

ENVIRONMENTAL
SCIENCES
LABORATORYWARNING
NO SMOKING

Environmental Sciences Laboratory

GRAND JUNCTION, COLORADO

★ DENVER
● GRAND JUNCTION

COLORADO

The U.S. Department of Energy (DOE) office in Grand Junction, Colorado, created the Environmental Sciences Laboratory (ESL) in 1991, prior to establishing the Department's Office of Legacy Management. At that time, a large, fully equipped analytical chemical laboratory, similar to commercial analytical laboratories, was operating at the DOE office site. DOE, recognizing the benefits of having a laboratory to support its remediation projects, converted a standing facility into the ESL and soon after established a small functional group for ESL scientists.

Geochemists, ecologists, and other scientists use the ESL to perform applied research, laboratory-scale demonstrations of soil and groundwater remediation and treatment technologies, and pilot-scale tests to supplement numerical modeling efforts. Originally, this work was typically funded by outside sources such as DOE remediation projects, the DOE Office of Environmental Management, and the U.S. Environmental Protection Agency. DOE later provided direct funding to the ESL to continue studying remediation technologies and the long-term performance of disposal cells. This funding led to the creation of the Applied Studies and Technology (AS&T) program, with the ESL there to provide specialized analytical support services.

The ESL continues to support AS&T projects, site characterization, and routine environmental monitoring activities. Over the years, the ESL has acquired more analytical instruments and expanded its capabilities beyond chemical analysis.

Environmental Sciences Laboratory Services

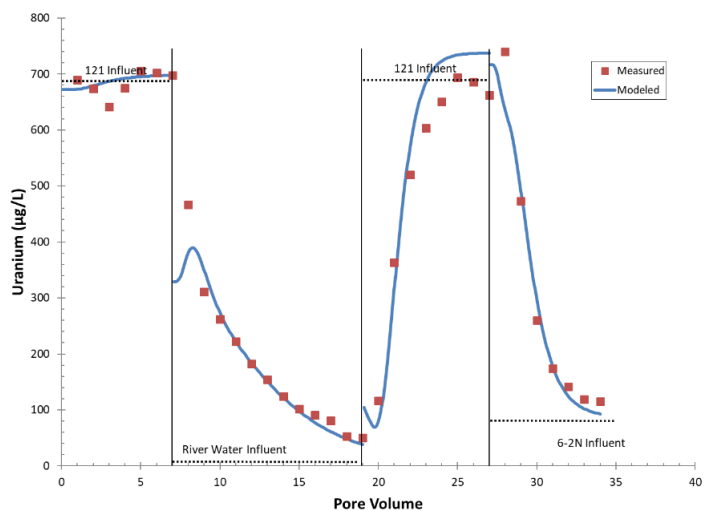
- Soil and aquifer physical properties analysis, including soil classification and saturated and unsaturated hydraulic properties.
- Groundwater contaminant transport modeling support.
 - › Batch and column tests.
 - › Contaminant speciation.
 - › Secondary source identification and release rates.
 - › Contaminant sequestration.
- Groundwater remediation technology, such as permeable reactive barriers.
- On-site support via mobile laboratory.

Leachability, Release Rates, and Reactive Transport Parameters Using Column Tests

Contaminant leachability and release rates under various conditions are a critical component for determining natural flushing rates and potential remedial options. The ESL can perform up to six column tests at once. These columns can be performed anoxically in our glove box. The resulting water samples can be analyzed in-house using the equipment described below. In addition to empirical data on sediment leachability and contaminant release rates, techniques developed under various AS&T projects can apply geochemical modeling to the column results. This modeling allows scientists to determine reactive transport parameters that can be included in LM site models. These models allow for a predictive evaluation of various remedial strategies, thereby providing a way to do cost-benefit analyses of the strategies before implementing any field testing.



Column experiment at the ESL.



Column experiment results with geochemical modeling.

Mobile Laboratory

ESL scientists conduct in-field testing using the mobile laboratory. The mobile laboratory trailer is powered and includes cabinets, a sink, and a fume hood to support environmental investigations and provide real-time analysis during field investigations or drilling campaigns.



Interior of the mobile lab.



The mobile lab in use during groundwater tracer testing.

Solids Processing Room

Solids from cores, sediments, and other areas are manipulated in the ESL soils processing room. Solid samples processing includes sieving, grinding, packing, drying, and digesting.



Solids processing room.

following ions: fluoride, acetate, chloride, nitrite, bromide, nitrate, phosphate, sulfate, iodide, sodium, potassium, magnesium, and calcium. Other analytical columns can be used to analyze other ions, such as organics. The ion chromatograph is used to analyze samples due to its relatively short analysis time, low detection limits, high selectivity in samples with a complex matrix, and species analysis (for example, NO_2^- and NO_3^-).



Dionex Aquion.

Laboratory Analytical Instruments

- Ion chromatograph.
- High-performance liquid chromatograph.
- Inductively coupled plasma-mass spectrometer.
- Total inorganic and organic carbon analyzer.

Ion Chromatography

Dionex Aquion

Ion chromatography separates ions in an ion-exchange column based on their affinity for the mobile or stationary phases. Eluent, an ion extraction liquid, carries the sample with its resident ions to the column and pushes the ions in the sample through the column. Ion species are then separated and detected at different times using conductivity or ultraviolet (UV) detection. The Dionex Aquion ion chromatograph, when properly equipped, can analyze the

High-Performance Liquid Chromatography Dionex UltiMate 3000

High-performance liquid chromatography (HPLC) is used to separate, identify, and quantify compounds within a mixture. It uses a pump to create high pressure to carry a solvent through a column. The high pressure allows columns to be packed with smaller particles than in regular columns, creating more surface area for interactions between the stationary phase and the mobile phase. This allows for better separation between the components in a mixture. Smaller compounds pass through the column more quickly than larger compounds, allowing them to be detected at different times. After the solvent passes through the column, it goes through a detector — UV, fluorescence, or both. The detector is set at a desired wavelength depending on the compound or compounds needing analysis. Samples

analyzed are water samples. HPLC is used because it has a UV and fluorescence detector, which detects nonionic species. In some cases, it is much more sensitive than conductivity detection.



Dionex UltiMate 3000.

Inductively Coupled Plasma-Mass Spectrometry

Agilent 7850

Inductively coupled plasma-mass spectrometry measures ions produced by a radio-frequency inductively coupled plasma. Analyte species originating in a liquid are nebulized and the resulting aerosol is transported into the plasma torch by argon gas. The ions produced are entrained in the plasma gas, introduced by a vacuum interface, and separated by a mass spectrometer based on their mass-to-charge ratio. The ions transmitted through the mass spectrometer are quantified by an electron multiplier and processed by the instrument's data handling system.

Solids and highly contaminated water samples are digested using one or more acids (nitric acid or hydrochloric acid) followed by hydrogen peroxide (if necessary) using a sample digestion vessel and cover. The digestate is reduced to low volume, cooled, adjusted to volume, and, if necessary, filtered.

No digestion is required prior to analysis for dissolved elements in water samples; instead, samples are preserved at the time of collection and filtered if necessary.



Agilent 7850 ICP-MS.

Carbon Measurements of Aqueous and Solid Samples

Shimadzu TOC-L

The Shimadzu TOC-L instrument analyzes nonpurgeable organic carbon in aqueous samples and total carbon and inorganic carbon determination in soil samples. The liquid analysis uses a combustion pathway with acidification and sparging as pretreatments to remove purgeable organic carbon. For both the aqueous and solid samples, the combustion method of carbon analysis employs the oxidation of all carbon species to CO_2 in the presence of a platinum catalyst. The CO_2 then passes through a series

of scrubbers and through a nondispersive infrared detector. The TOC-L is used because it has the capacity to efficiently oxidize hard-to-decompose organic compounds, including insoluble and macromolecular organic compounds. This is important because organic carbon can be an indication of bacteria, and organic compounds combine with other elements to produce molecules that can be harmful to the environment.



Shimadzu TOC-L.

ESL Sample Analysis Support Capabilities

The ESL is equipped with the necessary sample support infrastructure and equipment to ensure sample analysis integrity and support a wide range of research efforts. This equipment includes ample refrigerated sample storage, general chemistry analytical instruments, digestion blocks, and transport pumps.



ESL sample support equipment.

Contact Information

In case of an emergency at the site contact 911.

LM toll-free emergency hotline: (877) 695-5322

Documents related to the Environmental Sciences Laboratory are on the LM website at www.energy.gov/lm/environmental-sciences-laboratory-esl.

For more information about LM activities at the Environmental Sciences Laboratory in Grand Junction, Colorado:

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