GeoStabilization International®

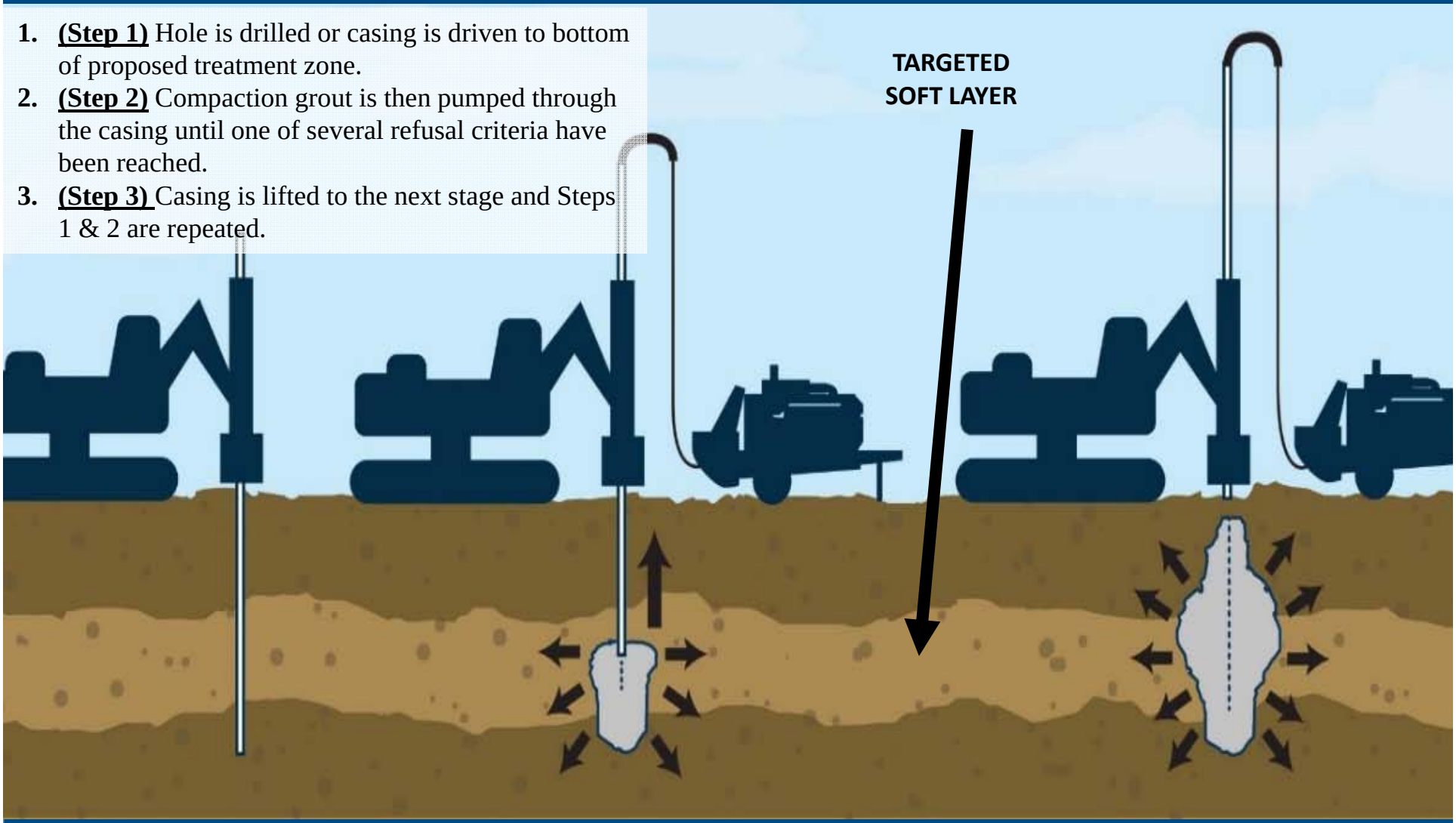
The Use of Compaction Grouting for Ground Improvement; Karst and Beyond

Tom Szynakiewicz, PE, D.GE

Compaction Grouting

Compaction grouting, otherwise known as Low Mobility Grouting (LMG) is the injection of low slump (typically less than 1”) cementitious grout into weak or soft soil layers throughout a weak soil profile in a primary/secondary pattern in order to **densify the soils for the purpose of increasing bearing capacity, decreasing settlement potential or general improvement**

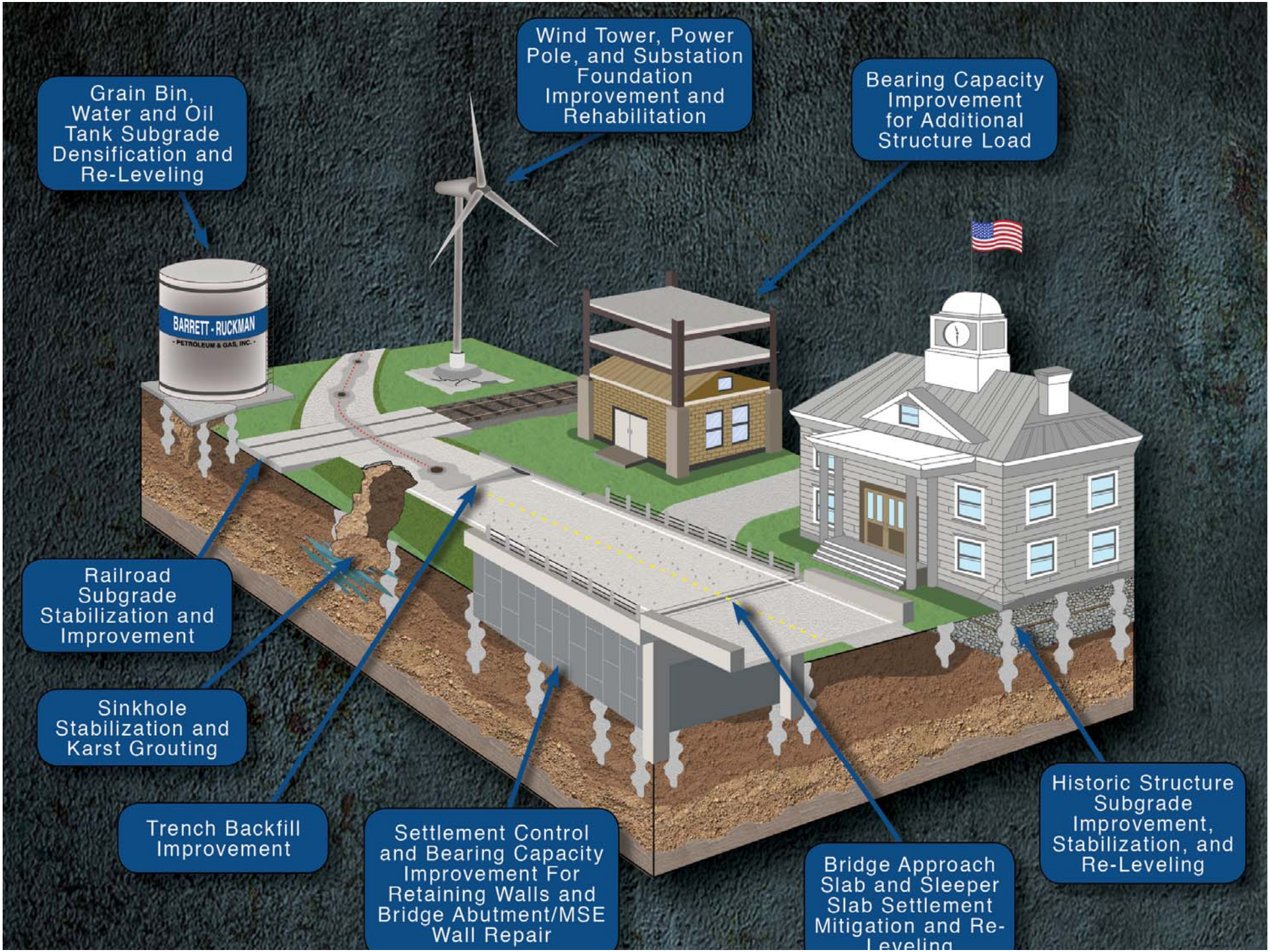
1. **<u>(Step 1)</u>** Hole is drilled or casing is driven to bottom of proposed treatment zone.
2. **<u>(Step 2)</u>** Compaction grout is then pumped through the casing until one of several refusal criteria have been reached.
3. **<u>(Step 3)</u>** Casing is lifted to the next stage and Steps 1 & 2 are repeated.



Geotechnical Compaction Grouting Applications

- Karstic Regions
- Rubble Fill
- Poorly Placed Fill
- Loosened Soil: Pre-Treatment
- Loosened Soil: Post-Treatment
- Liquefiable Soils
- Collapsible Soils

- Emergency Structure Settlement and Stabilization
- Karst Grouting
- Increasing Load Carrying Capacity of Existing Foundations
- To Compensate for Ground Loss During Tunneling


Grain Bin, Water and Oil Tank Subgrade Densification and Re-Leveling
Wind Tower, Power Pole, and Substation Foundation Improvement and Rehabilitation
Bearing Capacity Improvement for Additional Structure Load
BARRETT - RUCKMAN
- PETROLEUM & GAS, INC. -
Railroad Subgrade Stabilization and Improvement
Sinkhole Stabilization and Karst Grouting
Trench Backfill Improvement
Settlement Control and Bearing Capacity Improvement For Retaining Walls and Bridge Abutment/MSE Wall Repair
Bridge Approach Slab and Sleeper Slab Settlement Mitigation and Re-Leveling
Historic Structure Subgrade Improvement, Stabilization, and Re-Leveling

Advantages of Compaction Grouting

- Precise treatment
- Fast installation
- Can be performed in very tight access and low headroom
- No waste spoil disposal
- Wide applications range
- Non-destructive and adaptable to existing foundations
- Economic alternative to removal and replacement or piling
- Time tested and proven
- Site batching allows for necessary adjustments on the fly to maximize results

Compaction Grouting Process

Installation of grout pipe:

- Drill or drive casing
- Location very important
- Record ground information from casing installation

Initiation of grouting:

- Typically bottom up but can also be top down
- Grout rheology important (low mobility, not necessarily low slump)
- Usually pressure and/or volume of grout limited slow, uniform stage injection

Grout Batching

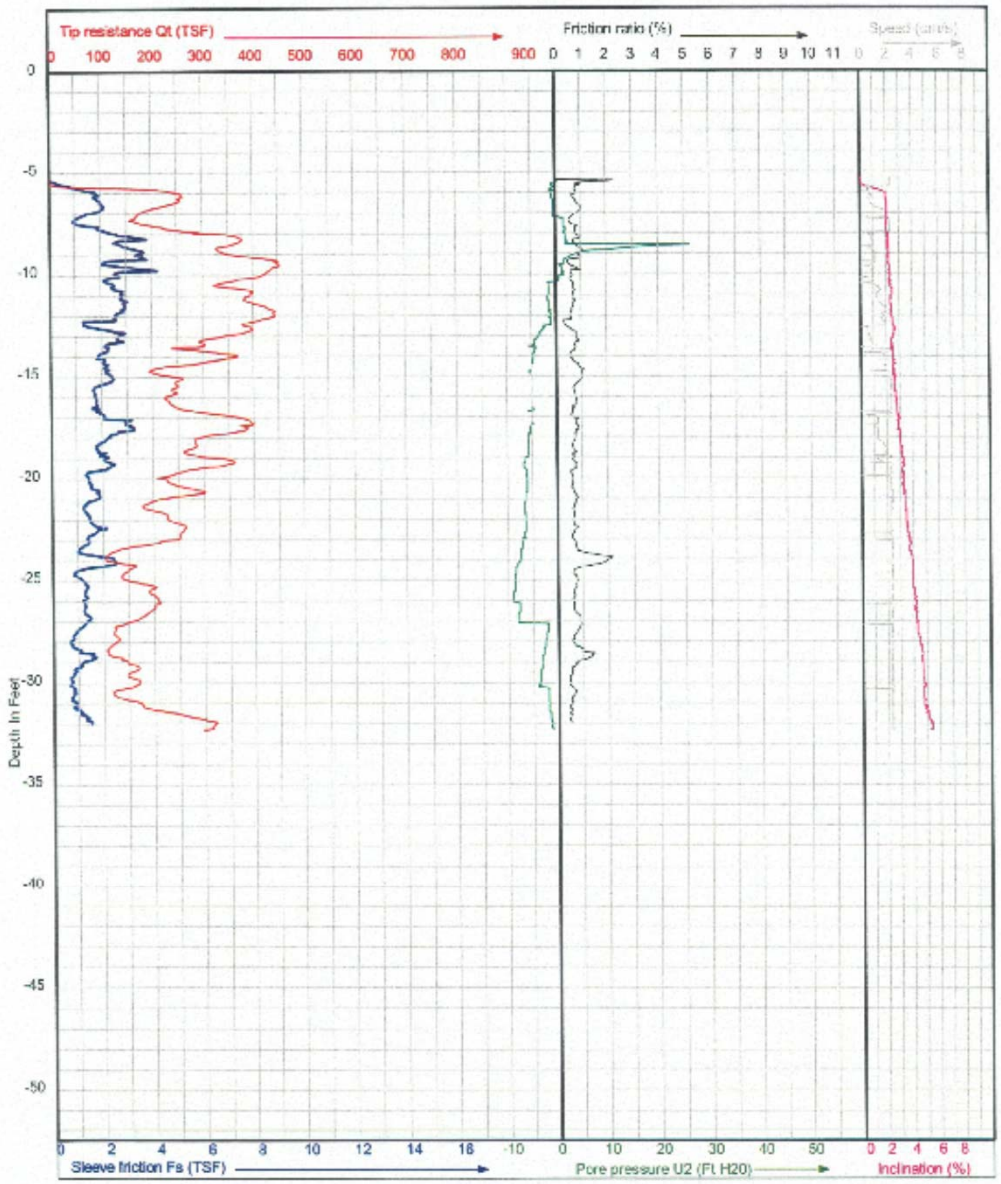
- On-site batching will aid control
- Grout rheology important
- Pressure, grout quantity, injection rate, and indication of heave are controlling factors
- Sequencing of plan injection points very important

Ideal Grout Make-Up

- 100 % passing 3/8”
- 15-25% passing #200
- Rounded pea gravel helps
- 10-20% cement by volume
- Slump is very important – typically less than 2” for pre-treatment and around 1” for underpinning and piles

Compaction Grouting QA/QC

- Grout logs for every hole at every one ft stage during production
- Pre-production test program can evaluate improvement
- Pre and Post SPT's
- CPT's
- Primary/Secondary nature of the method "notices" improvement between primary and secondary holes
  - Higher pressures
  - Lower grout takes



Project Number	23070015	CPT Operator	H. Garcia	Elevation (Ft MSL)
Sounding Location	1	Cone Type	CFIXYP10-15	
Test Number	1	Cone ID	060502	X-Coord
Client	Braun Intertec	Start Time	20:01	Y-Coord
Sounding Type	CPTU Sounding	Date	17-10-2007	Elev. Datum: WGS 84

GeoStabilization International®

Limitations

Like Any Ground Improvement Technique You Must Consider All Factors When Choosing A Remedial Technique

- The in situ vertical stress must be sufficient to enable the grout to displace the soil horizontally (if ground surface heave occurs densification will be minimized).
- The grout injection rate should be slow enough to allow pore pressure dissipation.
- Sequencing of grout injection is also important.
- Soils that lose strength during remolding (saturated, fine-grained soils; sensitive clays) should be avoided.
- Greater displacement will occur in weaker soil strata. Exhumed grout bulbs confirm that compaction grouting focuses improvement where it is most needed.
- Collapsible soils can usually be treated effectively with the addition of water during drilling prior to compaction grout injection.
- Stratified soils, particularly thinly stratified soils, can be cause for difficult or reduced improvement capability.

GeoStabilization International®

Geotechnicallly Problematic Conditions Where Compaction Grouting Can Be Effective

WWW.GEOSTABILIZATION.COM

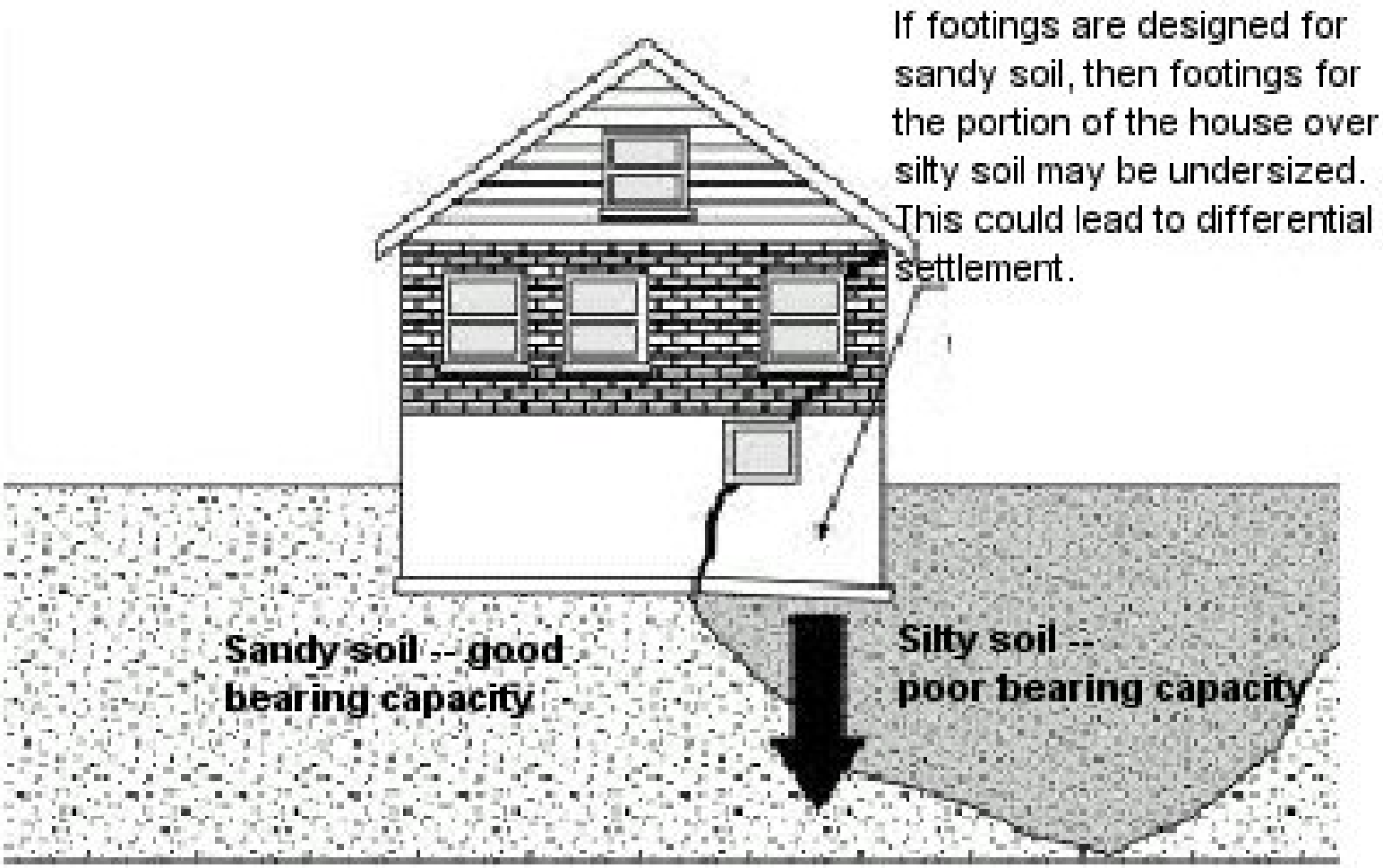
Collapsible Soils on Alluvial Fans

Karst

GeoStabilization International®

Culvert Washout or Sewer Line Collapse

Differing Soil Conditions Under Existing Structures




15365

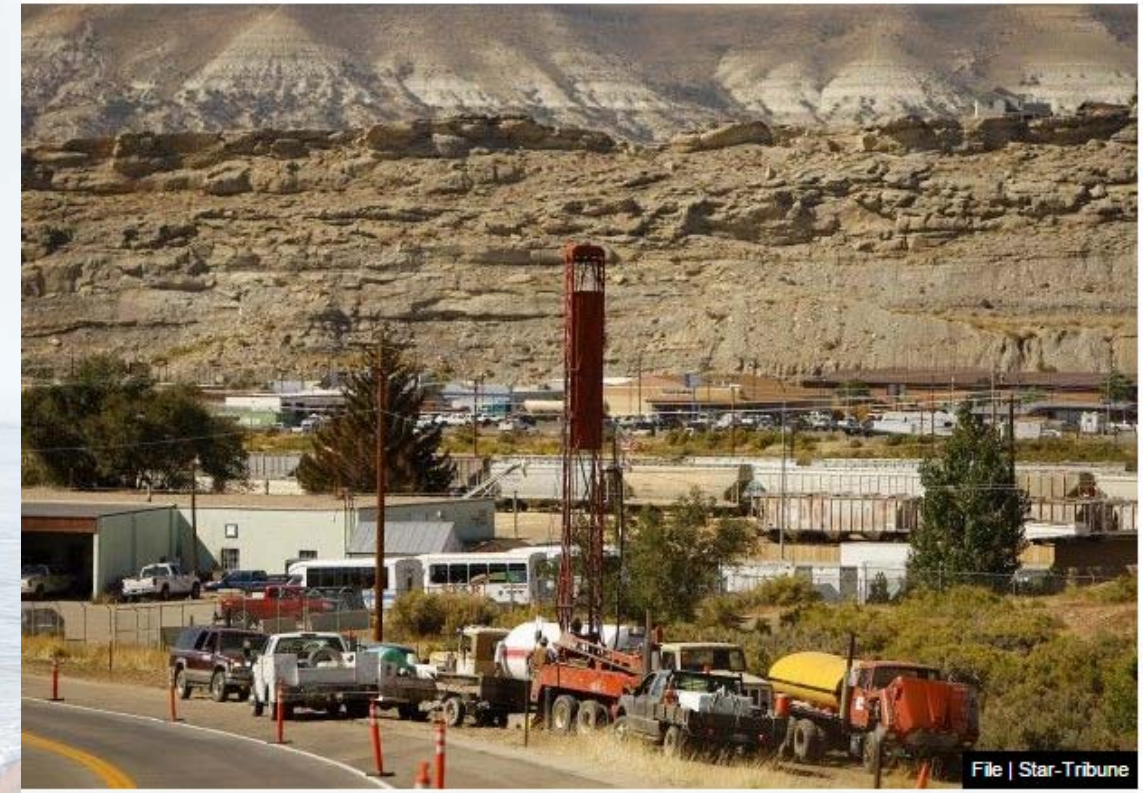
Urban Fills

Collapsing Mine Shafts

ROCK SPRINGS

More mine mitigation needed beneath Rock Springs

Recommend 0 Tweet 0 g+1 0 Share 1 Print Email



Workers use a drilling rig to access an abandoned mine along Loop Road in Rock Springs. Concrete pillars will be poured to shore up the mine.

Buy Now

November 16, 2014 5:00 pm • MATT NABER Rock Springs Rocket-Miner

(0) Comments

ROCK SPRINGS — Sweetwater County has a history of not sitting on stable ground.

GSI GeoStabilization International

Loess Deposits In Arid Areas

GeoStabilization International®

Day-to-Day Compaction Grouting Applications

Historical Structure Rehabilitation

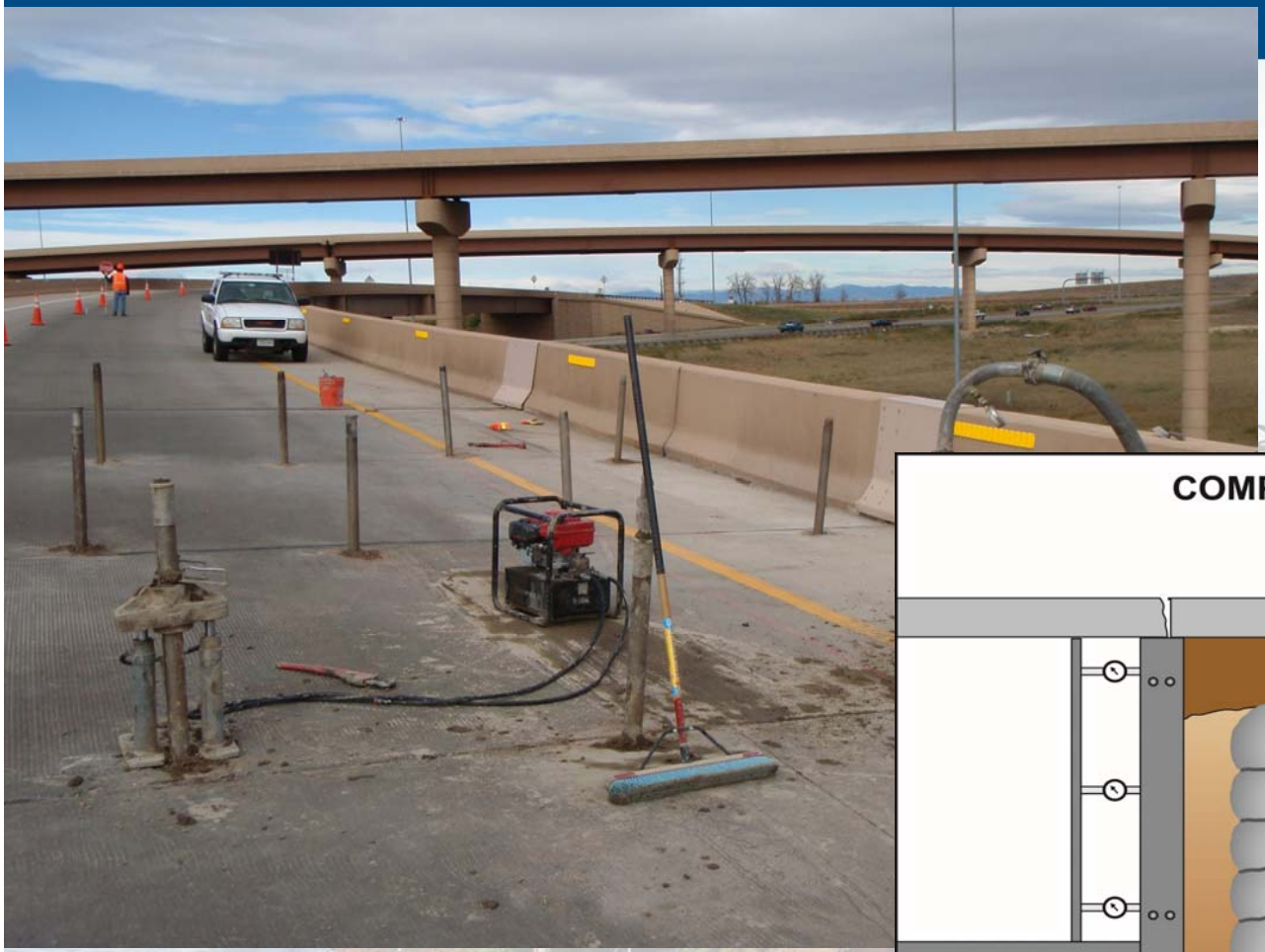
OSTABILIZATION.COM

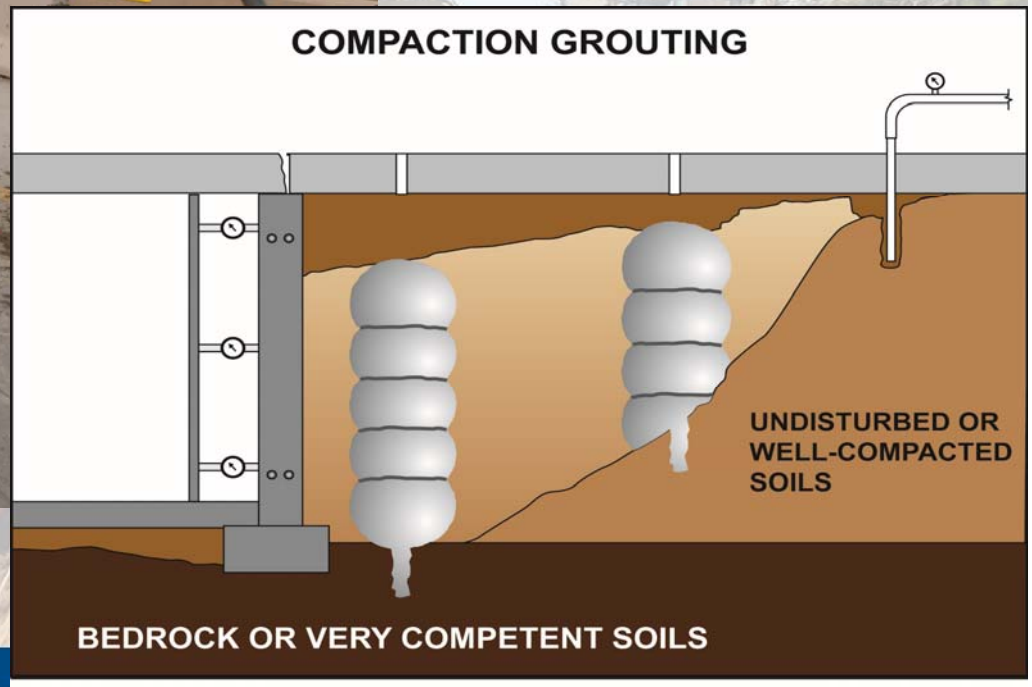
Night Work on Roadways Allows Road Reopening During Day

Roadway Embankment Stabilization

Soft Soils On Fill Side Of Roadway Settle Over Time

Sleeper Slab Re-Leveling and Stabilization



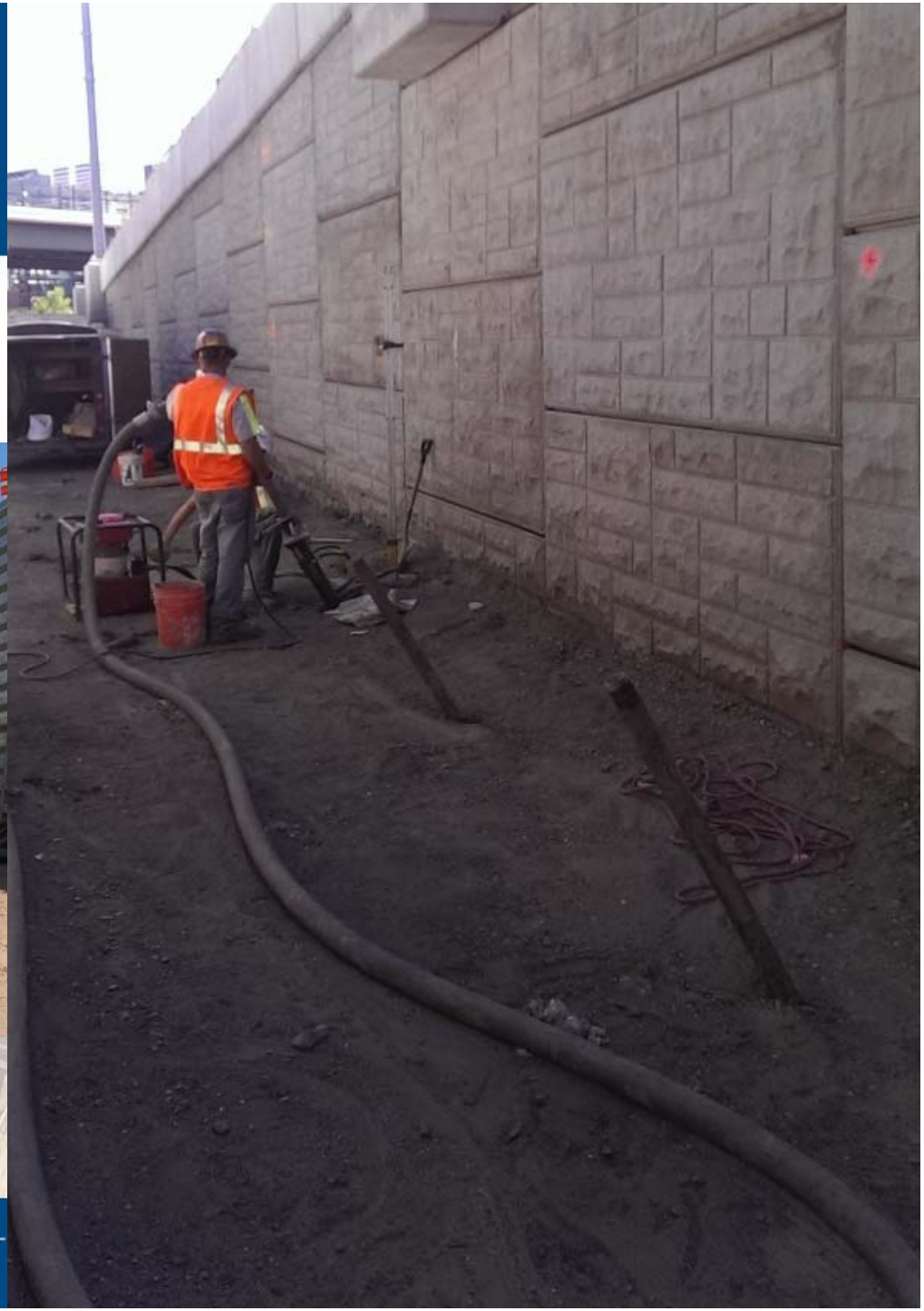


Bridge Approach or Parking Structure
Backfill Compaction Grouting

GSI GeoStabilization International®

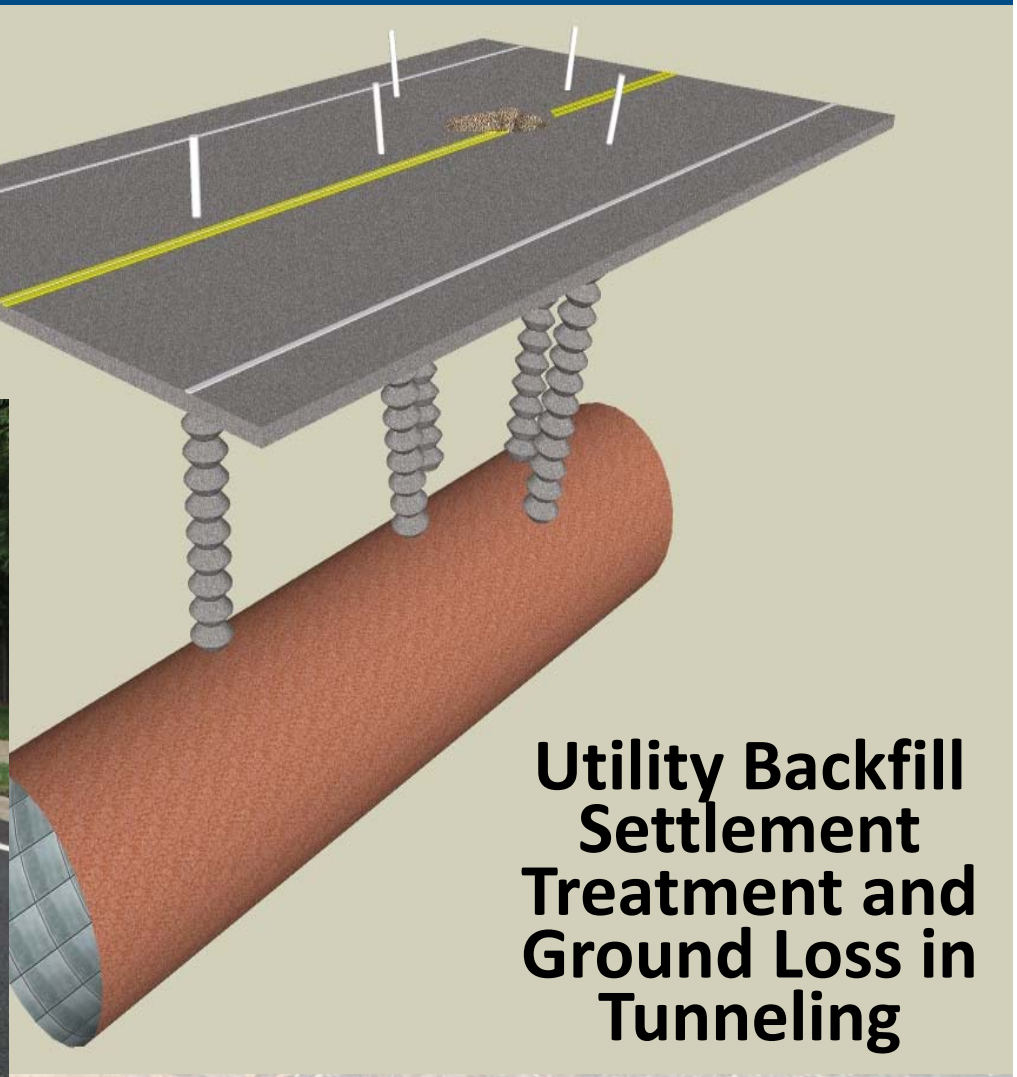
WWW.GEOST

MSE Wall Subgrade Stabilization

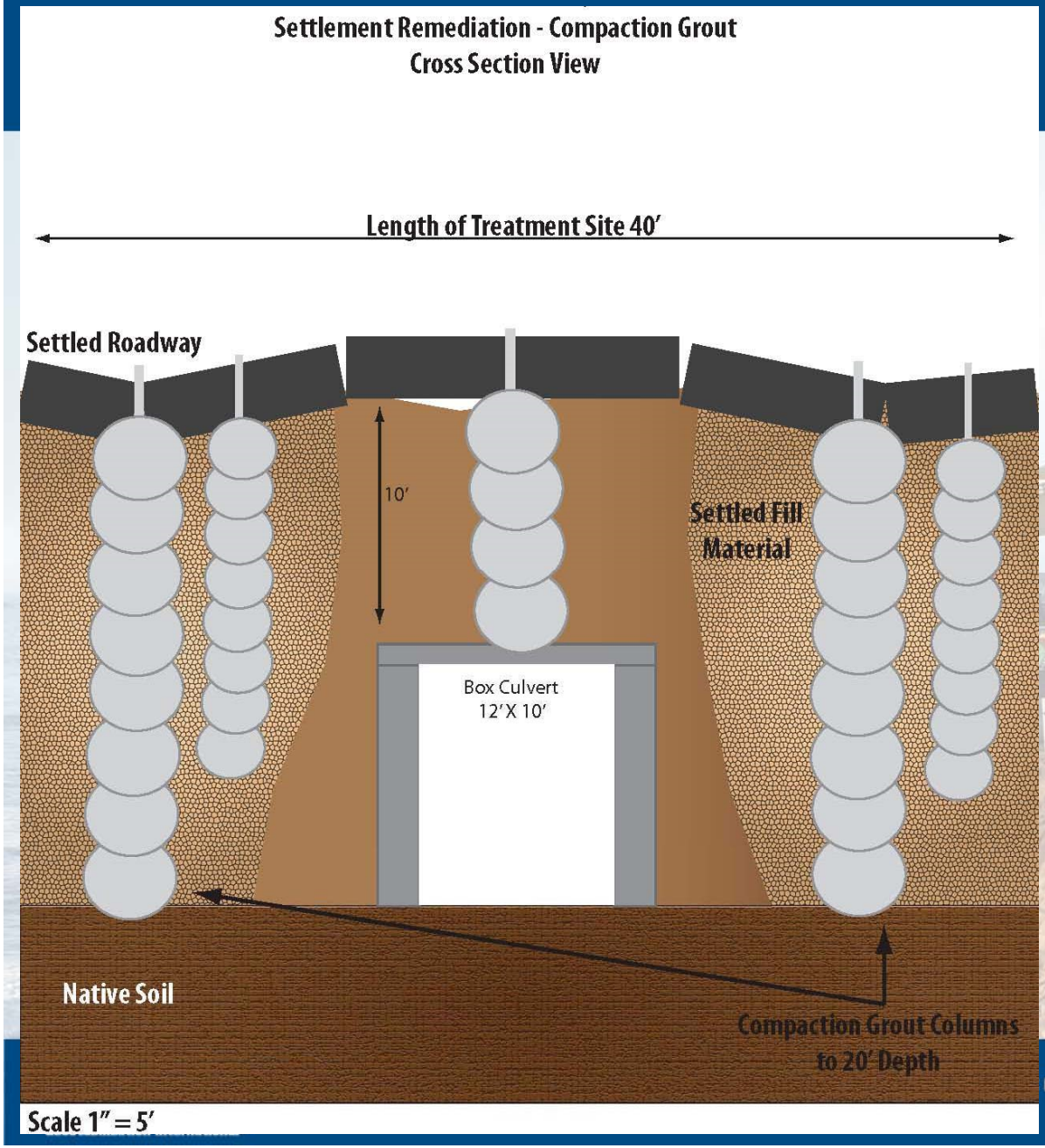


GeoStabilization International

WWW.GEOST



Utility Backfill Settlement Treatment and Ground Loss in Tunneling



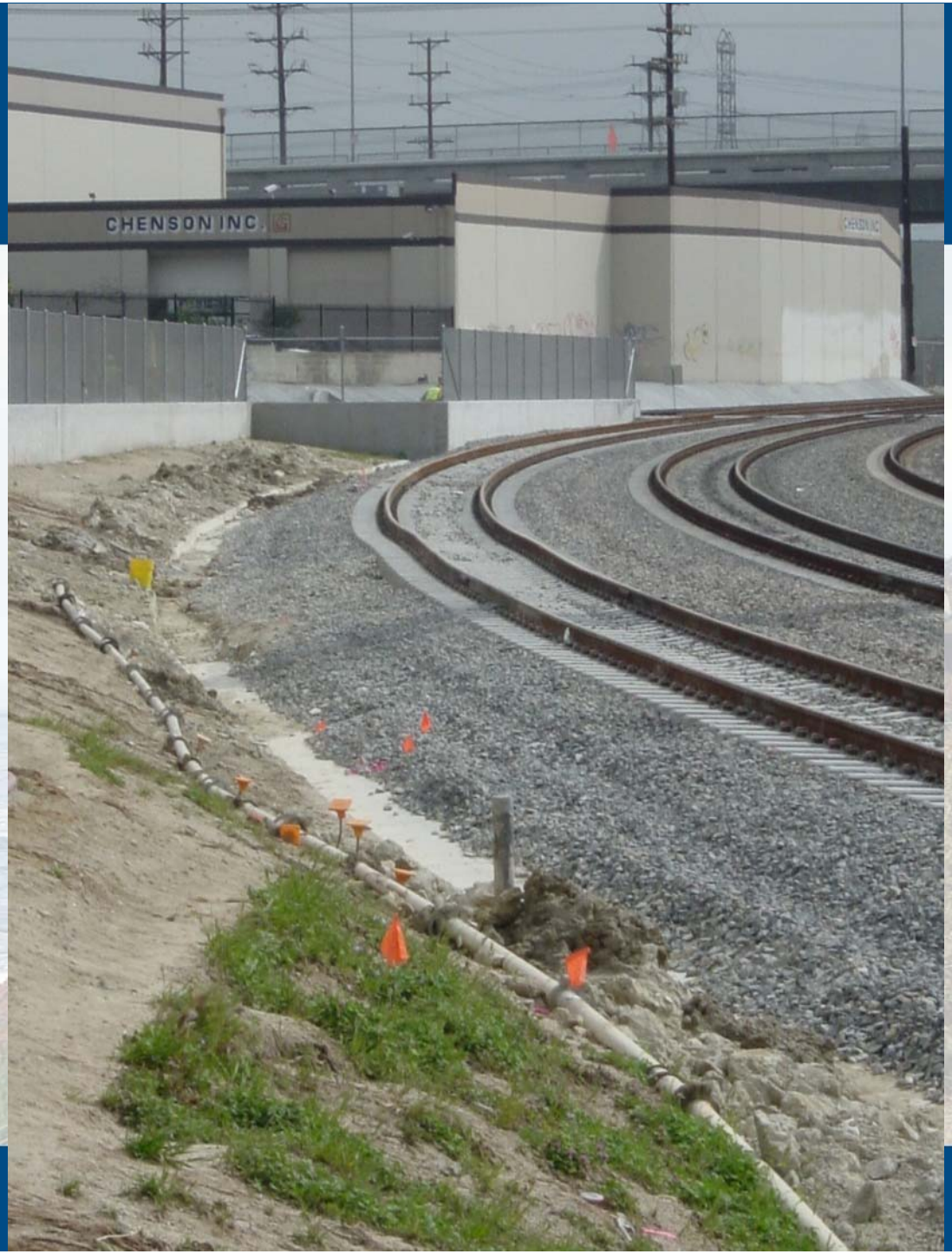
Trench Backfill Densification

Gas Compressor Station

Vibration Induced Settlement

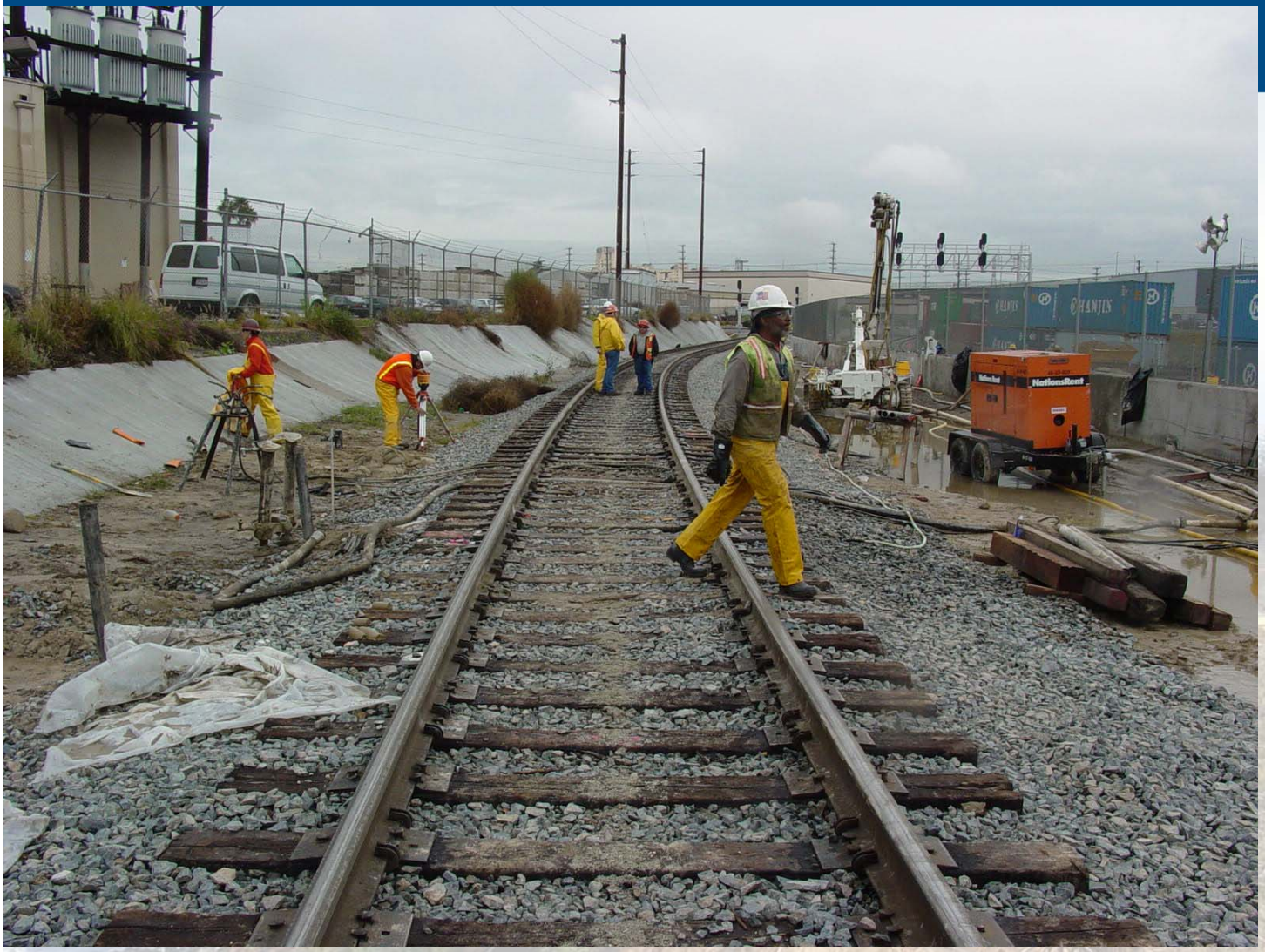
4” Total Settlement

ECIS Compaction Grouting



GeoStabilization International®

Grout Casing Installation



Grouting Operations and Surface Heave Monitoring

QUESTIONS?