



Expert Specialists in GeoContainment™ Sciences

BIG GUNS ENERGY SERVICES

Cavern Development and Operations – Service Offerings

Company Highlights

BGES provides specialized services and expertise in Cavern Design and Operations including caprock integrity testing, cavern modeling, and monitoring to meet regulatory requirements.



Big Guns Energy Services Inc. (BGES) is a privately-held Canadian technology company providing premier GeoContainment™ evaluation and integrated geoscience, engineering, and specialty testing services for petroleum and mining industries.



Awards recipient with outstanding reputation

- Alberta Oil Magazine's *Top 200* companies in 2015
- 2015 *Consultancy of the Year* at the Canada Oil & Gas Awards

Uniquely positioned within the industry

- One of a few cavern service companies
- Specialized equipment, knowledge, and experience.
- Offers an Integrated GeoContainment™ Service Model

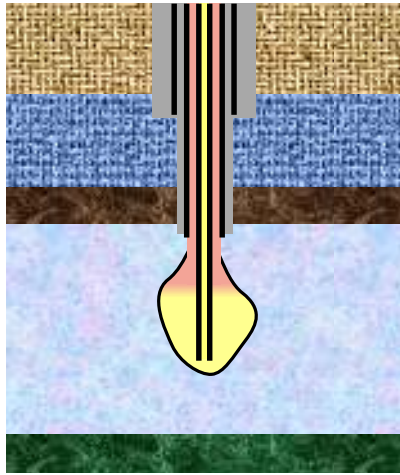
Market Focus

- Cavern development and integrity services
- Regulatory Compliance
- Optimization of Operations
- Due Diligence services

Service provider to major operators

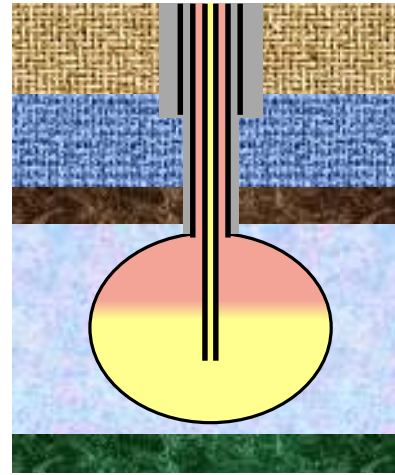
- Current customers include Suncor, Devon, Imperial Oil, Nexen, Husky, CNRL, ATCO, Plains Midstream, TransGas, Tervita

Salt Cavern Life Cycle – Service Needs



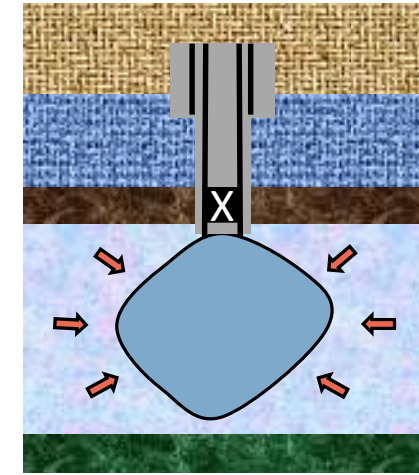
Beginning – Early Life:

- Location Selection, Regulatory Application
- Drilling and Coring, well completion
- Geomechanical study
 - Laboratory testing
 - Geomechanical Model/Simulations
- Solution Mining
 - Water Source
 - Sonar logging
 - Mechanical Integrity Test (MIT/A-MIT)
 - Waste/brine disposal



Midlife - Operations:

- Product type
- Max. / Min. Operating Pressures
- A-MIT
- Sonar Logging
- Model Maintenance

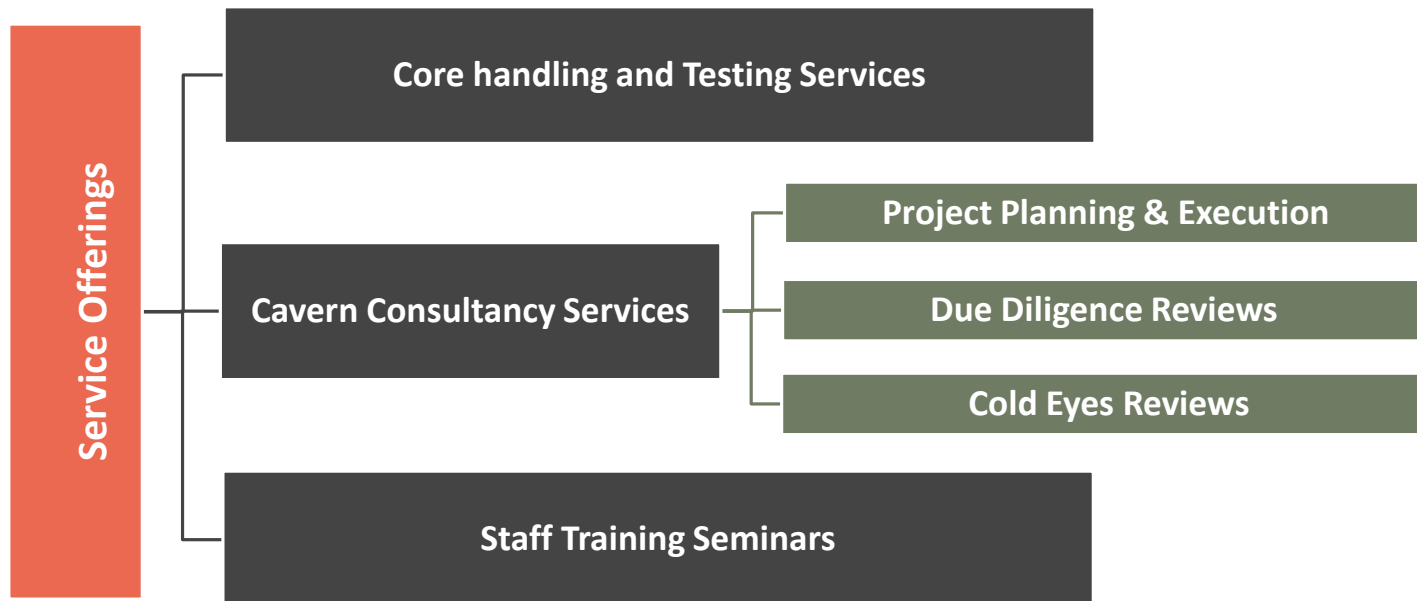
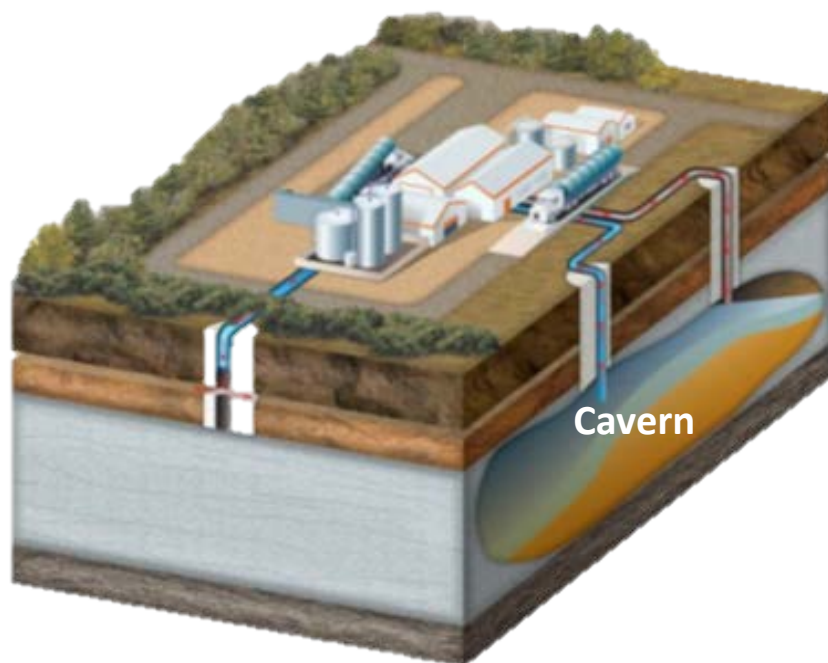


End of Life - Abandonment:

- Post Commercial Operational life, shut-in monitoring & maintenance
 - Abandonment application to regulatory body
 - Pressure and temperature monitoring
 - Final well plugging and reclamation

Service Offerings - Overview

**BGES provides full suite of technical services for the entire Life Cycle operations of the cavern
- from initial operations to cavern abandonment**



Coring and Lab Analysis Services

BGES is a leader in subsurface GeoContainment™ services with expertise in logging, field testing, laboratory testing, and simulation.

- Applying proven science to enable sustainable projects and to prevent disasters, whether it be safety, environmental, or financial.
- Combining a multi-disciplinary Geoscience & Engineering team with experienced operations personnel to provide full life cycle solutions.
- Other than BGES, there is only one other commercial lab in North America (in the U.S.) that conducts lab testing for salt caverns.

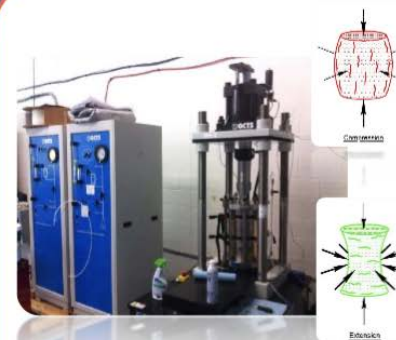
Coring and Lab Services



Caprock and Salt Core Handling

BGES's Geoscience & Engineering team provides solutions both in the field and in the laboratory to obtain high-quality data as inputs for model development.

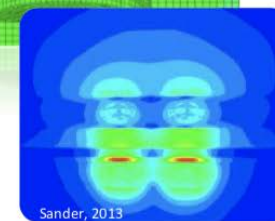
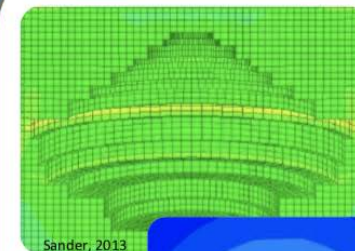
Quality data starts with quality core and accurate in situ measurements. Diligent core handling and management is key to a successful lab test. At BGES, we place great emphasis on the planning stage before and during field operations.



Laboratory Testing

BGES offers a full suite of geomechanical testing and analysis for salt, potash, and caprock projects. Test programs are designed to evaluate major elements of cavern behaviour, strength, stiffness and creep :

- Triaxial Compression (TC)
- Constant Mean Stress Triaxial – Compression (CMC)
- Constant Mean Stress Triaxial – Extension (CME)
- Multi-Stage Creep Test (MSCT)
- Brazilian Indirect Tensile Strength (BITS) Test
- Unconfined Compressive Strength (UCS) Test



Numerical Modeling & Simulation

BGES' staged modelling approach allows evaluation at several stage gates.

1. Development of 3D Mechanical Earth Model (3DMEM)
2. Simulation of existing caverns
3. Simulation of new cavern
4. History match of new cavern and long-term prediction

Consultancy Services– New Projects

Our consultancy services focuses on ensuring cost effective solutions and decision metrics for cavern design and operations from concept development through to end of life.

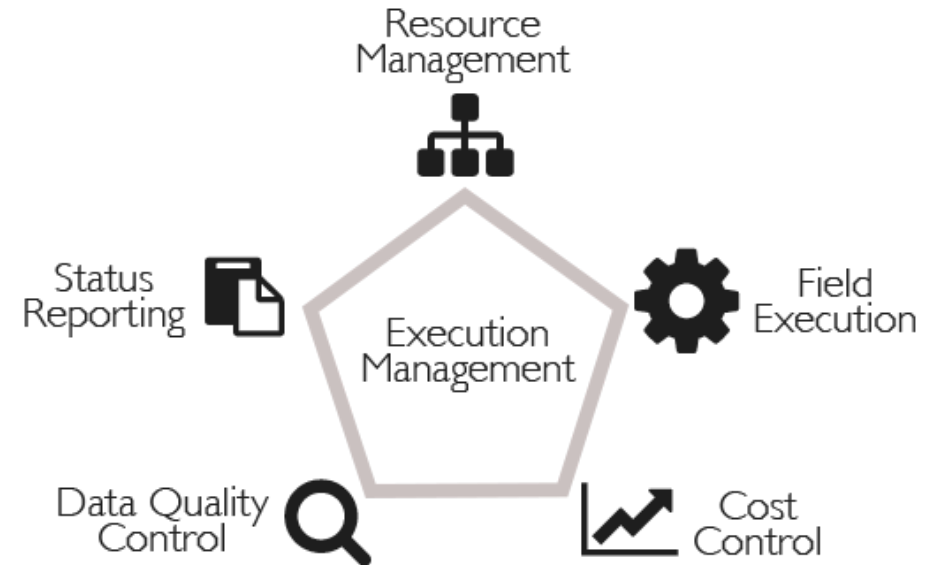
Project Planning Service

- Project Scoping
- Best Practices
- Test Program Design
- Resource Planning
- Scheduling
- Cost Estimating

Engineering / Geotechnical Support Service

- Data Quality Control
- Detailed Analysis of Data
- Comprehensive Reporting of Results
- Expert Recommendations
- Regulatory Application Assistance

Execution Management Service



Consultancy Services – Technical Reviews

Our participation in due diligence review undertakings will provide key decision metrics for M&A reviews, new cavern development, and other business needs.

- **Salt Caverns – M&A**

- Performance
- Operating Plan
- Risk Identification

- **New Cavern Development**

- Development Plan
- Expected Performance
- Operating Constraints

- **Other**

- Market Evaluations
- Insurance Submittals
- Regulatory Compliance

Due Diligence/Cold Eyes Review

- General Design
- Expected Capacity
- Historical Performance
- Operating issues
- Regulatory Compliance
- Regional Analogs

Key Decision Inputs

- Performance Outlook
- Key Risk Exposures
- Useful Life Estimate
- Cost Requirements
- Recommendations

BGES offers customized in-house training modules and direct training to management and operating personnel to achieve company's learning objectives.

Module 1 Cavern Design

- Design Objectives
- Geotechnical Parameters
- Performance Estimates
- Development Plan
- Regulatory Requirements

Module 2 Cavern Operations

- Operating Plan
- Operating Issues
- Performance Analysis
- Case Studies

Module 3 Regulatory Compliance

- Cavern 101
- Monitoring Requirements
- Risk Management
- Life Cycle of Caverns

Why BGES?

Unique Service Offerings

- Integrated Core and Lab Analytics
- Technical Consultancy Services
- Staff Training

Exclusive Partnership

- BGES has formed a new exclusive partnership with SOCON Sonar Well Services to perform top-quality cavern sonar surveys across Canada.
- SOCON is a world-renowned specialist in high-quality sonar surveillance of underground caverns.

Proprietary Processes

- BGES has developed a proprietary process for multi-stress permeability tests on caprock.

Establish Industry Credibility

- We know your business - history of providing subsurface, wireline, and GeoContainment™ services in Western Canada
- We know your business.

Asset Optimization

- Current focus on new cavern development and realignment of existing cavern infrastructure, creating a need for greater optimization including commodity changes, operating capacities, operating pressures, logistical integration

Risk Management & Liabilities

- In recent years the number of caprock failures in roof collapses in salt caverns have made subsurface critical for public safety, environmental protection and corporate risk management

Regulations

- Increasingly stringent and mandatory testing and monitoring requirements for salt caverns

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