

TRANSPORTATION RESEARCH BOARD

**Geotech Tools: Information & Technology
Guidance for Embankment, Ground
Improvement, & Pavement Applications**

Thursday, November 2, 2017
2:00-3:30PM ET

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.



REGISTERED CONTINUING EDUCATION PROGRAM



Purpose

Provide an overview of the Geotech Tools website.

Learning Objectives

At the end of this webinar, you will be able to:

- Understand how to access and navigate the GeoTechTools website and guidance system



GeoTechTools: Information & Technology Guidance for Embankment, Ground Improvement, & Pavement Applications



Webinar Goal

Integration of GeoTechTools

into your Practice –

both program delivery

and project development

www.GeoTechTools.org

Webinar Objectives

- **Stimulate more effective communication between project planners, designers and construction engineers**
- **Generate project solutions that factor constraints and mitigate risks**
- **Make better informed decisions**

Introduction and SHRP 2 Overview

A significant number of all construction claims in highway works are related to geotechnical issues.

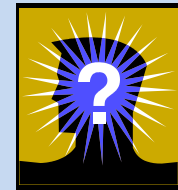


www.GeoTechTools.org



R02 Project is a Renewal Project

- **Renewal:** making rapid, innovative construction possible for “ordinary” projects





Renewal

- **Innovative – a change to how you are doing things today**
- **Innovative construction – requires innovative or changes to the entire project planning and deployment process**
- **Ordinary – means for every day, routine projects; not just large or challenging projects**

www.GeoTechTools.org

**A Comprehensive Web-Based
Information & Guidance System for**

- **Embankment, Ground Improvement &
Pavement Applications**
- **Project Development and Delivery
Options**

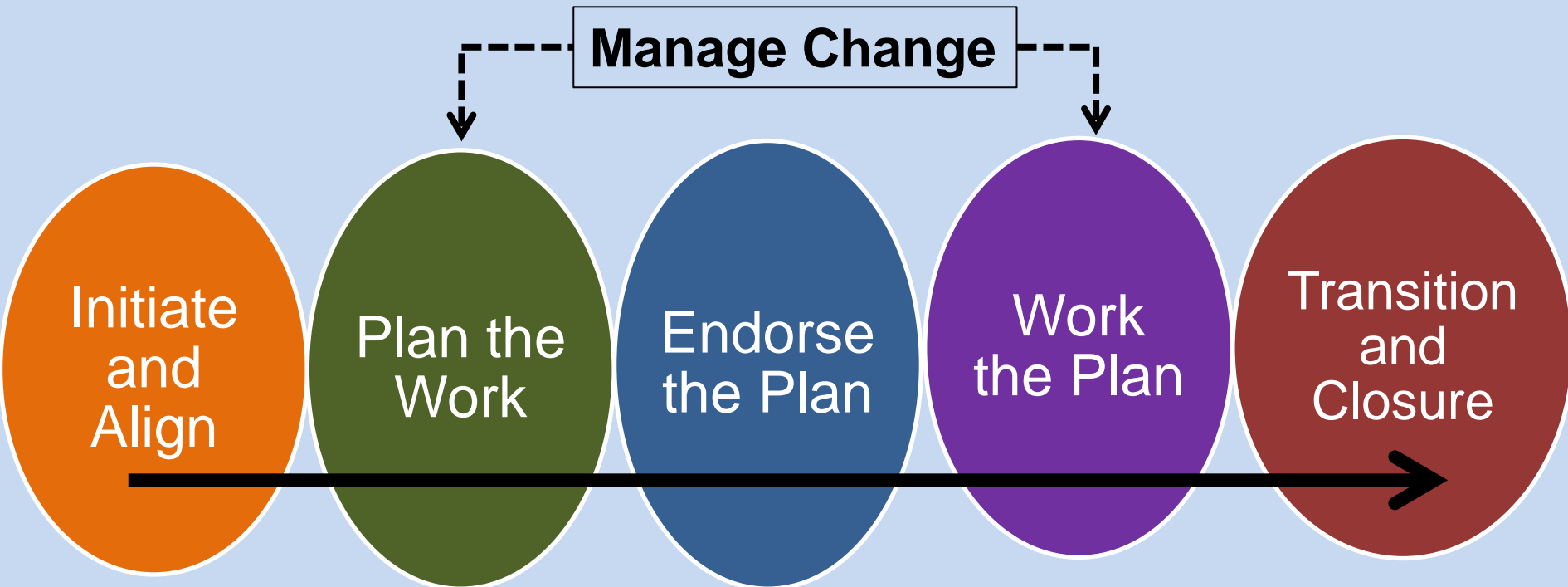
Project Planning: Constraints and Risks

Delivery/Contracting Methods

- **Methods:**
 - **Design-Bid-Build (D-B-B)**
 - **Design-Build (D-B)**
 - **Public-Private Partnership (P3)**
 - **Construction Manager – General Contractor (CMGC)**
 - **Value Engineering (VE)**
 - **Change Orders**
- **How are risks (geo-construction related) allocated?**

Project Management

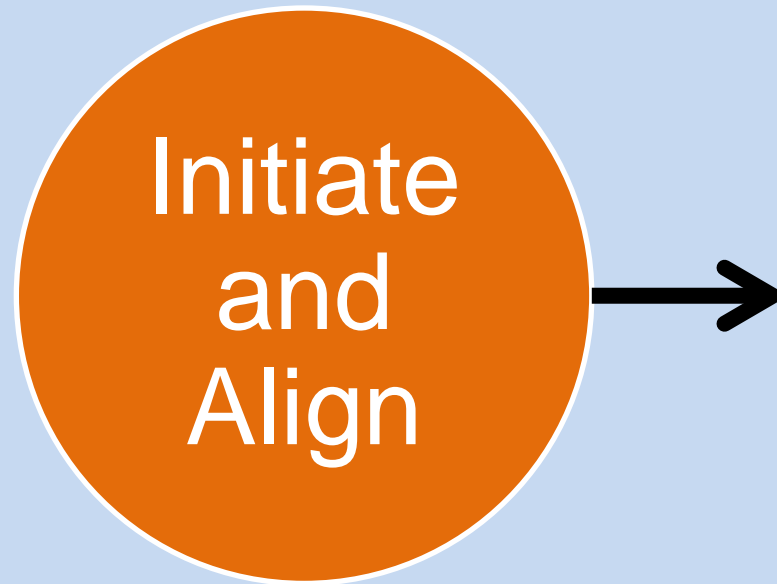
Example Guide Illustration:



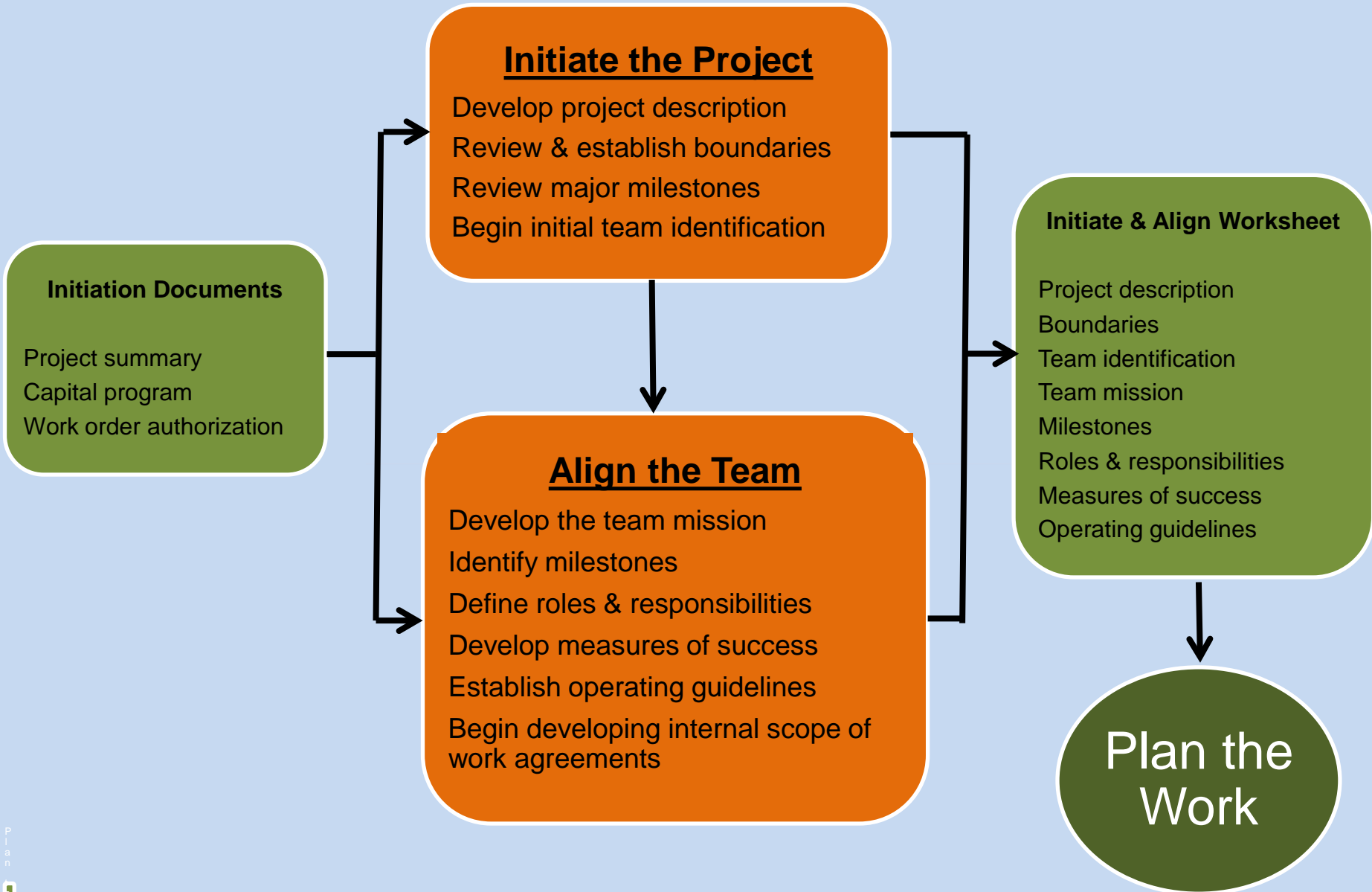
After: <http://www.wsdot.wa.gov/Projects/ProjectMgmt/PMOG.htm>

At what points do geotechnical issues start to arise?

Initiate & Align Component



Here we Review & Establish Boundaries, including Project Constraints



Typical Constraints

General

- **Schedule/Time**
- **Cost/Budget**
- **ROW Limits**
- **Traffic Flow**
- **Weather**
- **Environmental**

Geotech-Related

- **Subsurface Conditions**
- **Time of settlement**
- **Vibrations**
- **Noise**
- **Proprietary**

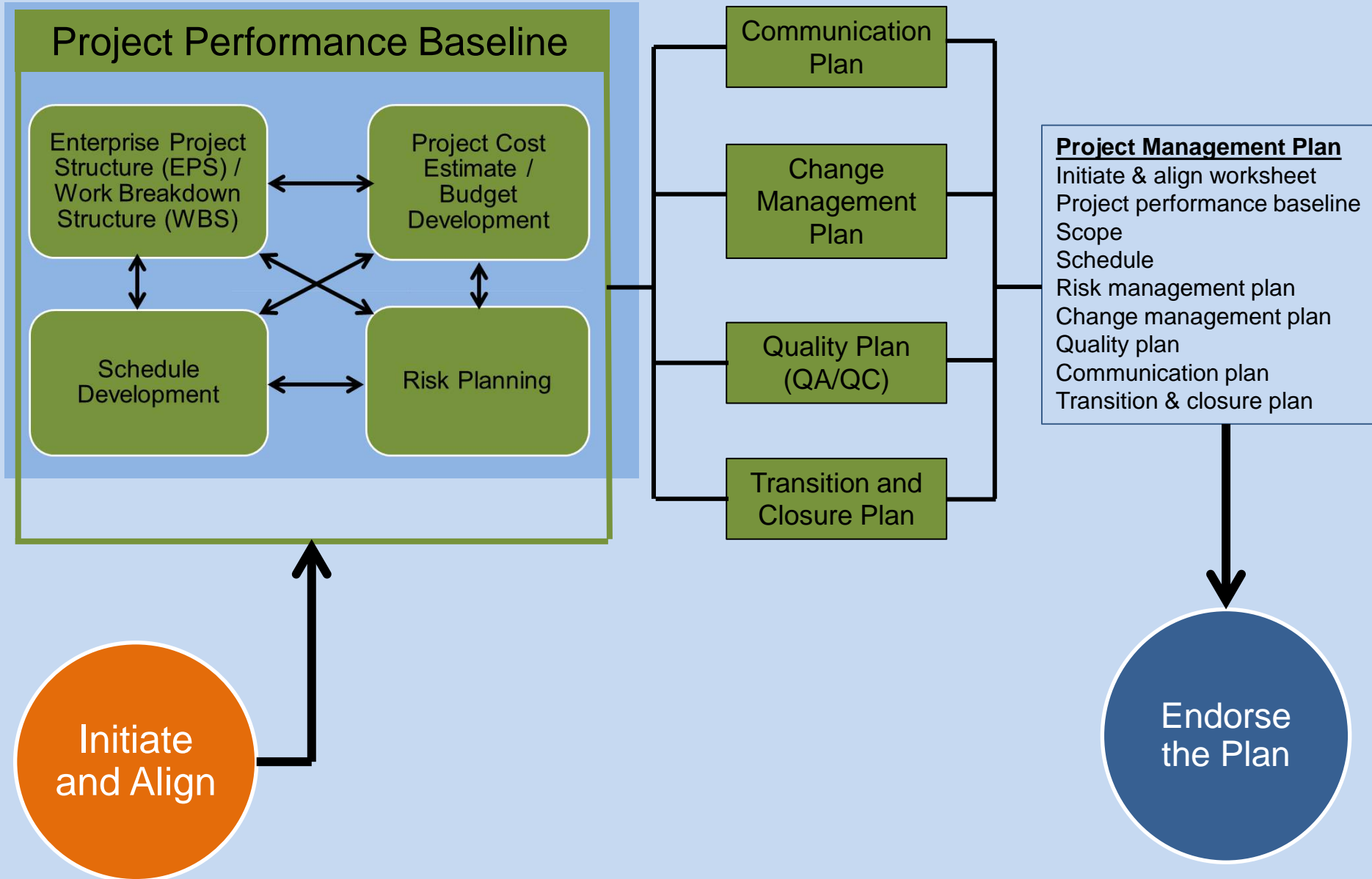
Benefits of GeoTechTools

- **Helps to identify technologies (options) applicable to your project “boundaries” and to assess relative speed and costs between candidate geotechnologies.**
- **Provides information needed to evaluate/engineer candidate geotechnologies for project-specifics.**

Plan the Work

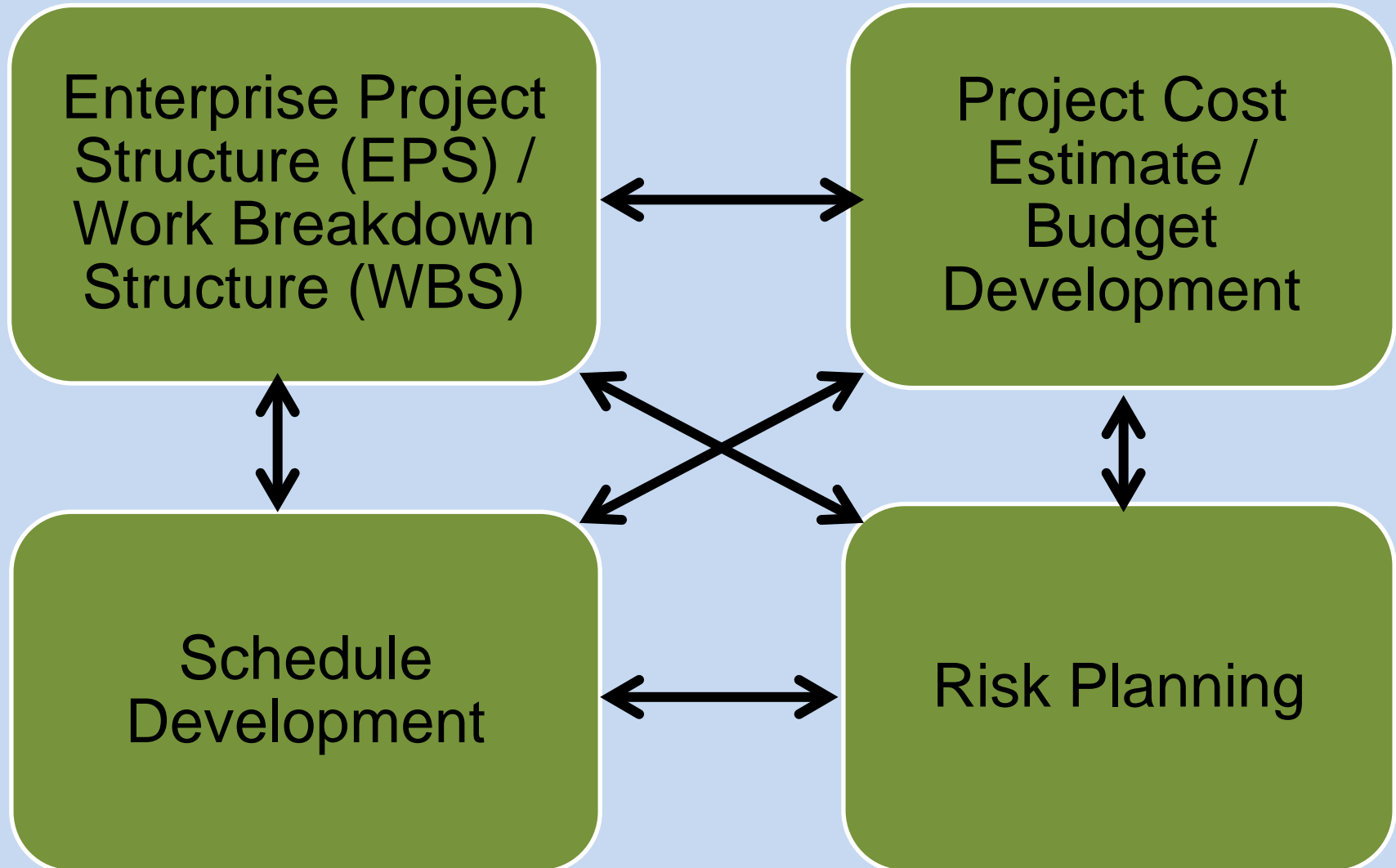


Plan the Work (con.)



Risk Planning

- Project Performance Baseline



Constraints & Risks

Examples

- **Constraint: 3-inch Settlement Limit**
- **Risk: Settlement exceeds 3 inches**

- **Constraint: 90% Settlement by 3 months**
- **Risk: 90% Settlement takes more than 3 months**

Typical Risks

General

- **Schedule/Delays**
- **Cost Overruns**
- **Underestimating Disruption**
- **Quality**
- **Errors & Omissions**

Geo-Related

- **Change of conditions**
- **Excessive Moisture**
- **Slope Instability**
- **Excessive Settlements**
- **Damage to Adjacent Structures**
- **Subsurface Investigation**

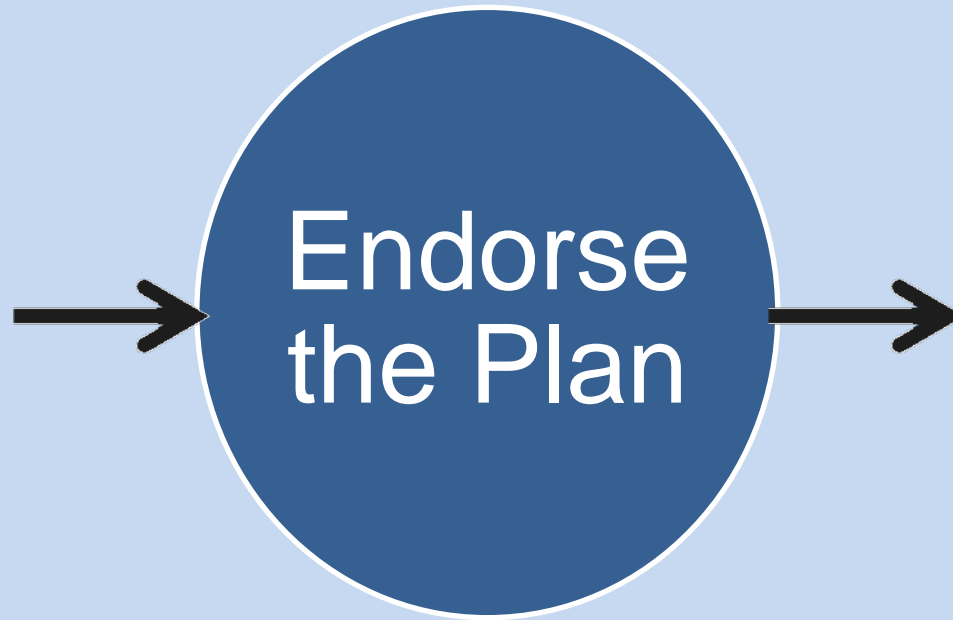
Benefits of GeoTechTools

- **Decreases chance that risks become real problems**
- **Provides options and tools to help address and reduce risk**

Making Decisions with GeoTechTools

- **Options by identifying candidate technologies, and providing a ranking of technologies. Relative rankings for:**
 - **Degree of establishment**
 - **Rapidity of construction**
 - **Minimize disruption**
 - **Longevity of constructed works**
- **Relative costs of geotechnologies to compare alternatives**

Endorse the Plan

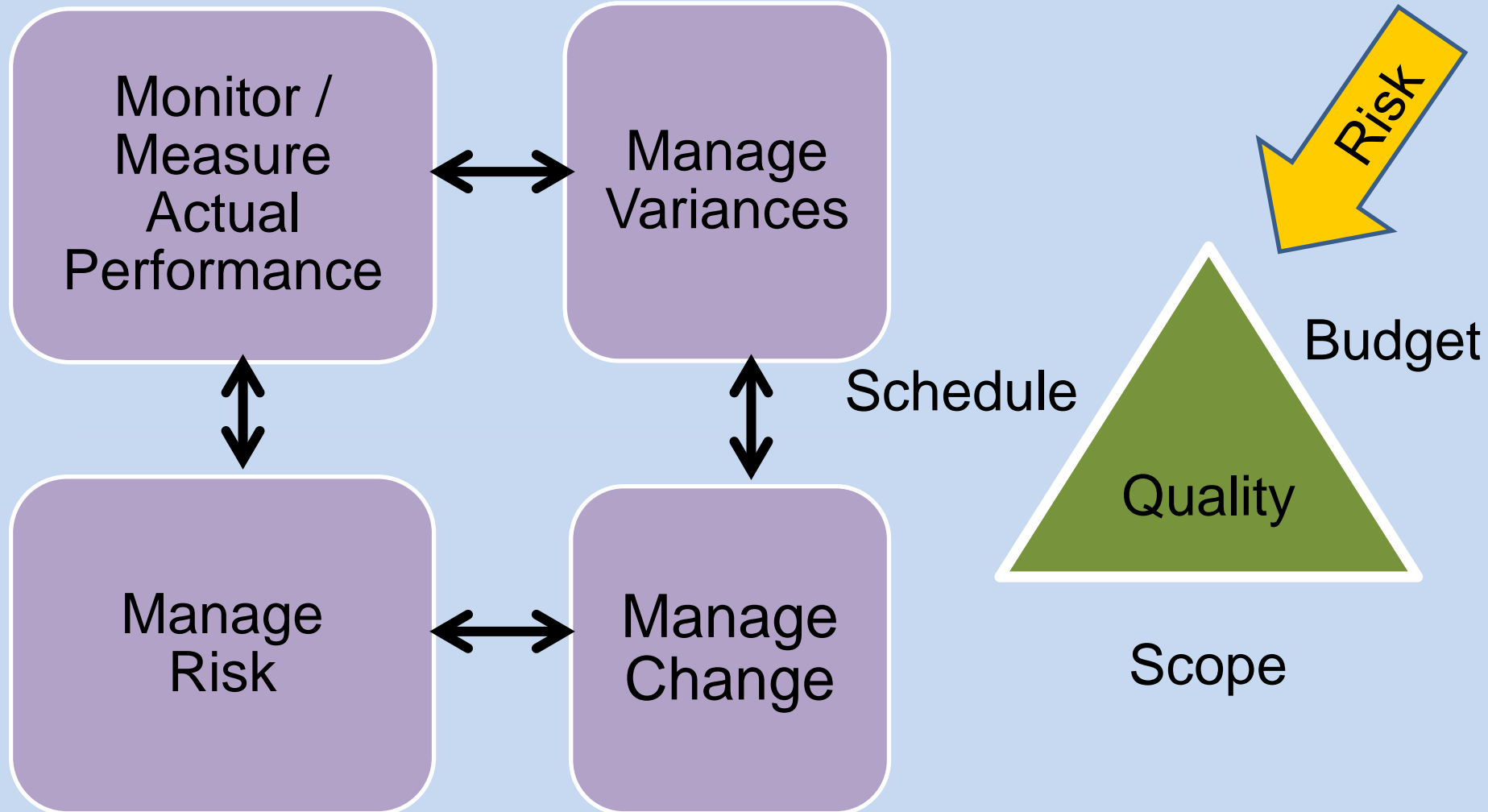


Work the Plan



Work the Plan (con.)

- Manage Current Plan



Working the Plan with GeoTechTools

- **Provides information on technologies that may be employed during construction to manage risks and variances.**
 - **Design Guidance**
 - **QC/QA Guidance**
 - **Specifications**

Risk Allocation

| Risk | Delivery Options | | |
|-------------------|------------------|---------|---------|
| | D-B-B | D-B | P3 |
| Design | Public | Private | Private |
| Ground Conditions | Public | Public | Private |
| Construction | Private | Private | Private |
| QC/QA | Public | Shared | Private |

Risks shift, but still exist

How or when you use GTT can vary – to perform work or to check work of others

GeoTechTools Project And Overview





Goal of GeoTechTools Project

To make geotechnical solutions more accessible to public agencies in the U.S. for rapid renewal and improvement of the transportation infrastructure.

“Project Vision”

Deep Mixing Methods



Aggregate Columns



Light Weight Fill



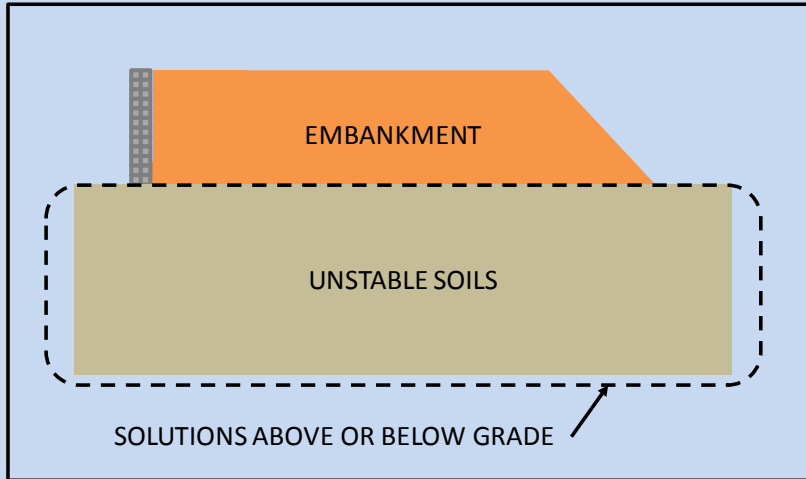
Column Supported Embankments



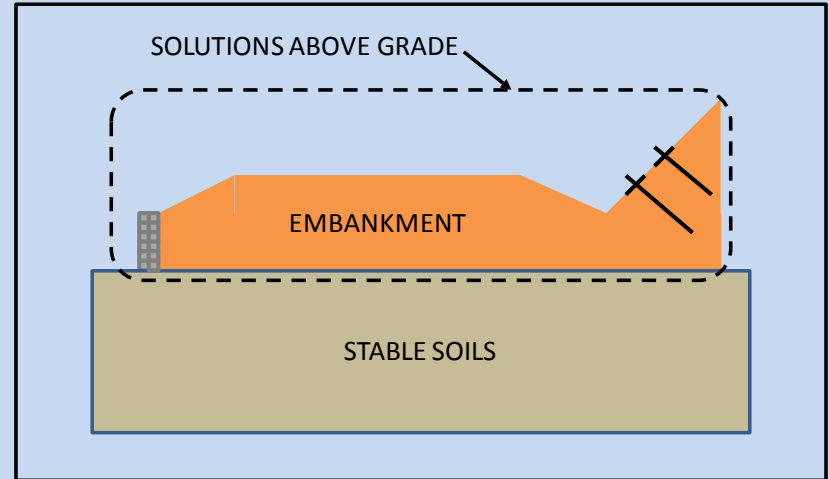
GTT Project Elements

- 1. New embankments and roadways over areas of unstable soils**
- 2. Widening and expansion of existing embankments and roadways**
- 3. Improvement and stabilization beneath the pavement structure**

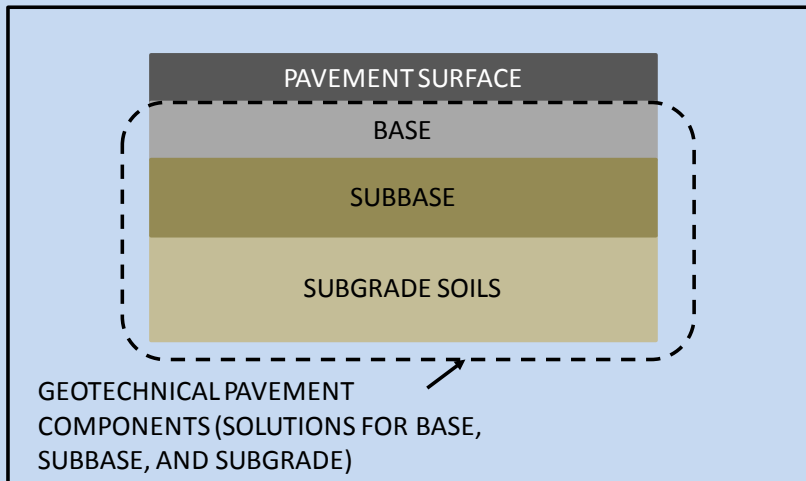
Application Areas



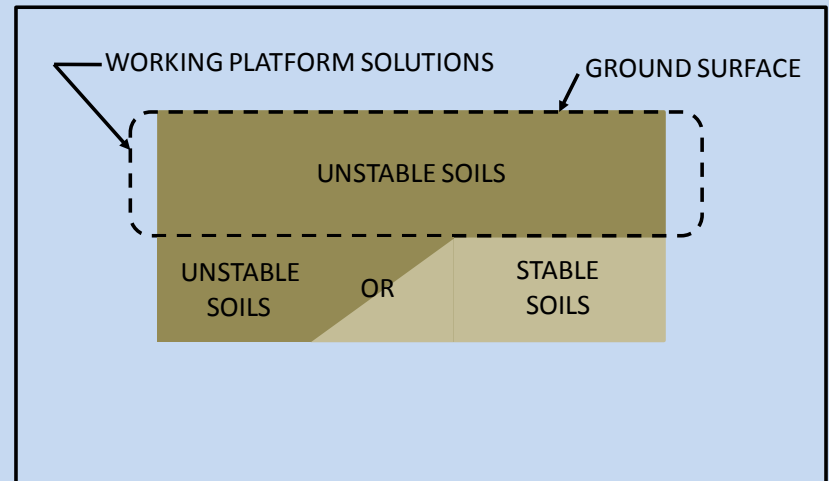
Construction over Unstable Soils



Construction over Stable/Stabilized Soils



Geotechnical Pavement Components (Base, Subbase, and Subgrade)



Working Platforms

Technologies Addressed

- **Aggregate Columns**
- **Beneficial Reuse of Waste Materials**
- **Bio-Treatment for Subgrade Stabilization**
- **Blast Densification**
- **Bulk-Infill Grouting**
- **Chemical Grouting/ Injection Systems**
- **Chemical Stabilization of Subgrades & Bases**
- **Column-Supported Embankments**
- **Combined Soil Stabilization with Vertical Columns**
- **Compaction Grouting**
- **Continuous Flight Auger Piles**
- **Deep Dynamic Compaction**
- **Deep Mixing Methods**

Technologies Addressed *(con.)*

- Drilled/Grouted & Hollow Bar Soil Nailing
- Electro-Osmosis
- **Excavation & Replacement**
- Fiber Reinforcement in Pavement Systems
- Geocell Confinement in Pavement Systems
- Geosynthetic Reinforced Construction Platforms
- Geosynthetic Reinforced Embankments
- Geosynthetic Reinforcement in Pavement Systems
- Geosynthetic Separation in Pavement Systems
- Geosynthetics in Pavement Drainage
- Geotextile Encased Columns
- High-Energy Impact Rollers
- Hydraulic Fill + Vacuum Consolidation + PVDs
- Injected Lightweight Foam Fill

Technologies Addressed *(con.)*

- Intelligent Compaction
- Jet Grouting
- Light Weight Fills
- Mechanical Stabilization of Subgrades & Bases
- MSE Walls
- Micro-Piles
- Onsite Use of Recycled Pavement Materials
- Partial Encapsulation
- PVDs & Fill Preloading
- Rapid Impact Compaction
- Reinforced Soil Slopes
- Sand Compaction Piles
- Screw-In Soil Nailing
- Shoot-In Soil Nailing
- Shored MSE Walls
- **Traditional Compaction**
- Vacuum Preloading w/ & w/o PVDs
- Vibrocompaction
- Vibro-Concrete Columns

End User TOOLS

- **Main product: Web based information and guidance system**

www.GeoTechTools.org

- **Project summary reports**

www.TRB.org/SHRP2/researchreports

Reports are under RENEWAL, Pavements, R02

Objectives of the Web-Based System

1. Identify potential technologies for the four Applications. → *>50 Technologies*
2. Provide current, up to-date information → *8 Products /Tools for each Technology*
3. Provide guidance to develop a ‘short-list’ of applicable technologies
4. Provide guidance for project-specific screening
5. Provide an interactive, programmed system

Primary Audience

- **Public agency personnel at Local, State and Federal levels**
 - **Geotechnical Engineers**
 - **Civil/Structural/Bridge Design & Construction Engineers, Pavement Design & Construction Engineers**
 - **Project Planners/Managers, Research, Maintenance, District Engineers**
- **Consultants, Contractors, A/Es**
- **Academics/Students**

End User Products/Tools

Case Histories:

Networking contacts

:

Engineers/Agencies receive recognition for their work

Build Technology CHAMPIONS

Use of GeoTechTools

- **Web site**
 - **Learn about technologies**
 - **Investigate candidate solutions**
 - **Locate design & QC/QA methods**
 - **Develop scoping cost estimates**
 - **Develop specifications**
- **Locate additional information in references**

System Mandates

The *system* should be:

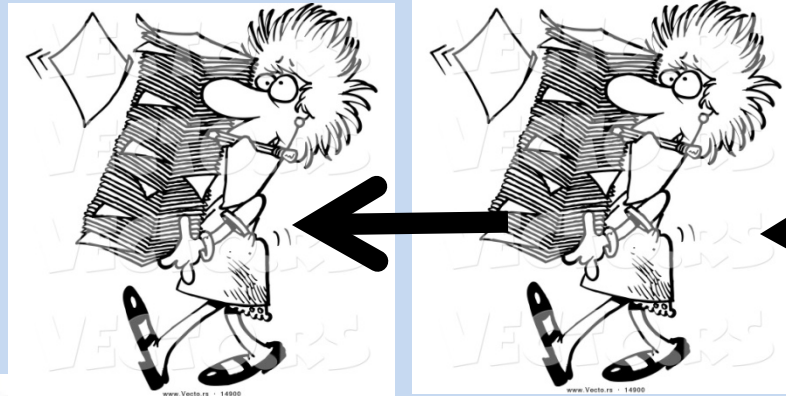
- **Simple**
- **Functional**
- **Completely populated**
- **Should be easily updatable**
- **Selection guidance should lead users to a short-list of potential, unranked technologies**

Value Added

The system *collects, synthesizes, integrates, and organizes* a vast amount of *critically important information* about geotechnical solutions on a *readily accessible* website

Research & Vetting Process

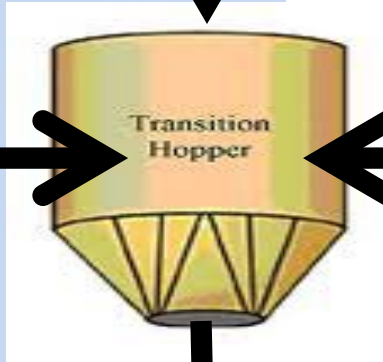
1,000s pages
Tech Docs



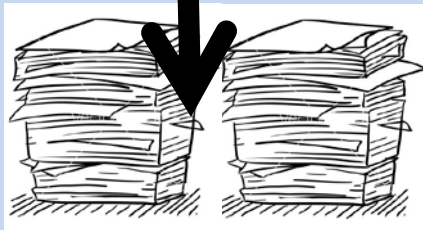
38 Post-Doc &
Grad Students



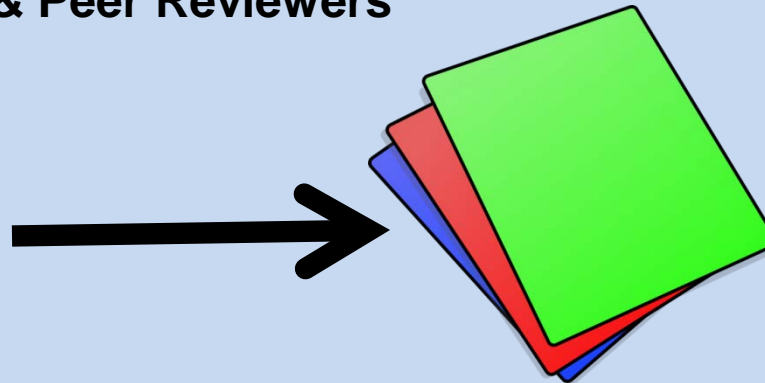
Research
&
Develop



38 Post-Doc & Grad Students
& 12 Principal Investigators
& Advisory Board
& Peer Reviewers



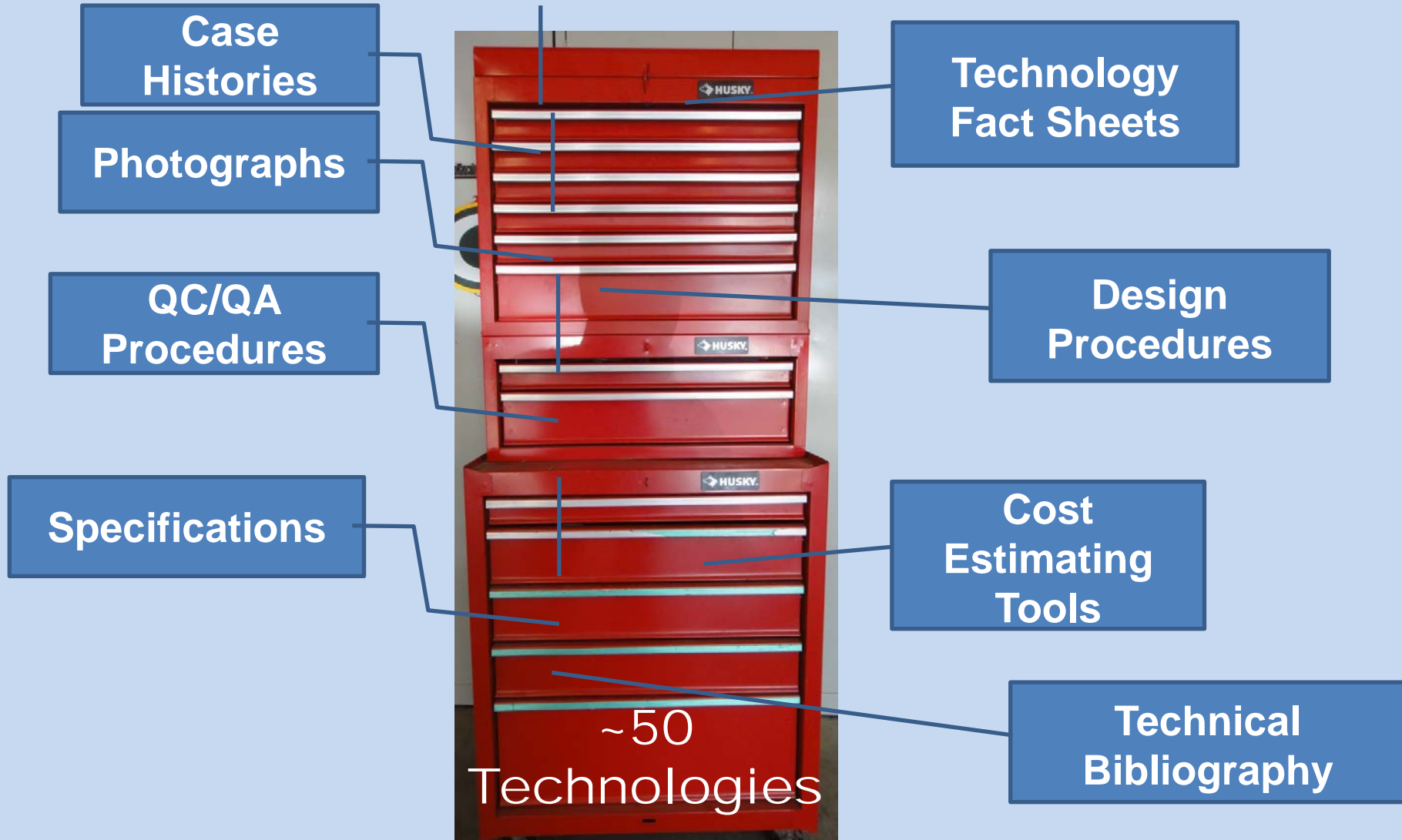
100s page
Summaries



8 Tools – 2 to 40
pages each

Not Just a New Tool

www.GeoTechTools.org



Development Note

GeoTechTools is a product developed through research funded by the Strategic Highway Research Program 2. The FHWA is implementing GeoTechTools in support of recommended technical guidance for identifying and deploying geotechnical solutions in Federal Aid project delivery. Additional information on FHWA recommended technical guidance can be obtained at www.fhwa.dot.gov/geotech

www.GeoTechTools.org

This is YOUR website.

**Be sure to contribute, to
maintain & keep it up to date.**

GeoTechTools Demonstration



Log-In

GEOTECH TOOLS

GEO-CONSTRUCTION INFORMATION
& TECHNOLOGY SELECTION GUIDANCE FOR
GEOTECHNICAL, STRUCTURAL, & PAVEMENT ENGINEERS



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OF THE NATIONAL ACADEMIES



Interactive technology
selection system

Photograph courtesy of Kansas Department of Transportation

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Opening Page

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STRATEGIC HIGHWAY RESEARCH PROGRAM
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ABOUT THIS WEBSITE

Geotech Tools: Geo-construction Information & Technology Selection Guidance for Geotechnical, Structural, & Pavement Engineers was developed by a SHRP 2 project with the goal of making geotechnical solutions more accessible to public agencies in the United States. This website is a toolkit of geotechnical information to address all phases of decision making from planning to design to construction. Transportation projects can be designed to be built faster, to be less expensive, and/or to last longer with use of these tools. Anyone involved in planning, design, and construction of transportation infrastructure will benefit from the information and resources available here. The information in the system is also applicable to non-transportation works and beyond the United States. We invite your comments and feedback on any aspect of the system. A *Users' Guide to the Information and Guidance System* is available. First time users are encouraged to review the [User's Guide](#).

What's New

Click here to download an icon for GeoTechTools.



This opening page has been revised to highlight *What's NEW*.

This opening page has been revised to emphasize that GeoTechTools is a living system and to encourage contributions to keep the system current and to expand its content.

Technical Revision Log

1. Intelligent Compaction
101 video added

Catalog of Technologies

The Catalog of Technologies provides a listing of all the technologies. For each technology, the following information is available:

- Technology Fact Sheet
- Photos
- Case Histories
- Design Guidance
- QC/QA Procedures
- Cost Estimating
- Specifications
- Bibliography

Technology Selection

Technology Selection is an interactive tool to identify candidate technologies for specific geoconstruction applications using project information and constraints. Final technology selection requires project-specific engineering. Technologies can also be accessed by classification or through a catalog of specific technologies.

Contribute

This is a living system; it is updated based upon your input. Users are strongly encouraged to contribute technical updates/corrections, case histories, cost information, photographs, and references to enhance and expand this web-based system. Users are also encouraged to report any bugs or glitches. All issues can be submitted through the [SUBMIT A COMMENT](#) link.

[A case history template is available in MS Word format.](#)

Catalog of Technologies

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ABOUT THIS WEBSITE

Catalog of Technologies

About the Technologies Listed

Included are ground improvement and geoconstruction technologies that are used for the following elements of construction:

- New embankment and roadway construction over unstable soils
- Roadway and embankment widening
- Geotechnical pavement components (base, subbase, and subgrade)
- Working platforms

An exception is that two traditional technologies—excavation and replacement, and traditional compaction—are included as often used "base" technologies, to which ground improvement and geoconstruction methods are often compared.

[Click here to view Catalog of Technologies with SHRP 2 R02 ratings](#) that also allows comparison of selected technologies.

Technology

- ▶ Aggregate Columns
- ▶ Beneficial Reuse of Waste Materials
- ▶ Bio-Treatment for Subgrade Stabilization
- ▶ Blasting Densification
- ▶ Bulk-Infill Grouting
- ▶ Chemical Grouting/Injection Systems
- ▶ Chemical Stabilization of Subgrades and Bases
- ▶ Column-Supported Embankments
- ▶ Combined Soil Stabilization with Vertical Columns
- ▶ Compaction Grouting
- ▶ Continuous Flight Auger Piles
- ▶ Deep Dynamic Compaction
- ▶ Deep Mixing Methods
- ▶ Drilled/Grouted and Hollow Bar Soil Nailing
- ▶ Electro-Osmosis

Rapid Impact Compaction Technology

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Technology Information

Rapid Impact Compaction

RIC uses equipment mounted on an excavator that drops a weight to densify soils. RIC provides controlled impact compaction to reduce settlement and improve geotechnical properties including stiffness and bearing capacity. Advantages include more efficient use of compaction energy, high uniformity of compaction, versatility of equipment, and small areas can be treated. This technique is applicable new embankments on unstable soils, embankment widening, and stabilization of the working platform.

Technology Fact Sheet

Photos

Case Histories

- Fire Station Complex, Chilliwack, British Columbia
- Building Liquefaction Mitigation, San Francisco, California
- Terminal Tanl 6, Tampa, Florida
- Random Fill Stabilization, Essex, United Kingdom

Design Guidance

Quality Control/Quality Assurance

Cost Information

Specifications

Bibliography

Check All

Clear



[Image credits](#)

Technologies

- ▶ Aggregate Columns
- ▶ Beneficial Reuse of Waste Materials
- ▶ Bio-Treatment for Subgrade Stabilization
- ▶ Blasting Densification
- ▶ Bulk-Infill Grouting
- ▶ Chemical Grouting/Injection Systems
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- ▶ Compaction Grouting
- ▶ Continuous Flight Auger Piles
- ▶ Deep Dynamic Compaction
- ▶ Deep Mixing Methods
- ▶ Drilled/Grouted and Hollow Bar Soil Nailing
- ▶ Electro-Osmosis
- ▶ Excavation and Replacement
- ▶ Fiber Reinforcement in Pavement Systems
- ▶ Geocell Confinement in Pavement Systems
- ▶ Geosynthetic Reinforced Construction Platforms

Downloading multiple documents



Check the individual boxes beside documents or use the "Check All" button to select the documents for download. After checking the desired documents, select the "Download Zip File" button at left to download your documents.

SHRP 2 Ratings for Rapid Impact Compaction

QUESTIONS

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- Fire Station Complex, Chilliwack, British Columbia
- Building Liquefaction Mitigation, San Francisco, California
- Terminal Tanl 6, Tampa, Florida
- Random Fill Stabilization, Essex, United Kingdom

- Design Guidance
- Quality Control/Quality Assurance
- Cost Information
- Specifications
- Bibliography

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Image credits

- ▶ Prefabricated Vertical Drains and Fill Preloading
- ▶ Rapid Impact Compaction
- ▶ Reinforced Soil Slopes
- ▶ Sand Compaction Piles
- ▶ Screw-in Soil Nailing
- ▶ Shoot-in Soil Nailing
- ▶ Shored Mechanically Stabilized Earth Wall System
- ▶ Traditional Compaction
- Vacuum Preloading with and without Prefabricated Vertical Drains
- ▶ Vibrocompaction
- ▶ Vibro-Concrete Columns

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Check the individual boxes beside documents or use the "Check All" button to select the documents for download. After checking the desired documents, select the "Download Zip File" button at left to download your documents.

SHRP 2 ratings for Rapid Impact Compaction

| Degree of Technology Establishment | Potential Contribution to SHRP 2 Renewal Objectives | | |
|------------------------------------|---|-------------------------------|-------------------------------------|
| | Rapid Renewal of Transp. Facilities | Minimal Disruption of Traffic | Production of Long-Lived Facilities |
| 2 | 4 | 1 | 3 |

(Rating Scale: 1 = not established or low applicability, 5 = well established or high applicability)

See the [SHRP 2 R02 Technology Ratings Summary](#) for a legend and description of rating development.

See the [SHRP 2 R02 Technology Ratings Summary](#) for a legend and description of rating development.

Rating Scale: 1 = very low, 2 = low, 3 = moderate, 4 = high, 5 = very high

Ratings Catalog

| Technology | Degree of Establishment | Potential Contribution to SHRP 2 Renewal Objectives | | |
|--|-------------------------|---|--------------------|-----------------------|
| | | Rapid Renewal | Minimal Disruption | Long-Lived Facilities |
| <input type="checkbox"/> ▶ Aggregate Columns | 4 | 3 | 1 | 4 |
| <input type="checkbox"/> ▶ Beneficial Reuse of Waste Materials | 3 | 2 | 1 | 3 |
| <input type="checkbox"/> ▶ Bio-Treatment for Subgrade Stabilization | 1 | 3 | 3 | 3 |
| <input type="checkbox"/> ▶ Blasting Densification | 3 | 3 | 2 | 4 |
| <input type="checkbox"/> ▶ Bulk-Infill Grouting | 3 | 4 | 4 | 4 |
| <input type="checkbox"/> ▶ Chemical Grouting/Injection Systems | 3 | 3 | 4 | 4 |
| <input type="checkbox"/> ▶ Chemical Stabilization of Subgrades and Bases | 5 | 4 | 2 | 4 |
| <input type="checkbox"/> ▶ Column-Supported Embankments | 3 | 5 | 1 | 4 |
| <input type="checkbox"/> ▶ Combined Soil Stabilization with Vertical Columns | 2 | 3 | 1 | 4 |
| <input type="checkbox"/> ▶ Compaction Grouting | 4 | 3 | 3 | 3 |
| <input type="checkbox"/> ▶ Continuous Flight Auger Piles | 4 | 4 | 1 | 4 |
| <input type="checkbox"/> ▶ Deep Dynamic Compaction | 5 | 4 | 1 | 4 |
| <input type="checkbox"/> ▶ Deep Mixing Methods | 3 | 4 | 1 | 4 |
| <input type="checkbox"/> ▶ Drilled/Grouted and Hollow Bar Soil Nailing | 4 | 4 | 3 | 4 |
| <input type="checkbox"/> ▶ Electro-Osmosis | 2 | 2 | 5 | 4 |
| <input type="checkbox"/> ▶ Excavation and Replacement | 5 | 2 | 1 | 4 |
| <input type="checkbox"/> ▶ Fiber Reinforcement in Pavement Systems | 2 | 3 | 2 | 4 |
| <input type="checkbox"/> ▶ Geocell Confinement in Pavement Systems | 1 | 3 | 2 | 4 |
| <input type="checkbox"/> ▶ Geosynthetic Reinforced Construction Platforms | 5 | 4 | 2 | 3 |
| <input type="checkbox"/> ▶ Geosynthetic Reinforced Embankments | 5 | 4 | 2 | 4 |
| <input type="checkbox"/> ▶ Geosynthetic Reinforcement in Pavement Systems | 4 | 4 | 2 | 4 |

PVDs and Fill Preloading Technology

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Technology Information

Prefabricated Vertical Drains and Fill Preloading

PVDs are band shaped (rectangular cross-section) products consisting of a geotextile filter material surrounding a plastic core that allow water flow. PVDs are used to accelerate the consolidation rate and strength gain of saturated, soft foundation soils by reducing drainage path lengths. Fill loading consists of a temporary surcharge load placed on the top of embankment to accelerate settlement in foundation soils. Advantages include reduced construction time, low cost, no spoil, durable and extensive experience. This technique is applicable to new embankments on unstable soils and embankment widening.

Technology Fact Sheet

Photos

Case Histories

Runway and Taxiway Extension,
Quad City Airport, Moline,
Illinois

Design Guidance

Quality Control/Quality Assurance

Cost Information

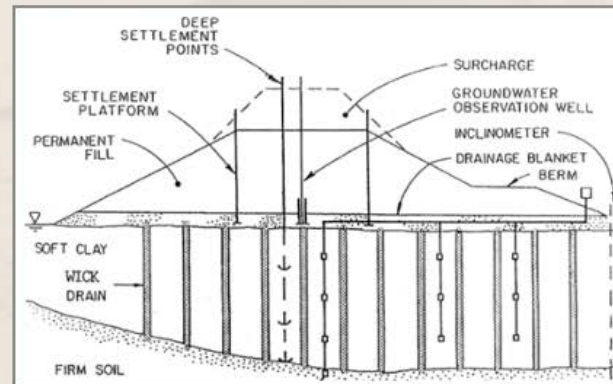
Specifications

Bibliography

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Technology

▶ Aggregate Column
▶ Beneficial Reuse
▶ Materials

▶ Bio-Treatment for
▶ Stabilization

▶ Blasting Densific

▶ Bulk-Infill Groutin

▶ Chemical Groutin
▶ Systems

▶ Chemical Stabiliz
▶ Subgrades and B

▶ Column-Supporte

▶ Combined Soil St
▶ Vertical Columns

▶ Compaction Grou

▶ Continuous Flight

▶ Deep Dynamic Co

▶ Deep Mixing Meth

▶ Drilled/Grouted a
▶ Soil Nailing

▶ Electro-Osmosis

▶ Excavation and R

▶ Fiber Reinforcem
▶ Systems

▶ Geocell Confinem
▶ Systems

▶ Geosynthetic Re

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- New embankment and roadway construction over unstable soils
- Roadway and embankment widening
- Geotechnical pavement components (base, subbase, and subgrade)
- Working platforms

An exception is that two traditional technologies—excavation and replacement, and traditional compaction—are included as often used "base" technologies, to which ground improvement and geoconstruction methods are often compared.

[Click here to view Catalog of Technologies with SHRP 2 R02 ratings](#) that also allows comparison of selected technologies.

Technology

- ▶ Aggregate Columns
- ▶ Beneficial Reuse of Waste Materials
- ▶ Bio-Treatment for Subgrade Stabilization
- ▶ Blasting Densification
- ▶ Bulk-Infill Grouting
- ▶ Chemical Grouting/Injection Systems
- ▶ Chemical Stabilization of Subgrades and Bases
- ▶ Column-Supported Embankments
- ▶ Combined Soil Stabilization with Vertical Columns
- ▶ Compaction Grouting
- ▶ Continuous Flight Auger Piles
- ▶ Deep Dynamic Compaction
- ▶ Deep Mixing Methods
- ▶ Drilled/Grouted and Hollow Bar Soil Nailing
- ▶ Electro-Osmosis

Rapid Impact Compaction Technology

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Technology Information

Rapid Impact Compaction

RIC uses equipment mounted on an excavator that drops a weight to densify soils. RIC provides controlled impact compaction to reduce settlement and improve geotechnical properties including stiffness and bearing capacity. Advantages include more efficient use of compaction energy, high uniformity of compaction, versatility of equipment, and small areas can be treated. This technique is applicable new embankments on unstable soils, embankment widening, and stabilization of the working platform.

Technology Fact Sheet

Photos

Case Histories

- Fire Station Complex, Chilliwack, British Columbia
- Building Liquefaction Mitigation, San Francisco, California
- Terminal Tanl 6, Tampa, Florida
- Random Fill Stabilization, Essex, United Kingdom

Design Guidance

Quality Control/Quality Assurance

Cost Information

Specifications

Bibliography

Check All

Clear



[Image credits](#)

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From Allen Marr, Ph.D., P.E., F.ASCE, NAE, "Geotechnical engineering and judgment in the information age," GeoCongress 2006, Geotechnical Engineering in the Information Technology Age.

Technologies

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Select “Agree”

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Technology Selection System Disclaimer

By accessing the Technology Selection System, the user understands, accepts responsibility for, and agrees to the following conditions and limitations:

- The user has read [User's Guide to the Information and Guidance System](#) and acknowledges the system constraints and limitations.
- TRB, SHRP 2, FHWA, and AASHTO do not provide user assistance or support for this system.
- The application of this system is the responsibility of the user. It is imperative that the responsible engineer understand the potential accuracy limitations of the program results, independently cross checks those results with other methods, and examines the reasonableness of the results with engineering knowledge and experience.
- There are no expressed or implied warranties as outlined in the [disclaimer](#).

Agree

Continue to Technology Selection System

Disagree

Return to Home Page

View Technologies by Classification

Technology Selection

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[View technologies by classification](#)

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- [Geosynthetic Reinforced Construction Platforms](#)
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- [Intelligent Compaction](#)
- [Mechanical Stabilization of Subgrades and Bases](#)
- [Rapid Impact Compaction](#)
- [Traditional Compaction](#)

Geotechnical Solutions for Soft Ground Drainage and Consolidation

- [Electro-Osmosis](#)
- [Excavation and Replacement](#)
- [Hydraulic Fill with Geocomposite and Vacuum Consolidation](#)
- [Prefabricated Vertical Drains and Fill Preloading](#)
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Geotechnical Solutions for Densification of Cohesionless Soils

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Access the interactive selection system

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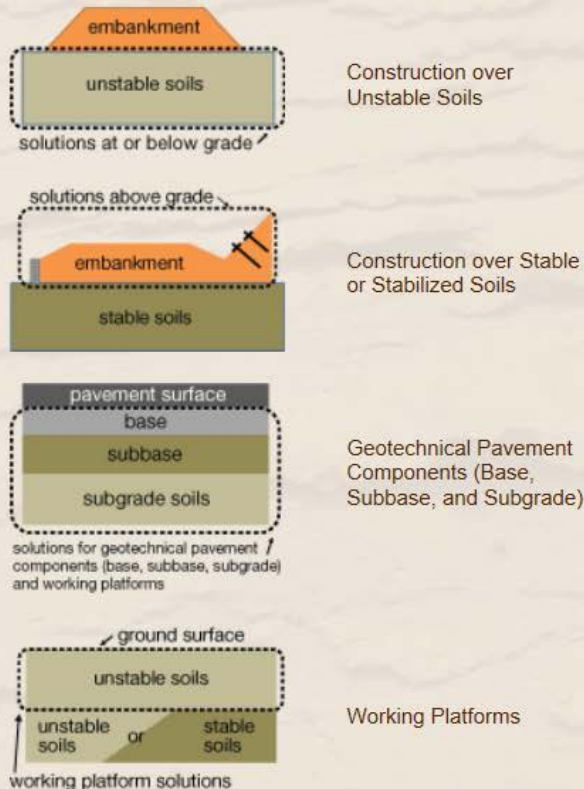
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Interactive Selection System

Select an Application ?

Begin the interactive selection system by selecting one of the applications to the right. These inputs are the basic information required for screening potential technologies.

The technologies shown in the far right-hand column are all the potential solutions available in this system. After selecting one of the applications below, a short list of potential solutions for the selected application will appear in the right hand column. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.



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? are found throughout the interactive selection system to provide additional information regarding each selection.

Construction Over Unstable Soils

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Interactive Selection System

Each screen will prompt for an input. These inputs are the basic information required for screening potential technologies. The technologies shown in the right-hand column are potential solutions for the selected application. As additional inputs are entered, potential technologies are highlighted and eliminated technologies are faded.

Your selections so far

Click on an item to return to a previous selection.



Selected Application Construction over Unstable Soils

Select a response that best represents project conditions

← return to
previous
selection

? Select Unstable Soil Condition

Wet and Weak, Fine Grained Soils

Unsaturated, Loose Granular Soils

Saturated, Loose Granular Soils

Voids – Sinkholes, Abandoned Mines, etc.

Problem Soils and Sites – Expansive, Collapsible, Dispersive, Organic,
Existing Fill, Landfills

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- ▶ Aggregate Columns
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- ▶ Geotextile Encased Columns
- ▶ High-Energy Impact Rollers
- ▶ Injected Lightweight Foam Fill
- ▶ Jet Grouting
- ▶ Lightweight Fill
- ▶ Micropiles
- ▶ Partial Encapsulation
- ▶ Prefabricated Vertical Drains and Fill Preloading

**For guidance on combining technologies, see [White Paper on Integrated Technologies for Embankments on Unstable Ground](#).*

Wet and Weak, Fine Grained Soils

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Your selections so far

Click on an item to return to a previous selection.



| | |
|-------------------------|----------------------------------|
| Selected Application | Construction over Unstable Soils |
| Unstable Soil Condition | Wet and Weak, Fine Grained Soils |

Select a response that best represents project conditions



? Depth below ground surface requiring treatment. This depth could be full-depth treatment of unstable soils or partial-depth treatment of unstable soils.

- 0 - 5 ft
- 5 - 10 ft
- 10 - 30 ft
- 30 - 50 ft
- Greater than 50 ft

*For guidance on combining technologies, see [White Paper on Integrated Technologies for Embankments on Unstable Ground](#).

? are found throughout the interactive selection system to provide additional information regarding each selection.

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 - Partial Encapsulation
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30 – 50 ft

Interactive Selection System

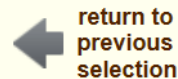
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Your selections so far


Click on an item to return to a previous selection.

| | | |
|---|----------------------------|----------------------------------|
|  | Selected Application | Construction over Unstable Soils |
| | Unstable Soil Condition | Wet and Weak, Fine Grained Soils |
| | Depth Below Ground Surface | 30 - 50 ft |


Select a response that best represents project conditions




This completes the screening process. The highlighted technologies on the right are the candidate technologies based on these selected inputs.

[Go to selection summary](#) 

Only proceed to project specific selection if you are experienced with selecting and implementing geoconstruction technologies.

[Continue to project-specific selection](#) 

**For guidance on combining technologies, see [White Paper on Integrated Technologies for Embankments on Unstable Ground](#).*

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Technologies

▶ Aggregate Columns

- Blasting Densification
- Bulk-Infill Grouting
- Chemical Grouting/Injection Systems

▶ Column-Supported Embankments

▶ Combined Soil Stabilization with Vertical Columns

- Compaction Grouting

▶ Continuous Flight Auger Piles

- Deep Dynamic Compaction

▶ Deep Mixing Methods

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- Excavation and Replacement

▶ Geosynthetic Reinforced Embankments

▶ Geotextile Encased Columns

- High-Energy Impact Rollers
- Injected Lightweight Foam Fill

▶ Jet Grouting

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Project-Specific Technology Selection for Construction over Unstable Soils

Selections Made

The following selections have been made so far. Click on an item to return to a previous selection.



Construction over unstable soils

Selected Application: Construction over unstable soils

Unstable Soil Condition: Wet and Weak, Fine Grained Soils ▼

Depth Below Ground Surface: 30 - 50 ft ▼

Select Project-Specific Characteristics

Answer the following questions that best describe the site conditions. Leave questions blank when the information is unknown (at this time) or inapplicable. The list on the right will update as selections are made. Click on the [?](#) for additional information regarding each selection.

? Purpose of Improvement:
----- Make your selection ----- ▼

? Additional Purpose of Improvement:
----- Make your selection ----- ▼

? Select Project Type:
----- Make your selection ----- ▼

? Site Characteristics:
----- Make your selection ----- ▼

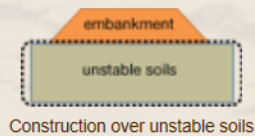
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 - Rapid Impact Compaction
- ▶ Sand Compaction Piles
 - Vacuum Preloading with and without Prefabricated Vertical Drains
 - Vibrocompaction
- ▶ Vibro-Concrete Columns

Purpose of Improvement

Project-Specific Technology Selection for Construction over Unstable Soils

Selections Made

The following selections have been made so far. Click on an item to return to a previous selection.



Selected Application: Construction over unstable soils

Unstable Soil Condition: Wet and Weak, Fine Grained Soils ▼

Depth Below Ground Surface: 30 - 50 ft ▼

Select Project-Specific Characteristics

Answer the following questions that best describe the site conditions. Leave questions blank when the information is unknown (at this time) or inapplicable. The list on the right will update as selections are made. Click on the [?](#) for additional information regarding each selection.

? Purpose of Improvement:

----- Make your selection -----

- Increase Resistance to Liquefaction
- Increase Strength
- Increase Bearing Capacity
- Bypass Soft Ground
- Reduce Immediate Settlement
- Seepage Barrier (cutoff wall)
- Reduce Consolidation Settlement
- Increase Rate of Consolidation



? Site Characteristics:

----- Make your selection -----



- ▶ **Aggregate Columns**
 - Blasting Densification
 - Chemical Grouting/Injection Systems
- ▶ **Column-Supported Embankments**
- ▶ **Combined Soil Stabilization with Vertical Columns**
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Questions



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- Vern Schaefer, *Iowa State University*, vern@iastate.edu

Get Involved with TRB

- Getting involved is free!
- Join a Standing Committee (<http://bit.ly/2jYRrF6>)
- Become a Friend of a Committee (<http://bit.ly/TRBcommittees>)
 - Networking opportunities
 - May provide a path to become a Standing Committee member
- For more information: www.mytrb.org
 - Create your account
 - Update your profile

97th TRB Annual Meeting: January 7-11, 2018

Take Part in the *Careers in Motion* Networking Fair

EVENT HOSTED IN PARTNERSHIP WITH:

Mobility Lab™

Eno
Center for Transportation

YOUNG PROFESSIONALS in TRANSPORTATION

COMTO
Creating the Future

WIS
Advancing Women in Transportation

APTA
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

NEW

INDUSTRY EMPLOYERS AND WORKFORCE CHAMPIONS!

Join us at the **new** *Careers in Motion* Fair!

The *Careers in Motion* Fair is a networking event planned to support expansion of the multi-modal transportation workforce. The event will provide an opportunity for prospective employers from a wide range of sectors to meet with young to seasoned professionals interested in working for their organizations.

Event attendees will be conference registrants whose careers and professional interests span across multiple transportation-related disciplines. Hiring managers will be onsite to network and offer career information and advice. **TRB's Young Members Council will coordinate professional development programming and content.**

The *Careers in Motion* initiative helps serve the mission of TRB's new Diversity and Inclusion Task Force—to facilitate making diverse and inclusive involvement a core value for TRB staff, volunteers, contract awardees, projects, and the transportation communities TRB serves.

January 7, 2018 | 10:00 a.m. – 2:00 p.m. | Table Fee: \$1,250

Please contact Patrice Davenport at pdavenport@nas.edu

TRB TRANSPORTATION RESEARCH BOARD

<http://bit.ly/CareersInMotionFair>