RISK
Considerations for Geotechnical Construction

George K. Burke, P.E., D.GE

Sr. V.P. Engineering

HAYWARD BAKER
Geotechnical Construction
KELLER

www.HaywardBaker.com

Advice from Dr. Elio D'Appolonia (1995)

- Risk Categories
  - Knowns
  - Known-Unknowns
  - Unknowns
- Knowns can be identified clearly
- Known-Unknowns can be identified from experience and intuition
- Unknowns will always be there

Sharing experiences permits newer project managers to identify the Known-Unknowns

HAYWARD BAKER
Geotechnical Construction

Risk Management-A Practical View (Lane, 2003)

- Experience enables us to implicitly manage risks
- Sharing experience is much more difficult than you might think

HAYWARD BAKER
Geotechnical Construction

Understanding and Containing Geotechnical Risk (Trenter, 2003)

- Earliest on the job
- Methods are faster than ever before
- Methods require fewer people to perform

Less time to react to hazards that are revealed, and fewer people to identify and mitigate them

And the impact extends to all of the follow-on work

HAYWARD BAKER
Geotechnical Construction

Managing Geotechnical Risk: Time for Change (Clayton, 2001)

- Properties and distribution of the ground and groundwater beneath a construction site are pre-existing (and out of our control)
- Ground and groundwater conditions
  - Highly variable
  - From place to place
  - And with depth
- Construction in the ground is carried out at the start of a project…so delays will affect latter stages of construction

So what do we do?

- Geotechnical risk exists
- We know little about it
- But we must design with what we know

So MANAGE IT!

HAYWARD BAKER
Geotechnical Construction

Kinds of Construction Risks

- Weather
- Insurance and bonding
- Safety
- Soil and Rock
- Groundwater
- Design
- Performance
- Verification
- Schedule
- Materials
- Resources
- Contract
- Subcontract
- Access
- Experience
- Proximity to sensitive structures or utilities

1.Do I have a good enough understanding of the subsurface conditions?

- Site History
  - Structures, utilities, old foundations
  - Old fills and/or surcharge loads
  - Old stream beds, lakes, beaches
  - Previous quarries or mine activity

1. Do I have a good enough understanding of the subsurface conditions?

- Sampling and insitu testing
  - SPTs
  - CPTs
  - Other insitu tests
  - Site reconnaissance observations

"You can observe a lot just by watching."
(Yogi Berra)

HAYWARD BAKER
Geotechnical Construction

1. Do I have a good enough understanding of the subsurface conditions?

- Laboratory testing
  - Does the testing provide:
    - Direct parameters for design?
    - Of the strata desired?
    - To the depth of influence appropriate?
  - Or must you interpret the parameters used by indirect means?

1. Do I have a good enough understanding of the subsurface conditions?

- Interpretations
  - Rely on local knowledge
    - Investigated sites nearby
    - Seen lab testing from similar materials
    - Observed performance from previous construction
  - Evaluate what you have
    - Do you have enough of what you need?
    - Is there genuine historic awareness?

HAYWARD BAKER
Geotechnical Construction

1. Do I have a good enough understanding of the subsurface conditions?

- Recommendations
  - Do they result from variable data?
  - Do they consider the construction risks?
  - If unsatisfactory, is there time to get what you need?
  - Have they identified the hazards?

HAYWARD BAKER
Geotechnical Construction

2. Are the objectives of the construction clearly understood?

- There can be several objectives of the construction
  - Identify them
  - In priority
- Don't be ambiguous: it only leads to disagreements

Offering a bid proposal to do the work, exclusive of exceptions to the terms and conditions of a contract, is considered acceptance of the constructability of the work in accordance with the plans and specifications

3. Can the requirements of the specification be met?

- Expectation must be consistent with the technology
  - Understand the method
  - Understand the product
  - Understand the verification method
- How do you do this?
  - Seek out experts
  - Question all important aspects
  - Understand variability and how to design for it
  - Question the process to know what is controllable and what is not

4. Does the schedule impact achieving the specification requirement?

- From a technical perspective:
  - Evaluate if the verification can be completed and accepted prior to the next phase of construction
  - Issues include:
    - Curing of samples
    - Time rate of consolidation
    - Performance testing

5. Are the materials available to support my project needs?

- Just-in-time inventory is affecting all construction
- Specialized materials require further investigation
- Proximity to the suppliers can impact the construction

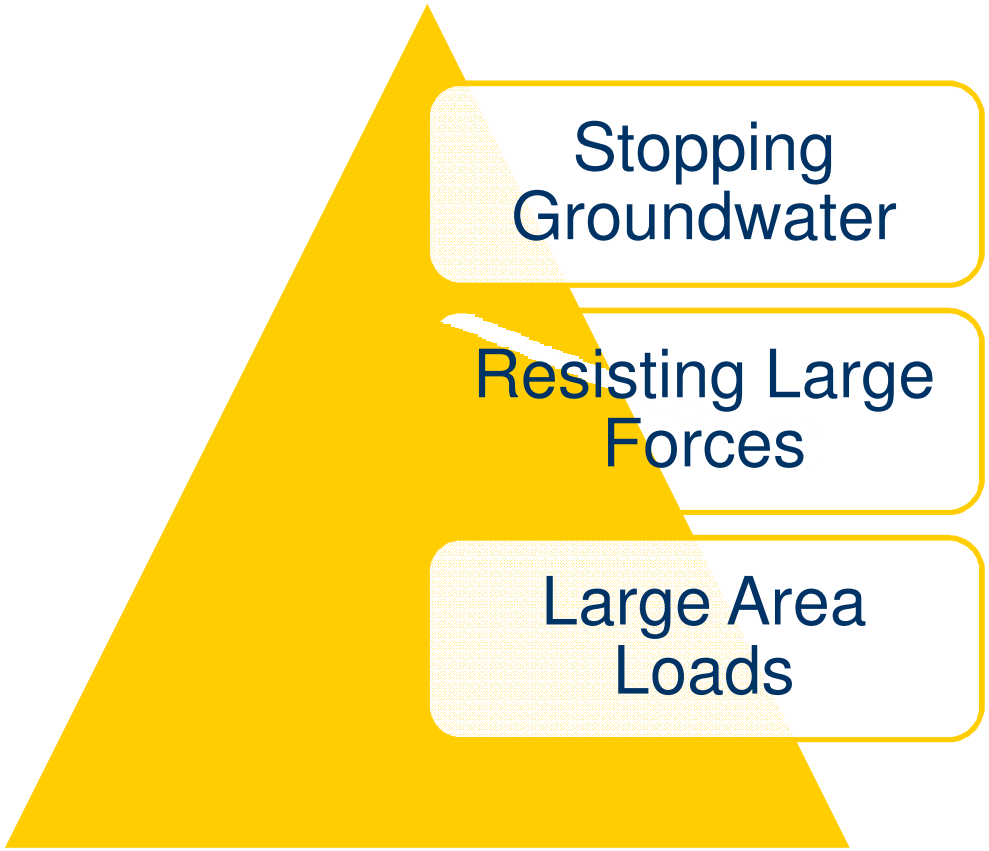
6. Is there another way to achieve the objectives?

- The value of specialized construction is difficult to assess
- Some specialist contractors are better at some technologies than other technologies
- Performance based contracts can offer value
  - Be certain the objective can be met with proposed system(s)
  - Be certain the performance can be verified
  - Be certain the contractor is qualified and has the resources

7. Are there operational or contractual issues that could impact construction?

- Can the project logistics be worked out
- Fair allocation of subsurface risk
- Bureaucratic impacts that could restrict communications

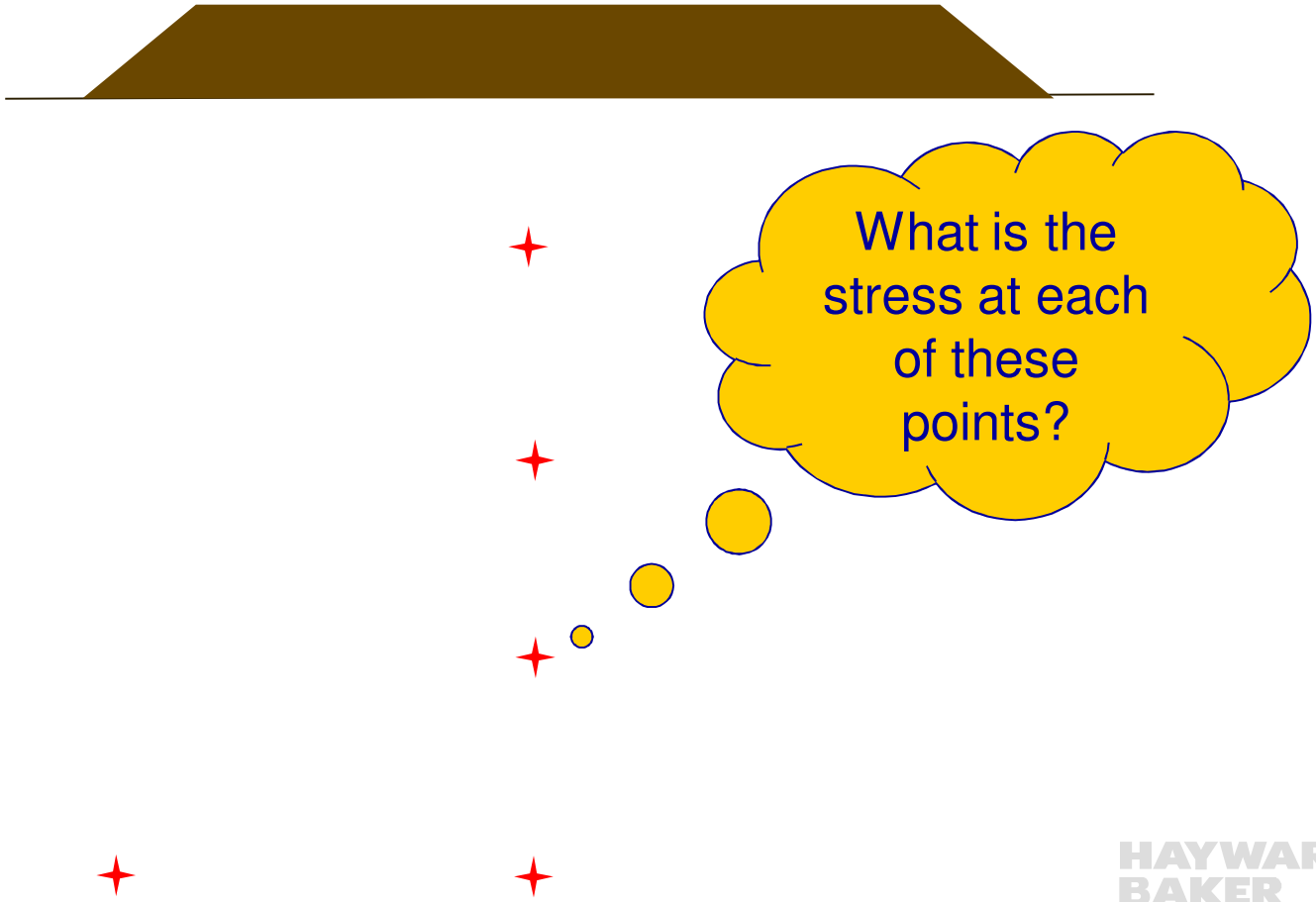
3 Biggest Challenges
(*Greatest Risks*)



HAYWARD BAKER
Geotechnical Construction

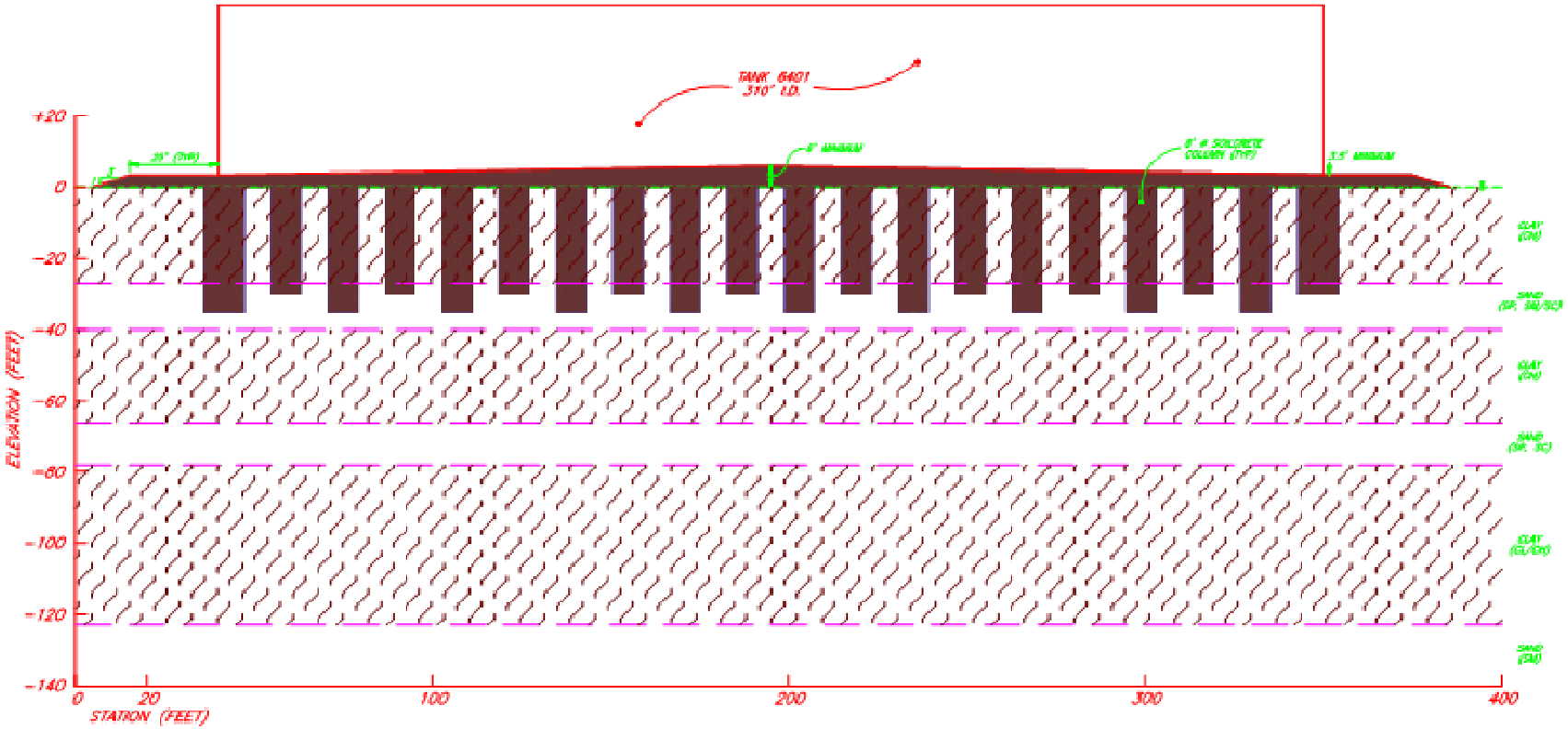
Large area loads

- Dams, embankments, tanks



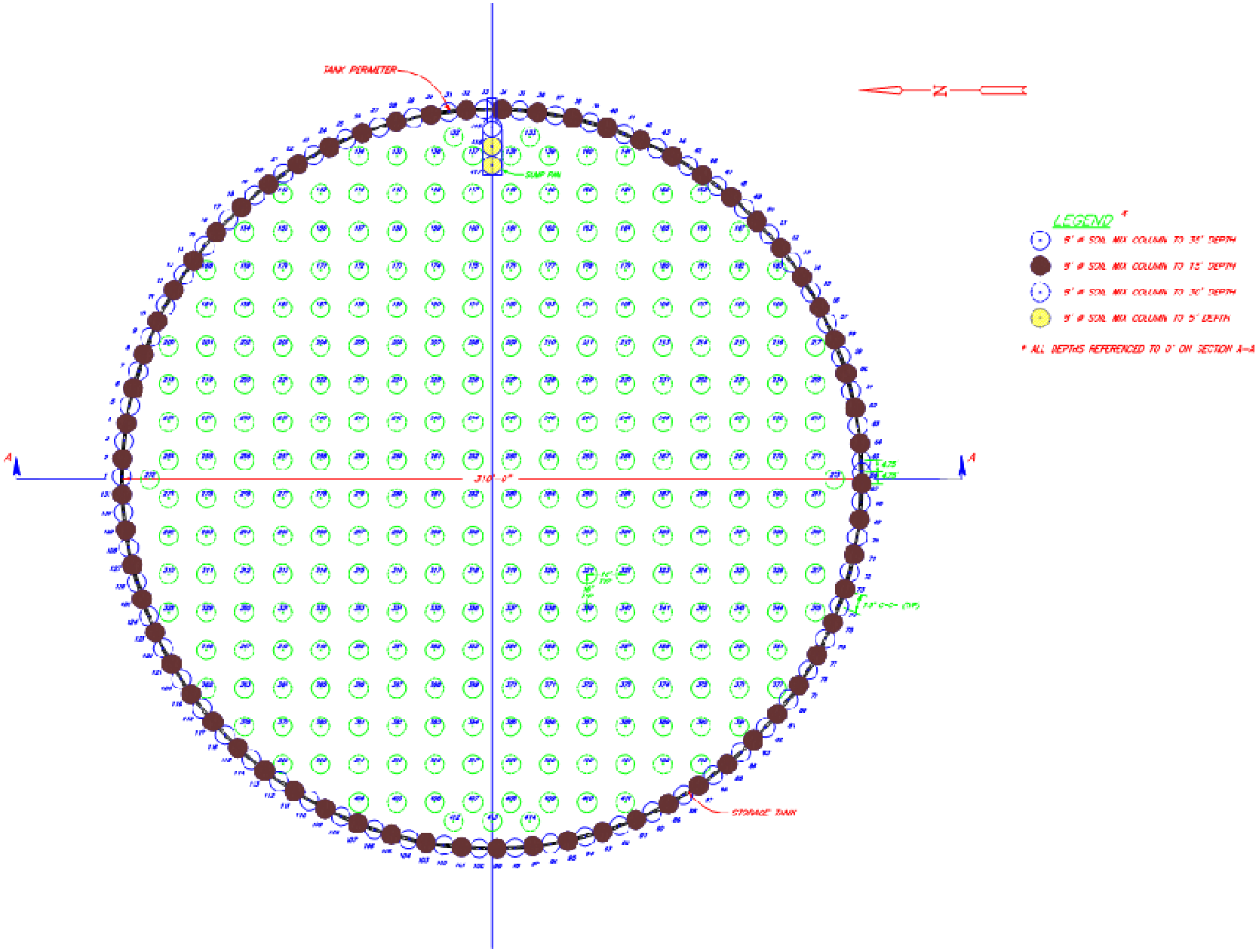
Tank Farm in South Louisiana

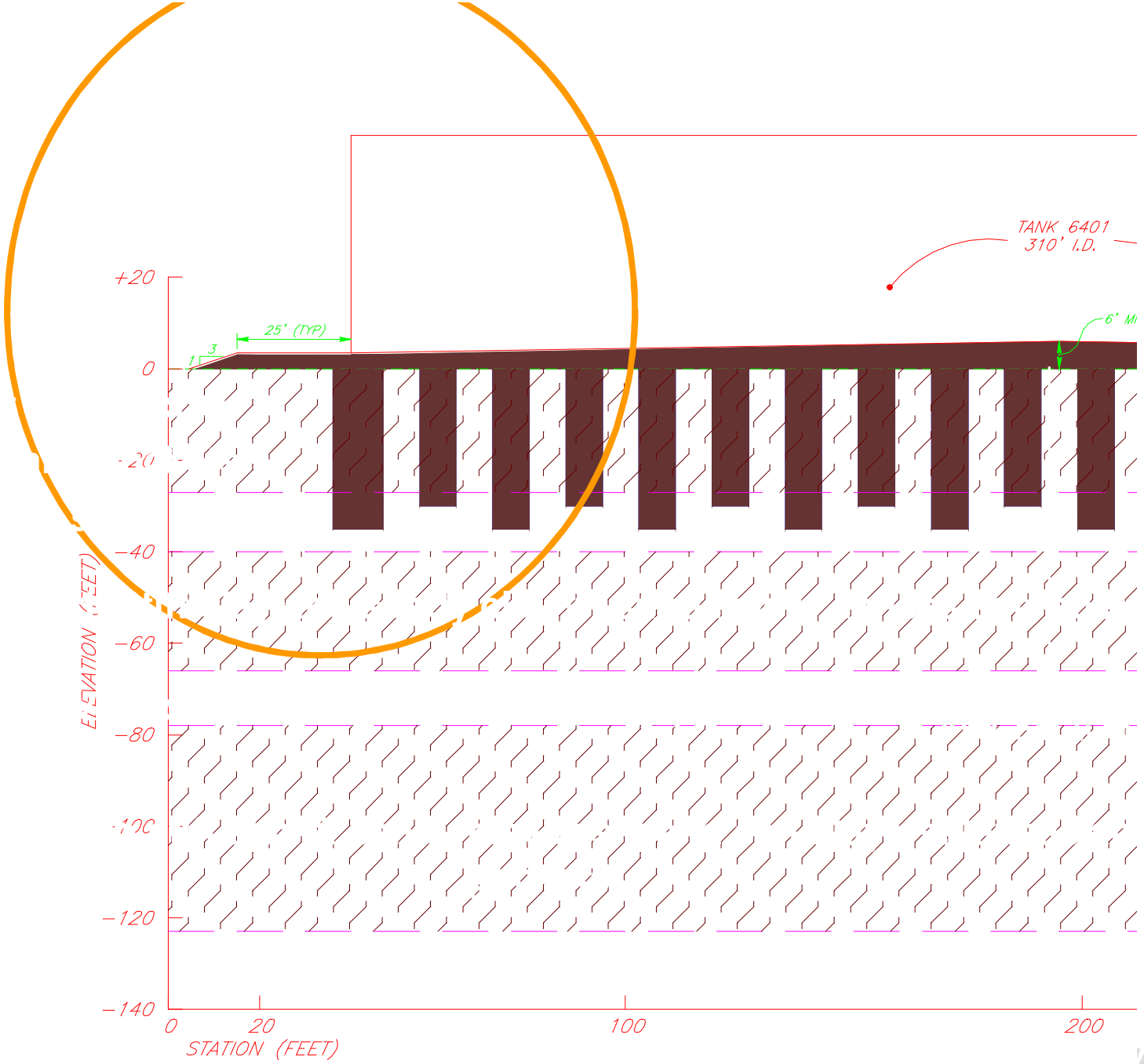
Cross-section



HAYWARD BAKER
Geotechnical Construction

Plan


TANK PERIMETER
SUMP PIT
STORAGE TANK
LEGEND *
9' Ø SOIL MIX COLUMN TO 35' DEPTH
9' Ø SOIL MIX COLUMN TO 15' DEPTH
9' Ø SOIL MIX COLUMN TO 30' DEPTH
9' Ø SOIL MIX COLUMN TO 5' DEPTH
* ALL DEPTHS REFERENCED TO 0' ON SECTION A-A



Undrained F.S. against Edge Shear (without preconsolidation)

Case	F_e
Pad and empty tank	4.03
10 feet of water	2.12
20 feet of water	1.44
30 feet of water	1.09
40 feet of water	0.88

Issues

- Need instrumentation to show strengthening during hydro testing
- Watch subsurface delections
- Watch settlements
- 1st 2 tanks used the hydro test to preconsolidate the ground
- Last 10 tanks used a soil surcharge to preconsolidate the ground
- Next 3 tanks took treatment to 75 ft deep to save time of consolidation

HAYWARD BAKER
Geotechnical Construction

Resisting large forces

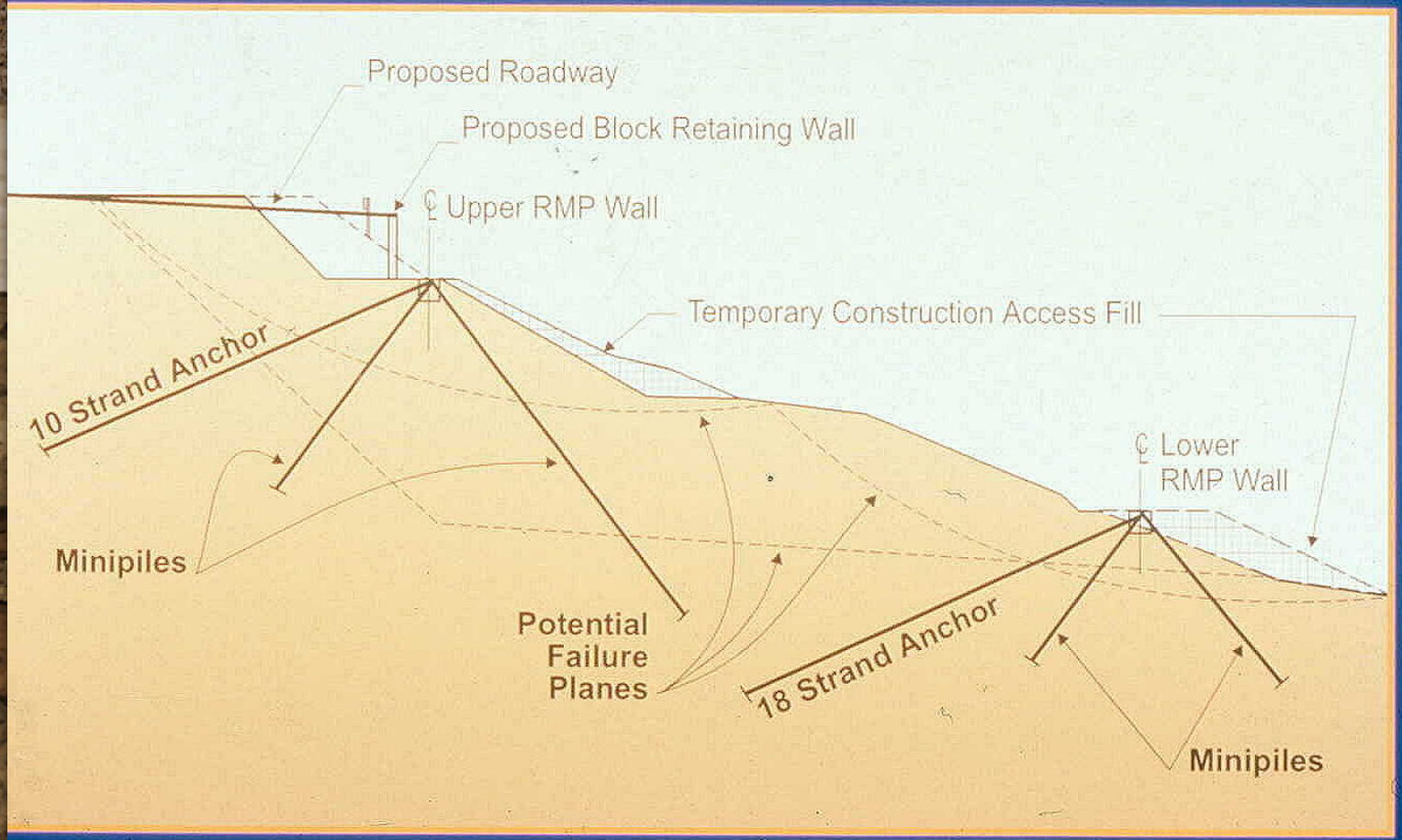
- Landslides (especially those that are moving)
- Deep excavations
- *Groundwater usually plays a major role*

HAYWARD BAKER
Geotechnical Construction


Wheeler Gulch, CO

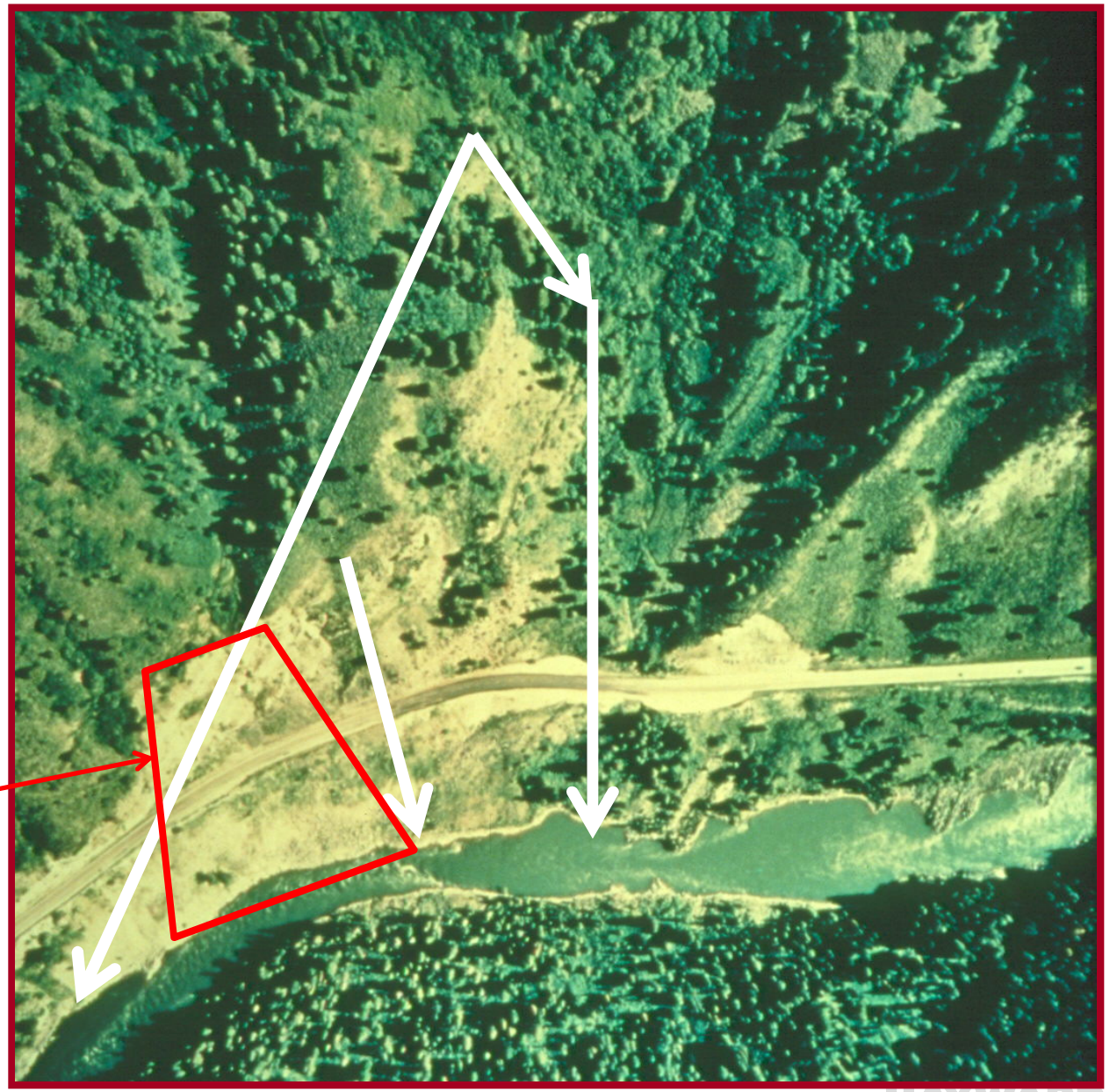
Reticulated Minipile Wall
Blue Trail Slide, Alpine, Wyoming

Cross Section

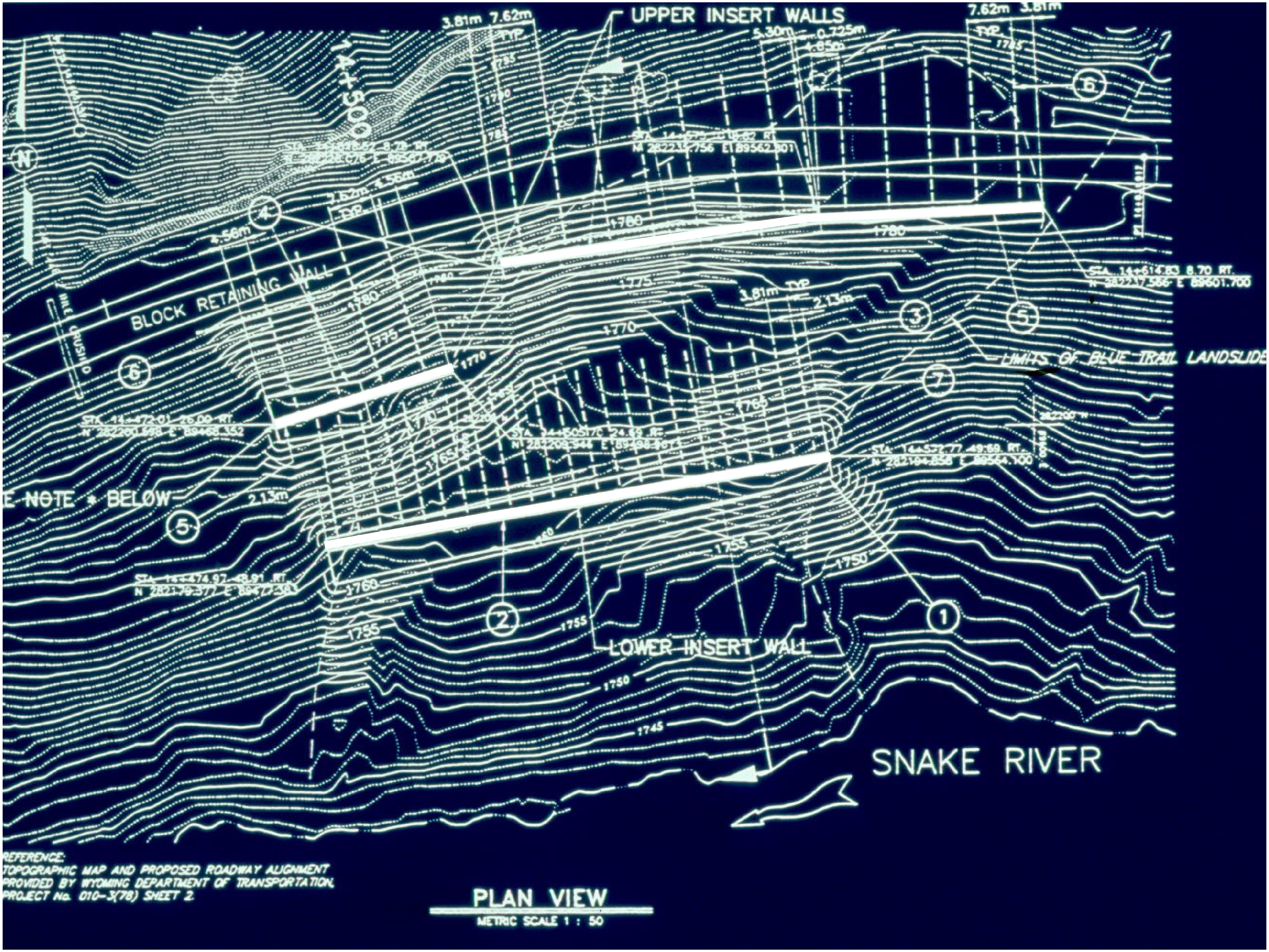


Hayward Baker
CI801/5170

Blue Trail Slide



HAYWARD BAKER
Geotechnical Construction


UPPER INSERT WALLS
3.81m 7.62m
7.62m 3.81m
TYP.
5.30m 0.725m
4.85m
14+500
BLOCK RETAINING WALL
LIMITS OF BLUE TRAIL LANDSLIDE
SEE NOTE * BELOW
LOWER INSERT WALL
SNAKE RIVER
1780
1775
1770
1765
1760
1755
1750
1745
STA. 14+614.83 8.70 RT.
N 282237.566 E 89601.700
STA. 14+472.01 26.00 RT.
N 282260.598 E 89468.352
STA. 14+572.77 49.69 RT.
N 282194.858 E 89564.100
STA. 14+474.97 48.91 RT.
REFERENCE:
TOPOGRAPHIC MAP AND PROPOSED ROADWAY ALIGNMENT
PROVIDED BY WYOMING DEPARTMENT OF TRANSPORTATION,
PROJECT No. 010-3(78) SHEET 2.
PLAN VIEW
METRIC SCALE 1 : 50

Aerial View of Work Site

Finished Cap – Upper Wall

Drilling

Finished Project

HAYWARD BAKER
Geotechnical Construction

10 years later

HAYWARD BAKER
Geotechnical Construction

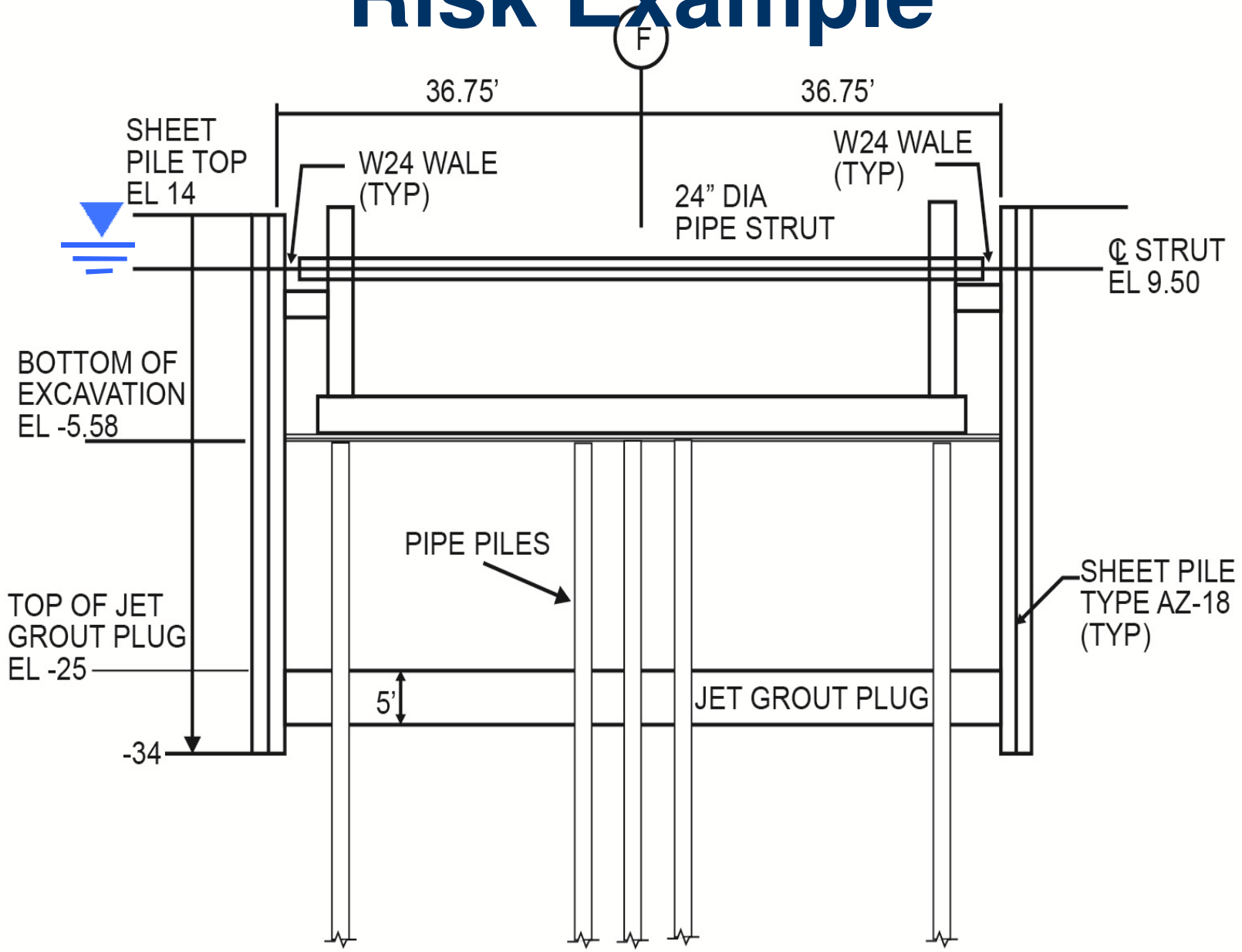
Adjacent Landslide, 2011

HAYWARD BAKER
Geotechnical Construction

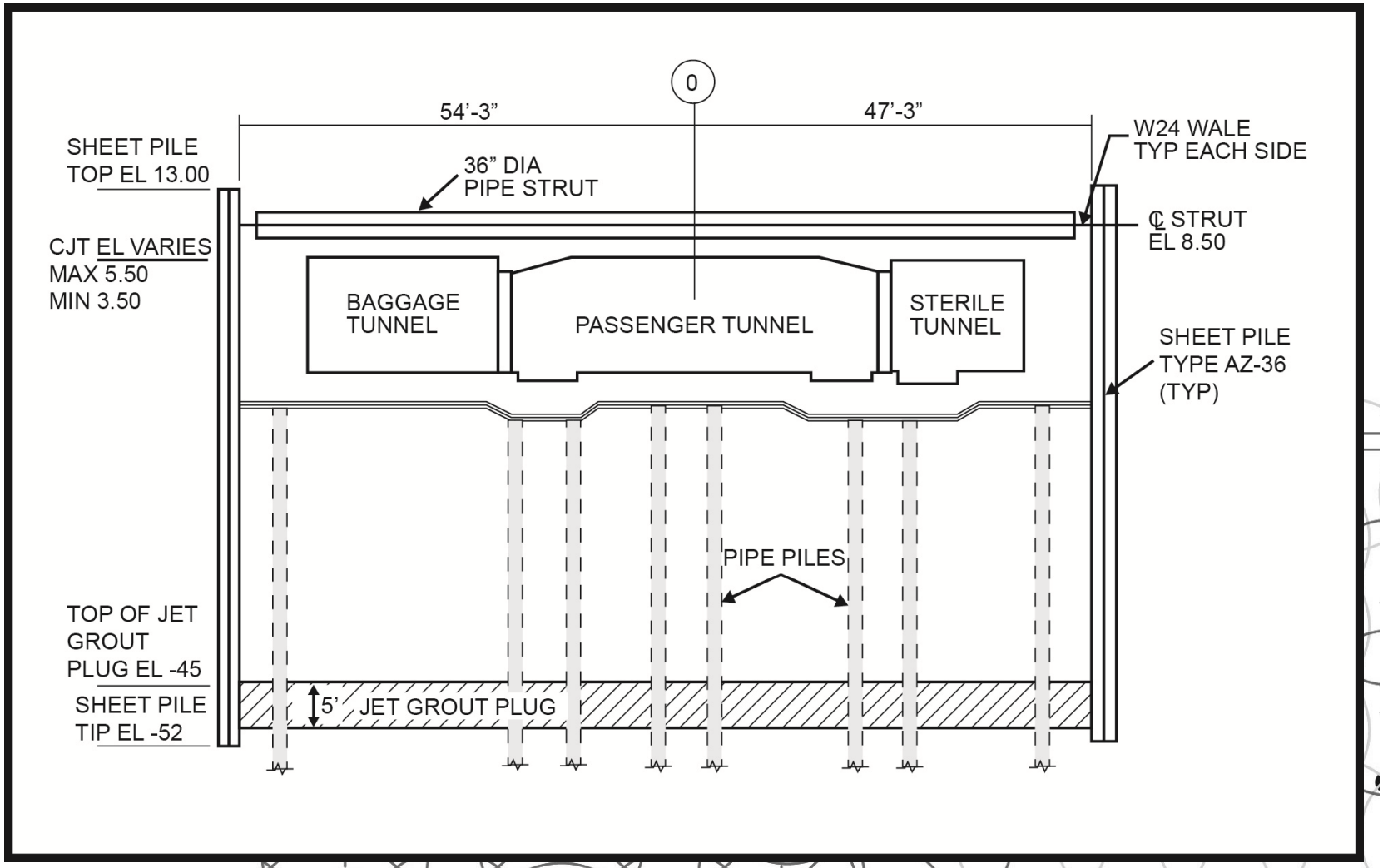
Stopping Groundwater

- Requires perfection (windowless)

Risk Example



HAYWARD
BAKER
Geotechnical Construction


0
54'-3"
47'-3"
SHEET PILE
TOP EL 13.00
36" DIA
PIPE STRUT
W24 WALE
TYP EACH SIDE
℄ STRUT
EL 8.50
CJT EL VARIES
MAX 5.50
MIN 3.50
BAGGAGE
TUNNEL
PASSENGER TUNNEL
STERILE
TUNNEL
SHEET PILE
TYPE AZ-36
(TYP)
PIPE PILES
TOP OF JET
GROUT
PLUG EL -45
SHEET PILE
TIP EL -52
5'
JET GROUT PLUG

Risks identified

Before Construction

- Schedule…LDs in the prime contractors contract
- GW pumping tolerance limited to 130 gpm
- Best resources needed

Post project scrutiny

- QC was good
- Best sequence used,
  - Ground disturbance from pile installation?
  - Reflection of energy?
- Fill included jetting obstructions
- Unforeseen government intervention

HAYWARD BAKER
Geotechnical Construction

Summary

- Geotechnical construction is risky!
- Subsurface conditions cannot be perfectly represented
- Identify as many known-unknowns as possible
- Contractors/consultants/owners alike do not possess x-ray glasses
- Do you homework, use this checklist

Thank You!

Questions are welcomed!

HAYWARD BAKER
Geotechnical Construction
KELLER

www.HaywardBaker.com