Safety Evaluations of Hidden Dam – Seepage Models Meet Reality

2011 AEG Annual Meeting

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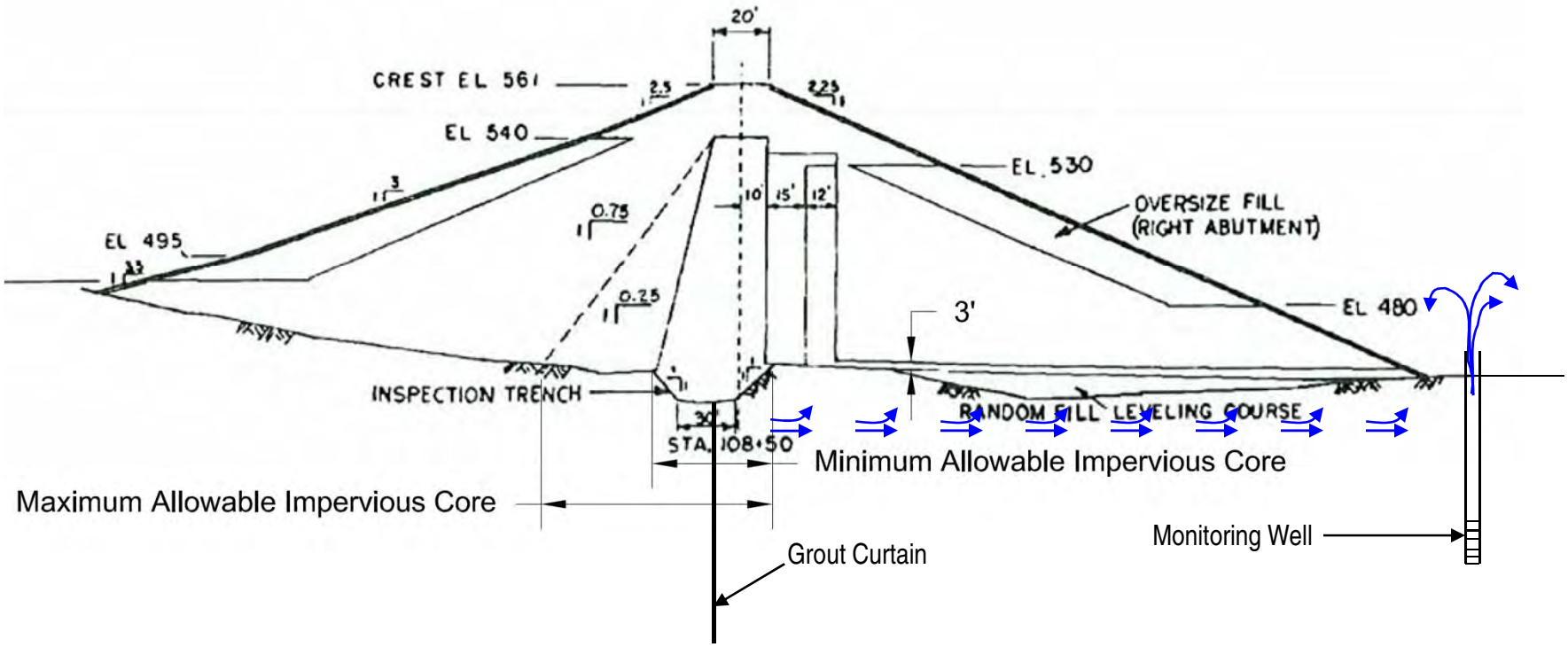
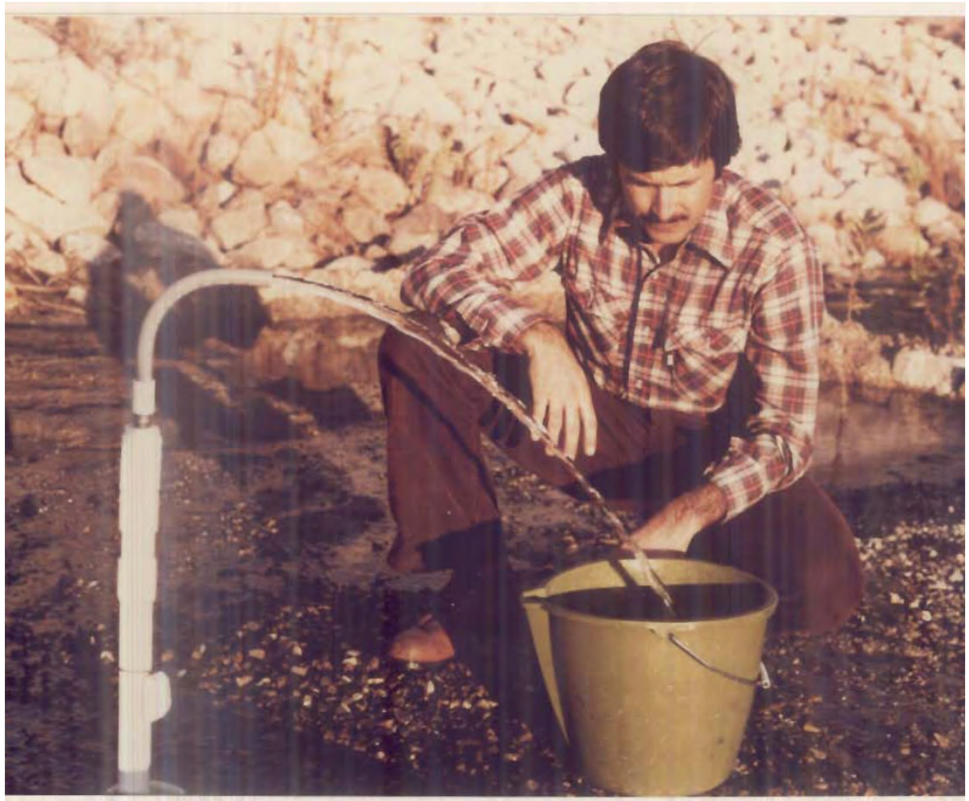
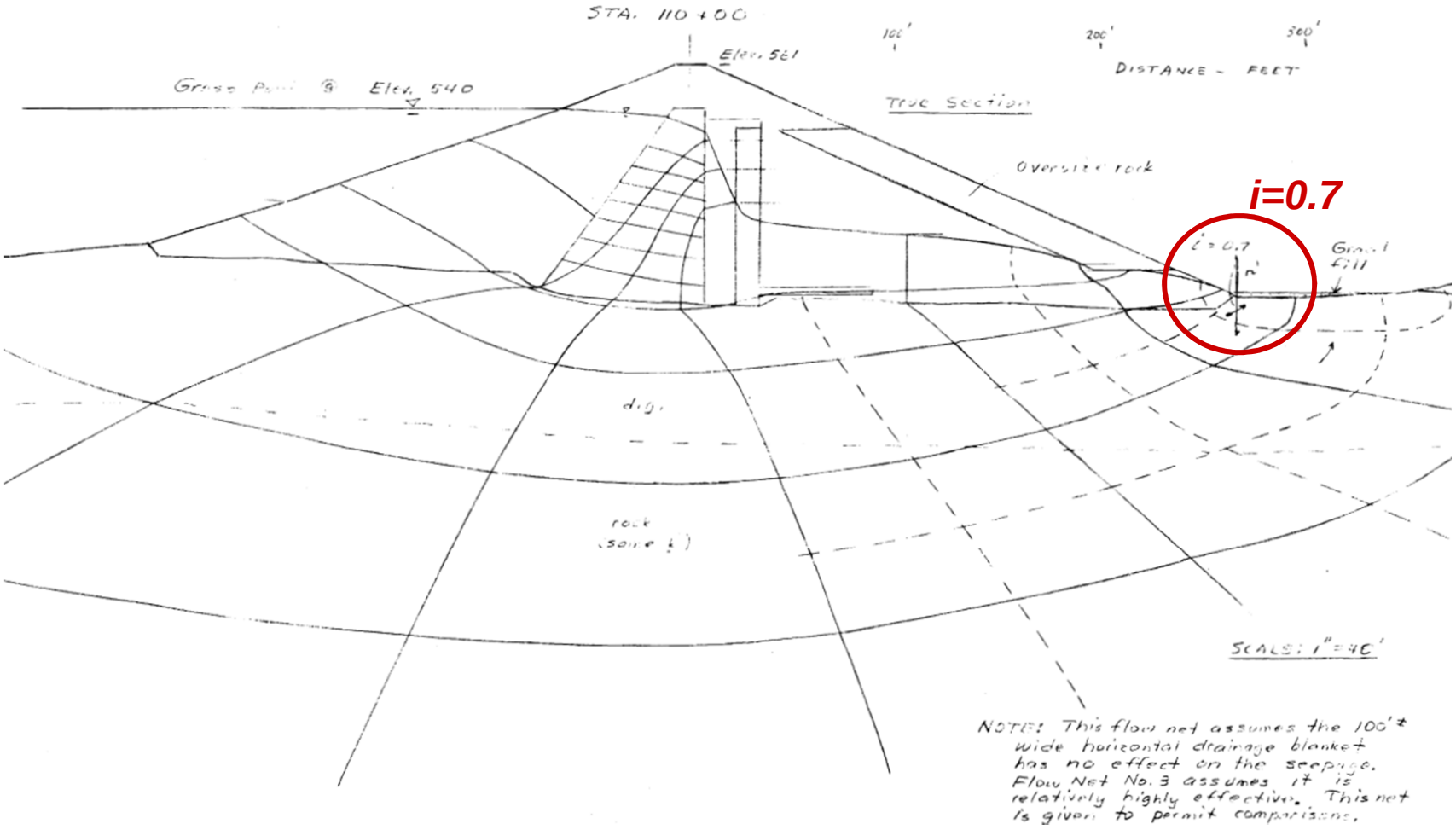
Kleinfelder


Black Butte Dam and Lake
Coyote Valley Dam, Lake Mendocino
Warm Springs Dam, Lake Sonoma
Englebright Dam and Lake
Martis Creek Dam and Reservoir
New Hogan Dam and Lake
Burns, Bear, Owens, and Mariposa Reservoirs
Buchanan Dam, Eastman Lake
Hidden Dam, Hensley Lake
Pine Flat Dam and Lake
Terminus Dam, Lake Kaweah
Success Dam and Lake
Farmington Dam and Reservoir
Reno
Sacramento
Stockton
San Francisco
Fresno
Sacramento River
San Joaquin River
PACIFIC
OCEAN
50
80
101
5
99


Hidden Dam and Hensley Lake


20'
CREST EL 561
2.5
2.25
EL 540
EL 530
OVERSIZE FILL
(RIGHT ABUTMENT)
EL 495
3
0.75
10'
15'
12'
0.25
EL 480
3'
INSPECTION TRENCH
RANDOM FILL LEVELING COURSE
30'
STA. 108+50
Minimum Allowable Impervious Core
Maximum Allowable Impervious Core
Grout Curtain
Monitoring Well

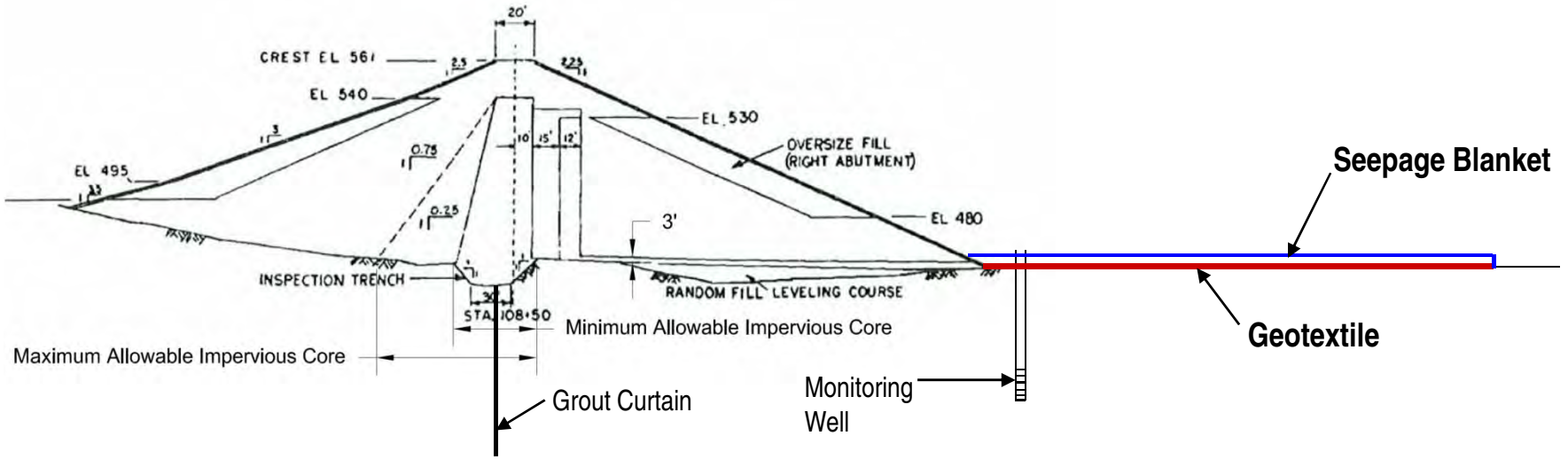



STA. 110+00
Elev. 561
Grass Point @ Elev. 540
100'
200'
300'
DISTANCE - FEET
True Section
Oversized rock
i=0.7
i' = 0.7
n'
Graded fill
dig.
rock
(some ↓)
SCALE: 1" = 40'
NOTE: This flow net assumes the 100'± wide horizontal drainage blanket has no effect on the seepage. Flow Net No. 3 assumes it is relatively highly effective. This net is given to permit comparisons.

"Since it is never possible to know the true level of safety of dams with seepage problems such as appear to exists at the Hidden Dam and Reservoir project, I urge that every effort be made to secure funds to accomplish a substantial fix in the next construction season…."

Very Truly Yours, Harry R. Cedergren, 1980


DISPOSAL AREA Z
DISPOSAL AREA X
R/W FENCE
EXIST. 24" CMP
EXIST. 36" CMP
Measuring weir - see detail on Sheet 8
Stilling basin and measuring weir - see Sheet 6
Sta. 108+50
Sta. 109+15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Minimum Allowable Impervious Core
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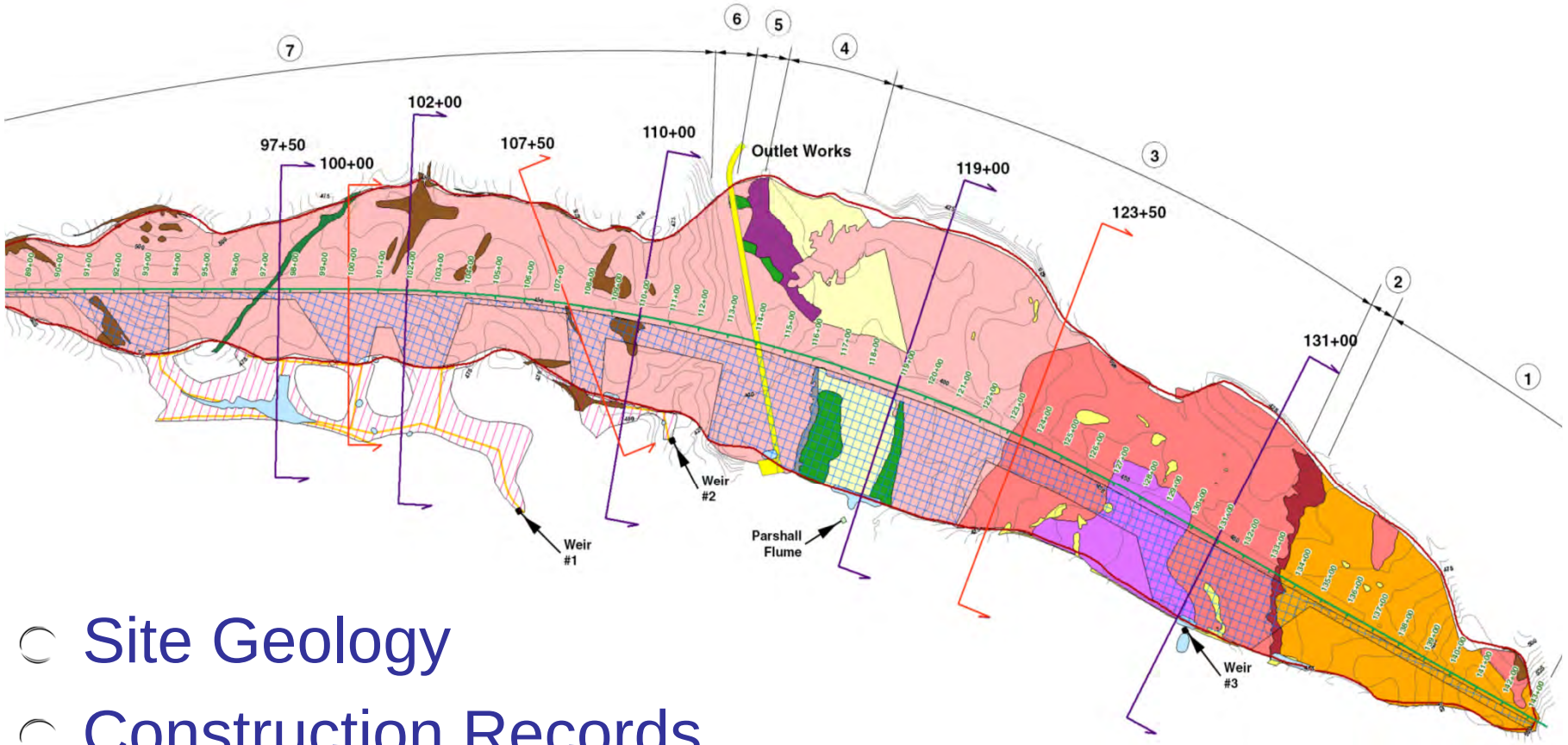
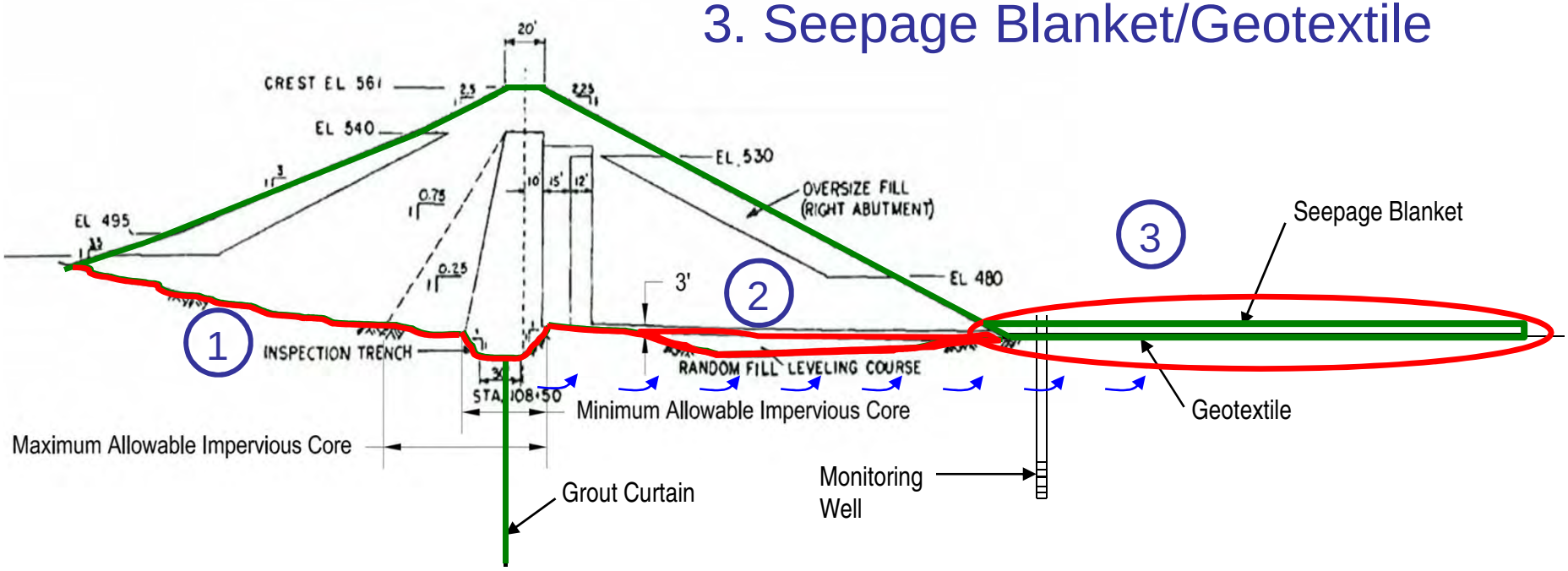
Seepage Blanket
Geotextile



- Site Geology
- Construction Records
- Instrumentation Data
- Previous Studies

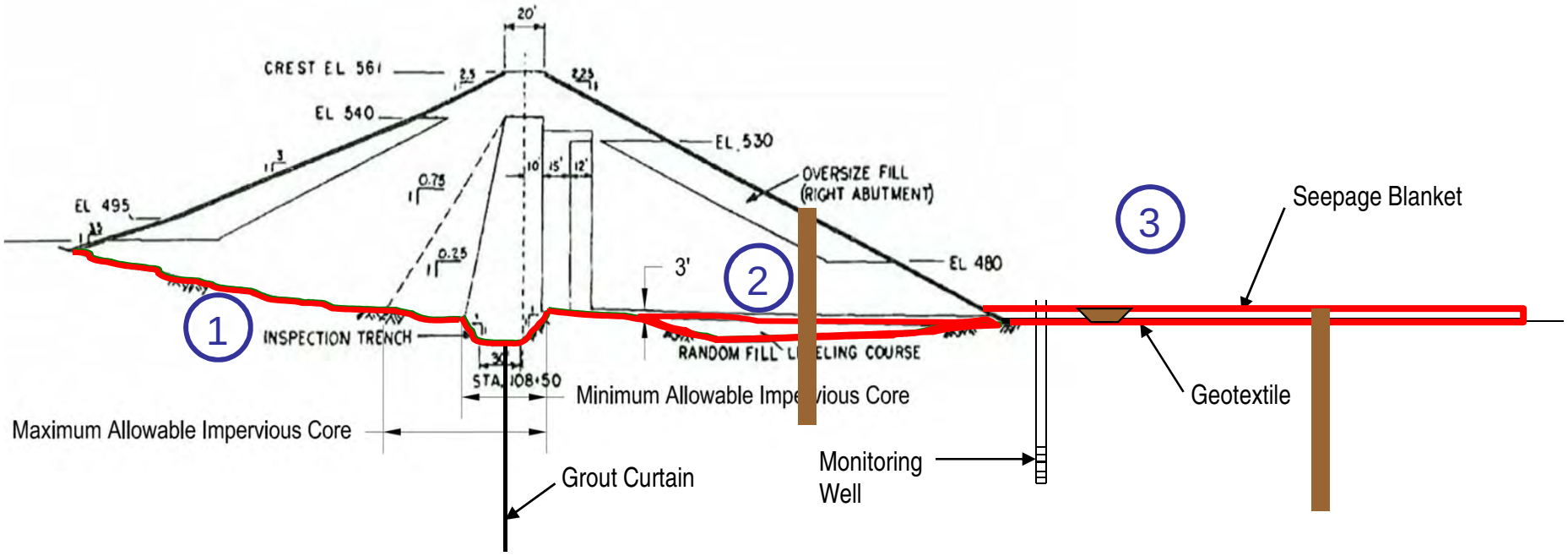
Potential Problem Areas:

1. Weathered Bedrock
2. Leveling Course
3. Seepage Blanket/Geotextile

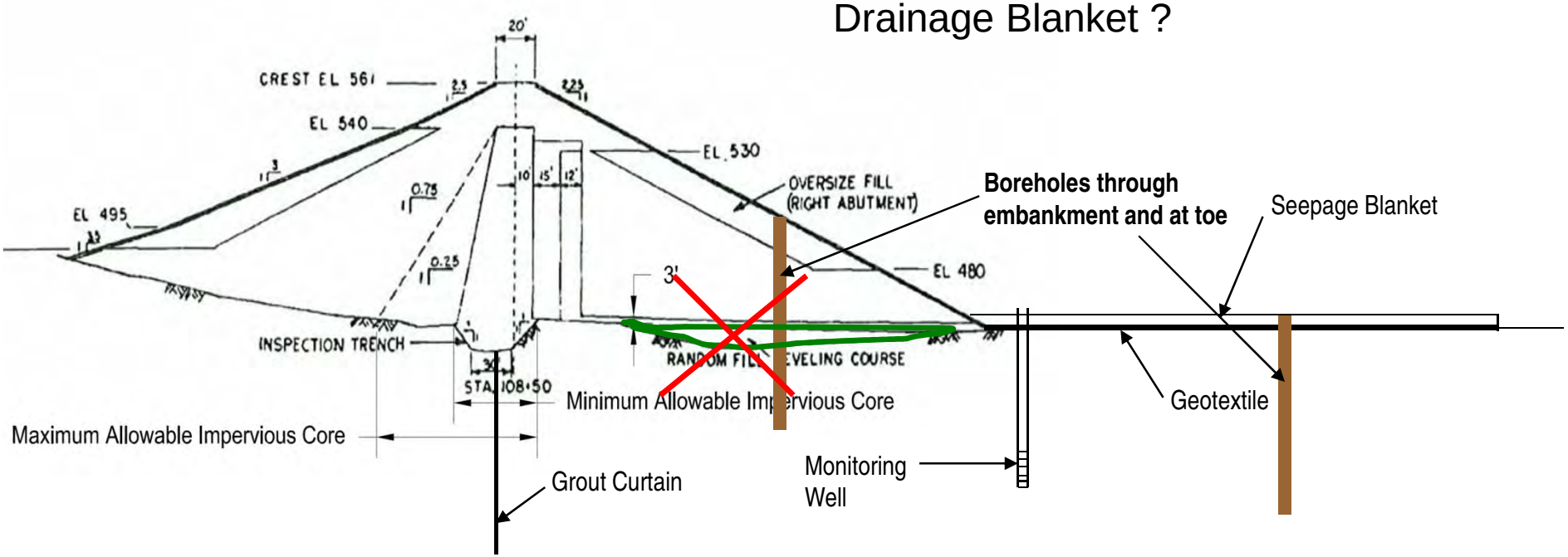


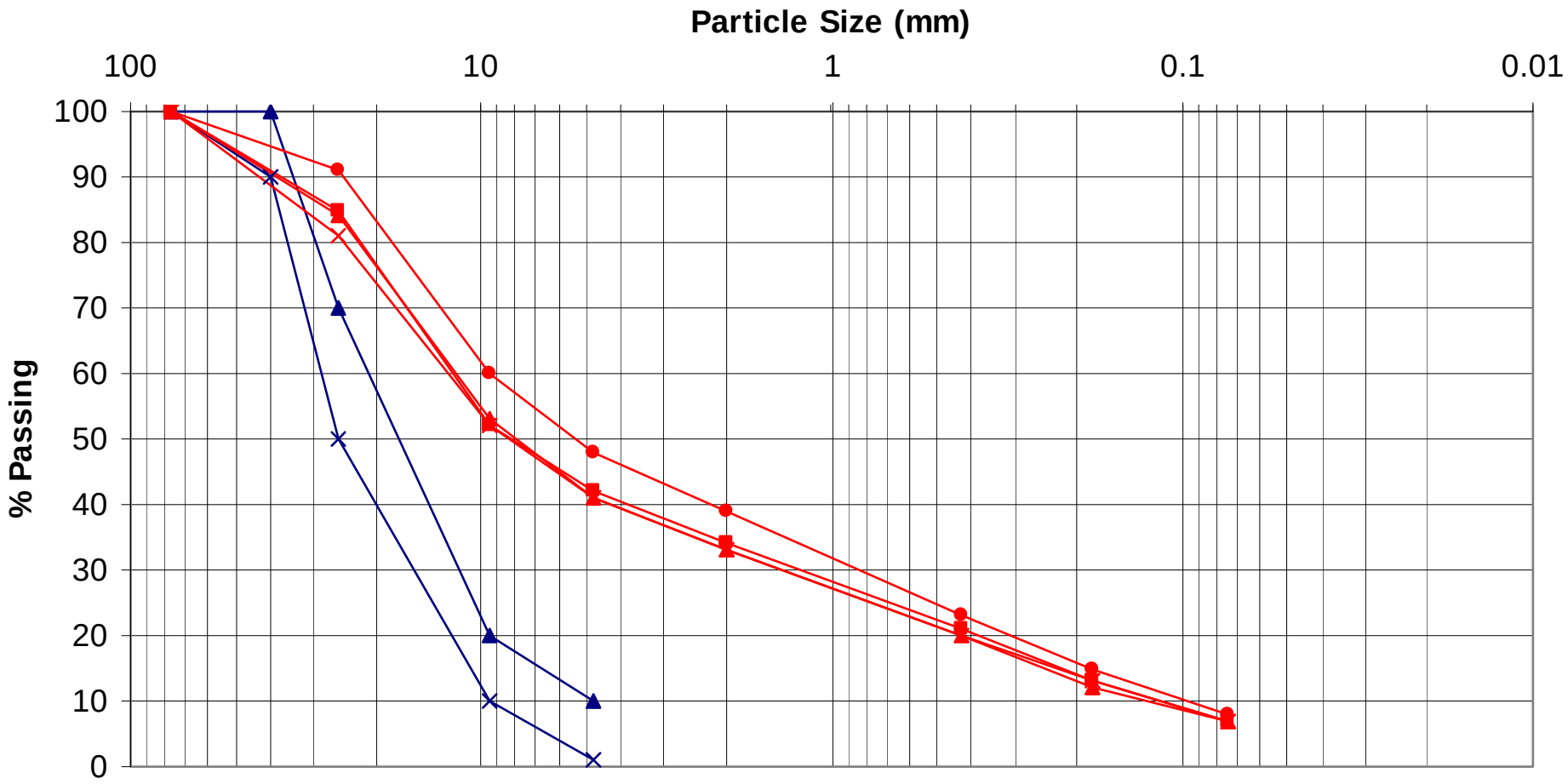
Explorations:

- Borings
- Piezometers
- Test Pits



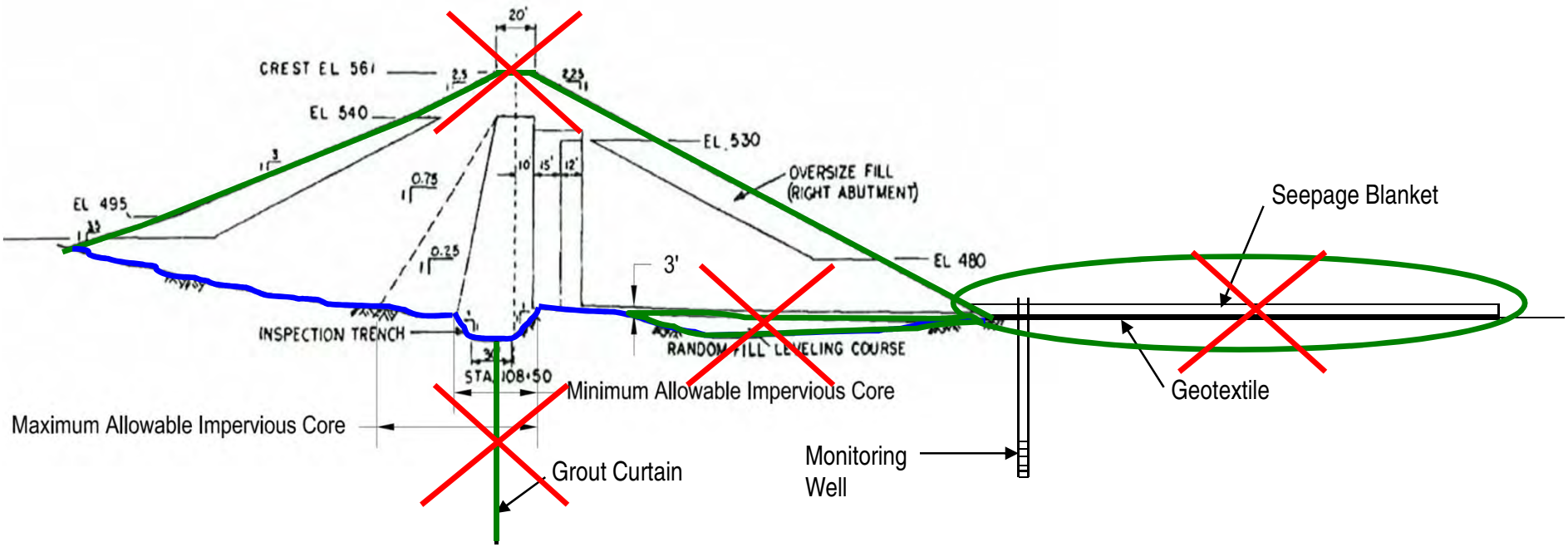
Leveling Course ok
Drainage Blanket ?




Particle Size (mm)
100
10
1
0.1
0.01
% Passing
100
90
80
70
60
50
40
30
20
10
0

Working Hypotheses

- Out of Spec Material?
- Contamination and Breakage due to Sonic Drilling?
- Movement of Fines?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Minimum Allowable Impervious Core
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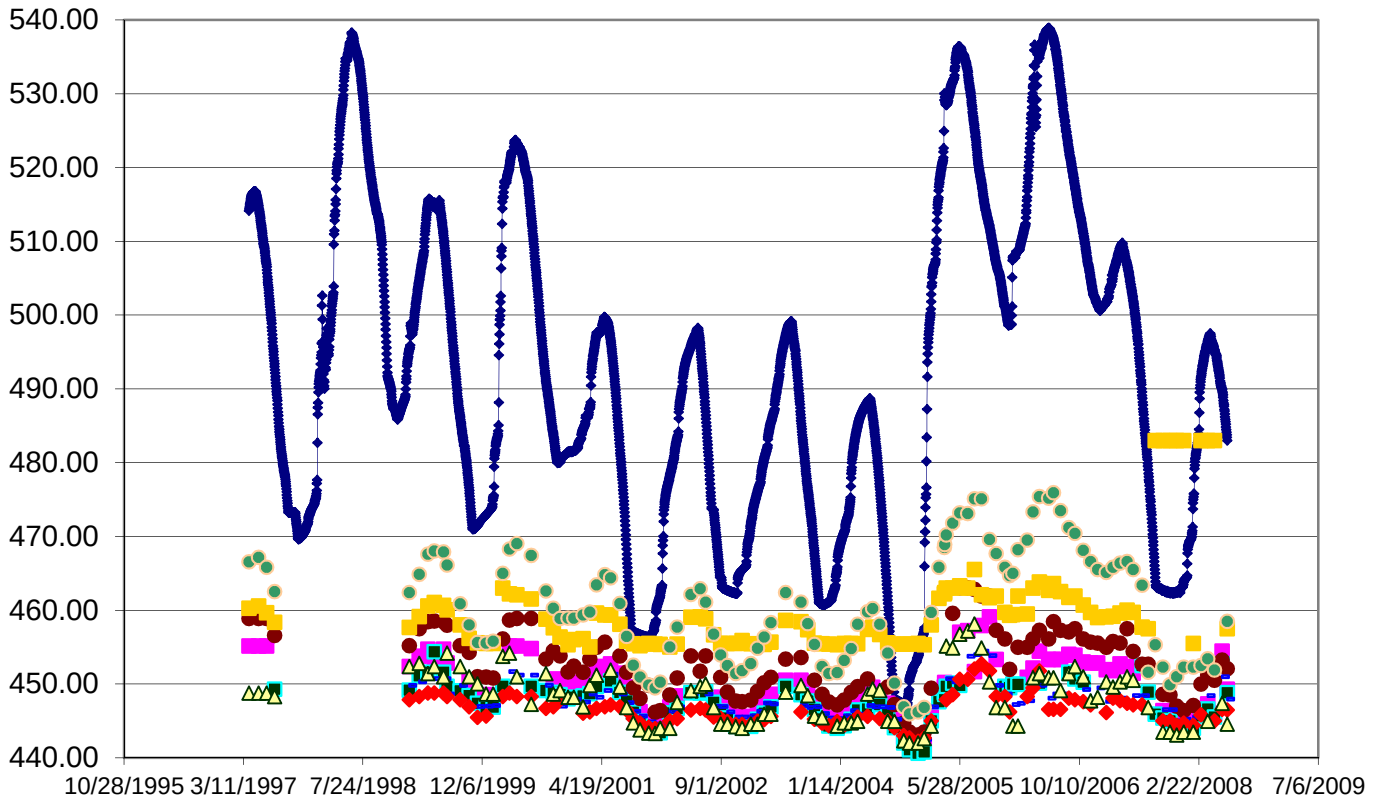
Geotextile
Grout Curtain
Monitoring
Well

Instrumentation

- 16 open tube piezometers
- 51 observation wells
- Parshall flume
- 3 v-notch weirs
- Over 30 years of data

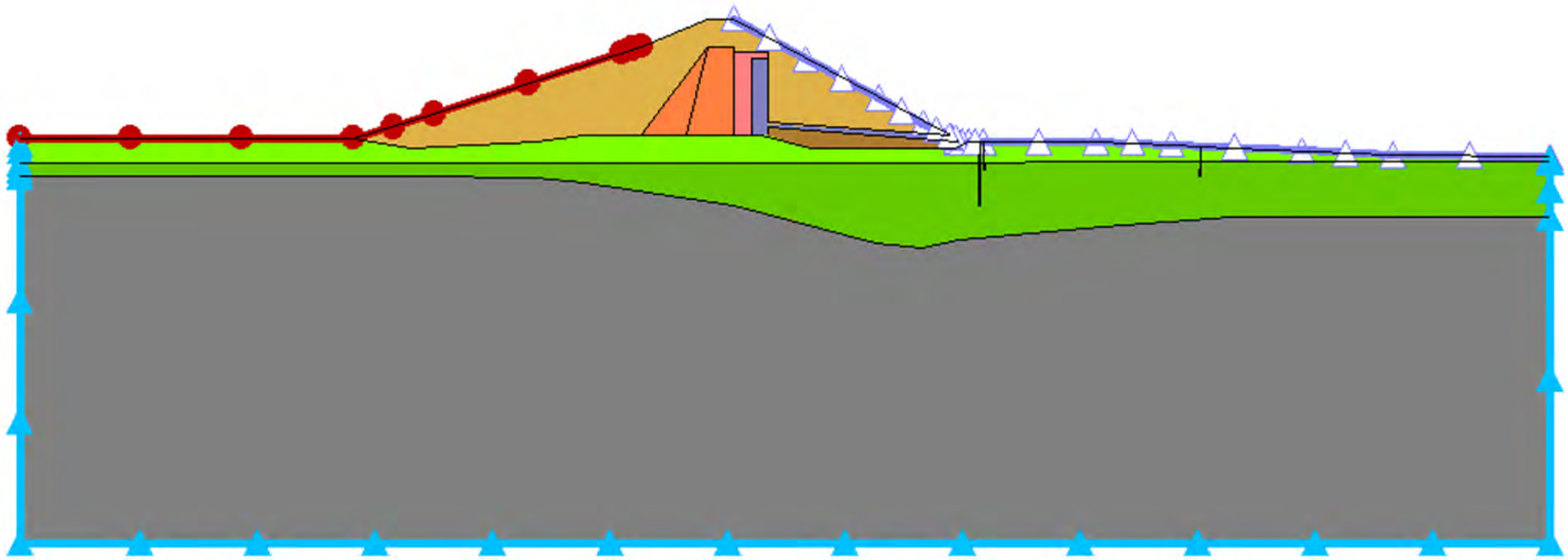
- Reliable readings
- Representative
- Outliers
- Trends
- Triggers



Computer Model Calibration

- Observation well readings at high pool
- Seepage quantities at the toe
- Response to pool fluctuations
- Initiation of artesian conditions
- Combination of dry test pits with overflowing wells

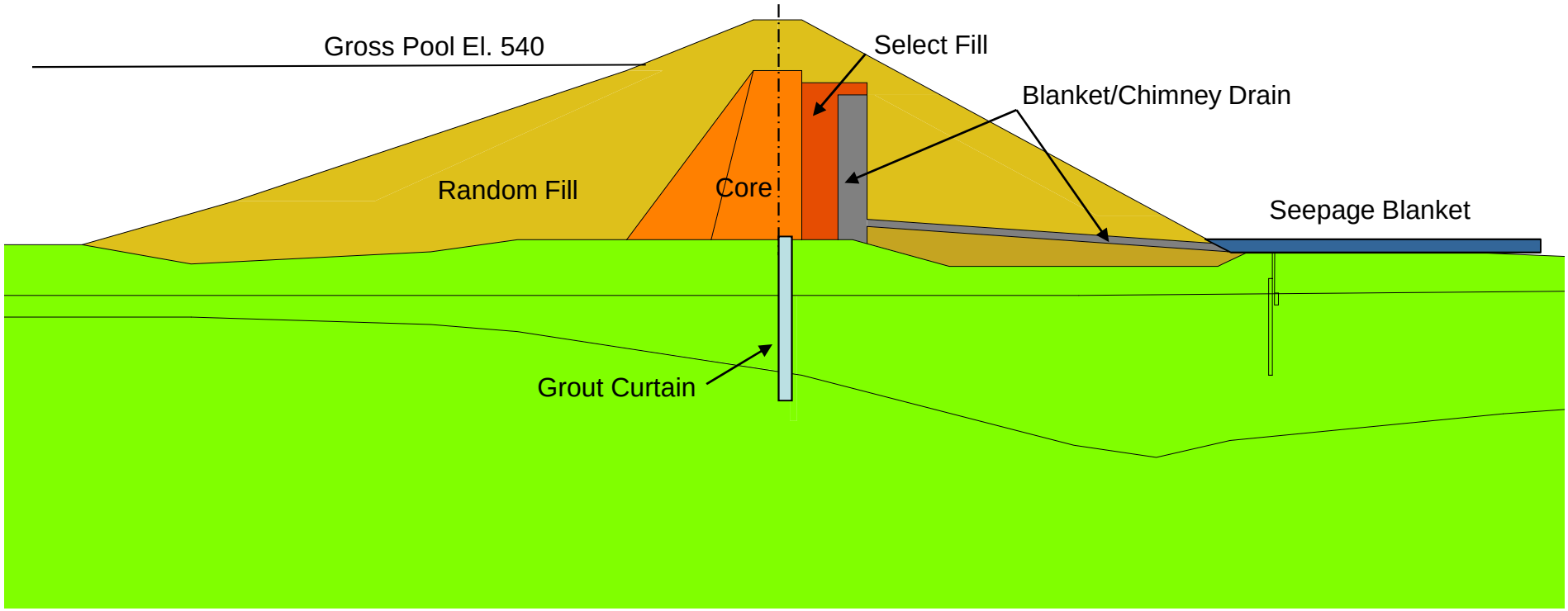
Model Setup



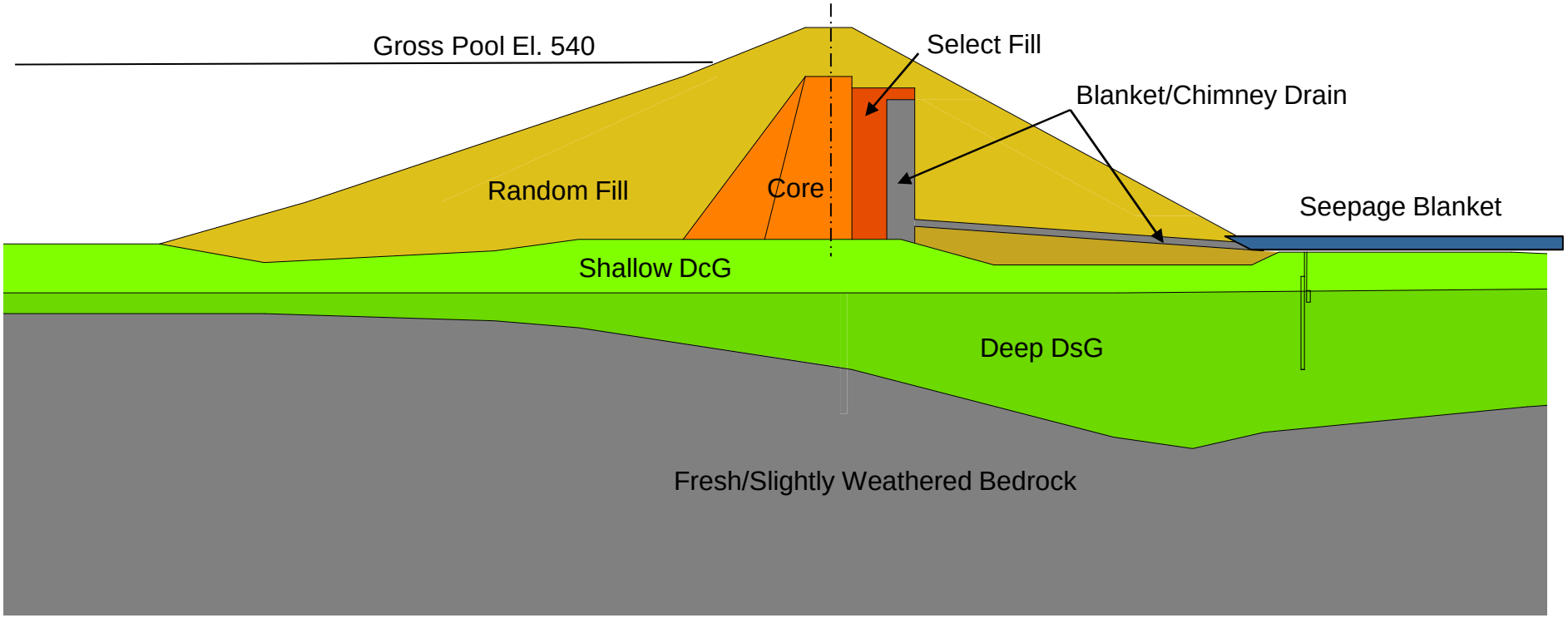
Computer Model Sensitivity

- Presence of open fractures
- Effective/ineffective grout curtain
- Confining layer in upper part of bedrock
- Combination of fractures and confining layer
- Clogged blanket drain
- Local pressure relief from observation wells

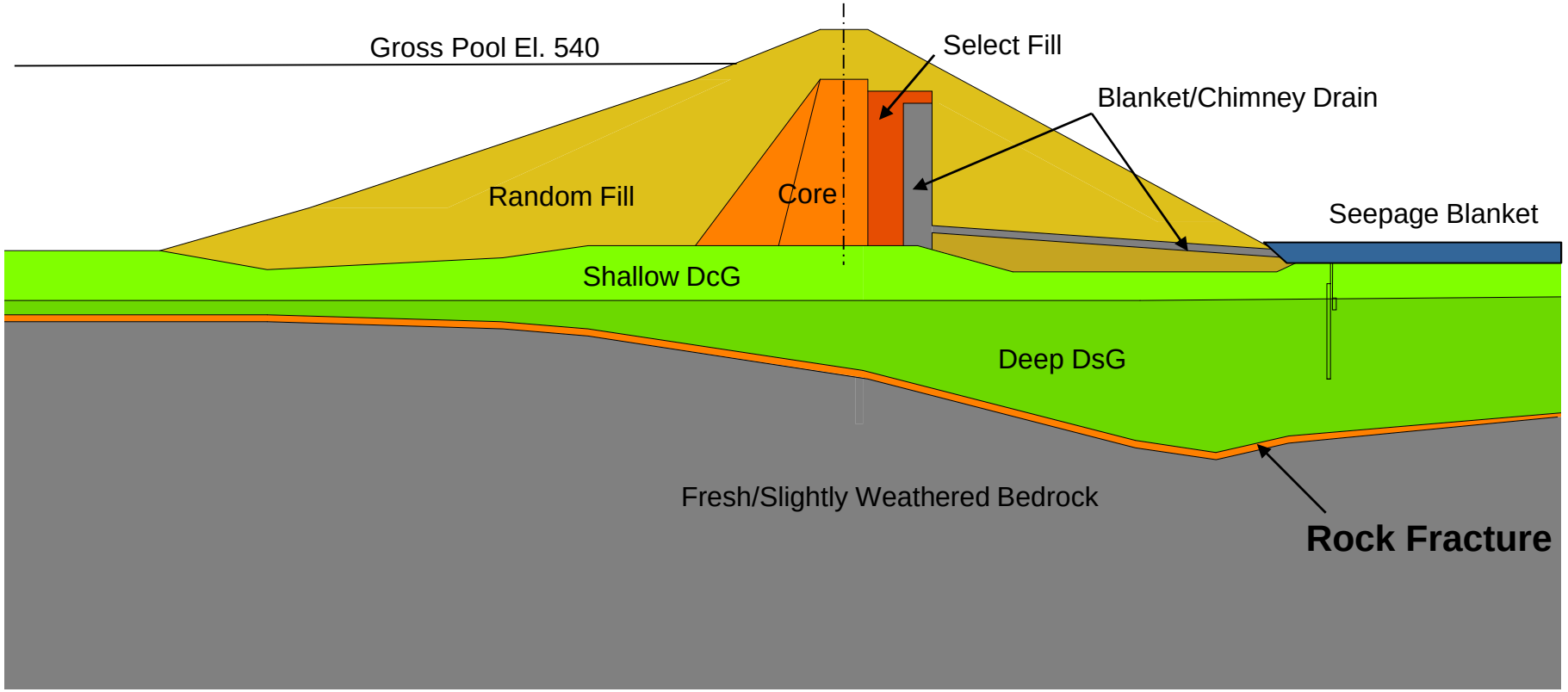
Model A: Uniform Foundation



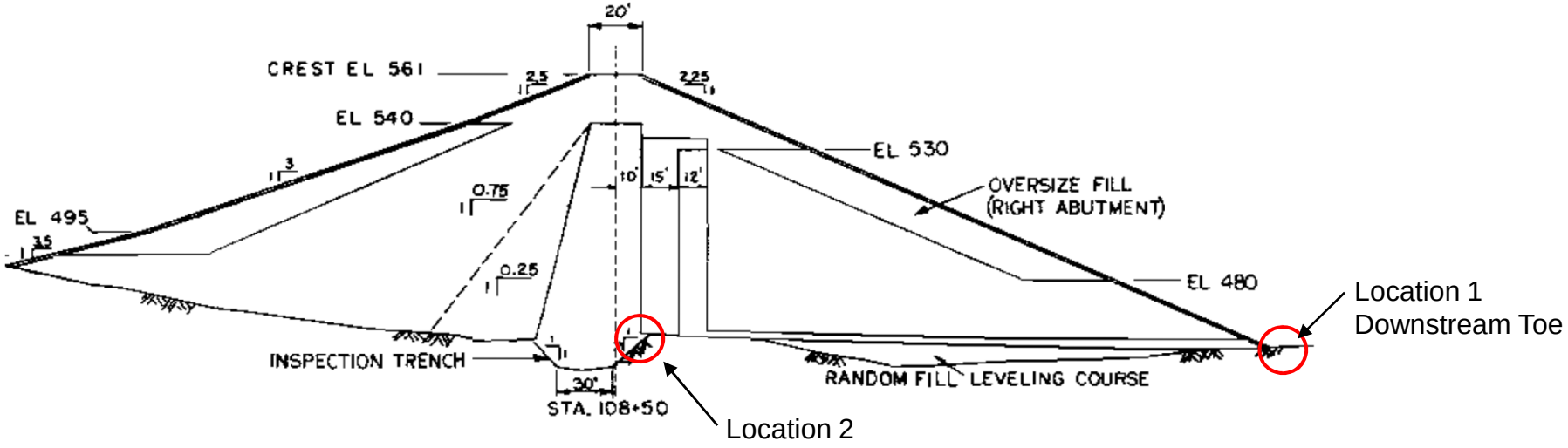
Model B: Confining Layer



Model C: Rock Fracture Flow



3 models with 3 answers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RANDOM FILL LEVELING COURSE
Location 1
Downstream Toe
Location 2

Seepage Analysis Results

- Seepage through discrete rock fractures or joint intersections
- Seepage pathways open to reservoir and continuous
- Confining layer in shallow bedrock foundation
- Grout curtain inefficient
- High exit gradients

Conclusions

- Insight into complex seepage conditions
- Key influence parameters
- Supported current risk rating

Thank You!