



Justin W. Knudsen, P.E., QP
Associate

Sr. Civil-Geotech Engineer / Project Manager

Education

MS, Geotechnical Engineering, University of Colorado, 2002
BS, Civil Engineering, University of Colorado, 2000

Registrations/Certifications

Professional Engineer: Nevada (#019172); Missouri (#2014032638); Minnesota (#56157); Colorado (#54591); Idaho (#18054); Montana (#60223); New York (#102718-01); Texas (#143475)
Registered Member SME (#4185223RM)
QP, Qualified Person – National Instrument 43-101

Experience Summary

Mr. Knudsen is a Professional Engineer (Geotechnical BS and MS) and Project Manager with more than 18 years of experience in the mining industry applying his geotechnical expertise designing tailings dams, heap leach pads (HLP), waste rock dumps, and other earthen structures. Justin's field experience includes designing and executing geotechnical investigation plans using multiple drilling methods, including hollow stem auger, diamond core, sonic, and cone penetration testing (CPT) equipment. In addition, Justin applied these field fundamentals to hone his analytical and modeling skills, including geo-mechanical soil and rock testing, geosynthetic materials testing, slope stability, seepage, consolidation, and settlement analyses.

With a fundamental foundation in field and analytical geo-techniques combined with sound mentoring and a team-player personality, Justin advanced to a Lead Geotechnical Design Engineer and Project Manager leading projects from feasibility through final engineering and "for construction" designs. Many of Justin's designs have been built, requiring him to serve as Resident Engineer and Deputy Engineer of Record (EoR) for operating tailings dam(s) throughout the Western United States, México, and Perú.

Project Experience

Mine Tailings / Waste Facilities

ENGINEER OF RECORD, JURISDICTIONAL DAMS | ELKO, NEVADA

Deputy Dam Engineer for eight dams located at the Goldstrike Mine requiring annual inspections and other EoR duties. Provided ongoing engineering support, including civil/geotechnical design for existing tailings dams raises and a new tailings dam design. Directed an extensive geotechnical investigation including geophysics, CPT, sonic drilling, and mud rotary drilling for a critical TSF investigation program. Analyses performed included 3-dimensional slope stability analyses, 2-dimensional seepage, slope stability and settlement analyses, tailings consolidation, waste rock consolidation, and wick drain program evaluation. Served as resident engineer during the 500+ acre tailings dam raise. Prepared design reports, technical specifications, construction quality assurance (CQA) Manuals, construction drawings, As-Built Reports, and permitting support for multiple TSF raises and closure plans. Project Engineer during field investigations and analyses to maximize storage capacity in the tailings impoundment. Supervised construction of two water diversion channels approximately 5 miles in length. (Tetra Tech, 2004 to 2011; Tierra Group, 2012 to Present)

SAN ALBINO MINE TSF, WASTE ROCK DUMP, AND WATER MANAGEMENT | NUEVA SEGOVIA, NICARAGUA

Project Manager responsible for dry stack TSF, waste rock dump, and site-wide water management. Developed an innovative drainage system and progressive reclamation design to manage dry stack operations in a tropical climate with high rainfall. Engineering and design activities included geotechnical investigation, geologic mapping, slope stability modeling, runoff analyses, several surface water diversion designs, water balance, and permitting support. Provided construction support working closely with the owner's team to build the mine under an aggressive design and construction schedule. Assisted the mine owner with tailings handling and stacking design which is crucial in the high-rainfall, tropical environment. (Tierra Group, 2019 to Present)

LA INDIA TSF | NICARAGUA

Completed a feasibility-level design for Condor Gold's La India project. Designed a TSF to accommodate 10 years of tailings production at 2,000 tons per day (tpd) in a fully geomembrane-lined TSF and designed a stormwater attenuation dam to feasibility level. (Tierra Group, 2020 to 2021)

TURQUOISE RIDGE TSF | NEVADA

Updated the TSF operations, maintenance, and surveillance (OMS) Manual and Emergency Preparedness and Response Plan (EPRP). Supported mine personnel in response to the Independent Geotechnical Review Board (IGRB) review comments related to dam drainage and instrumentation. Assisted with the EoR transition for the Turquoise Ridge TSF. (Tierra Group, 2019)

LA NEGRA MINE | QUERETARO, MEXICO

Engineering and consulting support and completed plans to restart tailings deposition in an upstream TSF dam. Developed innovative drainage system designs, including horizontal geocomposite drains and horizontal pipe drains installed with drill rigs. Directed multiple geotechnical investigations, including CPT and auger drilling, surface sampling, and borrow source evaluation. Completed staged buttress design deferring capital costs and allowing the mine to resume tailings deposition. Surface water diversions were designed and built in challenging topography. Met with federal regulators to explain TSF improvements. Provided construction support to expedite construction and improve quality. Also provided regular monitoring updates for permit compliance and long-term planning support for potential future TSFs. (Tierra Group, 2018 to Present)

DRY STACK TSF SCOPING STUDY | CONFIDENTIAL PROJECT

Participated in a multi-discipline team completing a scoping study for an iron ore mine. Performed a siting study and trade-off analyses for a dry stack TSF and waste rock dump evaluating multiple tailings storage methods (slurry, paste, and filtered), facility configurations, and potential for co-mingling tailings and waste rock. Completed staged dry stack design and surface water management for the TSF and surface water management for a waste rock dump. Worked with mining engineers, process plant designers, geologists, environmental consultants, and mine financial specialists to complete the project meeting the client's very aggressive schedule. (Tierra Group, 2020 to xxxx)

DRY STACK AND SITE-WIDE WATER BALANCE | HONDURAS

Completed a dry stack TSF and surface water management design and prepared a site-wide water balance for an iron ore mine in a tropical climate. Project challenges included high rainfall, difficult geologic conditions, and tight space constraints requiring efficient diversion, surface water controls, and dry stack layouts to maximize land use. Geotechnical investigations included drilling, test pits, and geophysics. Directed laboratory testing on filtered tailings and liner materials (geosynthetics). (Tierra Group, 2018 to Present)

WILLOW CREEK DAM REHABILITATION | ELKO COUNTY, NEVADA

Project Manager responsible for concrete dam rehabilitation for a ±100-year old concrete water supply dam. Performed research and options study investigating methods and materials to rehabilitate the dam and outlet works. Completed rehabilitation plans to repair damaged outlet valves, spalling concrete, and general weathering. Provided resident engineering support during construction. (Tierra Group, 2017 to 2018)

STIBNITE GOLD PROJECT TSF AND STORMWATER CONTROLS | STIBNITE, IDAHO

As Project Manager and Lead Geotechnical Engineer, led a team of engineers performing geotechnical investigations for the TSF, development rock storage facilities (DRSFs), mill, camp, and other infrastructures. Assisted the owner's team with permitting support, including the Draft Environmental Impact

Statement (EIS), dam safety permits, cyanidation permit, and various other support tasks to the permitting team. Planned and directed sonic, cone penetration testing, geophysics, and hollow stem auger drilling campaigns. Completed geotechnical characterization and design work based on findings to support the Feasibility Study. Led an engineering team to develop diversion options to reroute creek flow around the TSF and DRSFs. (Tierra Group, 2017 to Present)

LAS BRISAS PRELIMINARY ECONOMIC ASSESSMENT (PEA) | VENEZUELA

Project Manager responsible for a 2.1-billion-tonne TSF design supporting a Preliminary Economic Assessment (PEA). Completed conceptual water management plan laying the groundwork for future engineering and studies. Worked with the external multi-disciplinary team to complete the PEA. (Tierra Group, 2017)

SWEETWATER TSF RAISE DESIGN | VIBURNUM, MISSOURI

Project Manager responsible for two raise designs for a 40+-year-old TSF at the Sweetwater Mine. Unique design challenges were overcome with a comprehensive field investigation, including CPT and hollow stem auger drilling. Liquefaction analyses were performed and incorporated into the upstream raise design. A challenging hydrology model was completed, an existing spillway raise was designed, and an As-Built Report was prepared conforming to MDNR requirements. The second design raise (23 feet tall) included a rockfill buttress, saddle dam, and a new spillway. Provided construction design support, CQA data review, and construction planning. An As-Built report was also completed for the new raise. (Tierra Group, 2015 to 2021)

BRUSHY CREEK TSF RAISE DESIGN | VIBURNUM, MISSOURI

Project Manager responsible for a 17-foot dam raise design for an existing TSF at Doe Run's Brushy Creek Mine. The raise design required CPT, a liquefaction triggering analysis, seepage modeling, and slope stability modeling. In addition to the dam raise, a spillway raise was designed requiring hydrology and hydraulic modeling and riprap design. Provided EoR duties as the dam raise was constructed and prepared an As-Built Report. (Tierra Group, 2014 to 2017)

BRUSHY CREEK 2 TSF | VIBURNUM, MISSOURI

Project Manager and Lead Engineer responsible for a new TSF design at the Brushy Creek Mine capable of storing 36 million tons (Mt) of tailings solids. The new TSF requires a 185-foot tall dam planned for construction in four stages, including a clay starter dam and three raises using tailings cyclone underflow. Hydrology and hydraulic modeling was performed to design four spillways and a water balance was completed providing a planning tool for use throughout facility life. A geotechnical investigation was carried out, which utilized both hollow stem auger and diamond coring techniques. The design was approved by MDNR Dam and Reservoir Safety Council. (Tierra Group, 2014 to 2018)

BRUSHY CREEK 3 TSF | VIBURNUM, MISSOURI

Project Manager and Lead Engineer responsible for designing an alternative iteration to the Brushy Creek 2 TSF designed to accommodate state requirements for land use. The TSF dam is 141 feet tall and capable of storing 16 Mt of tailings solids. Three stages were designed, including a clay starter dam and two downstream raises. A geotechnical investigation was performed using hollow stem auger and diamond core drilling. Challenging foundation conditions required a large key trench and an integrated drainage system. Spillways were designed for each stage. The design was approved by MDNR Dam and Reservoir Safety Council. (Tierra Group, 2016 to 2017)

TSF COVER OPTIMIZATION | LA LIBERTAD, NICARAGUA

Project Manager responsible for tailings consolidation modeling and deposition planning providing operators with a plan to deposit tailings late in the TSF life. Executing the end-of-life deposition plan will save significant closure costs because less fill will be required to cover the facility. Work included evaluating closure cover options providing a planning tool for strategic closure of the site. (Tierra Group, 2017 to 2019)

CAETÉ AND TURMALINA MINING COMPLEXES | BRAZIL

Lead Geotechnical Engineer responsible for the geotechnical investigation, including CPT, hollow stem auger drilling, and in-situ sampling of dry stack and slurry TSFs. Liquefaction potential was evaluated using CPT and SPT data. Provided recommendations regarding tailings excavation and stacking procedures. (Tierra Group, 2016)

EL AGUILA CONCEPTUAL TAILINGS STUDY | OAXACA, MÉXICO

As Project Manager, led a multi-disciplinary team to complete a conceptual evaluation to determine economic feasibility to add a filter plant, paste plant, and dry stack TSF contributing to mine life extension. Cemented paste backfill was needed to expand the underground mine. The team evaluated filter and paste plant design, calculating CAPEX and OPEX costs required for overall mine planning. Multiple dry stack facility layouts of various sizes were designed and compared using a comparative matrix evaluating qualitative and quantitative criteria. (Tierra Group, 2017)

PITARRILLA PROJECT FEASIBILITY STUDY | DURANGO, MÉXICO

Project Manager responsible for feasibility level design of a 112-Mt TSF for a world-class silver deposit. Successfully led a multi-disciplined project team completing the civil layout, staging optimization, water balance optimization, geotechnical investigations, geologic hazard mapping, seepage and slope stability modeling, and surface water diversion design. The design team also completed a site-wide water management plan, allowing advanced water supply planning. Led project team to complete engineering reports and capital cost estimates included in an NI 43-101 compliant Feasibility Study for the Pitarrilla Project. (Tierra Group, 2012)

CHINCHÁN SOUTH DRY STACK TSF | SAN MATEO, PERÚ

Project Manager responsible for a dry stack TSF design and ongoing construction support during facility construction and operations. Completed reports and other submittals to local regulatory agencies (OSINERGMIN and MEM). Special considerations include steep topography, construction during inclement weather, and multiple successful peer reviews. (Tetra Tech, 2008 to 2011; Tierra Group, 2012)

TUCUSH TSF | HUARI ANCASH, PERÚ

Project Manager responsible for the TSF design raises as well as As-Built Reports to comply with regulatory requirements. This dam is built using cyclone underflow for the main embankment and a waste rock shell for added stability. A limited available footprint area created design challenges that were overcome with unique engineering solutions. (Tetra Tech, 2008 to 2011; Tierra Group, 2012)

BOVILL KAOLIN PROJECT | LATAH COUNTY, IDAHO

Project Manager responsible for NI 43-101 compliant PEA for a 1.5-Mt TSF. Multiple Trade-off Studies were completed to optimize the facility design while minimizing project costs. (Tetra Tech, 2011)

MT. TODD TSF | NORTHERN TERRITORY, AUSTRALIA

Responsible for civil and geotechnical design of multiple large TSFs for pre-feasibility and definitive feasibility studies. The project included a stability assessment of the current TSF for possible expansion and design of the new facility. Innovative liner design was needed to maintain containment of tailings while allowing cost-effective construction techniques. Multiple site visits were made over the years to oversee two field investigation campaigns and gather site-specific data. Provided a third-party review of current designs for TSF and waste rock dump cover plans. Reviews were critical to permitting efforts. (Tetra Tech, 2008 to 2011 and Tierra Group, 2020)

COZAMIN MINE TSF | ZACATECAS, MÉXICO

Project Manager responsible for the TSF centerline design raises as well as As-Built Reports to comply with requirements set for by the local environmental regulatory agency (SEMARNAT). Submittals included design and as-built drawings, construction specifications, and various reports. Special considerations included water management concerns, geotechnical design, and facility operation to maximize water recovery for process plant use. (Tetra Tech 2008 to 2010)

SOLEDAD TAILINGS EMBANKMENT SEEPAGE ANALYSIS | EL MOCHITO MINE, HONDURAS

As Geotechnical Engineer, performed finite element seepage analysis for new embankment design. Responsible for stability modeling and cross-section design for new tailings embankment. (Vector Colorado, 2005)

PASCUA LAMA PROJECT STABILITY ANALYSES | WESTERN ARGENTINA

As Geotechnical Engineer, responsible for stability analysis for a 102-meter (m) high earthfill tailings dam and a 30-m high earthfill and rockfill water storage dam located in the high Andes near the Chile-Argentina border. (Vector Colorado, 2005)

OLD VIBURNUM EARTHFILL BUTTRESS DESIGN | FLETCHER, BRUSHY CREEK, NEW LEAD BELT, MISSOURI

As Geotechnical Engineer, designed earthfill buttress for dynamic stability of existing tailings storage embankment. The design utilized on-site materials to minimize construction costs. (Vector Colorado, 2004)

MARLIN PROJECT DYNAMIC ANALYSES | MARLIN MINE, GUATEMALA

As Geotechnical Engineer, performed dynamic deformation and stability evaluations for an 85-m rockfill tailings embankment. Performed dynamic analyses for multiple earthquakes (predicting deformation for multiple slopes on the embankment) and a seepage study for the clay core of the embankment. (Vector Colorado, 2004)

MINA EL DORADO PRE-FEASIBILITY STUDY | SENSUNTEPEQUE, EL SALVADOR

As Geotechnical Engineer performed slope stability modeling for siting and designed a tailings embankment and impoundment. Performed detailed design of embankment cross-sections. (Vector Colorado, 2004)

Heap Leach Pads

LA TRINIDAD | SINALOA, MEXICO

Project Manager leading an experienced team providing HLP construction recommendations and a water balance. Work continued with a HLP expansion design, slope stability analyses, hydrologic analyses, diversion design, liner design, and leach solution collection piping design. Slope stability analysis interpretation and results provided a safe stacking plan to maximize ore storage capacity. Water balance analyses and “outside the box” ideas made it possible to forego a stormwater pond expansion saving significant HLP expansion construction costs. (Tierra Group, 2017)

BALD MOUNTAIN MINE | NEVADA

Project Manager and Senior Geotechnical Engineer assisting the Bald Mountain Mine Project Development Team with evaluating potential uses for spent ore on legacy heap leach facilities. Completed a collaborative Trade-off Study with site personnel to assess the potential for spent ore use in construction materials in future HLP construction and/or expansion. Construction costs, environmental impacts, permitting, and other implications were considered in the study. (Tierra Group, xxxx)

STERLING MINE HLP EXPANSION AND NEW PAD DESIGN | BEATTY, NEVADA

As Project Manager and Lead Geotechnical Engineer, responsible for designing an in-fill leach pad expansion and design of a new 20-acre HLP. The projects included civil layout, hydrology, hydraulic design, ore capacity optimization, liner design, solution recovery system design, slope stability modeling, and completion of a stacking plan. Challenges included adapting new designs to existing infrastructure, including solution collection piping, ponds, and stormwater controls. Design packages were submitted to the State of Nevada for the heap leach slot in-fill project, a process plant pond and pipeline reconfiguration, and the new leach pad. (Tierra Group, 2013 to 2015)

EL GALLO HLP EXPANSION | SINALOA, MÉXICO

Project Manager and Lead Engineer responsible for design and construction oversight for a 65,000-m² expansion of an existing HLP. The HLP expansion design included slope stability modeling, civil layout, ore capacity optimization, liner design, solution recovery system design, and completion of a stacking plan to guide ore placement during operations. Project challenges included incorporating existing infrastructure into the expansion design and choosing construction materials and methods that would allow rapid construction of a safe, environmentally sound facility. Provided construction oversight through multiple site visits working with local engineers to ensure the facility was built according to design. (Tierra Group, 2012)

BALD MOUNTAIN MINE | ELKO COUNTY, NEVADA

Assisted the Bald Mountain Mine Project Development Team with evaluating potential options for a legacy heap leach facility located within the proposed mine infrastructure expansion. Developed a decision tree to evaluate potential options and worked with site personnel and their environmental consultant characterizing spent ore in the legacy facility. Directed a geotechnical investigation and laboratory testing. Prepared technical memorandums describing the evaluation which were used in permitting efforts with state and federal agencies. (Tierra Group, 2019 to 2020)

ZONIA MINE HLP DESIGN | YAVAPAI COUNTY, ARIZONA

Completed a site investigation, stability analyses, and directed civil design of a HLP in mountainous terrain. The Zonia Project is a brownfields project, the site investigation focused on the existing HLP and surrounding area investigating the potential expansion of the existing pad. Civil and geotechnical designs were completed to pre-feasibility level resulting in engineering reports, drawings, and cost estimates in an NI 43-101 compliant pre-feasibility report. (Tetra Tech, 2009)

Mine Operations

AMERICAN GYPSUM HAUL ROAD SAFETY IMPROVEMENT EVALUATION | GYPSUM, COLORADO

As Project Manager, conducted an alternatives analysis to determine the most appropriate measures to improve safety on a steep haul road section. The analysis included basic engineering of runaway truck ramps, a mechanical vehicle arresting system, haul road realignment, and center berm arrestors. Alternatives were evaluated on effectiveness, construction requirements, maintenance needs, operational impacts, and environmental impacts. The alternatives analysis provided a tool to determine the most effective way to improve haul road safety. (Tierra Group, 2014)

FLORIDA CANYON ROCK SLOPE STABILITY EVALUATION | WINNEMUCCA, NEVADA

As Geotechnical Engineer, conducted an evaluation of rock slope stability at this large operating open pit gold mine to determine safe slope angles for continued pit expansion. Analyses included assessment of weak, shattered rock masses. (Vector Colorado, 2004)

Water Resources

MASBATE WATER TREATMENT PLANT DESIGN AND CONSTRUCTION | MASBATE, PHILIPPINES

As Project Manager, oversaw the design and provided construction and commissioning support to a 15,000 m³ per day water treatment plant (WTP) and over 7 km of pipelines. The WTP incorporates INCO and microfiltration processes to treat TSF supernatant water to Philippine discharge standards. The design team completed a geotechnical investigation, foundation design, pipeline design, and a complete WTP design, including structural, chemical, and process engineering. Additional work included modifications to the WTP flowsheet due to changes in discharge standards. (Tierra Group, 2013 to Present)

SHERMAN DAM EVALUATION | LOUP CITY, NEBRASKA

As Geotechnical Engineer, evaluated the existing toe-drain and blanket drain. The investigation included trench excavation and geotechnical borings. (Vector Colorado, 2004)

MIDWAY PROJECT RAPID INFILTRATION BASIN DESIGN | TONOPAH, NEVADA

As Project Engineer, designed a rapid infiltration basin to dispose of de-watering water produced during mining operations. Conducted a field investigation, including auger drilling and percolation tests, and designed the basin to accommodate flows up to 2,000 gallons per minute (gpm). Prepared drawings, calculations, and a final report supporting permitting efforts. (Tetra Tech, 2008)

RAILROAD VALLEY RAPID INFILTRATION BASIN DESIGN | ELY, NEVADA

As Project Engineer, designed a rapid infiltration basin to dispose of water recovered during oil production. Conducted a field investigation, including test pits and percolation tests, and designed the basin to accommodate flows up to 50 gpm. Prepared drawings and submittals in support of permitting efforts. (Tetra Tech, 2008)

Professional Affiliations

American Society of Civil Engineers; Member (2008 to 2011)
Society for Mining, Metallurgy, & Exploration (2011 to Present)
Colorado Mining Association; Member (2015)

Employment History

CURRENT EMPLOYER	TIERRA GROUP INTERNATIONAL, LTD.
POSITION	Senior Engineer
YEARS	2012 to Present
EMPLOYER	TETRA TECH, INC.
POSITION	Project Engineer
YEARS	2007 to 2011
EMPLOYER	VECTOR COLORADO, LLC
POSITION	Staff Civil Engineer
YEARS	2003 to 2007
EMPLOYER	KRAZAN & ASSOCIATES
POSITION	Staff Engineer
YEARS	2002 to 2003
EMPLOYER	GOLDER ASSOCIATES INC.
POSITION	Field Technician
YEARS	2000
EMPLOYER	ADVANCED TERRA TESTING
POSITION	Soil Technician
YEARS	1998 to 2000

Language Proficiency

English: Fluent
Spanish: Conversational (spoken, written)