

# Michael L. Raub, PG, CEG, QSP, QSD

## Principal Geologist



### Education

- M.Phil., Geology, University of Auckland, New Zealand, 1985
- B.A., Geology, University of California, Santa Barbara, 1979

### Registration and Certification

- Professional Geologist, California, 1987, #4415
- Certified Engineering Geologist, California, 1987, #1376
- 40-Hour OSHA Trained, 29 CFR 1910.120(e)(2)/8 CCR 5192
- Certified QSP/QSD

### Experience

34 years

### With AES

17 years

### Professional Activities

- Member, Geological Society of America

Michael Raub brings over 34 years of experience in investigations, permitting, engineering design and construction quality assurance programs for earthworks, landfill liners, final cover, groundwater monitoring systems, landfill siting, and associated civil improvements at dozens of landfill sites in California. He brings detailed site knowledge of OC Waste & Recycling landfill sites. He has served as either Project Manager or QA/QC Manager for a number of projects at FRB Landfill including the groundwater protection systems (liners and LCRS) design for the first two phases of landfill expansion, composite liner systems for Phases IVA, IVB and IVC. He served as Design Manager and QA/QC Manager for the Landslide Backcut Excavation project. For the Landslide Backcut Design and QA/QC project at FRB Landfill, Michael was also responsible for regulatory liaison that involved agency coordination with CDFG, Army Corps of Engineers (ACOE), Orange County HBP and the City of Irvine. He has detailed knowledge and hands on experience with permitting issues and he successfully coordinated AES' role with OC Waste & Recycling staff and other consulting teams to achieve timely securing of agency approvals. He also brings site-specific experience at Prima Deshecha Landfill during the landslide evaluations and construction materials investigations for Zone 1. Michael has also served as Construction Manager on a major expansion of the San Timoteo Sanitary Landfill, Landfarm liner construction at the Landers Sanitary landfill, and closure of Apple Valley and Big Bear Sanitary Landfills for the County of San Bernardino. His relevant experience includes:

- **Frank R. Bowerman Landfill, Orange County, California**

*Project Manager* for the design and preparation of construction plans and specifications for the 5.8 million cu. yd. Landslide Backcut Excavation project including grading plans, surface drainage and stockpile plans and horizontal drains. CM (Backup)/QA/QC Manager for Phases VIIA and VIIB expansions involving construction of 50 acres of composite liner including 6 million cu. yds. of excavation, 110,000 cu. yds. of low-permeability clay liner, and 6.5 million sq. ft. of geosynthetics. Also responsible for design of buttresses, landslide remediation measures, and liner design to suit exposed field conditions.

*Project Manager* for QA/QC and landfill engineering for Phase I of landfill construction. Reviewed exposed geologic conditions and grading design for their impact on the project constructability. Prepared design details and construction specifications for the composite compacted clay-flexible membrane lining and the leachate collection and removal system components of the groundwater protection system. Work was performed in a fast-track project to modify the landfill design to comply with Subtitle D regulations. Evaluated onsite clay sources, leading to the successful construction of a clay liner without requiring the import of clay. Developed and coordinated the construction QA/QC monitoring program for both clay and synthetic lining built at the site. Organized and coordinated compatibility

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testing and interface shear strength testing of geosynthetics. Phase I involved construction coordination and QA/QC for 75,000 cubic yards of clay lining and 1.5 million square feet of high-density polyethylene (HDPE). Designed a grading plan and construction sequencing for a 60-foot-deep subsurface barrier excavation.

*Project Manager* for the geotechnical exploration program for the 55-acre Phase II expansion. Evaluated subsurface conditions of compressible surficial soils and stability of 20 landslides up to 8 acres in size, and provided stabilization and remedial grading plan recommendations. Supervised drilling of 23 borings, geologic and laboratory evaluations of 4 major clay borrow sources. Evaluations identified 2.8 million cubic yards of soil suitable for clay liner construction. Designed grading plans and construction sequencing for earthwork and the installation of clay and synthetic lining system. Coordinated design review, CQA, and earthwork direction activities. Supervised the stringent CQA program during construction of the Phase II lining, involving 2 million cubic yards of excavation, 78,000 cubic yards of clay lining and 1.4 million square feet of HDPE geomembrane, and associated drainage, roadway and infrastructure improvements. Prepared QA/QC reports, survey and construction record drawings that were approved by the RWQCB.

*Project Manager and Engineering Geologist of Record* for the implementation of the Phase II construction QA/QC program and field engineering support during construction of the 17 acres of Subtitle D composite liner and leachate collection system. Supervised QA/QC observation and testing for 55,000 cy of compacted clay liner, 730,000 square feet of HDPE geomembrane, and 10,000 square feet of GCL as the primary liner system. Supervised QA/QC for the installation of 750,000 square feet of geotextile and 28,000 cubic yards of graded filter sand and piping forming the LCRS, and 56,000 cubic yards of overlying operations layer soil. Construction testing and inspection was provided for asphalt paving and concrete/steel for drainage structures. Compiled survey as-built information and prepared pay quantity estimates and Construction Record Drawings. Provided the review of in-grade geologic mapping of the containment area and adjacent excavations. Also reviewed submittals and field changes, and developed plan modifications to suit field conditions.

*Project Manager and Engineering Geologist of Record* for the landfill Phase IVA and IVB liner expansion covering 25 acres and consisting of a composite 2-foot compacted clay liner and 80-mil HDPE geomembrane. Construction included 1 million cubic yards of excavation, stockpile grading, subdrain installation, the liner and overlying leachate collection gravel layers with piping, protective soil cover, and about 2 miles of reinforced concrete-lined drainage channels. Mr. Raub supervised all aspects of the construction QA/QC program, including for earthwork, 85,000 cubic yards of clay liner, 1.1 million square feet of HDPE, geotextile, LCRS, soil cover and concrete, steel and asphalt. Provided field engineering for construction including plan clarifications, submittal review, plan modifications for changed conditions, and review of contract change orders for technical compliance. Compiled as-built survey data for development of pay quantities and Construction Record Drawings.

*Project Manager and Engineering Geologist of Record* for the implementation of the construction Phase IVC QA/QC program and field engineering support during construction of the 17 acres of Subtitle D composite liner and leachate collection system. Supervised QA/QC observation and testing for 55,000 cy of compacted clay liner, 730,000 square feet of HDPE geomembrane, and 10,000 square feet of GCL as the primary liner system. Supervised QA/QC for the installation of 750,000 square feet of geotextile and 28,000 cubic yards of graded filter sand and piping forming the LCRS, and 56,000 cubic yards of overlying operations layer soil. Construction testing and inspection was provided for asphalt paving and concrete/steel for drainage structures. Compiled survey as-built information and prepared pay quantity estimates and Construction Record Drawings. Provided the review of in-grade geologic mapping of the containment area and adjacent excavations. Also reviewed submittals and field changes, and developed plan modifications to suit field conditions.

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*Senior Geologist* for geotechnical investigation for landfill expansion including slope stability evaluation, seismicity and faulting studies, materials resources evaluation, and preparation of geotechnical report for regulatory agency review.

- **Santiago Canyon Landfill, Orange County, California**

*Construction Manager* (backup) and construction support for 130-acre moncover closure construction. Responsible for in situ cover characterization, limits of refuse delineation, and preparing design modifications to optimize existing cover thickness.

- **Olinda/Olinda Alpha Landfill, Brea, California**

Supervised two separate studies of active landslides and unstable slopes onsite. These studies included field investigations (geologic mapping, trenching and drilling), stability analyses and providing recommendations for stabilization by buttress fill and associated drainage improvements. Also performed geotechnical explorations for an access road, a groundwater pipeline, and a sediment basin reconstruction.

- **Camp Roberts Landfill, San Luis Obispo County, California.**

*Design Engineer and Construction Manager* for 12-acre landfill composite liner project including earthworks, clay liner and geosynthetics.

- **Big Bear Sanitary Landfill, San Bernardino County, California**

*Construction Manager* during CM services for the final closure construction project for the 79-acre landfill involving 5-foot thick monolithic cover on slopes and geomembrane/soil cover on top deck, benches and access road, and CQA services for drainage structures, roads, fencing, LFG headers and LFG monitoring probe installation. The project also included coordination with A/E firms.

- **San Timoteo Sanitary Landfill, San Bernardino County, California**

*Construction Manager* during CM/CQA services for Unit 2, Phase 3 expansion involving 6,000 cu. yds. of clay liner, 400,000 cu. yds. of engineered fill and over 1.5 million sq. ft. of geosynthetics installation including HDPE geomembrane, GCL, geotextile and protective membrane.

*Design Manager* for preparation of construction documents including grading plans and LCRS details and drainage plans for 5-acre Unit 2, Phase 3 composite liner and preparation of bid documents for \$5.0 million public works contract.

- **Apple Valley Sanitary Landfill, San Bernardino County, California**

*Lead Design Manager* for design of final closure plans for 40-acre landfill including preparation of construction plans, specifications and Engineers Estimate for \$4.5 million public works contract.

*Construction Manager* for closure construction including design support for reviewing field conditions and preparing modifications to grading plans to suit field conditions.

- **Landers Sanitary Landfill, San Bernardino County, California**

*Construction Manager/CQA Manager* for design, CQA and CM services for Septage Pond Modifications and Landfarm Liner project involving design and construction of geosynthetic liner system with leak detection, earthworks and installation of vadose zone wells and landfill gas monitoring probes. The geosynthetics for the ponds and landfarm liner consisted of two 60-mil HDPE geomembrane layers with drainage geocomposite sandwiched for leak detection. Project also included design and construction of new aprons for septage disposal.

- **Colton Sanitary Landfill, San Bernardino County, California**

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Design Support for final cover design and preparation of closure and post-closure plans for Phase 2 closure including alternative cover design and infiltration modeling.

- **Milliken Sanitary Landfill, San Bernardino County, California**

*Resident Engineer (Backup)* for the construction management and CQA services for the Phase 3 final closure construction. The closure included construction of 3-foot thick moncover for this 75-acre landfill including 50 acres of side slopes and 25 acres of deck areas.

- **Mid-Valley Sanitary Landfill, San Bernardino County, California**

*Construction Manager (Backup)* for the Unit 3, Phase 5A composite liner construction involving 25,000 cu. yds. of clay liner and 1,200,000 sq. ft. of geosynthetics.

- **Badlands Landfill, Riverside County, California**

*Project Manager* for Canyon 1 expansion QA/QC program including earthwork, 48,000 cubic yards of clay liner and LCRS placement covering 10 acres. Provided QA/QC monitoring and testing for clay borrow operations, production pad construction and during placement of clay liner with in the expansion area. Testing included geotechnical index tests, triaxial laboratory permeability, and BATM field permeability tests to verify that the  $1 \times 10^{-7}$  cm/sec maximum permeability standard had been achieved. The CQA program was conducted in conformance with CCR Title 23, Chapter 15 construction and design requirements in force at the time, and was reviewed and approved by the Santa Ana RWQCB.

*As Project Director*, supervised the CQA program for the construction of a Subtitle D composite liner and LCRS for the 5-acre Canyon 2 expansion. The bottom liner system consisted of 2 feet of compacted clay with a maximum permeability of  $1 \times 10^{-7}$  cm/sec, overlain by 60-mil HDPE geomembrane. Side slopes were lined with GCL overlain by the geomembrane. CQA services were provided for earthworks, compacted clay liner, GCL, geomembrane, geotextile, filter sand, operations layer, subdrainage and perimeter surface water drainage improvements.

- **Puente Hills Landfill, Los Angeles County, California**

*Field Geologist* during piezometer abandonment for Lower Western Cut.

*Field Geologist* responsible for supervising and coordinating the drilling, geotechnical logging and sampling of 13 borings ranging from 75 to 325 feet deep, and the construction of seven piezometers to depth of 325 feet. Compared surface geologic mapping data with stratigraphic and structural information obtained from the borings to develop a geotechnical model of the eastern canyon expansion area.

- **Calabasas Landfill, Los Angeles County, California**

Investigated the geotechnical and hydrogeologic characteristics for design of a bentonite slurry cutoff wall and leachate extraction well system including 460 feet of seismic refraction survey, and logging and sampling of 4 borings from 50 to 80 feet in depth by air rotary techniques.

- **55th Way Landfill, Long Beach, California**

*Design Support* during design of an alternative final cover system, construction CQA, and regulatory coordination during construction of final cover and conversion of the former 55th Way landfill into a public park and recreational area.

- **Savage Canyon Sanitary Landfill, Whittier, California**

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*Project Manager* for phasing plan for the incremental development of the back canyon of the landfill. Phasing design required addressing stability of a large landslide initiated during previous grading at the site and stability of the interim refuse fills.

Developed construction drawings, specifications and technical design report for the first incremental phase of expansion of the composite lining system. Also supervised preparation of hydrology and hydraulic calculations and prepared construction-level designs for a concrete-lined sediment control basin.

- **Double Butte Landfill, Riverside County, California**

*Project CQA Manager* for CQA services for the first phase of closure construction at the 100-acre landfill. Work included implementation of CQA testing, observation and reporting during placement of the 2-foot thick foundation layer as part of final cover.

- **West Riverside Landfill, Riverside County, California**

*Project Manager* for observation and testing for the 65-acre final cover system that meets Chapter 15 requirements, upgrading and installation of additional vertical wells for the landfill gas collection system, construction of concrete lined drainage channels and preparation of as-built report and construction plans. Project included stringent construction monitoring and testing for 104,000 cubic yards of compacted clay that forms the low-permeability layer of the final cover. The final cover consisted of 2 feet of foundation layer soil, 1 foot of compacted clay meeting a maximum permeability requirement of  $1 \times 10^{-6}$  cm/sec, and 1½ feet of vegetative layer soil.

- **McFarland-Delano Landfill, Kern County, California**

*CQA Manager* during QA/QC services for closure construction of the 40-acre landfill. The closure included construction of foundation layer, low-permeability-barrier layer, and vegetative soil cover.

- **Antelope Valley Public Landfill, Palmdale, California**

*Project Manager* for preparation of a Joint Technical Document for the expansion of a 115-acre landfill. Developed preliminary designs for the landfill expansion. Technical challenges included seismic stability of the refuse mass and final cover system due to ground motions from the San Andreas Fault, located at the property boundary. Oversaw the development of ground motions for a Mw 8 earthquake and a finite element model for site. Evaluated acceleration time histories using TELDYN. Calculated permanent deformations for refuse fill and shallow failures of the landfill cover. Developed a preliminary closure plan utilizing a monolithic soil cover as an alternative to prescriptive designs, suitable for the arid site. Prepared updated Monitoring and Reporting Program for groundwater and surface water. A major challenge to the development of the site was related to potential flooding of a creek at the property boundary. Supervised analysis of floodplain limits and channel velocities using HEC-RAS for the Capital Flood and 100-year, 24-hour flood events, required to address both state landfill regulations and local flood control design standards. Developed alternative solutions for channel modifications and bank scour analyses to define project improvements or set backs. Supported the client in preparation of the Conditional Use Permit application to the City of Palmdale and negotiating conditions regarding regional flood control issues.

- **Edom Hill Landfill, Riverside County, California**

*Field Geologist* during a preliminary geotechnical investigation to evaluate the suitability of a proposed transfer station site located in close proximity of the south branch of the San Andreas fault. Conducted geologic logging of a 415 foot-long trench to investigate faulting potential and to establish structure setbacks.

- **Ramona Landfill, Ramona, California**

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*Lead Investigator and Project Manager* for a comprehensive evaluation of landfill gas (LFG), soil vapor and groundwater extraction and treatment improvements for a site with groundwater impacted by tetrachloroethene, trichloroethene, and associated chlorinated aliphatic compounds. Compiled data and performed original studies to characterize complex hydrogeological conditions. Site groundwater flows in both deeply weathered and fractured bedrock units. Evaluated performance of existing groundwater and vapor extraction systems and made recommendations for system improvements to control and remediate groundwater at the facility. The evaluations included assessment of the existing LFGs collection system and flare. LFG perimeter probe monitoring data was compiled to define areas of migration. Conceptual designs were prepared for upgrades to collection system to control offsite migration and remove VOCs from the unsaturated zone. Conducted original studies to support design of a final corrective action plan, including resistivity profiling to define extent of weathered bedrock and fracture zones. Conducted testing of gas extraction wells within refuse and the unsaturated zone to evaluate effectiveness of existing systems and to develop data for design of final gas extraction systems to control VOCs in the unsaturated zone. Installed a test well and observation wells and conducted pump test to provide supporting information for the design of a final groundwater extraction and treatment system.

- **Tripp Salvage Landfill, Otay Mesa, California**

*As Lead Engineering Geologist*, prepared geotechnical report, final closure and post-closure maintenance plans, and construction level designs for closure of an inactive 7-acre auto shredder and burn dump ash landfill. Conducted interim closure inspections of waste pile and drainage. Prepared a geotechnical report presenting the results of field explorations, laboratory testing, and engineering evaluations for static and dynamic slope stability, liquefaction, and settlement. Provided technical review of geohydrology and surface water hydrology studies at the site. Principal author and civil designer for final closure documentation consisting of a final closure plan, construction drawings and specifications, emergency response plan, post-closure monitoring and maintenance plan and construction quality assurance plan consistent with CCR Title 27 and Federal Subtitle D requirements. Provided designs for achieve regulatory compliance for endangered species and wetlands mitigation, including native plant salvage and site re-vegetation. Currently coordinating the efforts for closing the California Environmental Quality Act approval process, including wildlife surveys, archaeological studies, and habitat assessments. Negotiating mitigations for project impacts to jurisdictional waters, wetlands and sensitive riparian habitat with City of San Diego, U.S. Army Corps of Engineers, US Fish and Wildlife Service, and California Department of Fish and Game.

- **Planning Area 18 East, Mission Viejo, California**

*Lead Field Geologist* for subsurface exploration of an 80-acre residential development in hillside terrain. Performed geological mapping and sampled and logged 15 borings and 12 trenches. Logging techniques included downhole inspection of large diameter borings, and recorded lithology and structural data. Identified surface and subsurface geometries and geotechnical conditions for five major landslides up to 31 acres in area and 100 feet deep. Prepared geologic report with maps and sections used in design of remedial grading measures.

- **Sunset Cove Landslide Evaluation, Palos Verdes Estates, California**

*As Lead Geologist*, conducted geotechnical exploration and evaluation of a large landslide along the coastal bluff of the Palos Verdes Peninsula. The landslide was progressively retreating landward, and had progressed to the point that the city roadways were being significantly impacted. The project included the drilling and sampling of four large-diameter borings to 175 feet below the ground surface. The borings were logged down-hole to identify potential landslide slip surfaces, site stratigraphy, and to photographically log the subsurface conditions. One borehole was fitted with a slope inclinometer to evaluate potential subsurface movements. Also conducted detailed mapping of landslide features, surrounding geology, and groundwater conditions. Developed detailed cross sections, identifying the clay-rich, altered volcanic ash units that contributed to the

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instability of the slope. Developed alternatives for the stabilization of the site, including bluff grading, buttress fills, dewatering and caisson solutions.

- **Active Fault Study, Cabrillo Fault, San Pedro, California**  
Conducted a field exploration including a surface rupture hazard study of possible active fault crossing a proposed housing development crossed by the Cabrillo Fault. Trenches across the site exposed complex fault relationships and offsets of Pleistocene terrace deposits and Miocene bedrock. Analyzed potential for future rupture and developed setbacks from the located fault trace for proposed structures.
- **Seismotectonic Hazard Evaluation, Mohaka Fault, Hawkes Bay, New Zealand**  
Conducted a field and office study of faulting potential for a major fault on the North Island of New Zealand. Analyzed aerial photos and mapped an 83-square-kilometer area along the fault trace. Conducted measurements of offset geologic features such as river terraces, soils, and volcanic ashes. Developed geologic and soil stratigraphy, including dating of features to determine rate and movement and earthquake recurrence intervals. Study used in regional analysis for a major hydroelectric dam project.

### Publications

- Raub, M. L., Morell, D. J., Aronson, E., Finegan, J. M., Keenan, R. J., Rivera, A. L., 2000. Mechanisms of Landfill Gas Migration in the Vadose Zone at an Arid Region Landfill. Proceedings from the 3rd Annual Arid Climate Symposium, Solid Waste Association of America, p2-1 – 2-11.
- Raub, M. L., 1997. Geotechnical Aspects of Landfill Operations, presentation for Basic Engineers Training Course, County of Orange Integrated Waste Management Department.
- Raub, M. L., 1995. Landfill Design, guest lecturer for Environmental Engineering Course, Department of Civil Engineering, California State University, Fullerton.
- Raub, M. L., 1995. Technology, Regulations and the Learned Experience at Municipal Solid Waste Landfills in Southern California; presentation at The Greening of Southern California: Strategies for the 21st Century, California State University, Fullerton.
- Raub, M. L., H.N. Cutten, and A.G. Hull, 1987. Seismotectonic Hazard Analysis of the Mohaka Fault, North Island, New Zealand; Proceedings from the Pacific Conference on Earthquake Engineering, August, Vol. 3, p. 219-230.
- Bryant, M. E., and M. L. Raub, 1986. The Cabrillo Fault - A Structural Problem, Palos Verdes Peninsula: in Baldwin, E.J. (Ed.) Geology and Landslides of Palos Verdes Hills, California; Guidebook, National Association of Geology Teachers, Far Western Section, Spring 1986, p. 64-68.