INTEGRATED GEOSCIENCES LABORATORIES, LLC.

(formerly PTS Laboratories, Inc.)

*(Environmental * Geotechnical * Core Analysis)*

6016 Centralcrest Street, Houston Texas, 77092. Phone: +1 (713) 316 1800

CAPABILITY, TESTING AND ANALYSES

Geotechnical Testing: Individual geotechnical tests, parameters and index properties for modeling, reporting, engineering and construction.

Basic core analysis (physical properties and index parameters) accurately define the physical characteristics of subsurface materials, usually soil, rock or sediments. These characteristics most often include dry bulk density, specific gravity, total porosity, air-filled porosity, pore fluid saturations (both NAPL and water), moisture content, air or vapor permeability, hydraulic conductivity, and grain size distribution. Geotechnical and construction related tests provide data for construction and engineering design. IGL routinely works with both clean and contaminated material. Our wide range of equipment can be used to measure the physical properties of soil and rock cores taken by virtually any sampling method.

Test Description	Method Reference	Sample Requirement
Porosity		
Total Porosity: pore volume measured with pore fluids removed (Archimedes or Boyle's Law)	API RP40	One 2" x 6" tube per sample
Air-filled and/or Water-filled Porosity: Includes Total Porosity, measured at as-received saturations (may report as volumetric moisture content)	API RP40	One 2" x 6" tube per sample
Total: Calculated; requires specific gravity and dry bulk density	ASTM D854, ASTM D2937	N/A
Effective (Drainage) Porosity: Centrifugal method, include total porosity	Mod. ASTM D425, API RP40	One 2" x 6" tube per sample
Permeability - Horizontal and Vertical Orientations Available		
Air Permeability		
Air: native-state (w/moisture) or intrinsic (w/out moisture)	API RP40	One 2" x 6" tube per sample
Air: slip corrected (equivalent liquid)	ASTM D4525	N/A
Air Permeability - Partially Saturated		
Air Permeability of partially saturated soils; measured at native (as-received) condition.	ASTM D6539	One 2" x 6" tube per sample
Water Permeability/Hydraulic Conductivity (additional fluids can be measured)		
Hydraulic Conductivity: saturated; flexible wall, triaxial permeameter	API RP40/EPA 9100	One 2" x 6" tube per sample
Hydraulic Conductivity: saturated; flexible wall, triaxial permeameter (horiz.)	API RP40/EPA 9100	One 2" x 6" tube per sample
Hydraulic Conductivity by ASTM D5084: saturated; flexible wall, triaxial permeameter	ASTM D5084	One 2" x 6" tube per sample
Intrinsic Permeability to Oil/Product (LNAPL)	API RP40	One 2" x 6" tube per sample
Identification and Index Properties		
Atterberg Limits: 3 point (dry method standard)	ASTM D4318	200 grams of soil
Classification: Engineering USCS (requires Particle Size & Atterberg Limits)	ASTM D2487	N/A
Classification: USDA (requires Particle Size)	USDA	N/A
Classification: Visual/Manual	ASTM D2488	N/A
Density: Measured grain (particle) density	API RP40	100 grams of material
Density: Bulk; dry unit weight	ASTM D2937	500 grams of material
Density: Bulk; dry unit weight (Shelby Tube)	ASTM D2937	500 grams of material
Specific Gravity: passing # 4 mesh	ASTM D854	200 grams of material
Core Logging: continuous or tube; Rockworks log format; per foot; requires slabbing, surface prep, min 10 feet	AAPG	N/A
Silt Density Index; field or source water	ASTM D4189	10 liters of fluid
Grain Size Analysis: includes tabular, graphical and statistical data		
Sieve (dry sieve only): 1" to 400 mesh	ASTM D422	500 grams of material
Sieve (dry sieve only): 1" to 400 mesh	ASTM D6913	500 grams of material
Laser Method (LPSA): 2mm <1 micron (medium sand through clay fraction - replaces hydrometer)	ASTM D4464	100 grams of material
Micro Size: Laser method; suspended solids in water or airborne particles, to 0.375 microns	ASTM D4464	500 mls of fluid
Sieve + Laser "Combo" (grain size analysis)	ASTM D422/4464	500 grams of material
Sieve + Hydrometer (grain size analysis)	ASTM D422	500 grams of material
Percent pass/retained on # 200 screen	ASTM D1140	500 grams of material
Sample Splits: Split sample in two or more fractions using dry dry sieve, per split or screen	ASTM D1140	500 grams of material
Clay Lumps and Friable Particles in Aggregates	ASTM C142	3000 grams of material
Lightweight Particles in Aggregates	ASTM C123	3000 grams of material
Organic Impurities	ASTM C40	500 grams of material
Sieve Analysis of Fine and Coarse Aggregates	ASTM C136	500 grams of material
Acid Insoluble Residue for Fine Aggregates	Tex-612-J	500 grams of material
Sample Cleaning: required for hydrocarbon impacted soils	N/A	500 grams of material

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CAPABILITY, TESTING AND ANALYSES

Integrated Geosciences Laboratories, LLC recently acquired PTS Labs which has been providing physical properties data and routine core analysis services for over five decades. Our background and experience therefore give us the unmatched capability to deliver quality data for use in risk assessment, modeling remediation design or meeting regulatory reporting requirements.

Test Packages

An **Integrated Geosciences Laboratories** Test Package combines several basic analyses and/or index properties to provide an integrated data package. We can also create custom packages that satisfy all modeling and risk assessment parameters or meet regulatory agency requirements.

Test Description	Method Reference	Sample Requirement
Soil Properties Package - Vadose Zone: Native sate permeability to air, total porosity, air-filled porosity, grain and bulk density, moisture content, total pore fluid saturation.	API RP40, ASTM D2216	One 2" x 6" tube per sample
Hydraulic Conductivity Package - Saturated Zone: Native State permeability to water, total and air-filled porosity, grain and bulk density, moisture content, total pore fluid saturation (reported as water only)	API RP40, ASTM D2216, EPA 9100	One 2" x 6" tube per sample
Pore Fluid Saturation Package: Pore Fluid Saturations (NAPL and water) by Dean Stark extraction; total porosity, air-filled porosity, grain density, dry bulk density, and moisture content	API RP40	One 2" x 6" tube per sample
Free Product Mobility Package: Applied Centrifugal force demonstrates product mobility; includes residual saturations by Dean Stark, total porosity, grain and bulk density (1 hour at 1000G).	Mod. ASTM D425, API RP40	One 2" x 6" tube per sample
Stepped Free Product Mobility Package (additional steps): Applied Centrifugal force demonstrates product mobility; includes residual saturations by Dean Stark, total porosity, grain and bulk density - Additional steps of 25G, 50G, 100G, 500G, 1000G at 10 hours per step.	Mod. ASTM D425, API RP40	One 2" x 6" tube per sample
Residual Saturation by Water Drive: Sample driven to residual saturation by water/NAPL displacement. Residual saturations by Dean Stark extraction, total porosity, bulk and grain density	Proprietary, API RP40	One 2" x 6" tube per sample
Capillarity Package: Air/Water Drainage: Air/Water Drainage Capillary Pressure Curve (air displacing water) with Air Permeability and Hydraulic Conductivity: includes fluid production vs. capillary pressure, total porosity, dry bulk density.	ASTM D6836, API RP40	One 2" x 6" tube per sample
Vapor Transport Package (Johnson-Ettinger): Input parameters for Johnson-Ettinger Model; Air Permeability (native and specific); porosity (total, effective, air-filled, water-filled), volumetric air and water, moisture content, intrinsic permeability/hydraulic conductivity, grain density, dry bulk density, TOC (foc), soil classification USDA/USCS (grain size + Atterberg Limits)	see individual tests for methods	One 2" x 6" tube per sample
Fluids Properties Package - LNAPL and Water Pair: Dynamic viscosity and fluid density at three temperatures, surface and interfacial tension for each fluid (three phase pairs; LNAPL/water, LNAPL/air; and water/air)	ASTM D1481, ASTM D445, ASTM D971	500 mls of fluid
CAL-EPA DTSC Vapor Intrusion Package: Cal-EPA DTSC Vapor Intrusion Model Parameters (Table 3 + Appendix H); Soil bulk and grain density, total porosity, moisture content, volumetric moisture and air, TOC/foc, and grain size distribution	see individual tests for methods	One 2" x 6" tube per sample
TCEQ/TNRCC Package: Intrinsic permeability/hydraulic conductivity, total porosity, air-filled porosity, dry bulk density, volumetric moisture content and foc (includes Effective Porosity).	EPA 9100, ASTM D2216, Walkley-Black, API RP40	One 2" x 6" tube per sample
Texas TRRP Tier II Package: Includes total porosity, air-filled porosity, dry bulk density, volumetric moisture content and foc	ASTM D2216, Walkley-Black, API RP40	One 2" x 6" tube per sample

Fluid Properties and Forensic Geochemistry

In our Fluid properties Lab, we analyze and characterize fluids sampled from environmentally contaminated sites. Measuring the physical properties of these fluids (crude oil, product, LNAPL, site field water, etc.) provides data for mobility analysis and remediation design. **Integrated Geosciences Laboratories, LLC** has extensive experience providing accurate and representative data from the most difficult fields to characterize the fluids found

Test Description	Method Reference	Sample Requirement
Fluids Characterization - DNAPL, LNAPL & Water (*all DNAPL tests - add 20%***)**		
Density/Gravity: LNAPL or Water	ASTM D1481	500 mls of fluid
Viscosity: LNAPL or Water; 3 temperatures; includes density and gravity	ASTM D445	500 mls of fluid
Single Point Viscosity: ambient; includes specific gravity	ASTM D445	500 mls of fluid
Interfacial Tension: per phase pair; air/water, air/product, product/water available	ASTM D971	500 mls of fluid
LNAPL cleaning; properties measurements	Proprietary	500 mls of fluid
LNAPL cleaning; per liter (for flow tests)	Proprietary	500 mls of fluid
***** for DNAPL measurements, add 20%*****		
Volume Sediment and Water (VSW)	ASTM D96	500 mls of fluid
Bulk fluid separation; gravimetric plus centrifugal (requires VSW test)	Mod. ASTM D96	500 mls of fluid
Reid Vapor Pressure	ASTM D323	500 mls of fluid
Simulated Distillation, requires Specific gravity	ASTM D2287	1 liter of fluid
OILPRINT™ High Resolution Chromatography: C4-C35+ Fingerprinting, forensic geochemistry for product, plume modeling. Includes basic interpretation.	IP 318/75M, FSCOT	500 mls of fluid

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Digital Core Photography

Our full-service imaging department is experienced at providing visible and ultraviolet (UV) digital photography. Our facilities are fully equipped with equipment customized for display of images captured from soils, unconsolidated sediments and rock cores. Extreme care is taken to color-match the actual core with digital images and prints. With over thirty years of experience creating visual records of subsurface materials, Integrated Geosciences Laboratories continues to improve the methodology.

Cores are handled cryogenically and cut open (slabbed) on IGL designed and built equipment. Frozen core is cut open using a horizontal band saw with diamond-segmented blade. After cutting, the slabbed core is cleaned and prepared for photography. Cores are typically slabbed into 1/4 - 3/4 sections providing enough bulk rock for lithologic description and plenty of material for analytical work.

Test Description	Method Reference	Sample Requirement
PhotoLog™ Digital Core Photography		
Full-scale: white light and UV; per foot	ASTM D5079	slabbed core sample
Full-scale: white light only; per foot	ASTM D5079	slabbed core sample
Core Slabbing and preparation, per foot (required for core photography). Core cryogenically cut using diamond segmented horizontal bandsaw	API RP40, Proprietary	full diameter sample
Core Image Archive, (digital images on CD/DVD). Includes upload of all imagery to IGL secure website for remote access/viewing/downloads by clients.	ASTM D5079	N/A

Soil Chemistry and Index Properties

Individual tests and parameters for risk modeling or determining mobility, fate and transport properties.

Test Description	Method Reference	Sample Requirement
Soil Chemistry		
Cation Exchange Capacity	EPA 9081	500 grams of material
Moisture Content	ASTM D2216	100 grams of material
Volumetric Moisture Content (water content)	API RP40	500 mls of fluid
Moisture, Ash, Organic Matter	ASTM D2974	100 grams of material
Soil Density Index; field or source water	ASTM D4189	
Soil/Water pH	EPA 9045/ATM D4972	200 grams of material
Total Organic Carbon of Fraction or Fraction Organic Carbon (TOC/foc)	Walkley-Black	100 grams of material
Total suspended Solids, TSS	APHA 2540D	500 mls of fluid
Sediment Concentration in Water; Method B - Filtration	ASTM D3977	
Sample cleaning; required for hydrocarbon impacted soil	API RP40	N/A

Petrographic Services

Petrographic and mineral analyses for characterizing soil and subsurface materials.

Test Description	Method Reference	Sample Requirement
Petrographic Services		
Standard Petrographic Thin Section Preparation	Proprietary	
Thin Section Petrography: Qualitative and Quantitative data available	Proprietary	
X-Ray Diffraction Analysis (XRD): Includes bulk and fine (clay) analysis	Proprietary	
Energy Dispersive X-Ray Analysis: Semi-quantitative elemental analysis for components > Na	N/A	
Scanning Electron Microscopy (SEM): Specimens evaluated and photographed with emphasis on pore structure, clay cement and paragenesis.	N/A	
SEM/EDS Analysis	Proprietary	

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Site Characterization and Remediation Simulation

Advanced Core Analysis is used in conjunction with basic core analysis to further define the intrinsic and more complex physical and chemical characteristics of subsurface materials (soil, rock or sediments) as they interact with fluids (water, hydrocarbons, etc.) vapor, or other materials (Remediation Simulation, Flow Studies). These characteristic most often include capillary pressure or soil moisture retention curves, van Genuchten parameters, relative permeability, intrinsic permeability, hydraulic conductivity, air or vapor permeability, residual saturation, fluid mobility and soil or column leaching data. We can also create custom packages that satisfy your modeling and risk-based requirements or fully simulate remedial processes.

Test Description	Method Reference	Sample Requirement
Capillary Pressure Curves (Soil Moisture Retention)		
Centrifuge method: air displacing water; includes total porosity and dry bulk density	ASTM D6836	One 2" x 6" tube per sample
Porous Plate: air displacing water, includes porosity and density (call for TAT)	ASTM D2325/ASTM D3152	One 2" x 6" tube per sample
Pore Size Distribution: Mercury Injection; includes total porosity, bulk density	ASTM D4404	One 2" x 6" tube per sample
Specific Retention/Yield: includes total porosity	ASTM D425	One 2" x 6" tube per sample
van Genuchten Parameters & Relative Permeability	calculation	N/A
Brooks-Corey Parameters (requires VG curve fit)	calculation	N/A

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Test Description	Method Reference	Sample Requirement
Remediation Simulation		
Thermal Resistivity of Soil, per point	ASTM D5334	One 2" x 6" tube per sample
Resistivity of Soil	TEX-129-E	One 2" x 6" tube per sample
ISCO Bench Test Protocol: 14-Day reactor with various activations (AAP, H2o2, permanganate, etc.) available. Includes setup and parameter monitoring.	Proprietary	
Soil Oxidant Demand Test; SOD & TOD available	FMC/IGL	
Soil Buffering Test: Standard ISCO protocol	Proprietary	
Column Leaching Studies: Rigid or flexible-wall column simulates water leaching through soil.	ASTM D4874	
Water/LNAPL Relative Permeability: Unsteady State; includes production history, endpoint saturations and relative permeability curve.	JBN	One 2" x 6" tube per sample
Thermal Remediation: Steam drive or hot water	multiple	
Endpoint Saturations: water displacing LNAPL	dynamic	One 2" x 6" tube per sample
Establish Initial LNAPL Saturation: Dynamic Drive	dynamic	One 2" x 6" tube per sample
Compaction and Strength Tests		
Consolidation (up to 10 load/unload increments)	ASTM D2435	One 2" x 6" tube per sample
Direct Shear: per point - requires project consultation: Consolidated-Drained (CD) per point	ASTM D3080	One 2" x 6" tube per sample
Expansion Index	ASTM D4829	call
Standard Proctor Compaction	ASTM D698	5 gallon bucketful
4-inch mold		
6-inch mold		
Modified Proctor Compaction	ASTM D1557	5 gallon bucketful
4-inch mold		
6-inch mold		
Unconfined Compressive Strength - soil	ASTM D2166	One 2" x 6" tube per sample
Unconfined Compressive Strength - rock	ASTM D2938	One 2" x 6" tube per sample
Unconsolidated Undrained Triaxial Compression (U.U.) per point	ASTM D2850	One 2" x 6" tube per sample
Triaxial Shear Test (C.U.) per point	ASTM D4767	One 2" x 6" tube per sample

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CAPABILITY, TESTING AND ANALYSES - *PICKUP & HANDLING, DISPOSAL, STORAGE AND MISCELLANEOUS CHARGES*

Test Description	Method Reference	Sample Requirement
SAMPLE PICKUP AND HANDLING		
Sample pickup; No charge for jobs over $1000 within 25 miles radius of IGL facility. Charged at $2.25/mile after 25 miles.	N/A	N/A
Core Preservation Services; Cryogenic, ambient, or other	N/A	N/A
Wellsite or field sampling Technician; 40 Hour OSHA trained		

Test Description	Method Reference	Sample Requirement
SAMPLE STORAGE AND DISPOSAL		
Core storage, frozen/refrigerated; per foot or sample per month	N/A	N/A
Core storage, ambient; per foot or sample per month	N/A	N/A
Sample Storage for "Hold" samples; each per month	N/A	N/A
Fluid Storage up to 0.5 liter; each per month (greater volumes, call)	N/A	N/A
Core Disposal: non-contaminated continuous core; per foot	N/A	N/A
Sample Disposal: non-contaminated sample; per sample	N/A	N/A
Disposal: petroleum hydrocarbon contaminated samples; per foot or per sample	N/A	N/A
Sample Disposal (or return to site): DNAPL, hazardous, or chlorinated contaminated soil or fluid; shipping & handling	N/A	N/A
LNAPL Disposal, typical hydrocarbons (non-chlorinated), per liter	N/A	N/A

******All samples are disposed or returned to client 30 days after completion of testing unless other arrangements are made. Samples received cryogenically preserved will be stored frozen at standard core storage rates from sample date of receipt. Each bag or jar sample will be charged disposal at per foot unit rates******

Test Description	Method Reference	Sample Requirement
MISCELLANEOUS & OTHER CHARGES		
Cooler Return: minimum charge	N/A	N/A
Dry Ice; per pound	N/A	N/A
Cryogenic cores require LN2 plug-cutting; per Liquid Nitrogen Tank	N/A	N/A
EDD (Electronic Data Deliverables): Electronic Report + QC/QA pkg; MS Excel, PDF or similar format billed at 15% of analytical cost. Additional formats available by quotation	N/A	N/A
Web Hosting of project data on IGL secure website after 90 days; per project per month billed at 0.5% of project cost		
Rush Charges:		
* Same day: +200%		
* 24 - 48 hours: +100%		
* 2 - 3 business days: +75%		
* 4 - 5 business days: +50%		
* 6 - 9 business days +25%		
EPA Health Level Surcharges:		
Level C +25%; Level B +50%		

******Turnaround Time (TAT) varies and is dependent upon testing, preparation, lithology, and sample volume. For example, 10-business day TAT starting next business day from sample receipt available for Index Properties, some individual tests and packages, while capillarity package requires 3 - 6 weeks. Please call for scheduling and availability.******

CROGENIC CORE SHIPPING INFORMATION

****** Integrated Geosciences Laboratories keeps large marine coolers in stock at our Houston, TX facility to be used by Clients at no charge for the purpose of shipping cores. Contact our Customer Service Representative to obtain Core Handling and Shipping Recommendations. ******