geotechnical exploration, testing, analysis and preliminary design recommendations for the redesign of the I-15 “collector” system between 800 South and 1700 South in Salt Lake City. This project involved embankment widening with retaining walls and bridge replacement and widening.

- Project manager for the geotechnical exploration, testing, analysis and preliminary design recommendations for the I-15 600 South off-ramp in Salt Lake City.
- Project manager for the I-15 Stage I geotechnical corridor investigation from 10800 South to 500 North in Salt Lake County, Utah. This project involves providing preliminary geotechnical recommendations for the roadway widening and reconstruction of structures along a 17.6 mile segment of I-15. This project provided preliminary settlement calculations for over 50 bridge sites and wick-drain analysis for embankment settlement.
- Engineering geology analysis for proposed 945m long funicular railway system for ski resort access near Provo, Utah.
- Project manager for the UDOT Stage I geotechnical investigation of the 17.6 mile-long segment of I-15 through the urban Salt Lake Corridor. This project involved CPT soundings and deep SPT borings, preliminary settlement analysis for bridge foundations and highway embankments, wick-drain analysis, and seismic microzonation of the corridor. Dames & Moore also prepared guideline manuals for subsurface, exploration, geotechnical analysis and design, and soil classification.

Professional History

Principal Engineering Geologist, Western GeoLogic, Salt Lake City, UT (2001-present)
 Operations Manager, URS Corporation, Salt Lake City, UT (2000-2001)
 Managing Principal-In-Charge, Dames & Moore, Salt Lake City, UT (1997-2000)
 Sr. Geologist - Geoscience Manager, Dames & Moore Salt Lake City, UT (1995-97)
 Sr. Engineering Geologist, Delta Geotechnical Consultants, Salt Lake City, UT (1992-95)
 County Geologist, Salt Lake County Public Works, Salt Lake City, UT (1985-92)
 Teaching and Research Assistant, Utah State University, Logan, UT (1983-85)
 Staff Engineering Geologist, Seegmiller International, Salt Lake City, UT (1981-83)

Professional Affiliations

Board Member and Chair, Utah Geological Survey (1997-2005)
 Member, University of Utah Geological Engineering Advisory Board (2004-present)
 Member, Utah State University Dept. of Geology Advisory Board (2004-present)
 Member, Utah Geologic Association
 Member, Salt Lake School District Seismic Committee, (1989-1992)
 Member, Geological Review Committee, Nuclear Repository Waste Siting Study, Davis/Lavender Canyons, Utah (1982-1983)

Professional Awards

American Planning Association, *1991 Award of Merit* in recognition of achievement in information technology made to the state of Utah for the Earthquake Awareness and Hazard Mitigation Video.
 American Planning Association: *1990 Award of Merit* for development of Salt Lake County's Natural Hazards Ordinance.
 U.S. Geological Survey: *1989 Certificate of Appreciation* for implementation of measures to reduce losses due to earthquakes in Utah.

Citizenship

United States

Countries Worked In

United States, Canada, Jamaica

Language Proficiency

English

Partial List of Publications

Batatian, L.D., Christenson, G.E., and Nelson, C.V., 2003, Guidelines for Evaluating Surface-Fault Rupture Hazard Studies in Utah: Utah Geological Survey Miscellaneous Publication 03-6, 14p.

Batatian, L.D. and Nelson, C.V., 2002, Salt Lake County Natural Hazards Ordinance, Chapter 19.75 of the Salt Lake County Zoning Ordinance.

Batatian, L.D. and Nelson, C.V., 1999, Fault setback requirements to reduce fault rupture hazards in Salt Lake County: Association of Engineering Geologists Program with Abstracts, 42nd Annual Meeting, p. 59.

Nelson, C.V., Brink, J.D., Heppler, Leslie, Braceras, Carlos, Bishoff, Jon, and Brown Keith, 1997, Interpretation of late-Pleistocene and Holocene stratigraphy and depositional environments in the Salt Lake Valley, Utah using borehole logs and cone penetrometer soundings: Geological Society of America Abstracts with Programs, vol. 29, no. 6, p. 56.

Nelson, C.V., Sakai, S., and Gunalan, K.N., Evaluating soil strength gain due to embankment loading - A case study from the I-15 Corridor reconstruction project, Salt Lake County, Utah: Proceedings of the 32nd Symposium on Engineering Geology and Geotechnical Engineering - March 26-28, 1997, Boise, Idaho, in press.

Crouse, C.B., Nelson, C.V., McGuire, J., and Bischoff, J., Seismic hazard analysis of the I-15 Corridor - Salt Lake County, Utah: Proceedings of the 32nd Symposium on Engineering Geology and Geotechnical Engineering - March 26-28, 1997, Boise, Idaho, in press.

Nelson, C.V., 1995, Rockfall hazard risk assessment and probability - A Case Study, Ogden Canyon, Utah: Environmental and Engineering Geology of the Wasatch Front Region, Utah Geological Association Publication 24, p. 157-160.

Nelson, C.V., 1995, Rockfall hazard probabilistic risk analysis, A case study, Ogden Canyon, Utah: Geological Society of America Abstracts With Programs, Vol. 27, No.4, p. 49.

Nelson, C.V., 1993, Rockfall hazards: A guide for land-use planning, Salt Lake County, Utah: U.S. Geological Survey Professional Paper 1519, p. 138-142.

Nelson, C.V., and Christenson, G.E., 1992, Establishing Guidelines for Surface Fault Rupture Hazard Investigations - Salt Lake County, Utah: Proceedings of the Association of Engineering Geologists 35th Annual Meeting, p. 242-249.

Lowe, Mike, Nelson, C.V., Robison, R.M., and Christenson, G.E., 1991, Reducing Earthquake and Other Hazards Through Land-Use Planning, Wasatch Front, Utah: Annual Earthquake Engineering Research Institute Meeting (poster session abstract), Salt Lake City, UT, February 14-16.

Lund, W.M., Christenson, G.E., Harty, K.M., Hecker, S., Atwood, G.A., Case, W.F., Gill, H.E., Gwynn, J.W., Klauk, R.H., Mabey, D.R., Mulvey, W.E., Sprinkel, D.A., Tripp, B.T., Black, B.D., and Nelson, C.V., 1990, Geology of Salt Lake City, Utah, United States of America: Association of Engineering Geologists Bulletin, Vol. 27, No. 4, p. 391-478.

Nelson, C.V., and Raseley, R.C., 1990, Estimating Sediment Yield and Implementing Erosion-Control Mitigation Measures Following A Wild Fire Event, The Affleck Park Fire Case: Utah Non-Point Source Water Quality Conference Abstracts, p. 3.

Madsen, G.E., Anderson L.R., and Nelson, C.V., 1990, The Uses of Opinion Surveys in Earthquake Risk Reduction Programs in Utah: Presented at the Earthquake Engineering Research Institute Meeting, Palm Springs, California.

Nelson, C.V., and Raseley, R.C., 1990, Debris Flow Potential and Sediment Yield Analysis Following Wild Fire Events in Mountainous Terrain: Proceedings of the American Society of Civil Engineers International Symposium on the Hydraulics/Hydrology of Arid Lands, p. 54-59.

Madsen, G.E., Anderson, L.R., Barnes, J.H., and Nelson, C.V., 1989, Earthquake Risk and Defensive Policies as perceived by Community Leaders and the Public: Report to the Utah Council on Intergovernmental Relations, Second Annual Summit Conference, August 25, 1989, Salt Lake City, UT, 15p.

Nelson, C.V., 1989, Rock Fall Hazards, A Guide to Land Use Planning: Salt Lake County, Utah: U.S. Geological Survey Open-File Report 90-225, p. II-1 - II-15.

Nelson, C.V., 1989, Geologic Hazard Maps for Land Use Planning and Development, The Special Study Area Approach, Salt Lake County, Utah: Geological Society of America Abstracts With Programs, Vol. 21, No. 6, p. A-19.

Nelson, C.V., and Raseley, R.C., 1989, Evaluating the Debris Flow Potential After a Wild Fire; Rapid Response Using the PSIAC Method, Salt Lake County, Utah: Geological Society of America Abstracts with Programs, Vol. 21, No. 5, p. 121.

Christenson, G.E., Lowe, Mike, Nelson, C.V., and Robison, R.M., 1989, Wasatch Front County Hazards Geologist Program: Association of Engineering Geologists 32nd Annual Meeting Abstracts with Programs, p. 56-57.

Lowe, Mike, Robison, R.M., Nelson, C.V., and Christenson, G.E., 1989, Slope Failure Hazards in Mountain Front Urban Areas, Wasatch Front, Utah: Association of Engineering Geologists Abstracts and Program, 32nd Annual Meeting, p. 90-91.

Nelson, C.V., 1988, Preparation and Use of Earthquake Ground Shaking and Rock Fall Hazard Maps, Wasatch Front, Utah: Geological Society of America Abstracts with Programs, Vol. 20, No. 6, p. 459.

Nelson, C.V., 1988, Dresden Lane Fault Investigation: Utah Geological & Mineral Survey Report of Investigations No. 218, p. 129-131.

Nelson, C.V., 1988, Geoseismic Evaluation, Granite Fire Station, Salt Lake County, Utah: Utah Geological & Mineral Survey Report of Investigations No. 218, p. 99-128.

Barnes, J.H., and Nelson, C.V., 1988, Natural Hazards Ordinance: Salt Lake County Code of Ordinances, Chapter 19.75, Book Publishing Company, Seattle, WA, p. 671-673.

Christenson, G.E., Lowe, M.V., Nelson, C.V., and Robison, R.M., 1987, Geologic Hazards and Land Use Planning, Wasatch Front, Utah: Geological Society of America Abstracts with Programs, Vol. 19, No. 5, p. 265-266.

Christenson, G.E., Lowe, M.V., Nelson, C.V., and Robison, R.M., 1987, Geologic Hazards and Land Use Planning, Wasatch Front: Utah Geological & Mineral Survey-Survey Notes, Vol. 21, No. 1, p. 3-14.

Nelson, C.V., Christenson, G.E., Lowe, Mike, and Robison, R.M., 1987, The Review Process and Adequacy of Engineering Geologic Reports Wasatch Front, Utah, in McCalpin, James, (ed.), Proceedings of the 23rd Annual Symposium on Engineering Geology and Soils Engineering: Utah State University, April 6-8, 1987, p. 83-85.

Nelson, C.V., 1987, Surface Fault Rupture and Liquefaction Potential Hazard Area Map: Salt Lake County Public Works - Planning Division, Salt Lake City, UT, Scale 1:37,000.

Liddell, W.D., Nelson, C.V., Boss, S.K., and Martin, R.E., 1987, Sedimentological and Foraminiferal Characterization of Shelf and Slope Environments (1-234m), North Jamaica: Proceedings of the Third Symposium on the Geology of the Bahamas, CCFL Bahamian Field Station, p. 91-98.

Liddell, W.D., Boss, S.K., and Nelson, C.V., 1986, Sedimentological Characterization of Holocene Shelf and Slope Environments (1-300m) North Jamaica: Proceedings of the Third Symposium on the Geology of the Bahamas, San Salvatore, Abstracts, p.16.

Nelson, C.V., Liddell, W.D., and Martin, R.E., 1985, Bathymetric Distribution of Foraminifera Over the Range of 1-240m in Carbonate Shelf and Slope Environments: Geological Society of America Annual Meeting Abstracts with Programs, Vol. 17, No. 7, p. 675.

WESTERN GEOLOGIC, LLC

WILLIAM CRAIG BARTHOLOMEW

Title Senior Environmental Assessor

Expertise Environmental Due Diligence
Litigation Support

Academic Background M.B.A., Eccles School of Business, University of Utah, 2003
B.S. Physical Geography/Environmental Science, University of Utah, June 1988

Experience Mr. Bartholomew has over 29 years of experience managing a wide variety of environmental consulting and due diligence projects. His environmental work has included Phase I Environmental Site Assessments, Transaction Screen analyses, and soil and groundwater characterization projects involving a variety of contaminants and media. He has provided expert witness and third-party review services in a number of environmental assessment related cases.

Environmental Site Assessments

- Directed, reviewed, or conducted hundreds of Phase I Environmental Site Assessments and Transaction Screens for a variety of commercial and industrial facilities throughout the western U.S. (Alaska, Arizona, California, Colorado, Idaho, Nebraska, New Mexico, Montana, Oregon, Texas, Utah, Washington, Wyoming), as well as Mexico.

Groundwater Studies & Phase II Site Characterizations

- Managed and directed numerous Phase II environmental site characterizations to determine extent and magnitude of soil and ground water contamination.
- Conducted soil and sediment sampling to describe the extent of radioactive impact at an abandoned uranium mine that adjoins a National Recreation Area.

Professional History

Senior Environmental Assessor, Western Geologic, LLC, Salt Lake City, Utah
– 2006 to present

Senior Scientist, SECOR International, Inc., Salt Lake City, Utah – 2003 to 2005

- Served as the Due Diligence Coordinator for SECOR's Rocky Mountain/Gulf Region, overseeing environmental site assessment projects originating from multiple offices within a six-state area. Created and implemented business development strategies, work-product standardization efforts, and quality assurance measures relating to due diligence services.

Associate Scientist, SECOR International, Inc., Salt Lake City, Utah - April 1997 to June 2003 (P.T. 2001-2003)

- Recognized for superior client development and service. Managed all elements of SECOR's environmental due diligence consulting services conducted in Utah, including marketing, proposal preparation, contract negotiation, project delegation, technical oversight, report editing, invoicing, and customer service.
- Served as the western-states account manager for a major national client. Managed environmental consulting activities including compliance auditing, impact assessment, risk assessment, subsurface investigations, and NEPA studies.
- Proficient with numerous state and federal environmental regulations including CERCLA, RCRA, TSCA, and the Salt Lake County Environmental Health Rules. Invited to provide expert testimony regarding site assessment issues.

Owner/Operator, Kayenta Environmental, Inc., Salt Lake City, Utah - January 1995 to March 1997

- Conceived, organized and founded a sub-chapter S corporation specializing in environmental due diligence services. Conducted or delegated all aspects of the company's financial, managerial, and technical operations. Gained a diversified client base and successfully completed numerous projects in Utah and Idaho.

Director, Environmental Site Assessment, EnviroSearch International, Inc., SLC, Utah - February 1992 to June 1994

- Youngest EnviroSearch employee to be promoted to position of Director. Managed three professionals and staff in all aspects of Phase I Environmental Site Assessment. Frequently invited to present short courses on environmental due diligence to banking, insurance, and legal audiences. Co-authored a customized health and safety seminar for a national petroleum pipeline company and presented the seminar on numerous occasions in Utah, California, Texas, and Louisiana. Participated with ASTM during the development of the *E-1527 Phase I Environmental Site Assessment Standard*.

Project Manager, EnviroSearch International, Inc., Salt Lake City, Utah - September 1989 to January 1992.

- Excelled as Project Manager for over 100 Phase I Environmental Assessment projects. Trained colleagues in branch offices to assist with Phase I due diligence projects, streamlined Phase I work practices, and broadened existing client base.

Certifications & Training

Certified EPA/AHERA Asbestos Inspector No. 663
OSHA HAZWOPER Standard 29, CFR 1910.120
Environmental Regulations, Executive Enterprises, 1990
First Aid/CPR

Citizenship

United States

Countries Worked In

United States, Mexico

Language Proficiency

English

WESTERN GEOLOGIC, LLC

BILL D. BLACK, P.G.

Title Associate Engineering Geologist

Expertise Environmental Due Diligence
Environmental Geology
Engineering Geology
Geologic Hazards
Groundwater Geology

Academic Background B.S., Geology, Weber State University, 1986, top department graduate

Registration Professional Geologist – Utah #5224898

Experience Mr. Black has over 27 years of experience conducting geologic investigations, mostly gained while working as a project geologist for the Utah Geological Survey. His expertise is in fault and seismic studies; geologic hazards mapping, analysis and mitigation; landslide, debris flows, and slope stability; and radon. He has completed numerous fault investigations under the U.S. Geological Survey's National Earthquake Hazard Reduction Program (NEHRP), and radon-hazard studies under the Environmental Protection Agency's State Indoor Radon Grant (SIRG) Program. Mr. Black served from 1998 to 2000 on the Utah Division of Comprehensive Emergency Management Interagency Technical Team.

Mr. Black also has experience in field reconnaissance and sampling of stream sediment for economic mineral evaluation, including trace mineral suites characteristic of Kimberlite deposits in northern Wyoming. Mr. Black has been involved in hydrogeologic investigations measuring spring flow and water quality, environmental investigations determining suitability for landfills and wastewater soil-absorption systems, and conducted numerous geotechnical report reviews for local governments.

Mr. Black has been involved in hydrogeologic investigations measuring spring flow and water quality, environmental investigations determining suitability for landfills and wastewater soil-absorption systems, and conducted numerous geotechnical report reviews for local governments.

Environmental Site Assessments

- Conducted numerous Phase I Environmental Site Assessments, Phase II Subsurface Investigations, and Environmental Transaction Screens for a variety of commercial and industrial facilities throughout the western U.S.

Hydrogeology Projects

- Conducted a depth to bedrock seismic refraction study for Spring City, Utah municipal water well location in cooperation with the Utah Division of Water Resources.
- Conducted water quality and flow measurements for potential water sources, Antelope Island State Park, Utah.
- Conducted percolation tests and assisted in field bedrock characterization for a waste-water soil-absorption system suitability study for Duchesne County, Utah.
- Mapped areas of shallow ground water in Tooele Valley and the West Desert Hazardous Industry Area, Utah.
- Conducted shallow drilling studies to determine depth to the unconfined aquifer, Ogden Valley, Utah, for a water quality assessment.

Environmental Geology

- Authored and co-authored studies mapping and evaluating the radon-hazard potential of the lower Weber River area, Weber and Davis Counties, Utah; Tooele Valley, Tooele County, Utah; western Salt Lake Valley, Salt Lake County, Utah; and Sandy and Provo Cities, Salt Lake and Utah Counties, Utah.
- Compiled, mapped, and published the statewide radon-hazard potential map for Utah.
- Assisted in field reconnaissance for four proposed landfill sites in Wasatch County, Utah.

Geologic Hazards

- Authored and co-authored six NEHRP fault and trenching studies at sites along the Wasatch fault zone, Oquirrh fault zone, Mercur fault, and West Cache fault zone in Tooele, Cache, Salt Lake, and Utah Counties, Utah.
- Principal investigator, Cache Landmark Engineering, Canyon Ridge Estates fault trenching project, East Cache fault zone, North Logan, Cache County, Utah.
- Assisted with the Mapleton Megatrench project, Provo segment of the Wasatch fault zone, Utah County, Utah in cooperation with URS Corp. (Oakland, CA) and the Utah Geological Survey.
- Conducted numerous geologic hazard assessments for water tanks, schools, fire stations, and School Trust Lands in Utah.
- Evaluated and documented geologic effects associated with the 1992 St. George earthquake and Springdale landslide; evaluated causes and effects of the 1999 Weber-Davis Canal breach in Riverdale, Weber County, Utah; and responded to numerous other geologic hazard events in Utah resulting from landslides, rock falls, canal failures, and earthquakes.
- Mapped geology and geologic hazards of Tooele Valley and the West Desert Hazardous Industry Area, Tooele County, Utah; co-author for Geologic hazards of the Ogden area and Geology of Salt Lake City.
- Co-authored the digital Quaternary fault and fold database and map of Utah.
- Conducted numerous geologic hazard and site suitability assessments for water tanks, schools, fire stations, subdivisions, and State Trust land sales.

Economic Mineral Evaluation

- Conducted stream sediment sampling for trace minerals characteristic of Kimberlite deposits, Big Horn Mountains, Wyoming.

Geologic Hazards - Land Use Planning

- Prepared the geologic hazards analysis and maps for Tooele County Planning Division for Tooele Valley. Geologic hazards of prime consideration included: surface fault rupture, earthquake ground shaking, landslides, rock fall, debris flow, problem soils, stream flooding, liquefaction, shallow ground water, and radon.
- Prepared the geologic hazards analysis and maps for Tooele County Planning Division for the West Desert Hazardous Industry Area. Geologic hazards of prime consideration included: earthquake ground shaking, landslides, rock fall, pond and sheet flooding, problem soils, liquefaction, shallow ground water, and radon.
- Conducted numerous geologic and geotechnical consultant report reviews for developments in Cache, Weber, Davis, Morgan, Salt Lake, and Utah Counties, Utah.

Professional History

Associate Engineering Geologist, Western GeoLogic, Salt Lake City, UT (2003-present)
Project Geologist, Utah Geological Survey, Applied Geology Section, Salt Lake City, Utah (1995-1999).

Geologist, Utah Geological Survey, Applied Geology Section, Salt Lake City, Utah (1990-1995).

Geotechnician, Utah Geological Survey, Applied Geology Section, Salt Lake City, Utah (1986-1990).
Field Geotechnician, North American Exploration, Kaysville, Utah (1986).

Professional Awards	Co-recipient, Geological Society of America John C. Frye award for 1995. Received numerous Utah Geological Survey awards for excellence. Received Utah Division of Radiation Control award for achievements in radon hazards.
Citizenship	United States
Countries Worked In	United States
Language Proficiency	English

Partial List of Publications

- Black, B.D., 1993, The radon-hazard-potential map of Utah: Utah Geological Survey Map 149, scale 1:1,000,000, 12 p. pamphlet.
- 1996, Radon-hazard potential of western Salt Lake Valley, Salt Lake County, Utah: Utah Geological Survey Special Study 91, scale 1:50,000, 27 p.
- Black, B.D., Giraud, R.E., and Mayes, B.H., 2000, Paleoseismology of Utah, Volume 9—Paleoseismic investigation of the Clarkston, Junction Hills, and Wellsville faults, West Cache fault zone, Cache County, Utah: Utah Geological Survey Special Study 98, 23 p.
- Black, B.D., Hecker, Suzanne, Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003, Quaternary fault and fold database and map of Utah: Utah Geological Survey Map 193DM, digital format GIS map and spatial database CD-ROM, scale 1:500,000.
- Black, B.D., Lund, W.R., and Mayes, B.H., 1995, Large earthquakes on the Salt Lake City segment of the Wasatch fault zone—summary of new information from the South Fork Dry Creek site, Salt Lake County, Utah, *in* Lund, W.R., editor, Environmental and engineering geology of the Wasatch Front region: Salt Lake City, Utah Geological Association Publication 24, p. 11-30.
- Black, B.D., Lund, W.R., Schwartz, D.P., Gill, H.E., and Mayes, B.H., 1996, Paleoseismology of Utah, Volume 7--Paleoseismic investigation on the Salt Lake City segment of the Wasatch fault zone at the South Fork Dry Creek and Dry Gulch sites, Salt Lake County, Utah: Utah Geological Survey Special Study 92, 22 p.
- Black, B.D., Mulvey, W.E., Lowe, Mike, and Solomon, B.J., 1995, Geologic effects, *in* Christenson, G.E., editor, The September 2, 1992 M_L 5.8 St. George earthquake, Washington County, Utah: Utah Geological Survey Circular 88, p. 2-11.
- Black, B.D., and Solomon, B.J., 1996, Radon-hazard potential of the lower Weber River area, Tooele Valley, and southeastern Cache Valley, Cache, Davis, Tooele, and Weber Counties, Utah: Utah Geological Survey Special Study 90, scale 1:50,000 and 1:100,000, 56 p.
- Black, B.D., Solomon, B.J., and Harty, K.M., 1999, Geology and geologic hazards of Tooele Valley and the West Desert Hazardous Industry Area, Tooele County, Utah: Utah Geological Survey Special Study 96, 6 plates, scale 1:100,000, 65 p.

-
- Lowe, Mike, Black, B.D., Harty, K.M., Keaton, J.R., Mulvey, W.E., Pashley, E.F., Jr., and Williams, S.R., 1992, Geologic hazards of the Ogden area, Utah, *in* Wilson, J.R., editor, Field guide to geologic excursions in Utah and adjacent areas of Nevada, Idaho, and Wyoming: Utah Geological Survey Miscellaneous Publication 92-3, p. 231-285. Winner of Geological Society of America's 1995 John C. Frye Environmental Geology Award.
- Lund, W.R., and Black, B.D., 1998, Paleoseismology of Utah, Volume 8--Paleoseismic investigation at Rock Canyon, Provo segment, Wasatch fault zone, Utah County, Utah: Utah Geological Survey Special Study 93, 2 plates, 21 p.
- Lund, W.R., Christenson, G.E., Harty, K.M., Hecker, Suzanne, Atwood, Genevieve, Case, W.F., Gill, H.E., Gwynn, J.W., Klauk, R.H., Mabey, D.R., Mulvey, W.E., Sprinkel, D.A., Tripp, B.T., Black, B.D., and Nelson, C.V., 1990, Geology of Salt Lake City, Utah: United States of America, Bulletin of the Association of Engineering Geologists, v. 27, no. 4, p. 391-478.
- Lund, W.R., Schwartz, D.P., Mulvey, W.E., Budding, K.E., and Black, B.D., 1991, Paleoseismology of Utah, Volume 1--Fault behavior and earthquake recurrence on the Provo segment of the Wasatch fault zone at Mapleton, Utah County, Utah: Utah Geological and Mineral Survey Special Studies 75, 41 p.
- Olig, S.S., Gorton, A.E., Black, B.D., and Forman, S.L., 2001, Paleoseismology of the Mercur fault and segmentation of the Oquirrh-East Great Salt Lake fault zone, Utah: URS Corporation, Unpublished Consultant Report, NEHRP Award No. 98HQGR1036, 41 p.
- Olig, S.S., Lund, W.R., Black, B.D., and Mayes, B.H., 1996, Paleoseismic investigation of the Oquirrh fault zone, Tooele County, Utah, *in* Lund, W.R., editor, Paleoseismology of Utah, Volume 6--The Oquirrh fault zone, Tooele County, Utah, surficial geology and paleoseismicity: Utah Geological Survey Special Study 88, p. 19-64.

WESTERN GEOLOGIC, LLC

KEVIN J. THOMAS

Title Environmental Professional

Expertise Environmental Due Diligence
Groundwater Geology
Borehole Geophysics
Structural Geology

Academic Background B.A. Geology, Utah State University, 1998, cum laude

Experience Mr. Thomas has over 10 years of experience working in geology in Utah. His expertise is in groundwater geology and borehole geophysics. He has collected and analyzed geophysical logs from water wells, designed monitoring-well completions, measured stream flows, analyzed drill cuttings, collected groundwater samples for testing, and worked on aquifer storage and recovery projects. He has completed the ASTM training course on the Phase I & Phase II Environmental Site Assessment Processes.

Environmental Site Assessments

- Conducted over 60 Phase I Environmental Site Assessments and Transaction Screens for a variety of commercial, agricultural, residential, and industrial properties in Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Washington.
- Conducted Phase II Environmental Site Assessments to evaluate the extent and magnitude of contamination.
- Conducted remediation projects to remove contaminated soil.

Hydrogeology

- Maintained network of monitoring wells in Snake Valley, including collection and processing of water-level data from transducers. Designed and maintained an online database for hosting the water-level data.
- Assisted in selecting sites and planning completions of over 70 monitoring wells for the Utah Geological Survey (UGS) Snake Valley groundwater monitoring network, using borehole-geophysical logs and well cuttings to determine optimal screen depths.
- Selected wells and springs statewide to sample for Utah's participation in the National Ground Water Monitoring Network.
- Collected groundwater samples for water-quality testing from wells and springs throughout Utah.
- Conducted an Aquifer Storage and Recovery (ASR) pilot project in Cache Valley, UT, including: identifying and evaluating potential surface-ponding and well-injection sites, monitoring a surface-ponding project to determine infiltration rates, and tracking subsurface water flow through micro-gravity surveys.
- Created basin-fill isopach and piezometric surface maps to investigate sources of poor quality groundwater in the Bothwell area, northern Utah. We determined that salt water from the nearby Great Salt Lake was not being pulled into the local groundwater by high rates of pumping in agricultural wells, and that the source of salt in the groundwater was likely dissolution of salt deposits in the soil that had been left by previous high stands of the Great Salt Lake.
- Delineated recharge and discharge areas in the basin-fill aquifer of the Beryl-Enterprise area in southwestern Utah.
- Measured stream flow with flumes and velocity meters in the Snyderville Basin, Sanpete Valley, and Snake Valley.

Geophysics

- Conducted borehole geophysical logging, processed, and analyzed the resulting well logs on nearly 100 water wells throughout Utah.
- Collected, processed, and interpreted Bouguer Gravity data in Morgan Valley, Utah, and along Ash Creek in southwestern Utah to help determine the thickness of the basin-fill aquifer systems, and to improve understanding of the regional groundwater system in the area of the Hurricane fault.
- Taught continuing education classes for water-well drillers on geophysical logs.

Structural Geology

- Identified characteristic geophysical well-log signatures of sub-seismic faults in eolian sandstone. Used core logging, well logs, thin sections, and permeability data taken from cores to establish the most useful logs to recognize sub-seismic faults and stratigraphic heterogeneities in eolian sandstone and quantify their hydrologic properties. Worked with reservoir engineers to create a hydrologic model for flow simulation.
- Conducted structural analysis of a range-bounding normal fault near Wendover, Nevada, by measuring fault plane and slickenline orientations. Determined state of stress on the fault by using computer software to analyze data.

Professional History

Environmental Professional, Western GeoLogic, Salt Lake City, UT (2015- present)
Geologist, Utah Geological Survey, Salt Lake City, UT (2005-2015)

Citizenship

United States

Countries Worked In

United States

Language Proficiency

English, Spanish, Portuguese

Publications

Blackett, R.E., Jordan, J.L., Thomas, K., Wallace, J., and Biek, R.F., 2009, A Concealed Geothermal System near Corner Canyon, Salt Lake County, Utah, *in* Tripp, B.T., Krahulec, K., and Jordan, J.L., editors, *Geology and Geologic Resources and Issues of Western Utah*: Utah Geological Association Publication 38, p. 235-250, CD.

Hurlow, H., Jordan, J.L., and Thomas, K., 2015, UGS Groundwater-Monitoring Network, *in* Hurlow, H., editor, *Hydrogeologic Studies and Groundwater Monitoring in Snake Valley and Adjacent Hydrographic Areas, West-Central Utah and East-Central Nevada*: Utah Geological Survey Bulletin 135, p. 91-124, DVD.

Inkenbrandt, P., Thomas, K., and Hardwick, C., 2013, Cache Valley Aquifer Storage and Recovery – Phase II: Utah Geological Survey Open File Report 615, 39 p., CD, online, <http://geology.utah.gov/online/ofr/ofr-615.pdf>.

Inkenbrandt, P., Thomas, K., and Jordan, J.L., 2013, Regional Groundwater Flow and Water Quality in the Virgin River Basin and Surrounding Areas, Utah and Arizona: Utah Geological Survey Report of Investigation 272, 46 p., CD, online, <http://geology.utah.gov/online/ri/ri-272.pdf>.

Shipton, Z.K., Evans, J.P., Lachmar, T., Thomas, K., Forster, C., and Snelgrove, S., 2001, The Three-Dimensional Structure of Fault Damage Zones and Implications for Permeability: Big Hole Fault Drilling Project: Logan, Utah, unpublished project report for US Dept. of Energy and petroleum industry consortium, variously paginated.

Thomas, K., Oaks, R.Q., Jr., Inkenbrandt, P., Sabbah, W., and Lowe, M., 2012, Cache Valley Principal Aquifer Storage and Recovery Site Assessment – Phase I: Utah Geological Survey Open File Report 579, 34 p., CD, online, <http://geology.utah.gov/online/ofr/ofr-579.pdf>.

Thomas, K., and Lowe, M., 2007, Recharge and Discharge Areas for the Principal Basin-Fill Aquifer, Beryl-Enterprise Area, Iron, Washington, and Beaver Counties, Utah: Utah Geological Survey Map 225, 14 p., CD, online, <http://geology.utah.gov/online/m/m-225/m-225.pdf>.

Thomas, K., 2006, Borehole-Geophysical Logging Program at the Utah Geological Survey [abs]: Geological Society of America Abstracts with Programs, Vol. 38, No.6, p. 6, online, https://gsa.confex.com/gsa/2006RM/finalprogram/abstract_104880.htm.

Wallace, J., Lowe, M., King, J., Sabbah, W., and Thomas, K., 2012, Hydrogeology of Morgan Valley, Morgan County, Utah: Utah Geological Survey Special Study 139, 146 p., CD, online, <http://geology.utah.gov/online/ss/ss-139/ss-139txt.pdf>.

Wallace, J., Thomas, K., and Lowe, M., 2010, Evaluation of Sources of Poor Quality Ground Water in the Bothwell Pocket Area, Lower Bear River Valley, Eastern Box Elder County, Utah: Utah Geological Survey Special Study 135, 50 p., CD, online, <http://geology.utah.gov/online/ss/ss-135.pdf>.