HANDOUT 4

Introduction to Geotechnical Engineering

"Why You Should Study Geotechnical Engineering"

or

"Who Needs a Foundation Engineer Anyway???"

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Steven F. Bartlett, Ph.D., P.E.

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What is Geotechnical Engineering?

- **Application of civil engineering to earthen materials**
  - **Soil**
  - **Rock**
  - **Groundwater**

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What is the difference between *soil* and *dirt*?

If you can grow food in it, get paid to analyze it, or get college credit for playing with it, it's *soil*; otherwise it's *dirt*.

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Branches of Geotechnical Engineering

- **Soil Mechanics**
- **Rock Mechanics**
- **Foundation Engineering**
- **Geoenvironmental Engineering**
- **Geotechnical Earthquake Engineering**
- **Geologic Engineering**

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Soil Behavior Introduction

"Concrete and Steel are textbook materials;
Soil is not."

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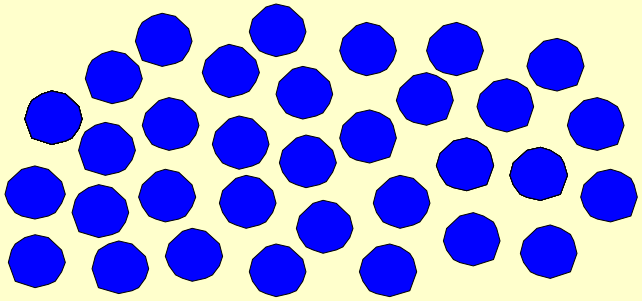
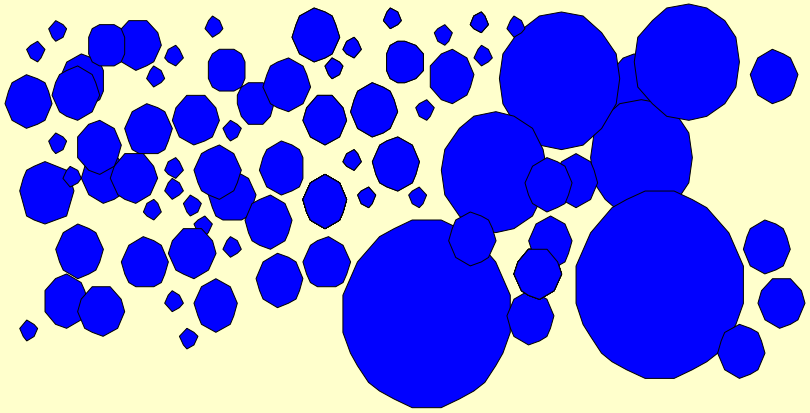
Soil is heterogeneous



Homogeneous



Heterogeneous

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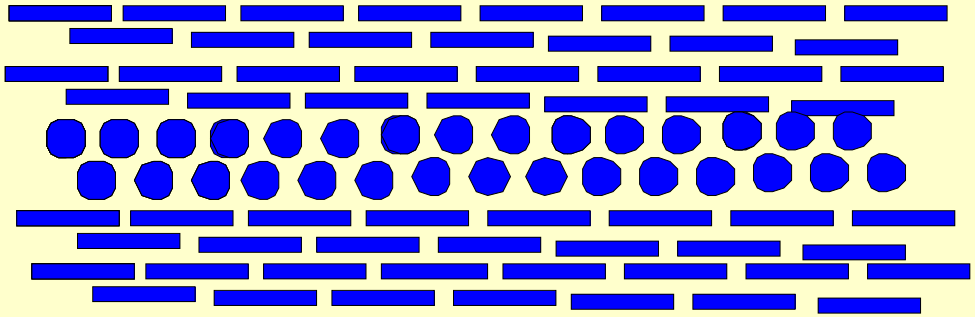
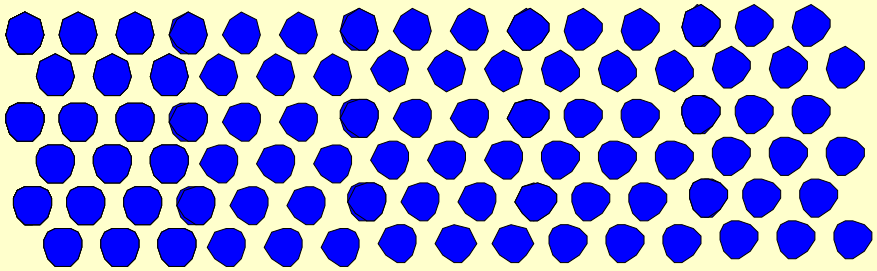
Soil is anisotropic



Anisotropic



Isotropic

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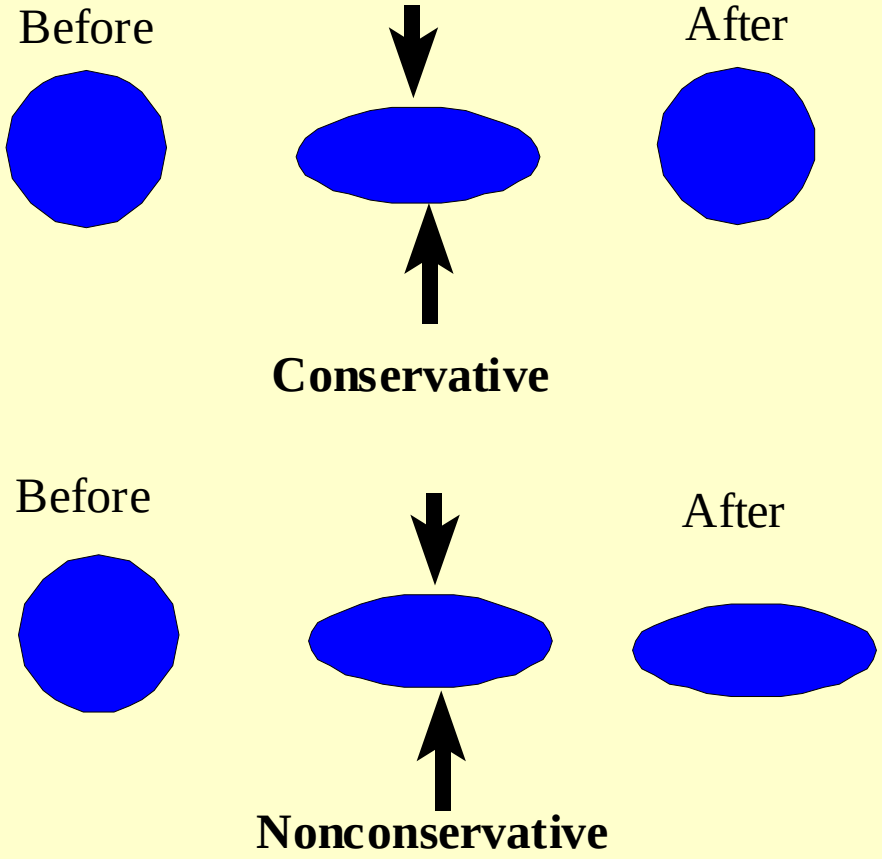
Soil is nonconservative



(but that doesn't mean it's liberal)

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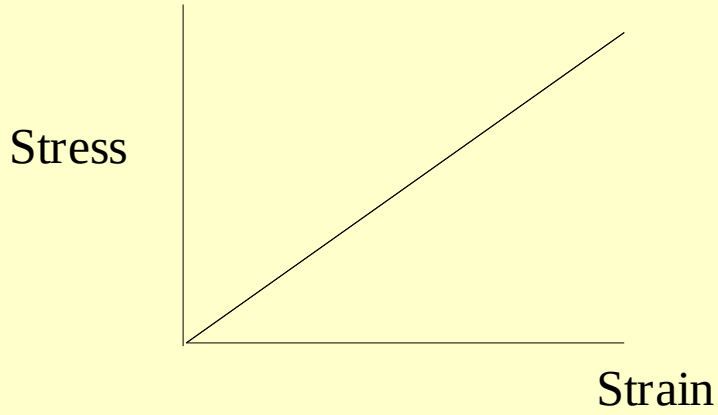
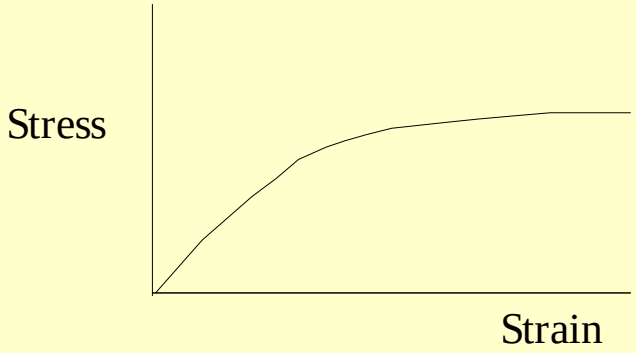
Soil is nonlinear



Linear



Nonlinear

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Examples of Geotechnical Projects
Panama Canal

Location: Panama

Completion Date: 1914

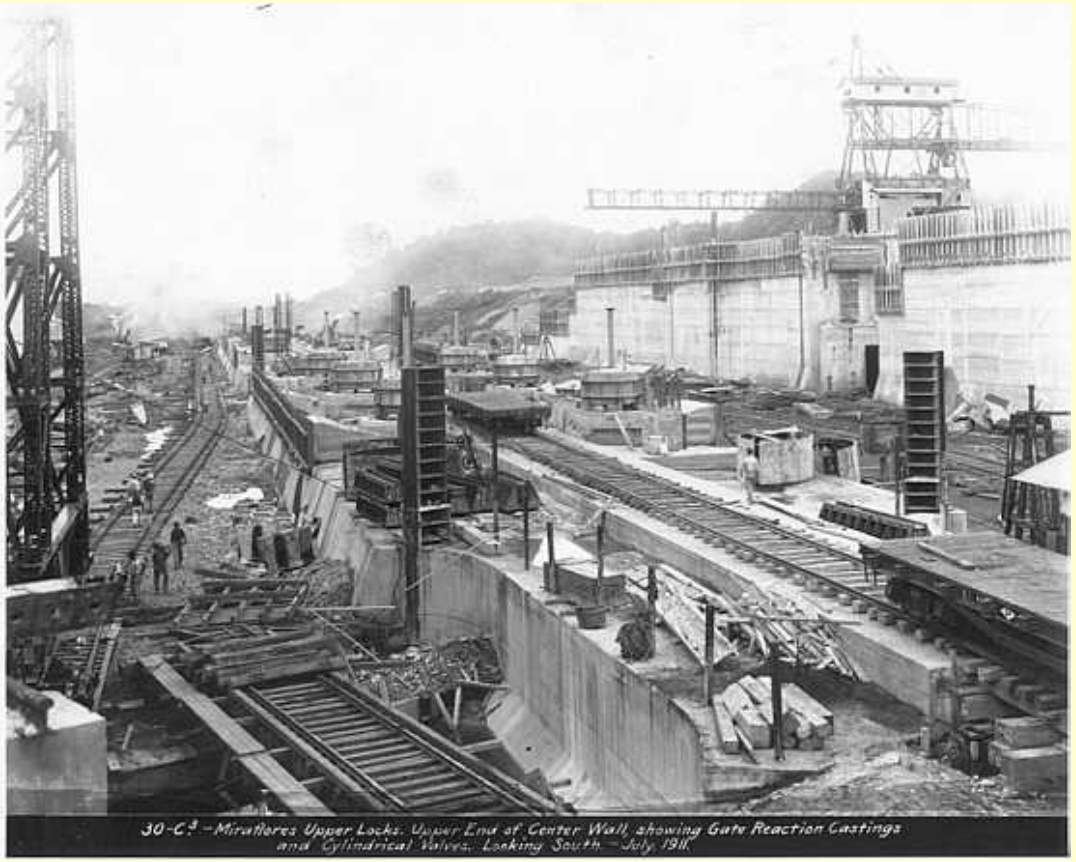
Length: 47.8 miles

Cost: $375 Million

Capacity: 14,000 vessels/yr.

Type: Lock canal

Materials: Rock, clay, concrete



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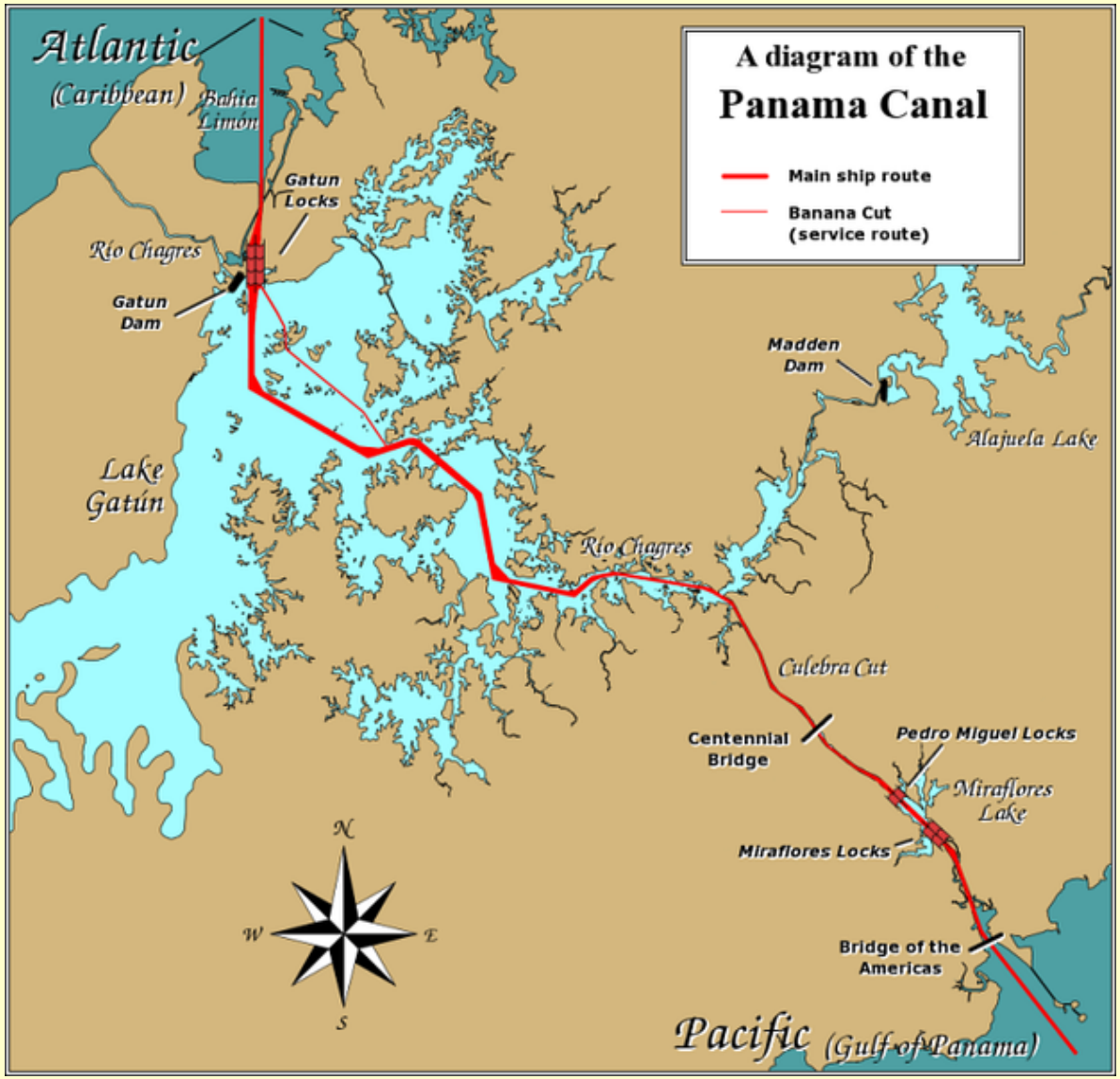
Panama Canal



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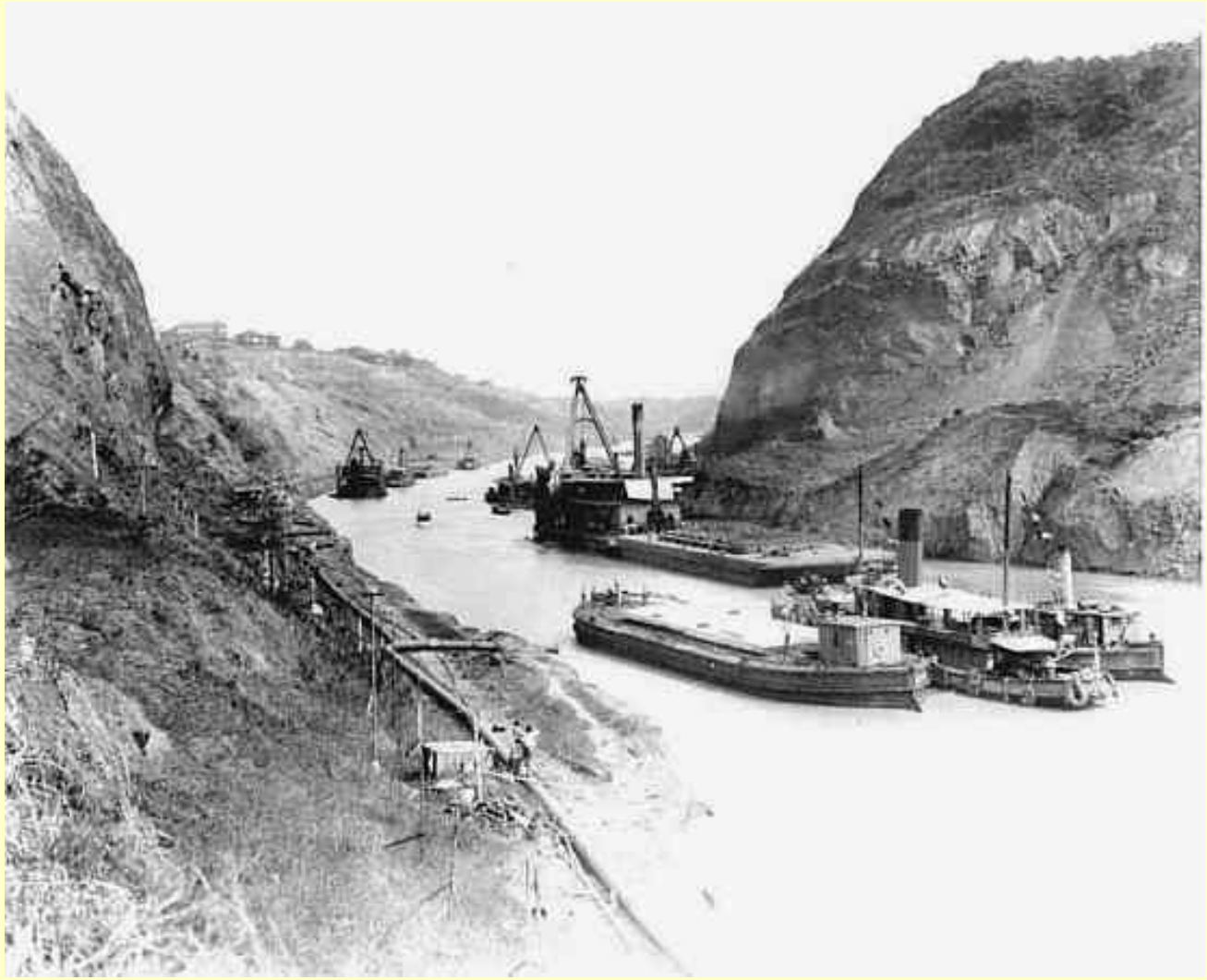
Panama Canal
Culebra Cut



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Panama Canal
Culebra Cut

• The excavation of the cut was one of the greatest areas of uncertainty in the creation of the canal, due to the unpredicted large landslides.

•The Americans had lowered the summit of the cut from 59 meters (193 feet) to 12 metres (40 feet) above sea level, at the same time widening it considerably, and had excavated over 76 million cubic meters m^3 (100 M cubic yards).

• Some 23 M m^3 (30 M cubic yards) of this material was additional to the planned excavation, having been brought into the cut by the landslides.

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Examples of Geotechnical Projects
Aswan Dam

Location: Aswan, Egypt

Completion Date: 1970

Cost: $1 billion

Capacity: 5.97 trillion ft^3

Type: Embankment

Materials: Rock, clay

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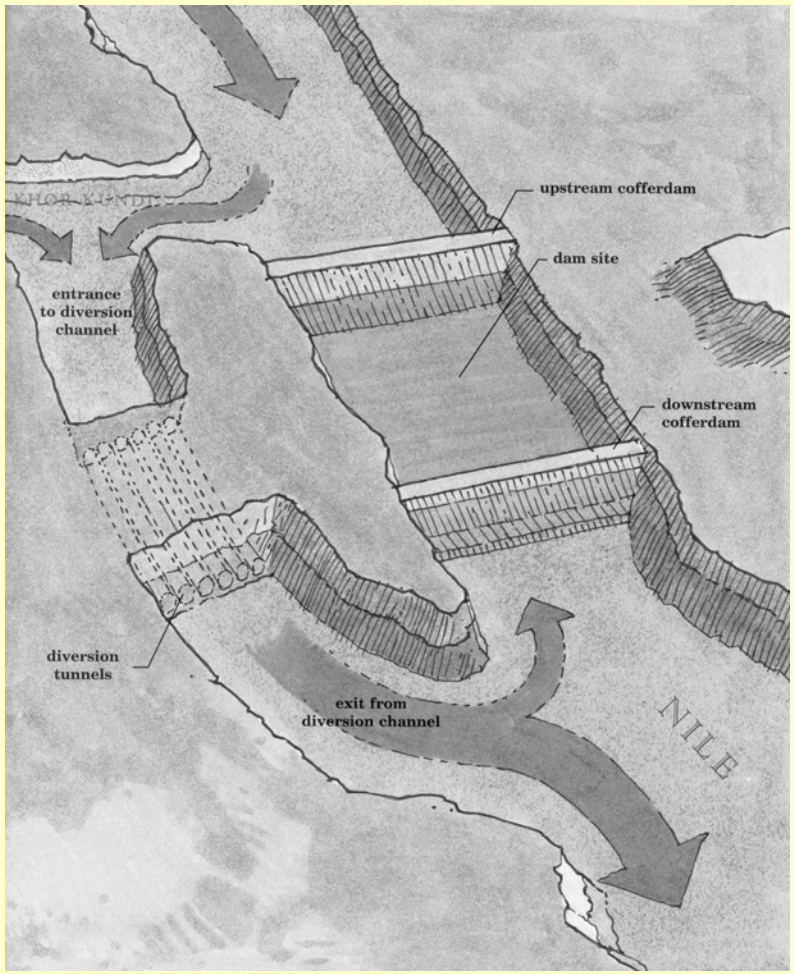
Aswan Dam
How do you keep the water out?



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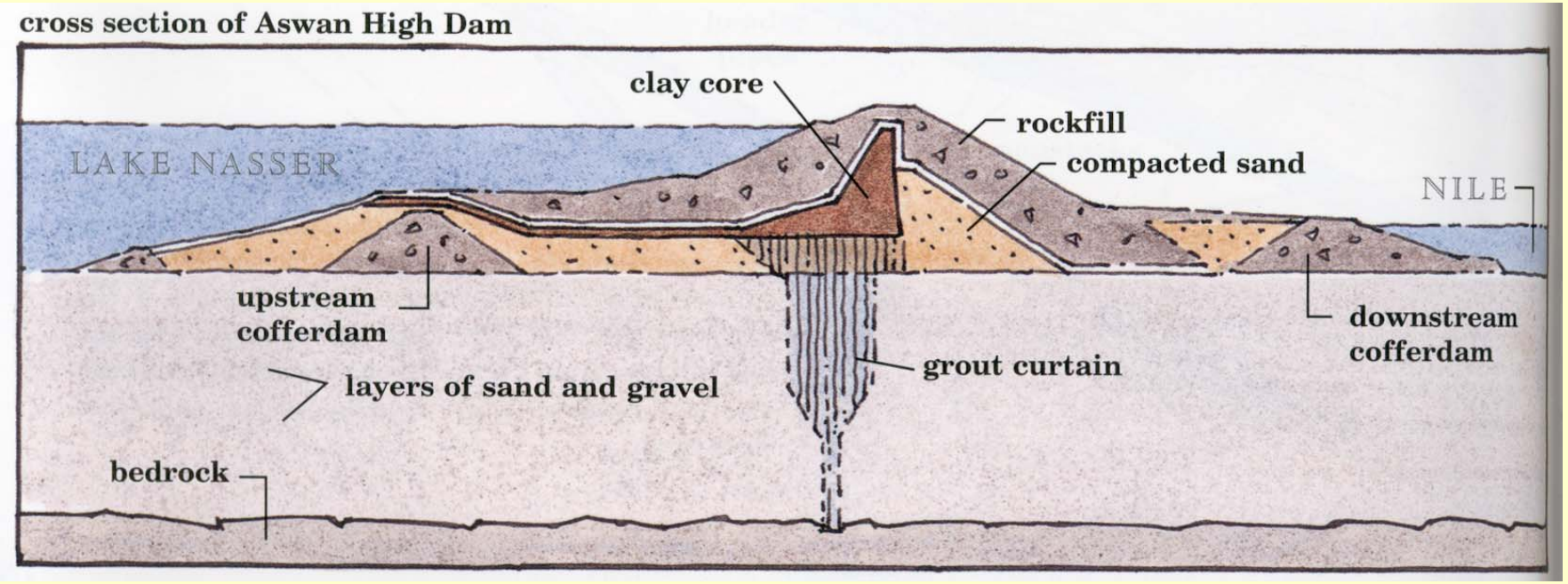
Aswan Dam
What about the core?



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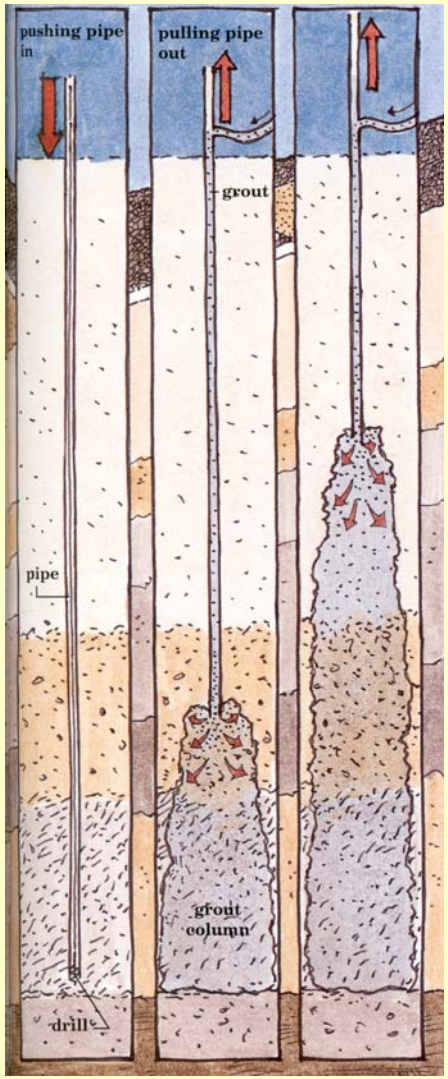
Aswan Dam
What is a grout curtain?



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Examples of Geotechnical Projects
Chunnel

Location: Folkestone, England
Sangatte, France

Completion Date: 1994

Cost: $21 billion

Length: 163,680 feet (31 miles)

Purpose: Railway

Setting: Underwater

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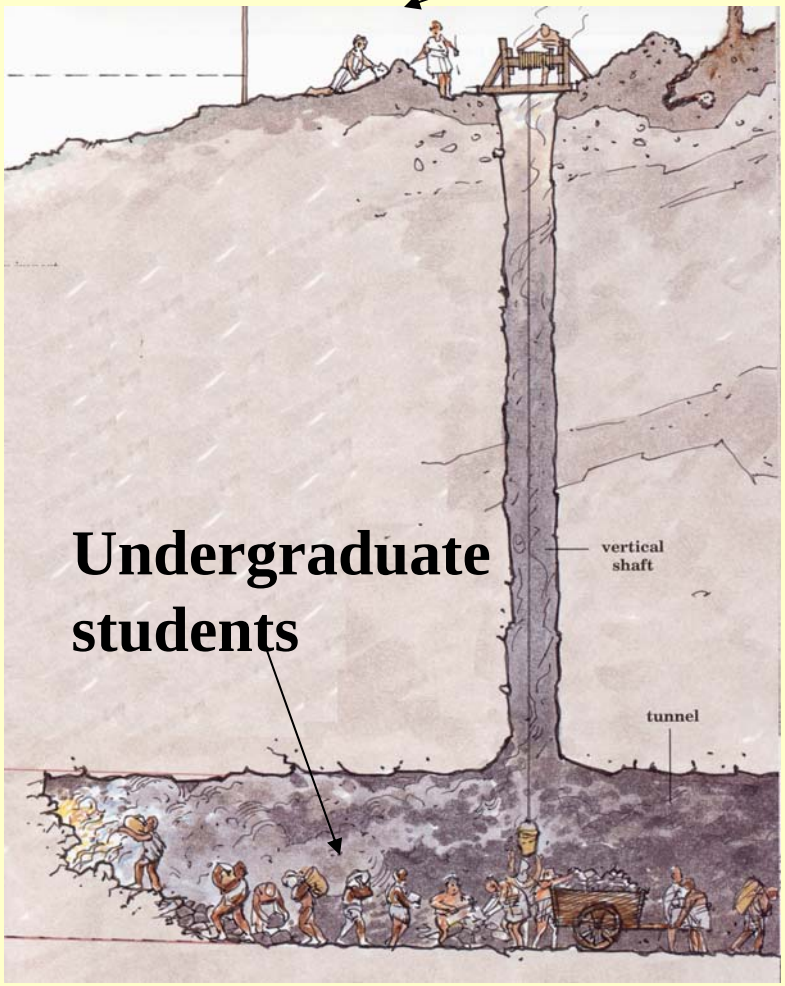
Tunnels

Old Way

Graduate Students



Undergraduate students

New Way

Professors

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Examples of Geotechnical Projects
Golden Gate Bridge Foundations

Location: San Francisco and Sausalito, California, USA

Completion Date: 1937

Cost: $27 million

Length: 8,981 feet

Type: Suspension

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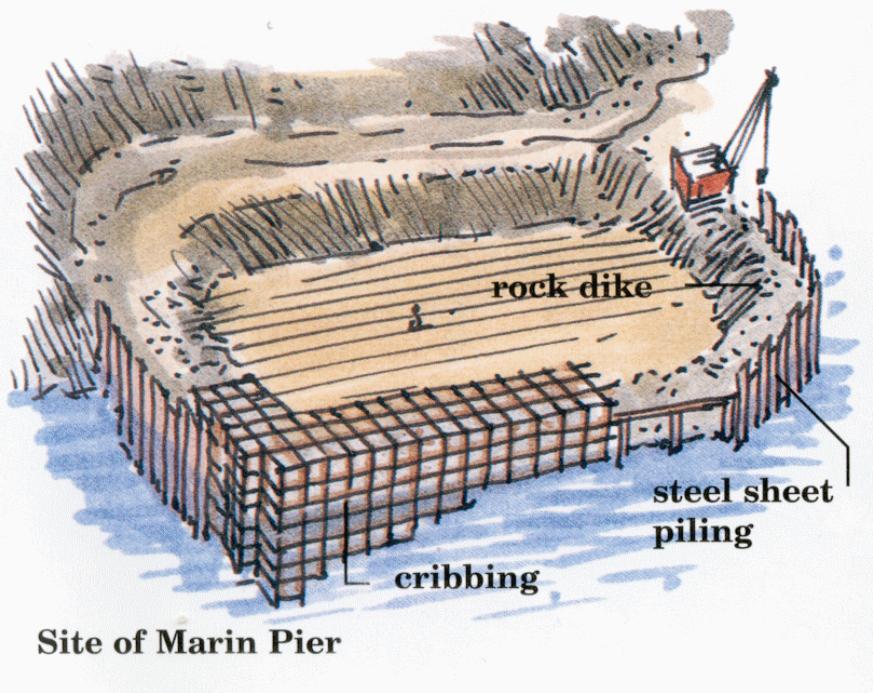
Golden Gate Bridge (Marin Pier)



1. **Start rock dike (Coffer)**
2. **Construct crib dike for the part that is in water (timber box filled w/ rock and set in place).**
3. **Install sheet piling.**
4. **Pump area dry.**
5. **Construct foundation on rock surface exposed below water level.**

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Examples of Geotechnical "Structures" Petronas Towers Foundations

Location: Kuala Lumpur, Malaysia

Completion Date: 1998

Cost: $1.6 billion

Height: 1,483 feet

Stories: 88

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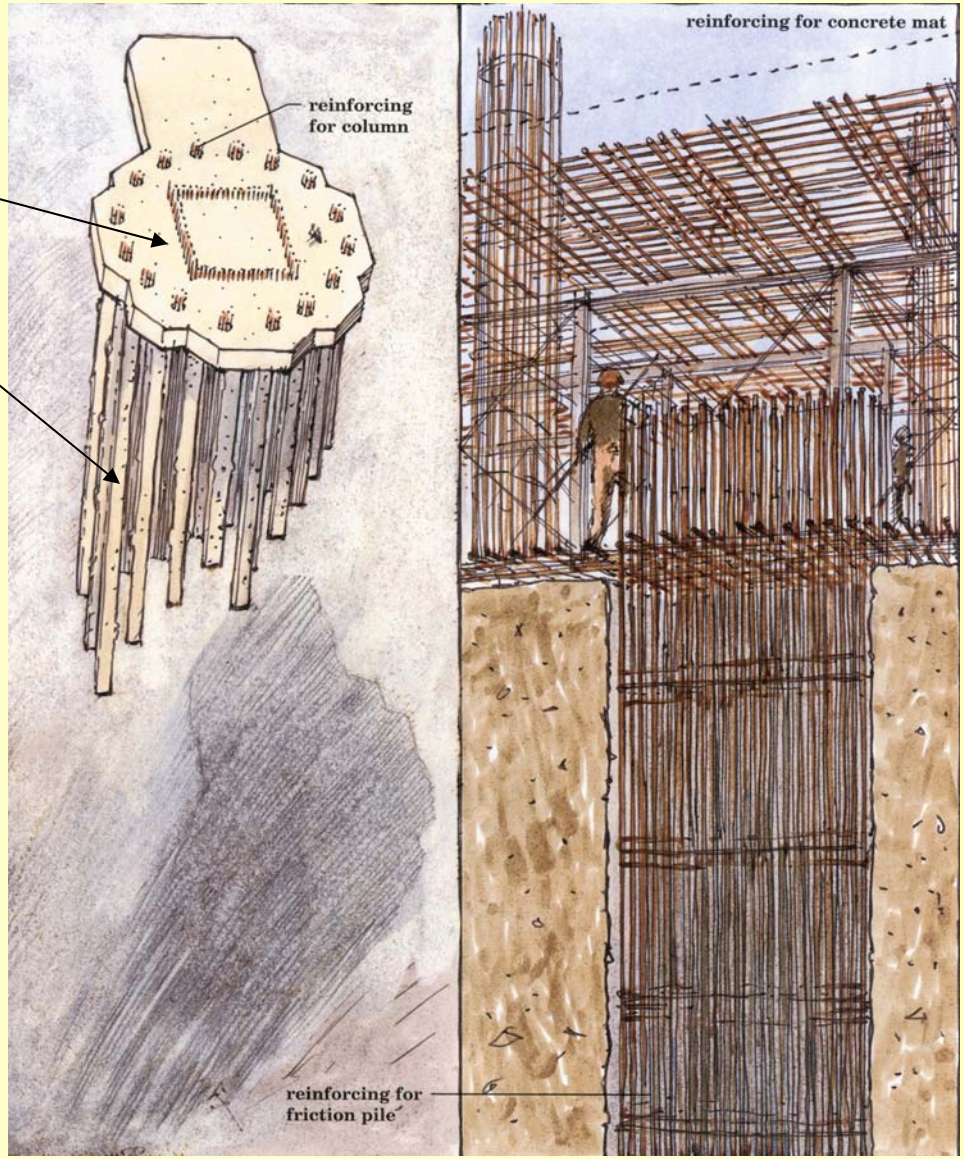
Petronas Towers Foundations

Concrete mat

Pile Foundation



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“Driven” Pile Foundations

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Offshore Pile Foundations

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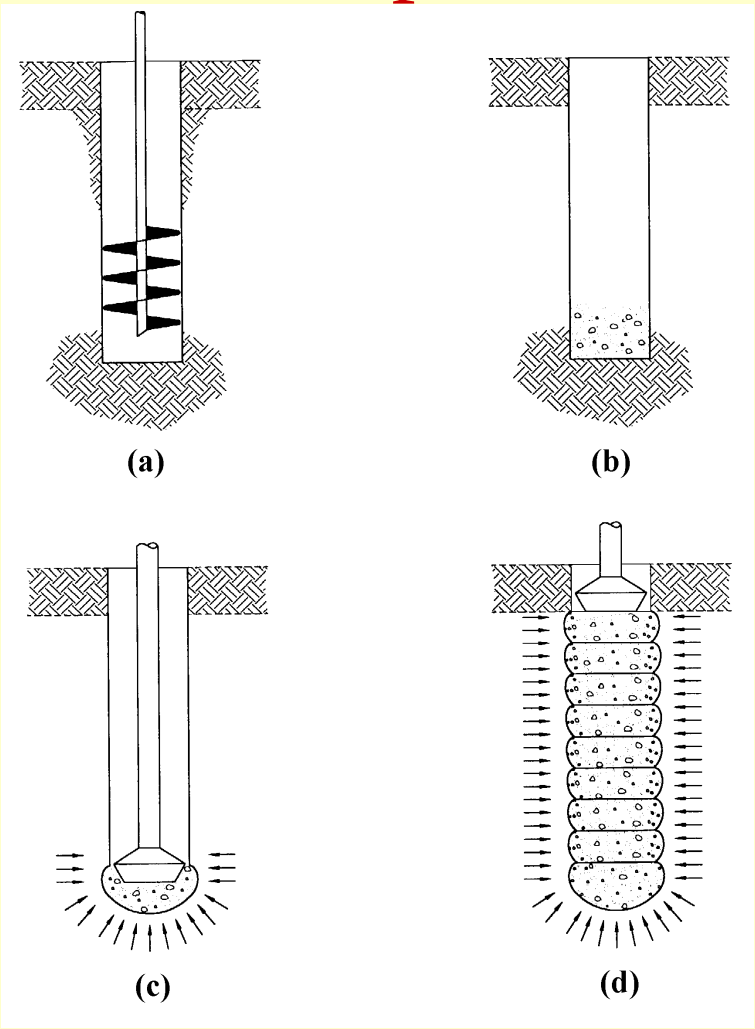
Ground Improvement



Geopier® *Rammed Aggregate Piers*

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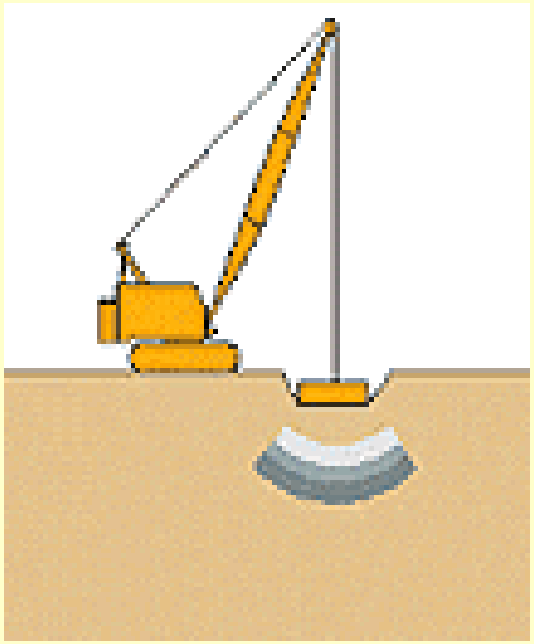
STEEL


NO
PARKING
ANY
TIME
CAT
252


CAT


JONES

Ground Improvement (cont)



Dynamic Compaction

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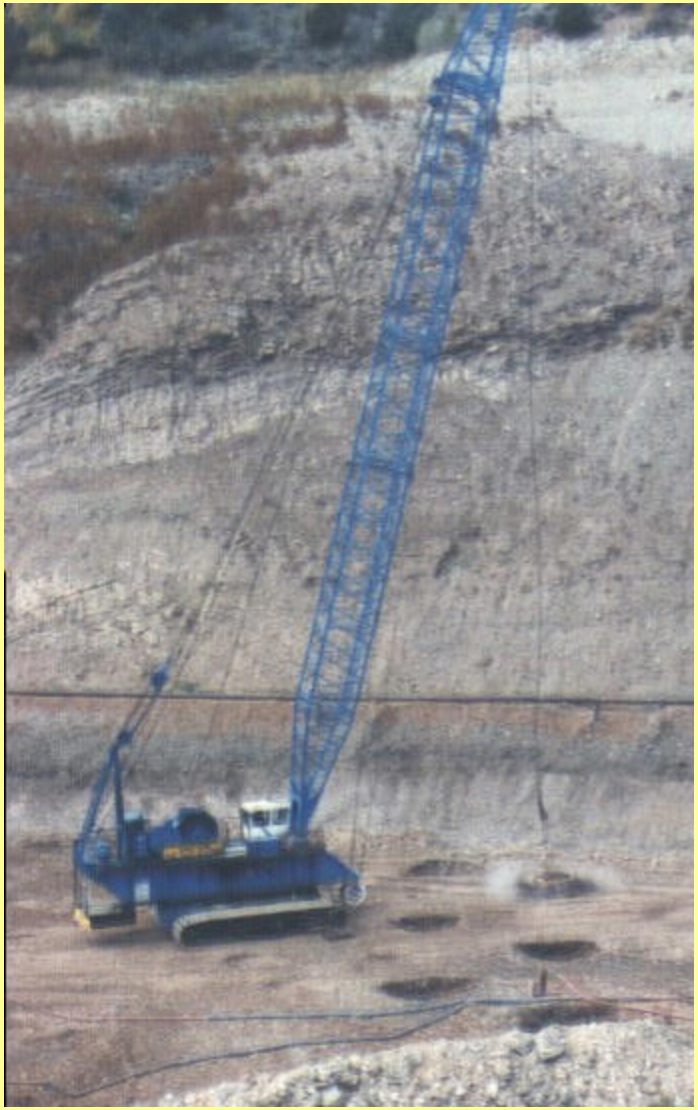
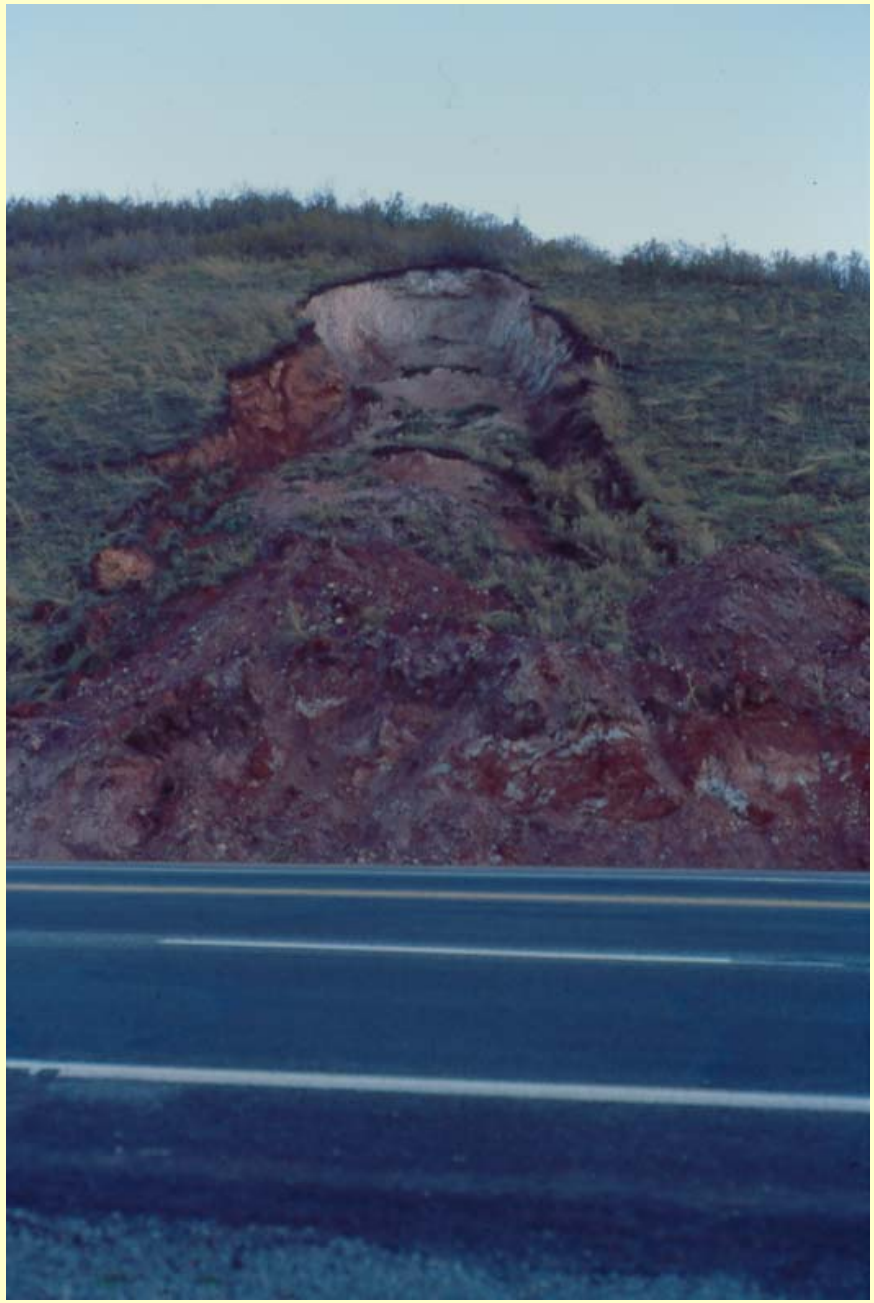


Landslides
Thistle Slide – Spanish Fork Canyon

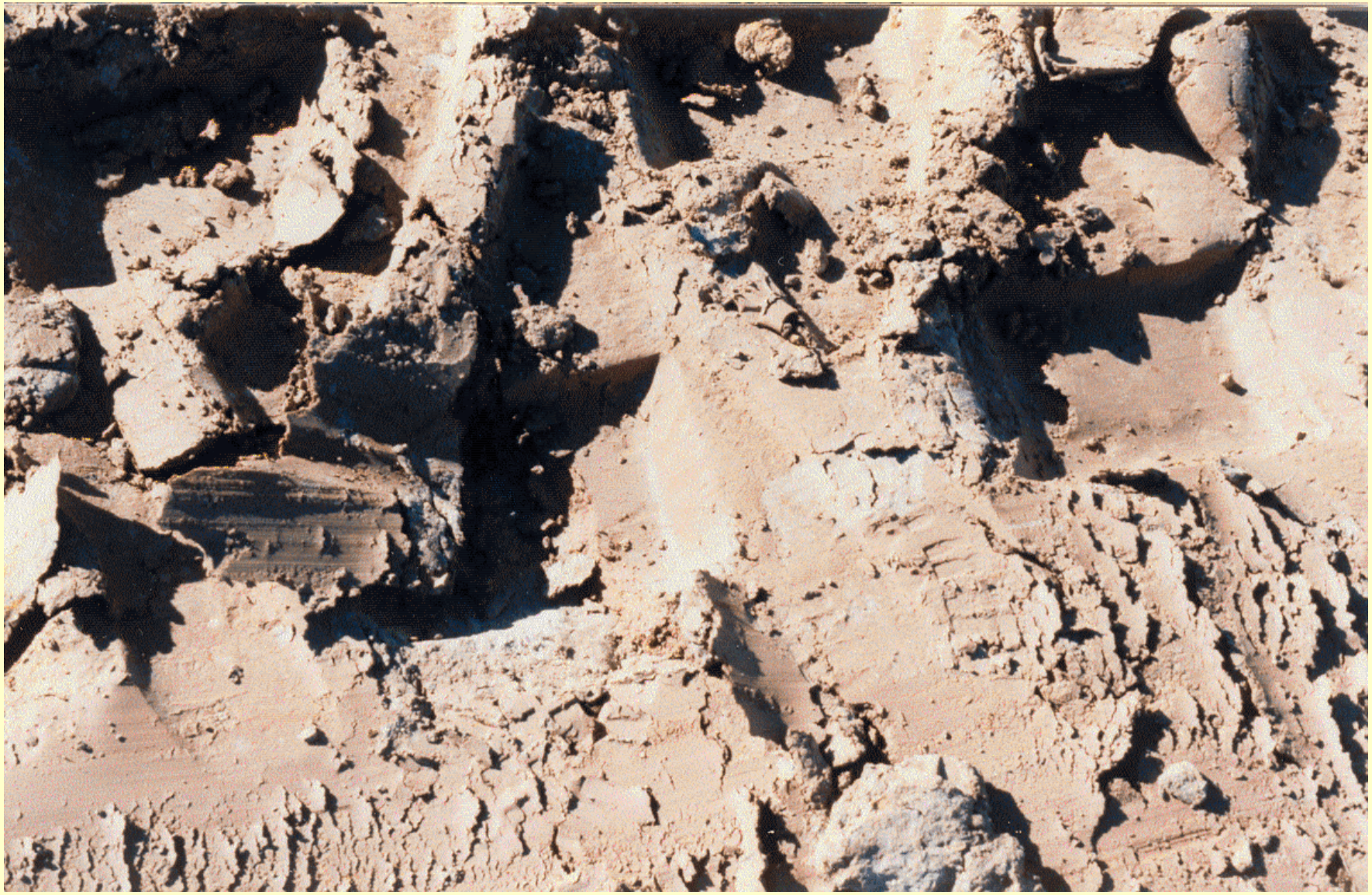


Mud Slide

Debris Flow (Mudslide with Boulders)

Sinkhole in Guatemala – February 2007

Geoenvironmental Engineering
Compacted Clay Cap for Refinery Site

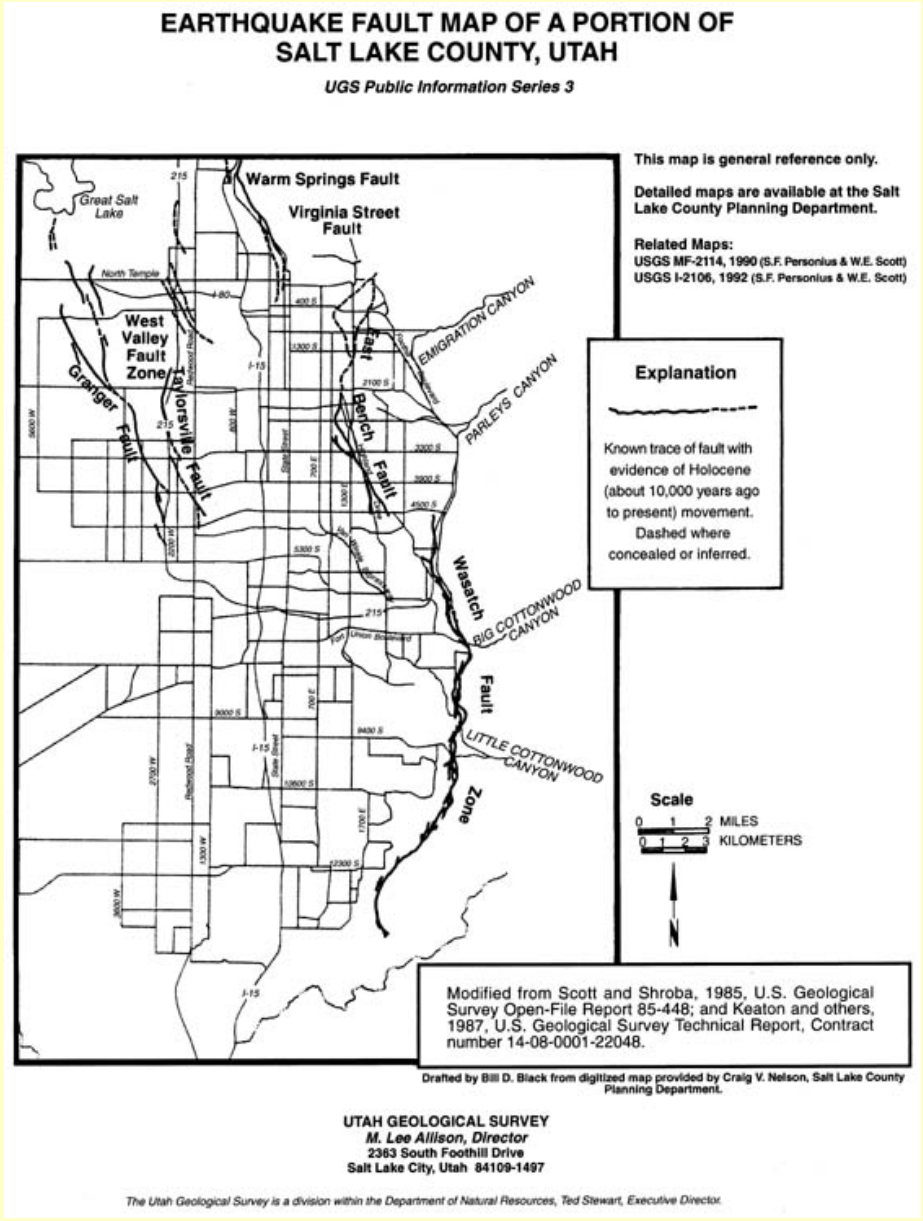


Earthquake Hazards
(San Andres Fault)

Wasatch Fault (Its your Fault!)

Wasatch Fault – Little Cottonwood Canyon

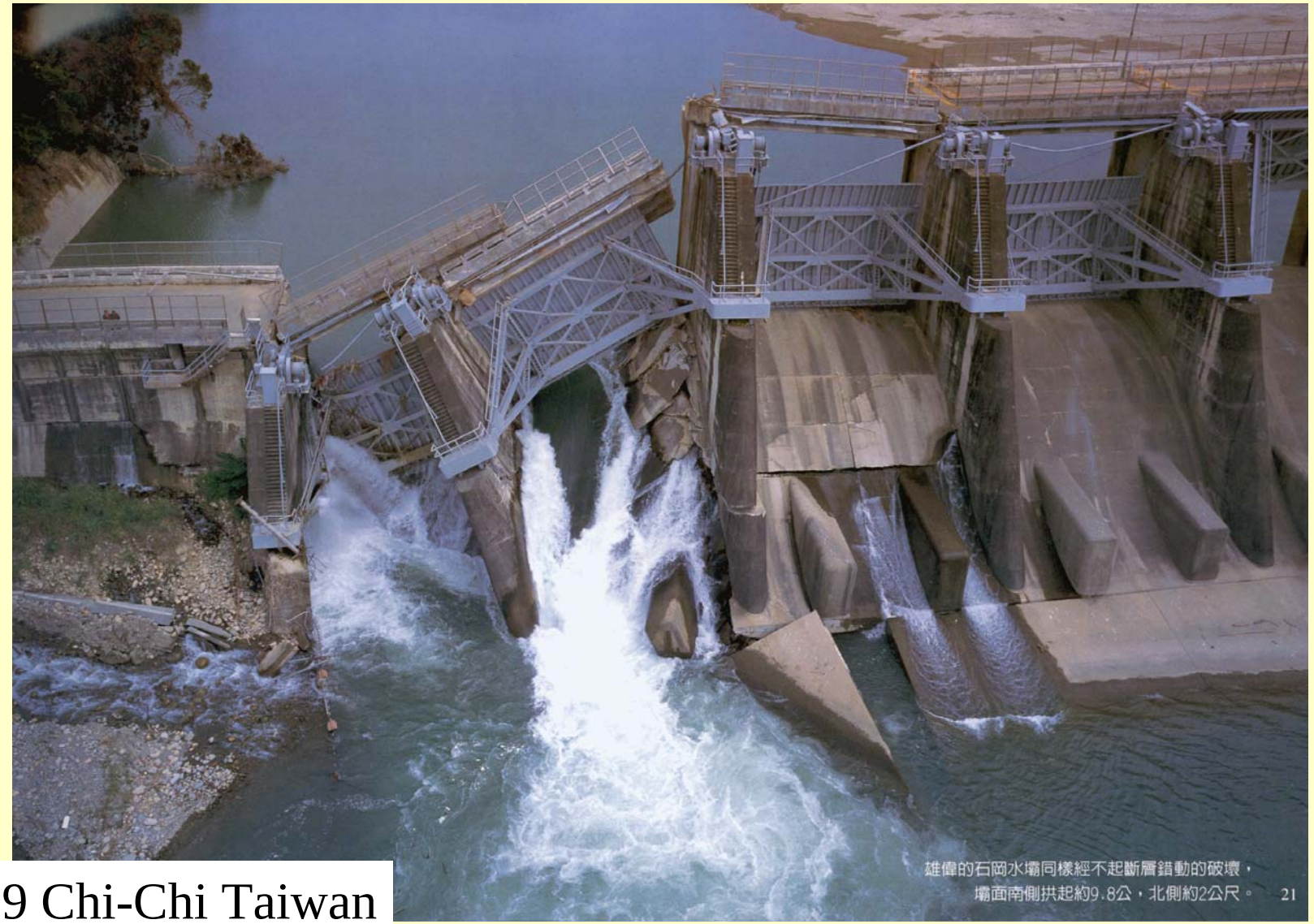
Wasatch Fault (Is your house safe?)



Fault Rupture

1999 Chi-Chi Taiwan Earthquake

Fault Rupture



1999 Chi-Chi Taiwan Earthquake

Strong Ground Motion

Strong Ground Motion
Building Collapse (Turkey)

Liquefaction Damage

Liquefaction occurred causing the buildings to roll over on their side. People evacuated out the windows

Liquefaction Damage

Earthquake-Induced Ground Failure