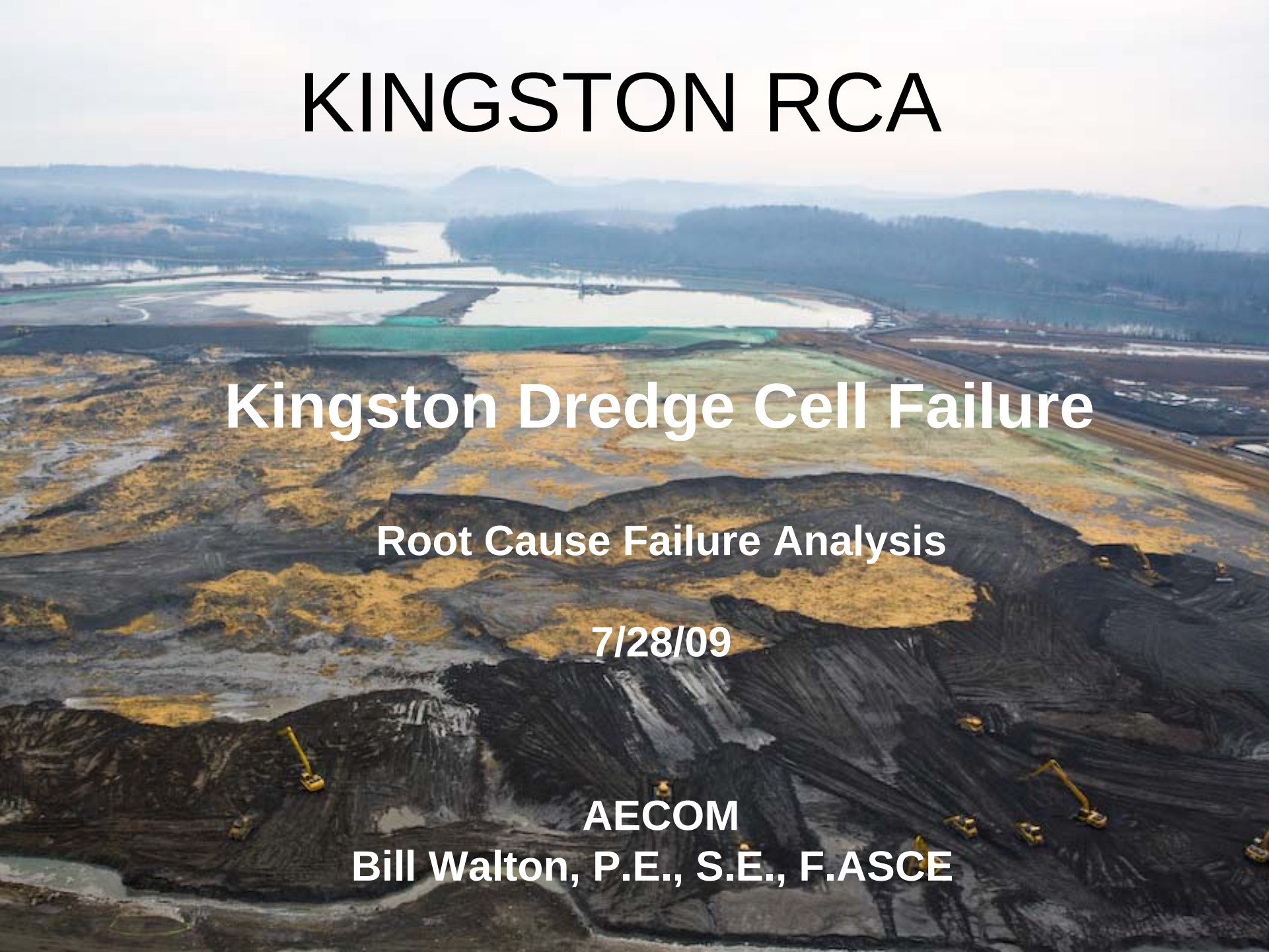
KINGSTON RCA



Kingston Dredge Cell Failure

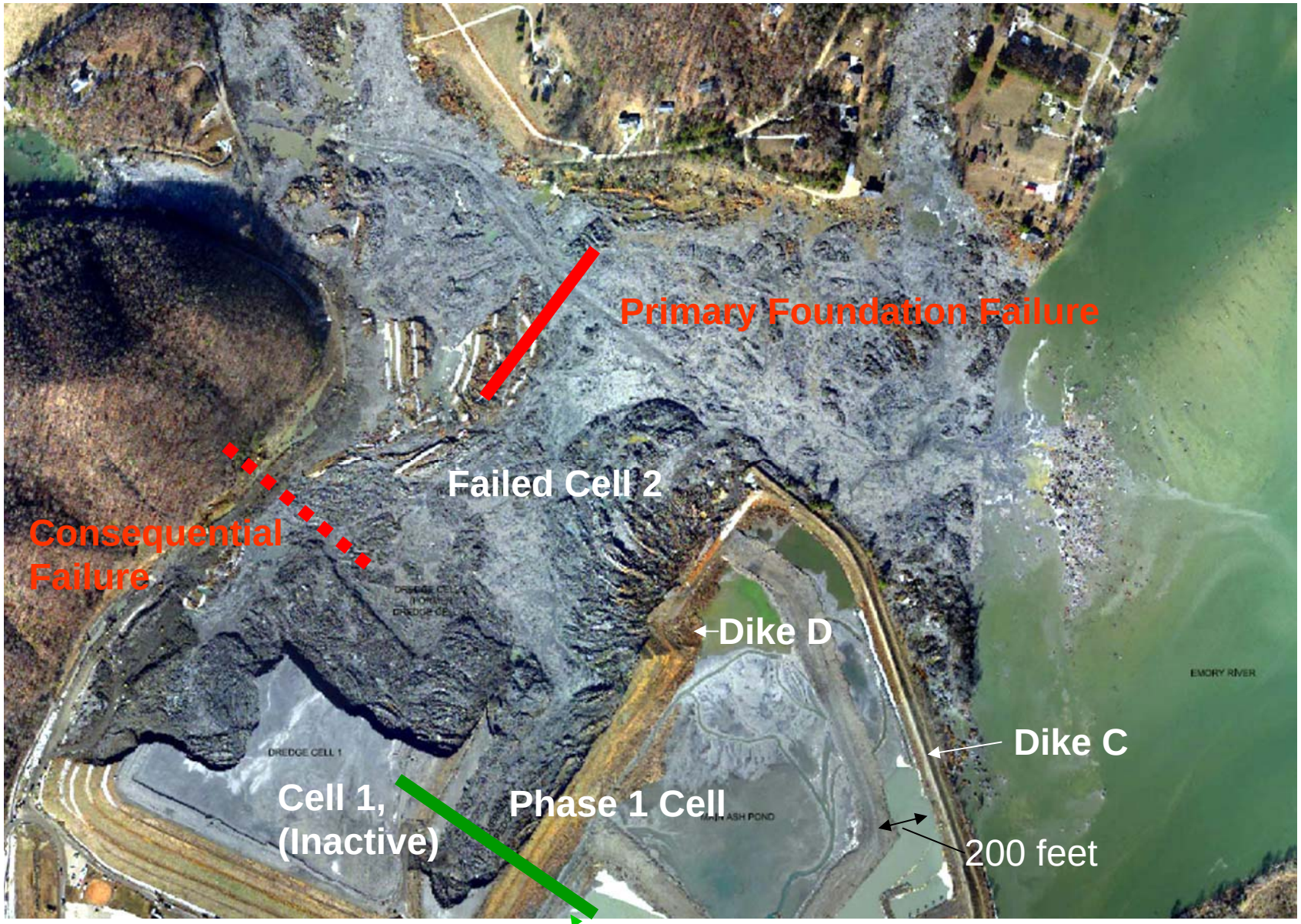
Root Cause Failure Analysis

7/28/09

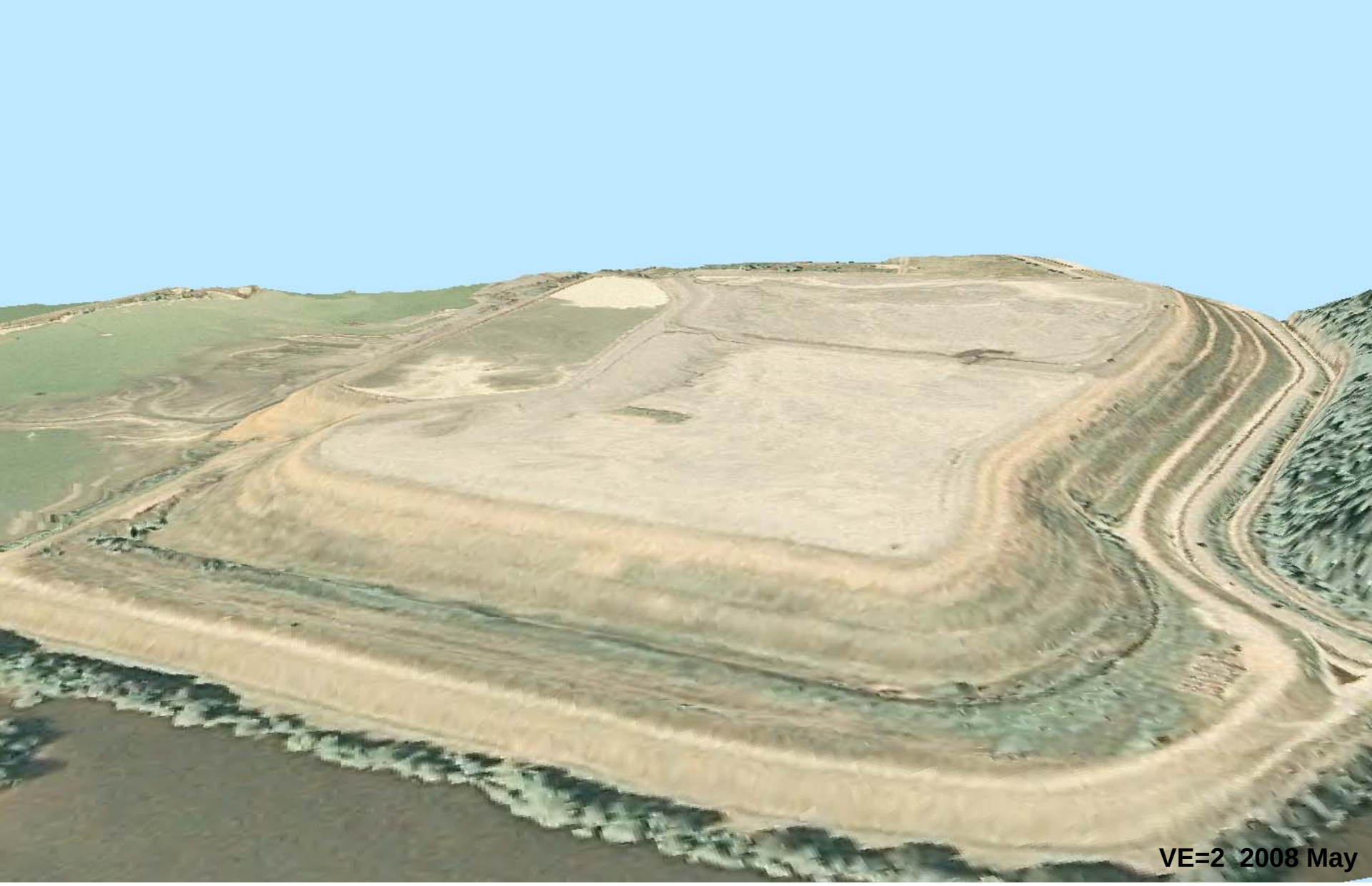
AECOM
Bill Walton, P.E., S.E., F.ASCE

Pre-failure Condition 4-5-2008

Post Failure Condition 12-30-08

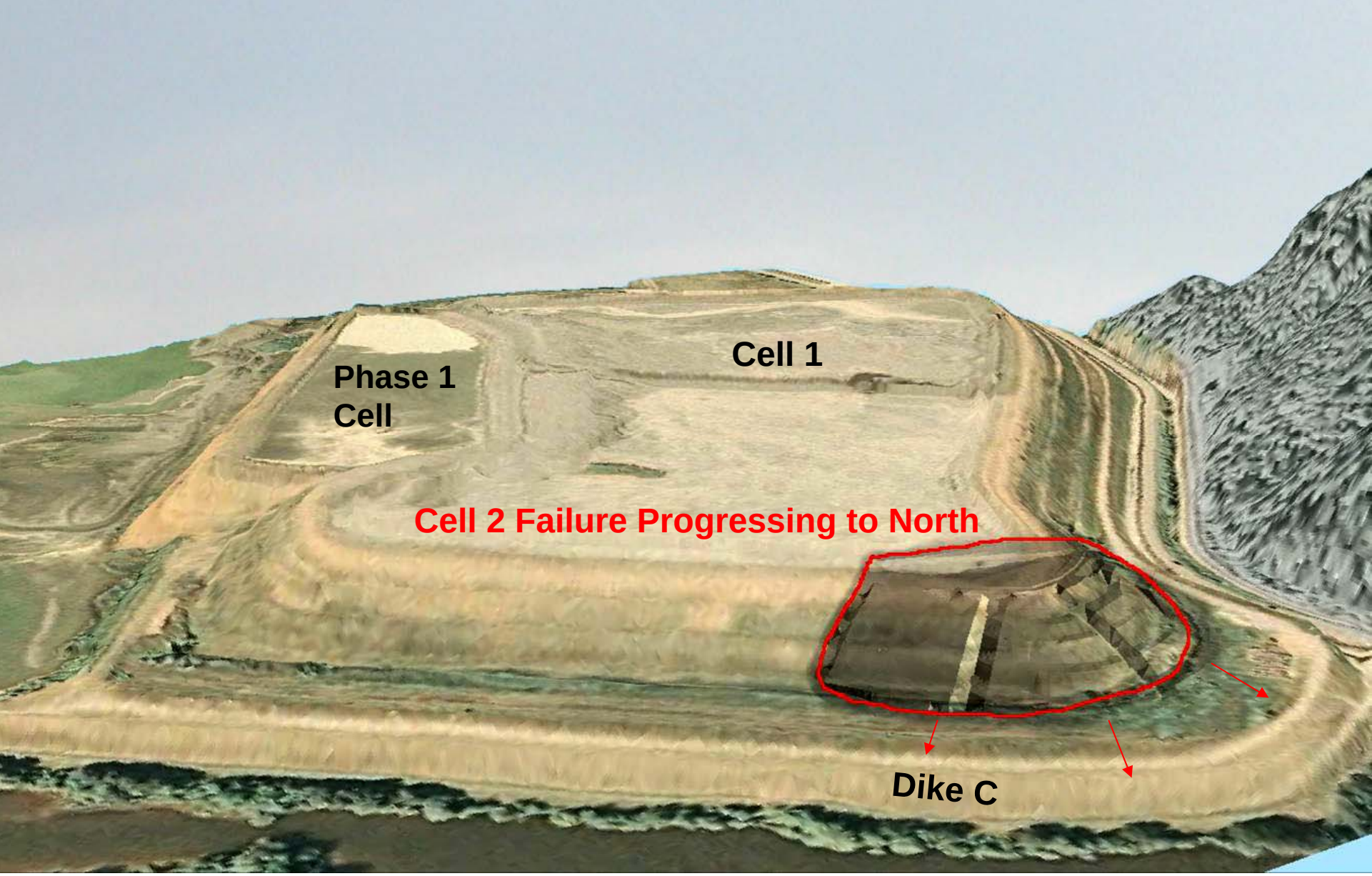


No Foundation Failure

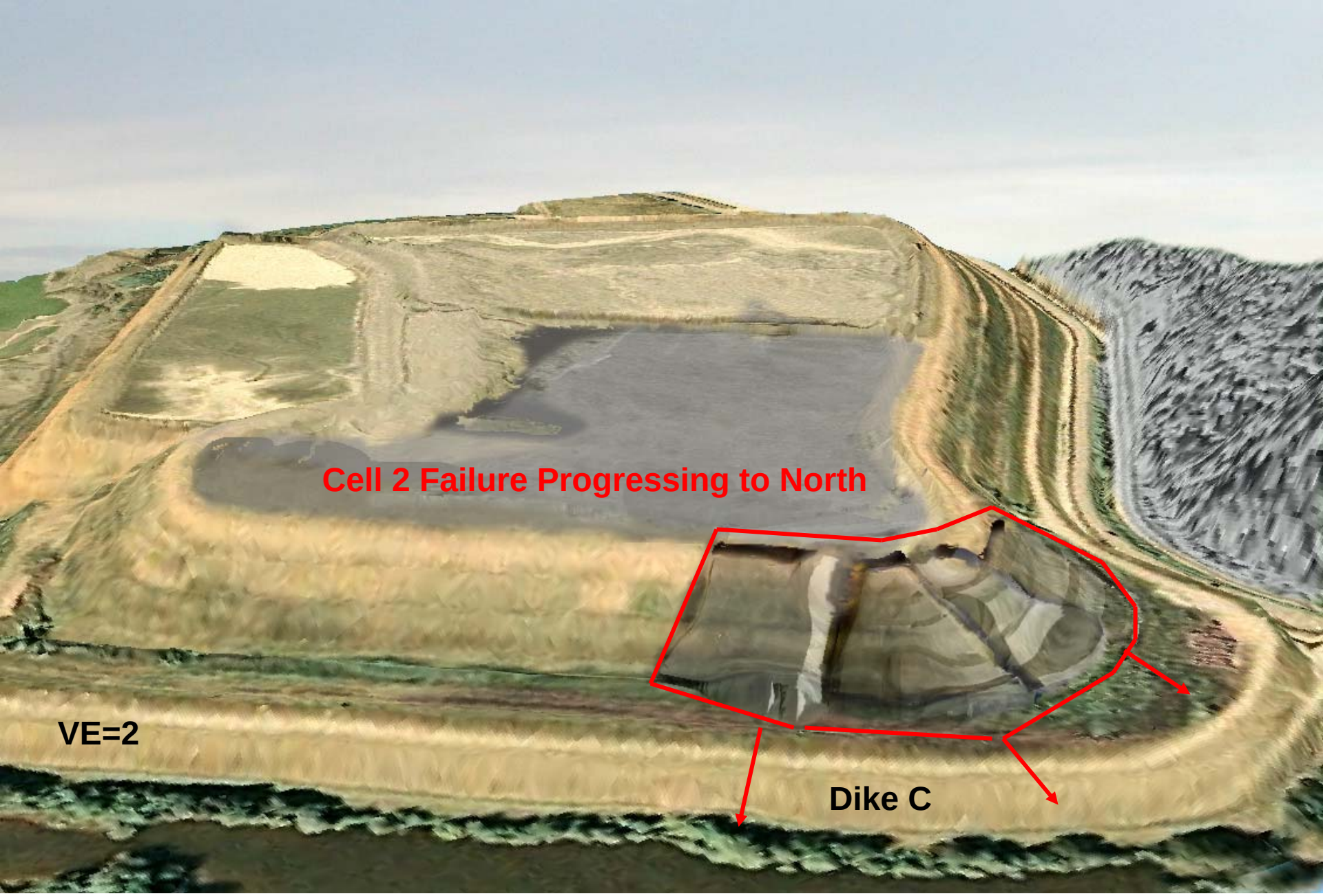


May 2008 Air Photo and Topography from Pre-Failure from TVA Surveys

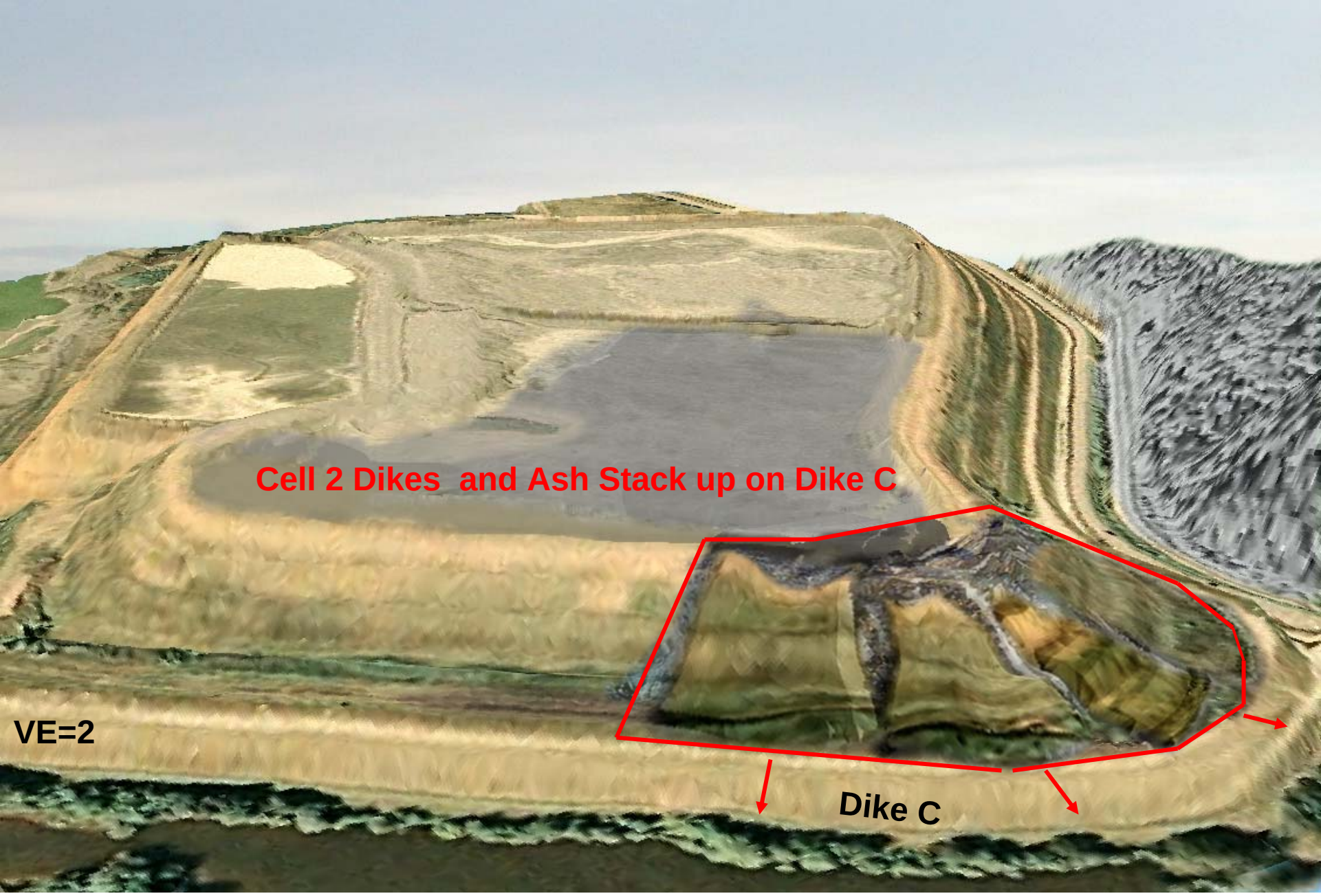
December 22, 2008 Expected Failure Location at NW Corner of Cell 2



December 22, 2008 Expected Failure Location at NW Corner of Cell 2



December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

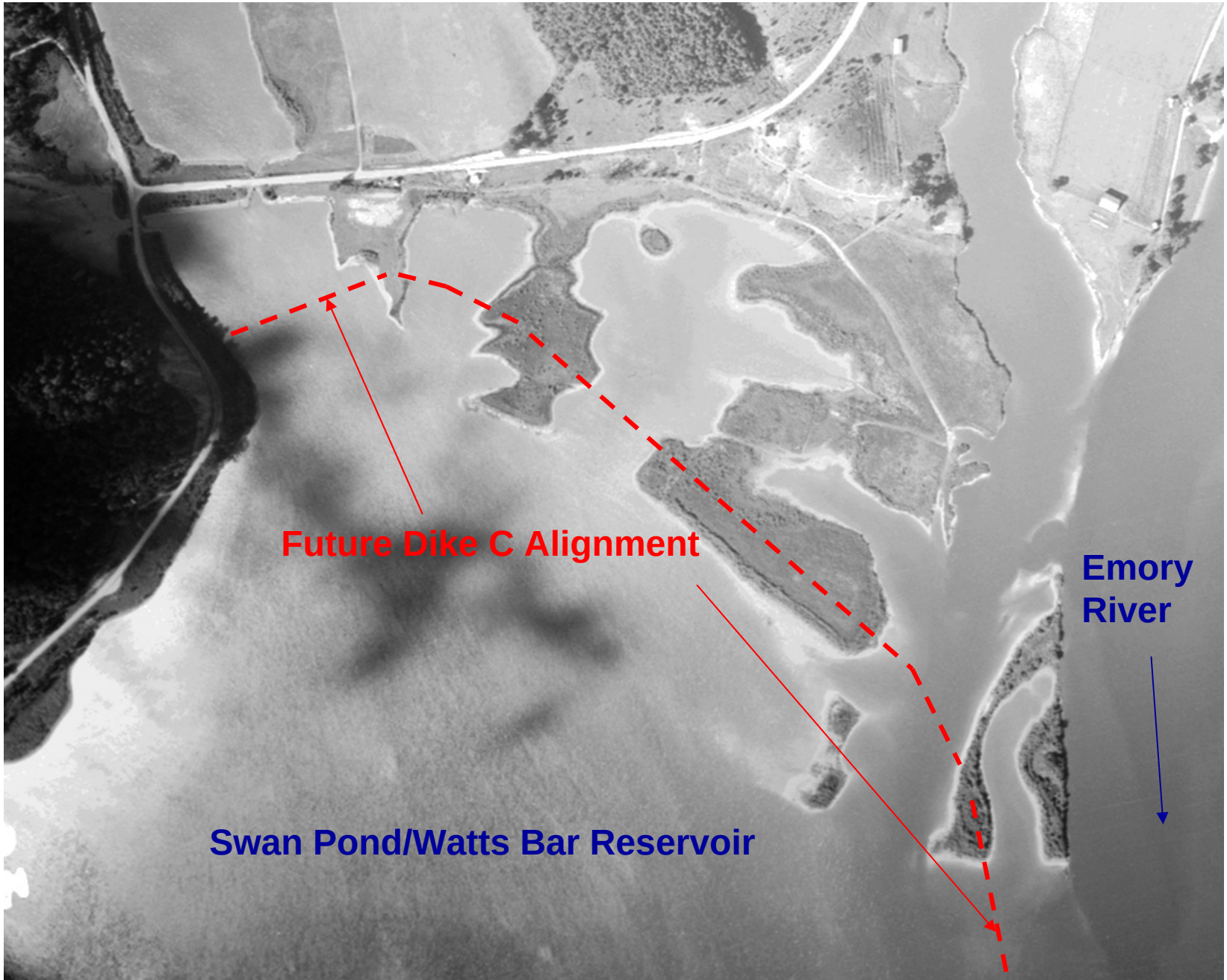


December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

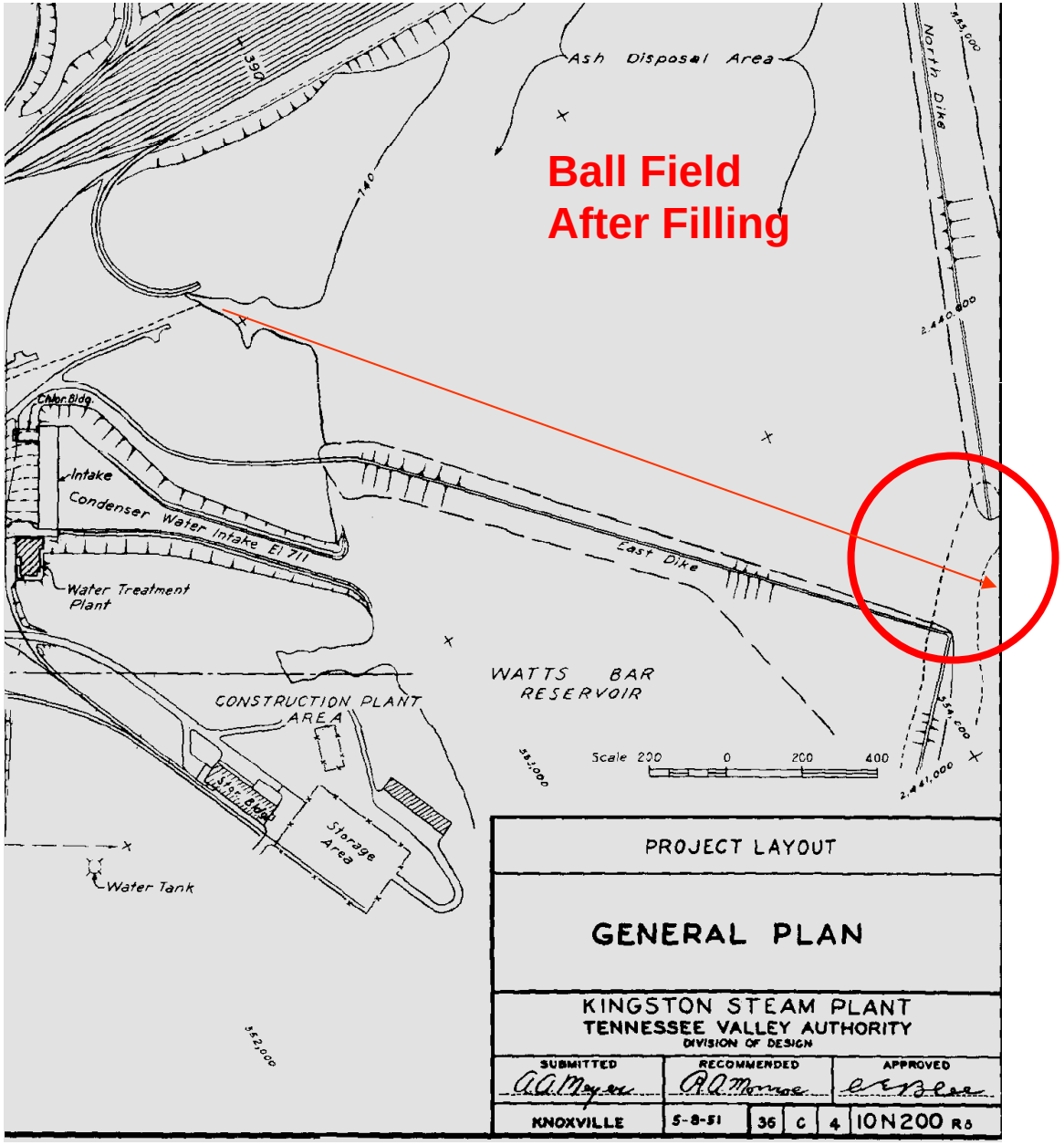
December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

December 23, 2008 Post Failure Photo Overlaid on TVA Surveys

09-23-1949

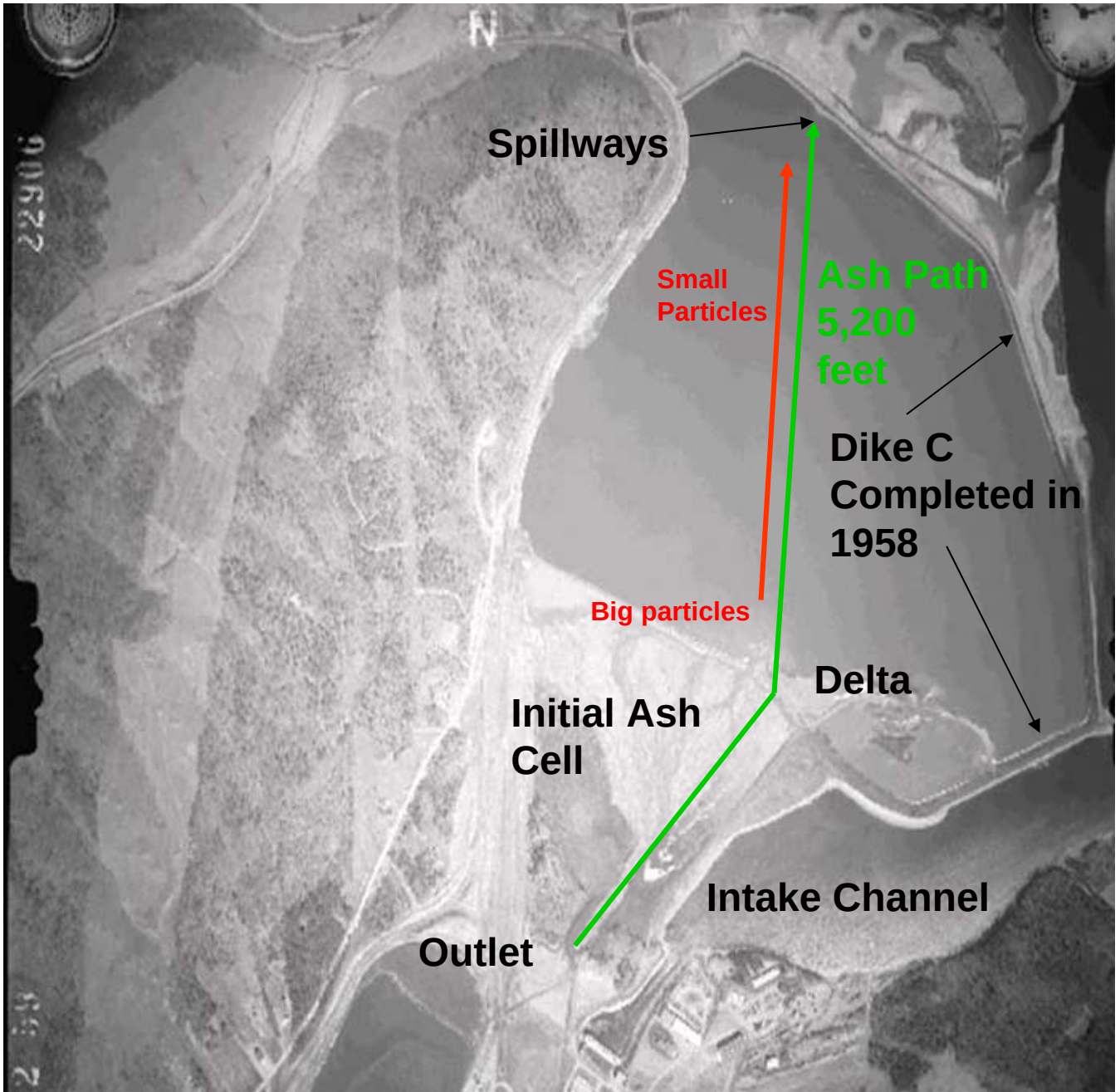

Future Dike C Alignment
Emory River
Swan Pond/Watts Bar Reservoir

Plant Discharged Ash to Reservoir



Prior to Dike C
No Closure
Open to Reservoir
1954 to 1958

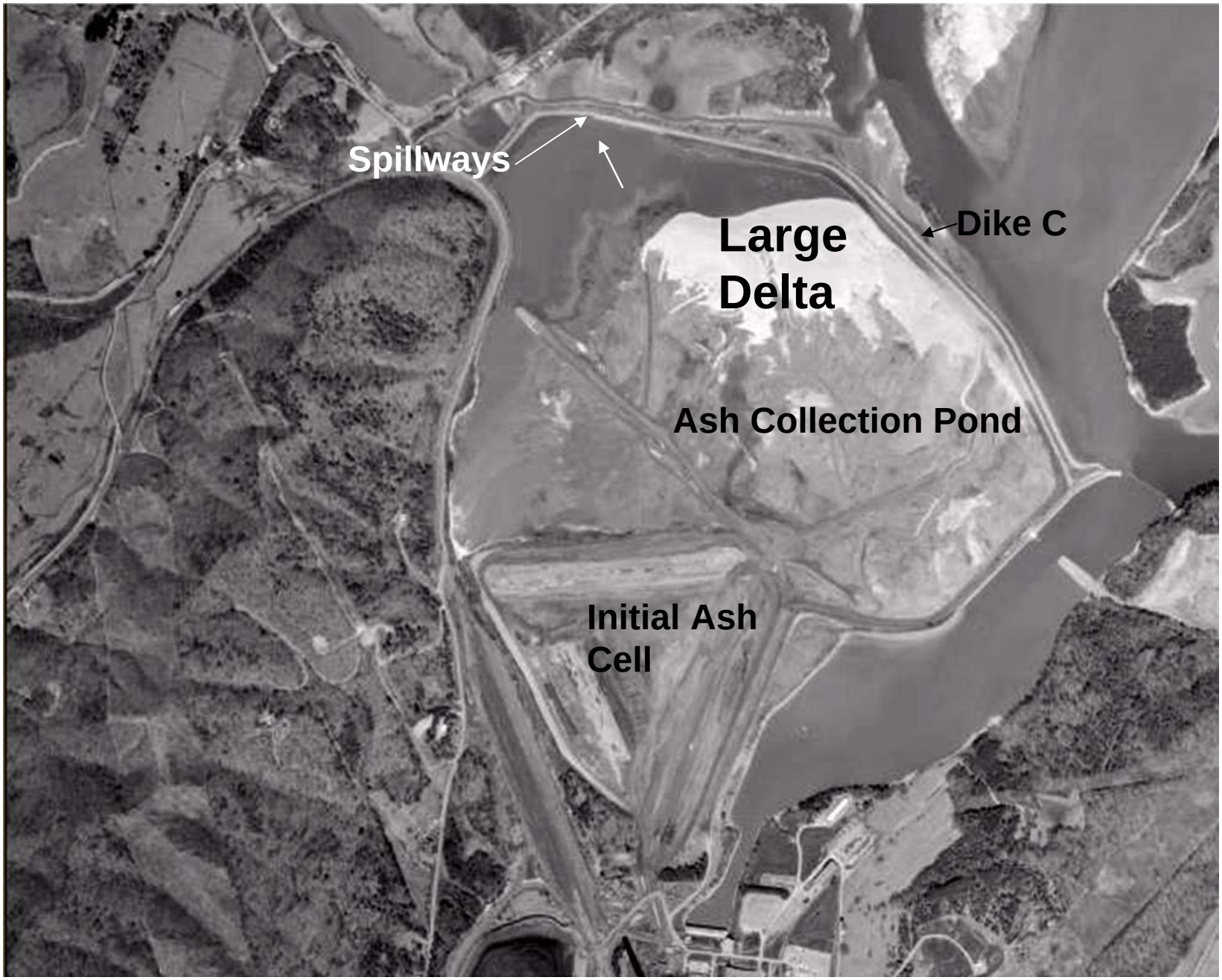
3-22-1959


N
Spillways
Small Particles
Ash Path 5,200 feet
Dike C Completed in 1958
Big particles
Delta
Initial Ash Cell
Intake Channel
Outlet

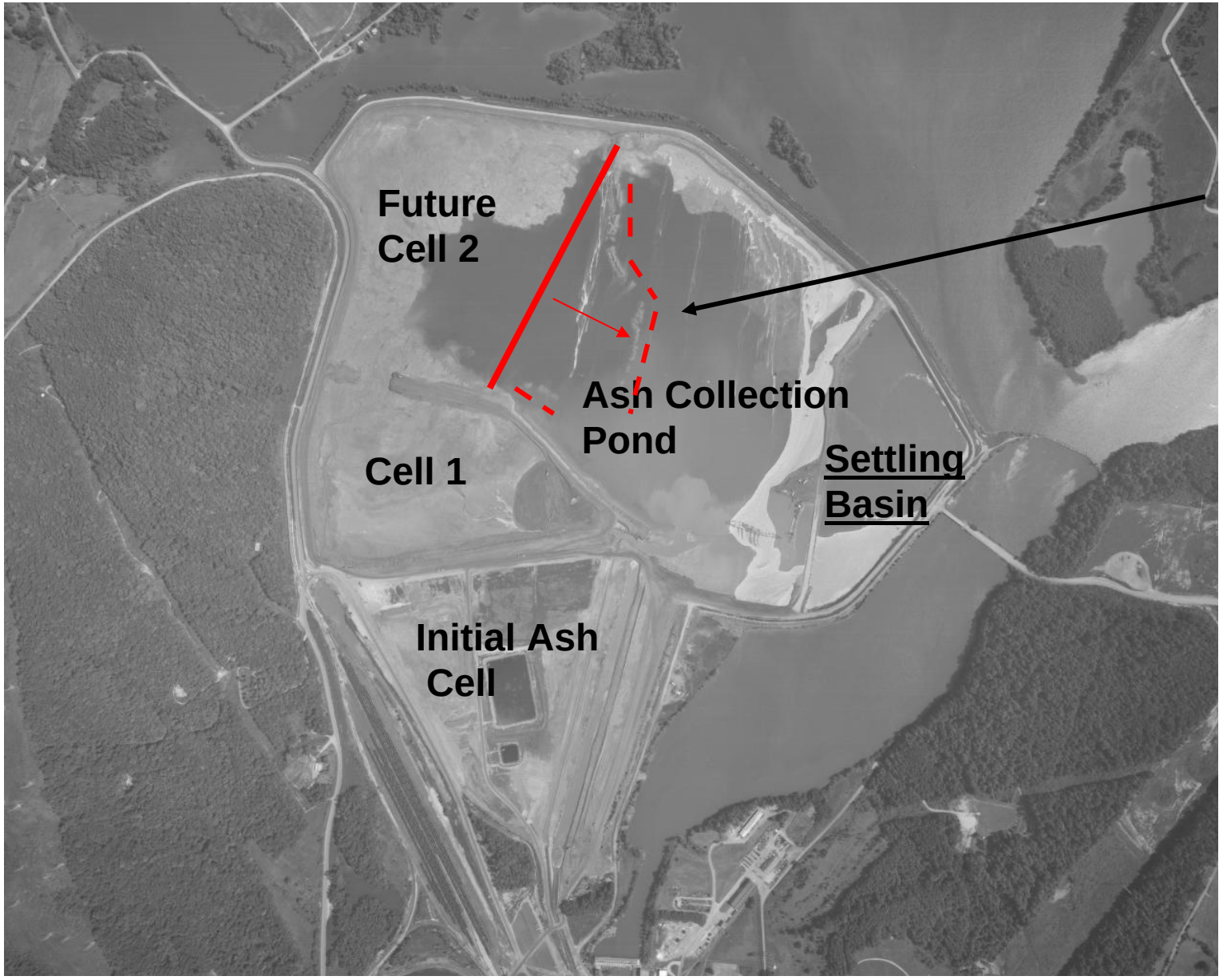
04-21-1962

Reservoir
Spillways
Ash Collection
Pond
Delta
Initial Ash Pond
Intake Channel

1976

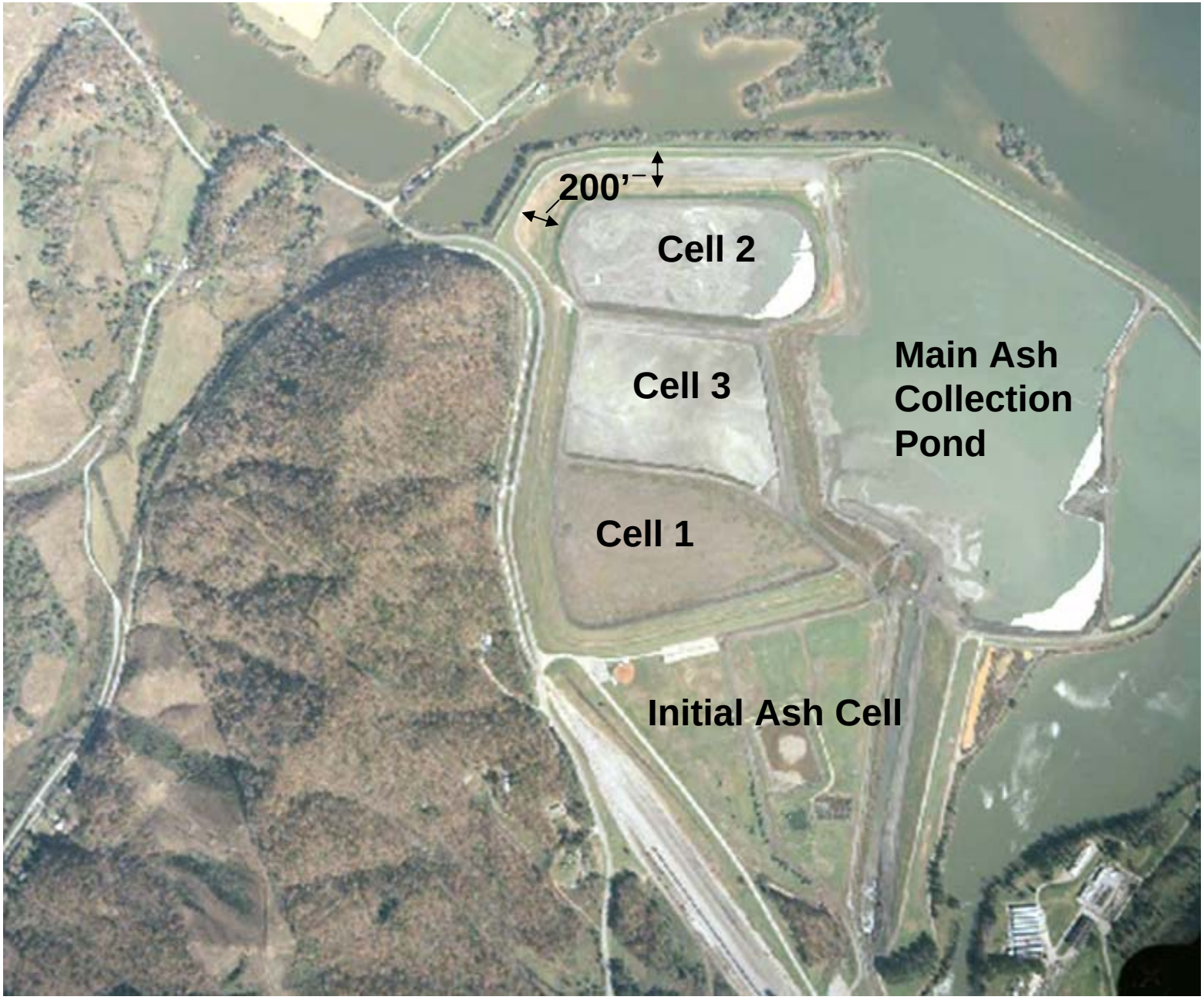

Spillways
Large Delta
Dike C
Ash Collection Pond
Initial Ash Cell

8-24-84



August 8, 1984 Divider Dike D Failure

11-3-1996


200'
Cell 2
Cell 3
Main Ash
Collection
Pond
Cell 1
Initial Ash Cell

4-5-2005

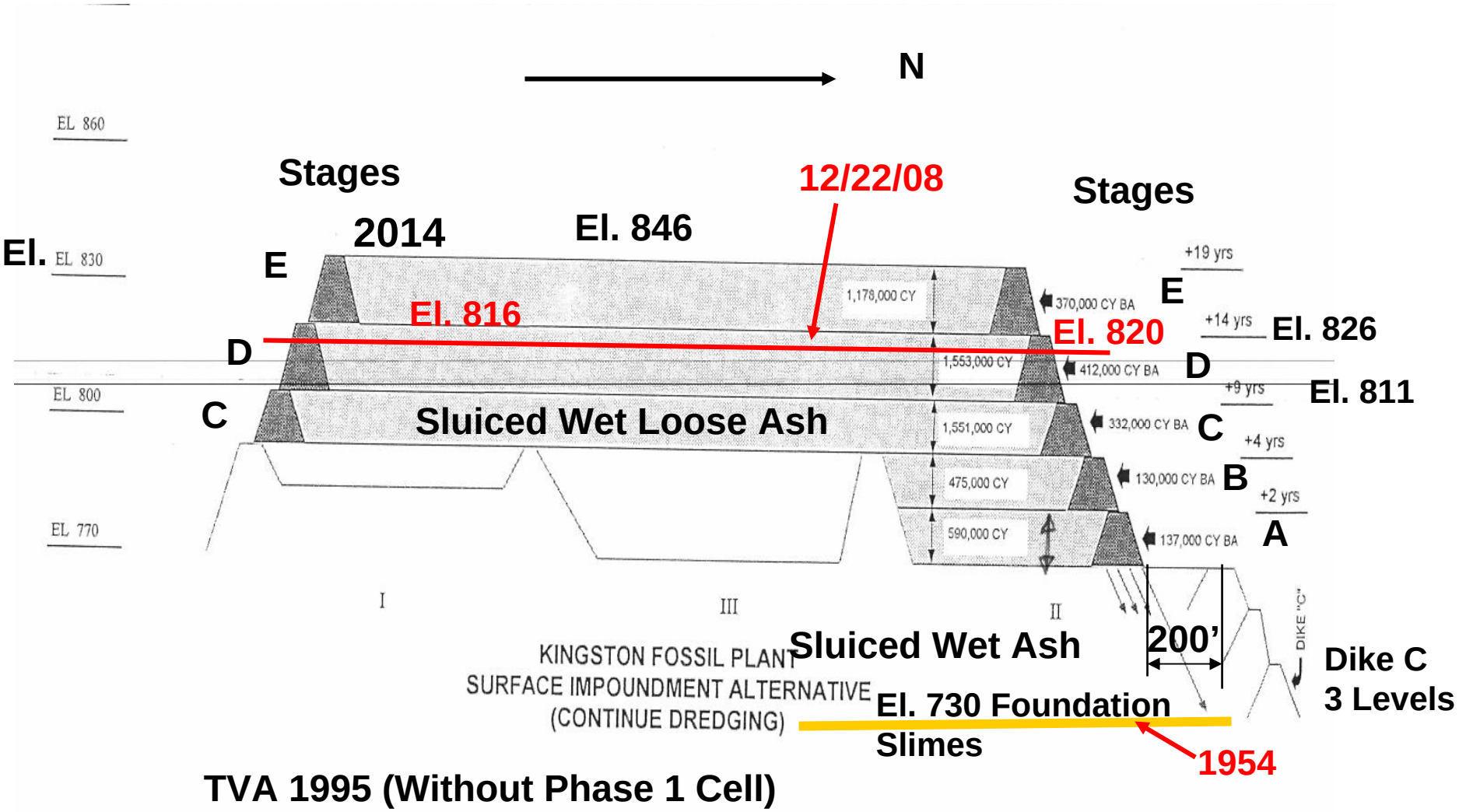
200’
Setback
2003
Slide
Cell 2
Cell 1
Phase 1 Emergency Cell
Ash Collection
Pond
Initial Ash Cell

Potential Failure Modes at Kingston Include:

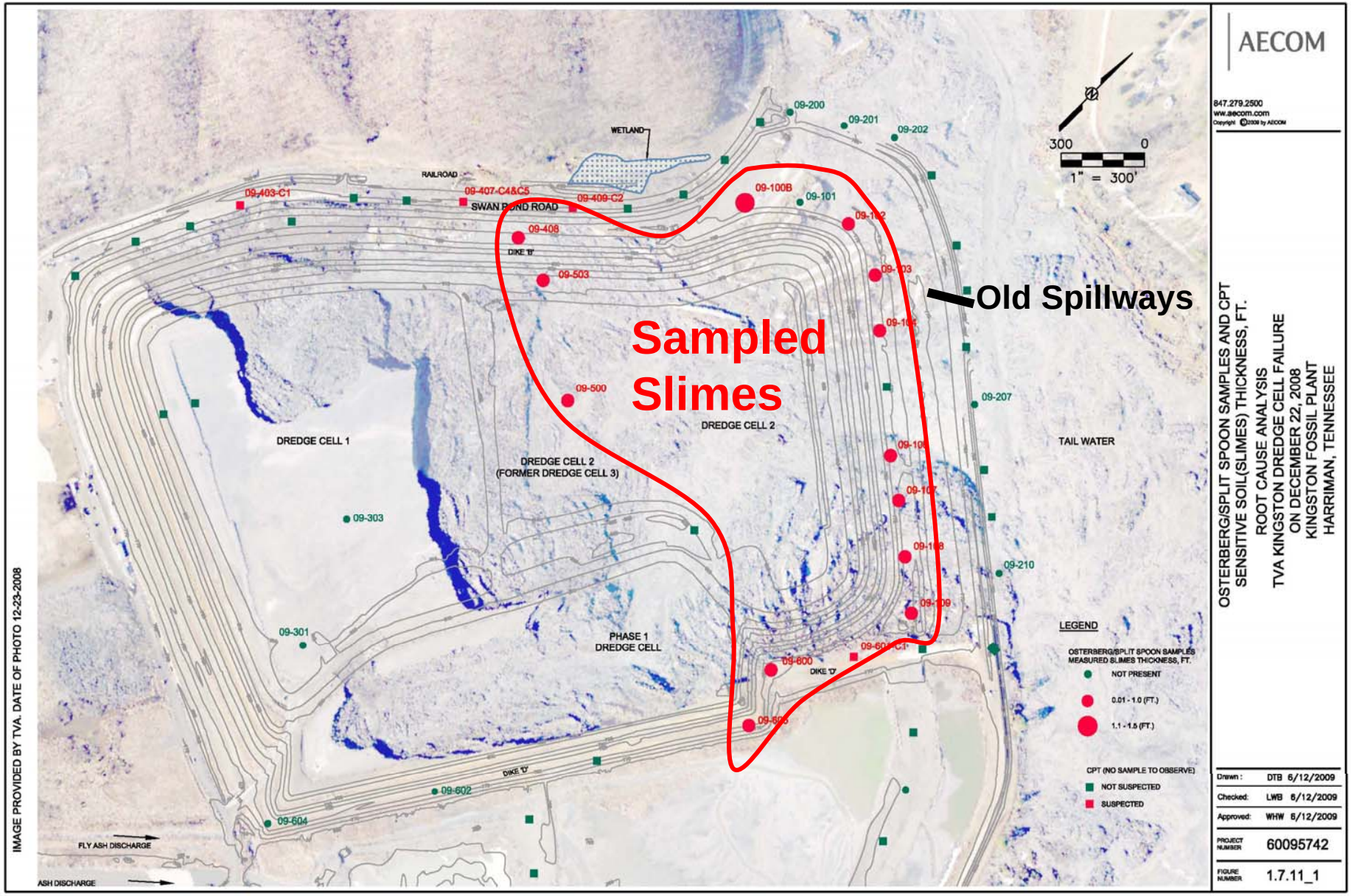
1. Earthquake Instability
2. Excess Rainfall
3. Rapid Reservoir Drawdown
4. Karstic Limestone Sinkhole or Bedrock Instability
5. Artesian Groundwater Instability
6. Shallow Dike Instability Due to Seepage Outbreak or Piping
7. Intermediate Depth Instability of Dredge Cell or Dikes
8. Deep Seated Instability of Dredge Cell through Ash Only
9. Increased Filling Rates into Dredge Cells
10. Deep Seated Foundation Instability Under Dredge Cells
11. Consequential Undrained Failure of Ash Causing Flow Slide (Static Liquefaction)
12. Progressive Failure after Initial Cell Breach or Slope Instability

Key Failure Modes

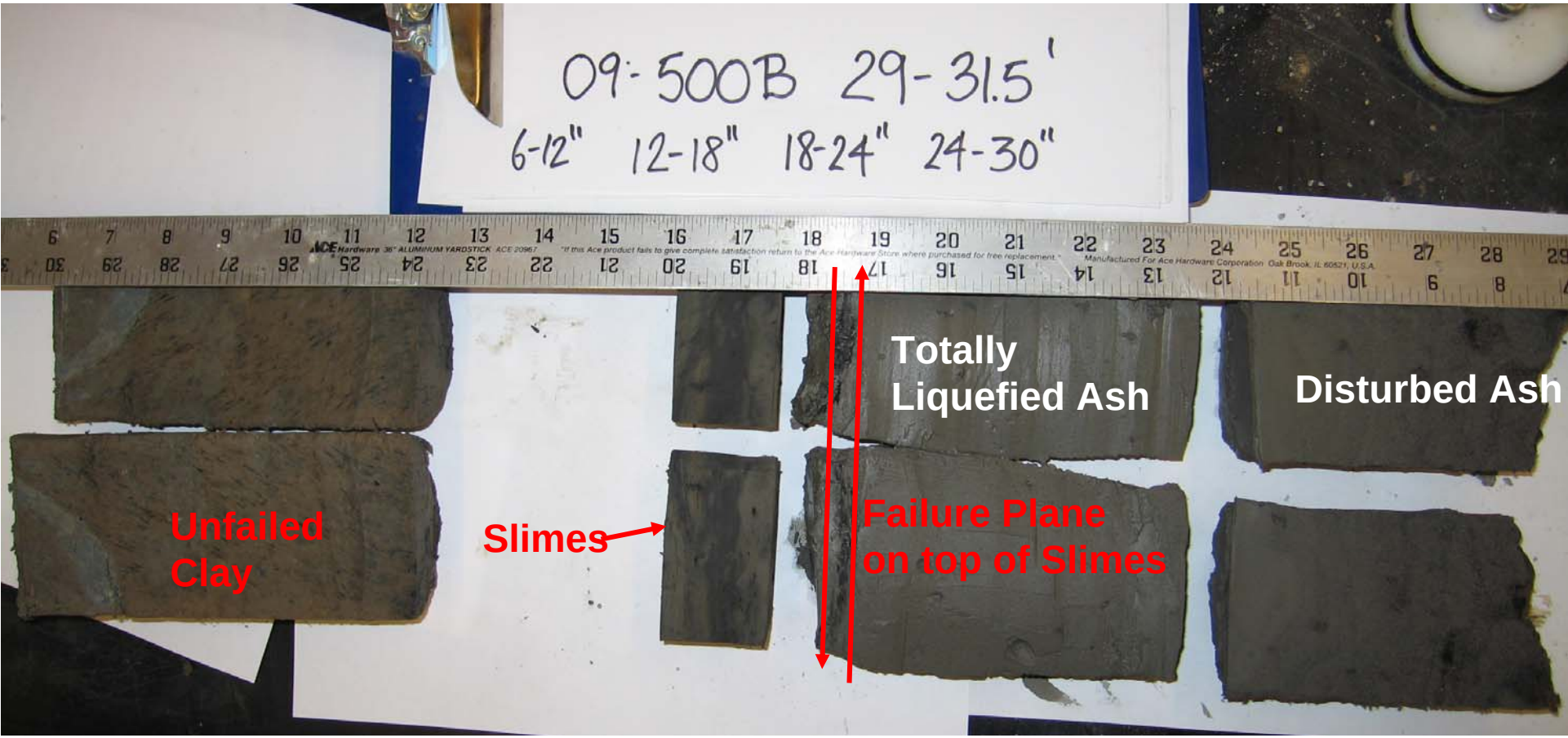
Active Cell 2 Filling, Dike Containment, and Foundation Supporting Loose Wet Ash



Location of Silt and Flyash Slimes Under Cell 2

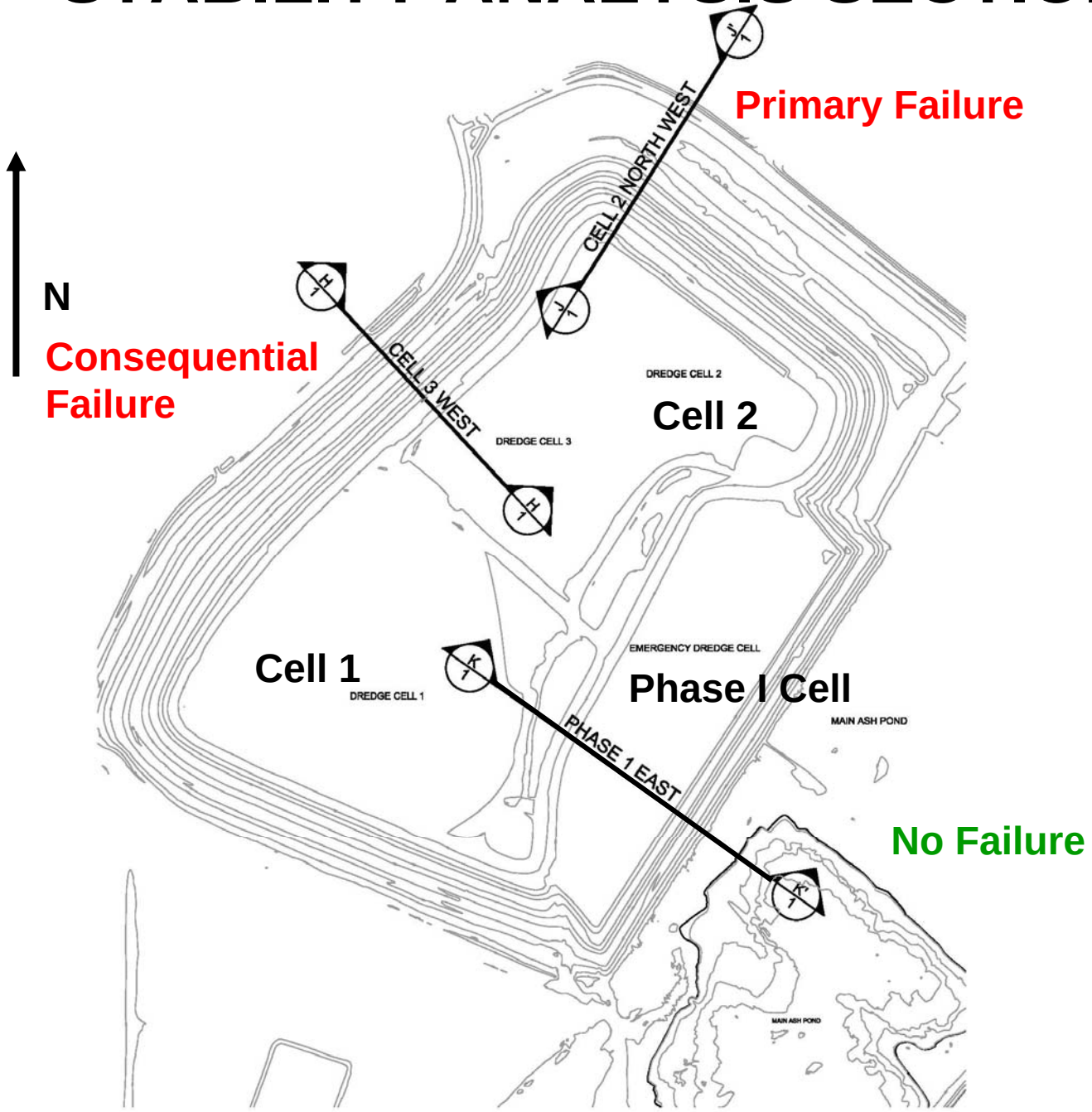


Clay/Laminated Slimes/Failed Ash at 09-500B, OST5

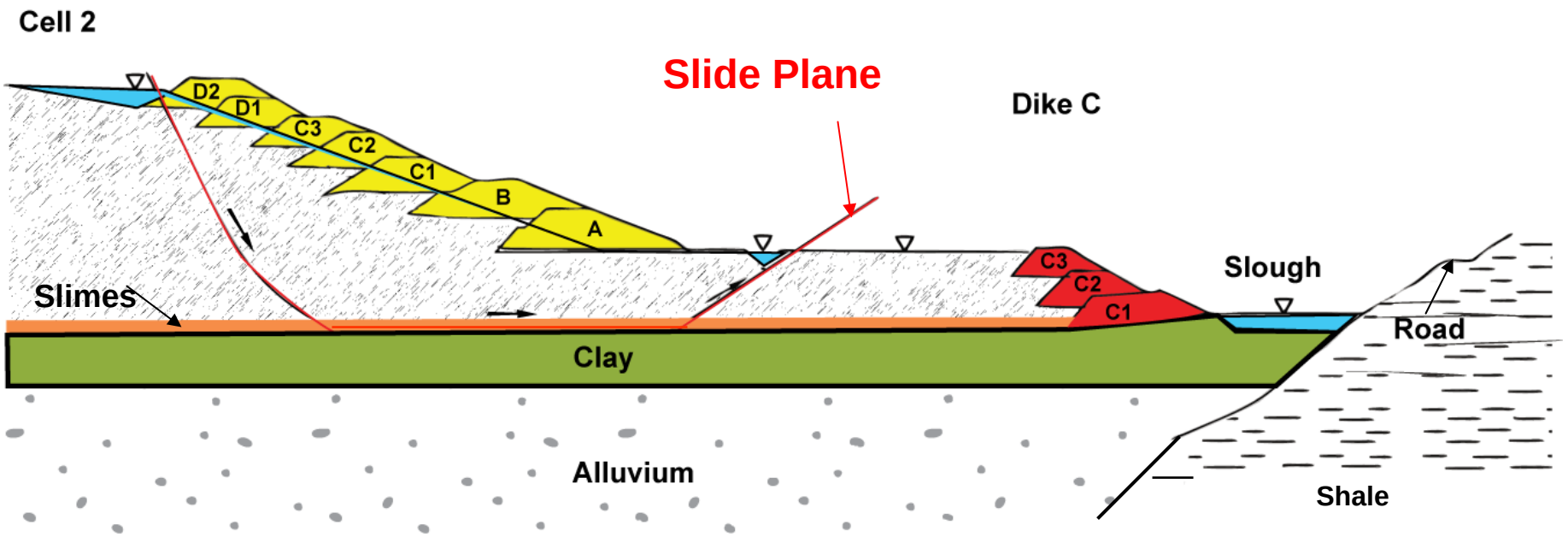


09-500B S5 29.0 to 31.5 ft

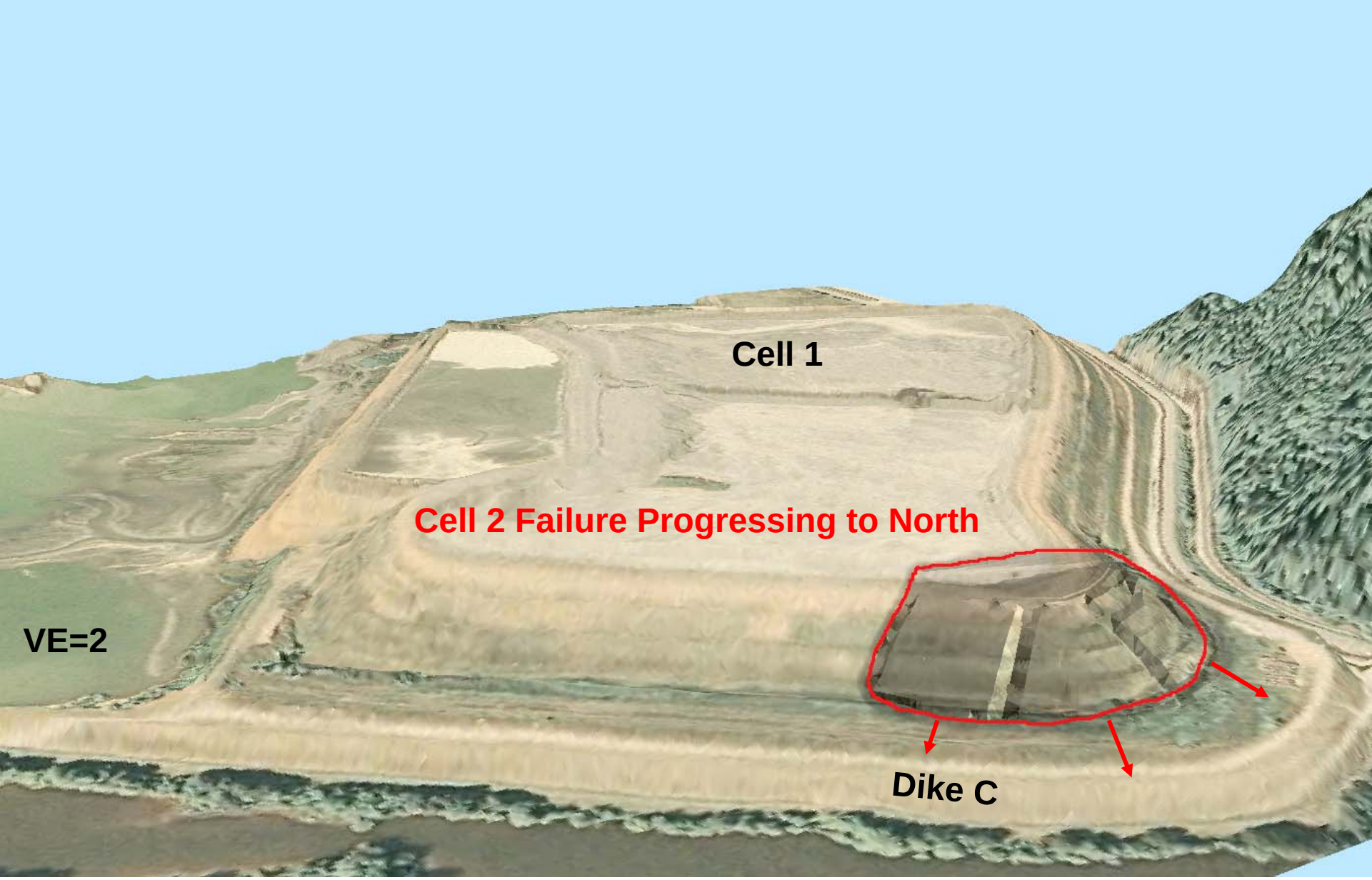
STABILITY ANALYSIS SECTIONS



Stage 1 - Initiation of Failure at North Side of Dredge Cell 2

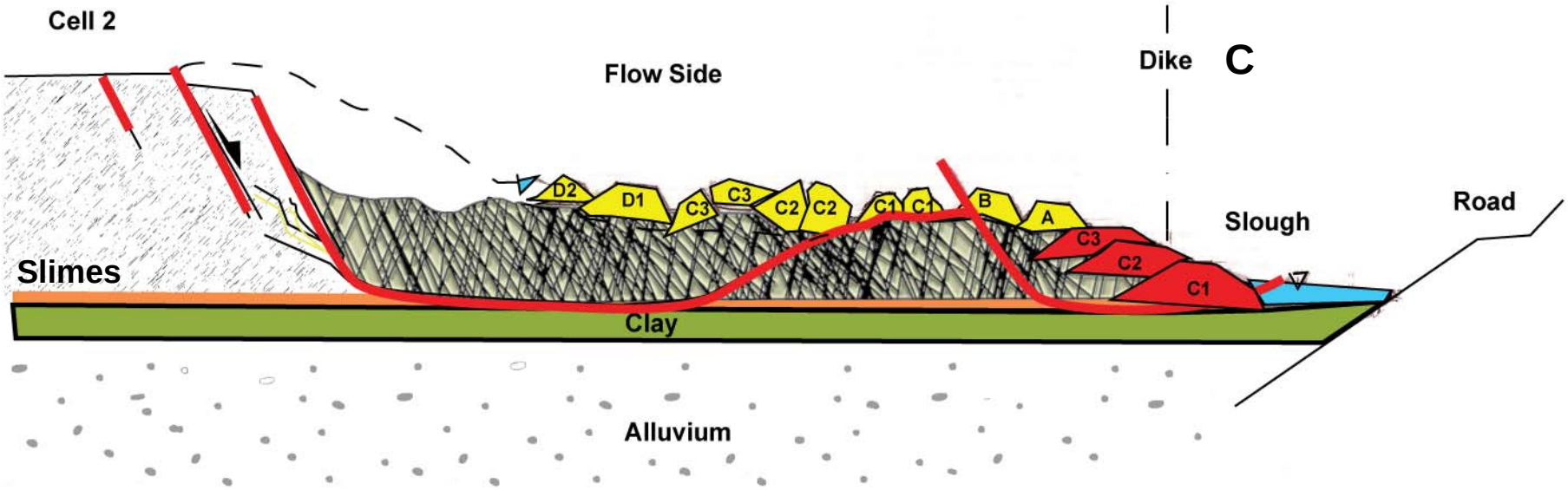


Looking West

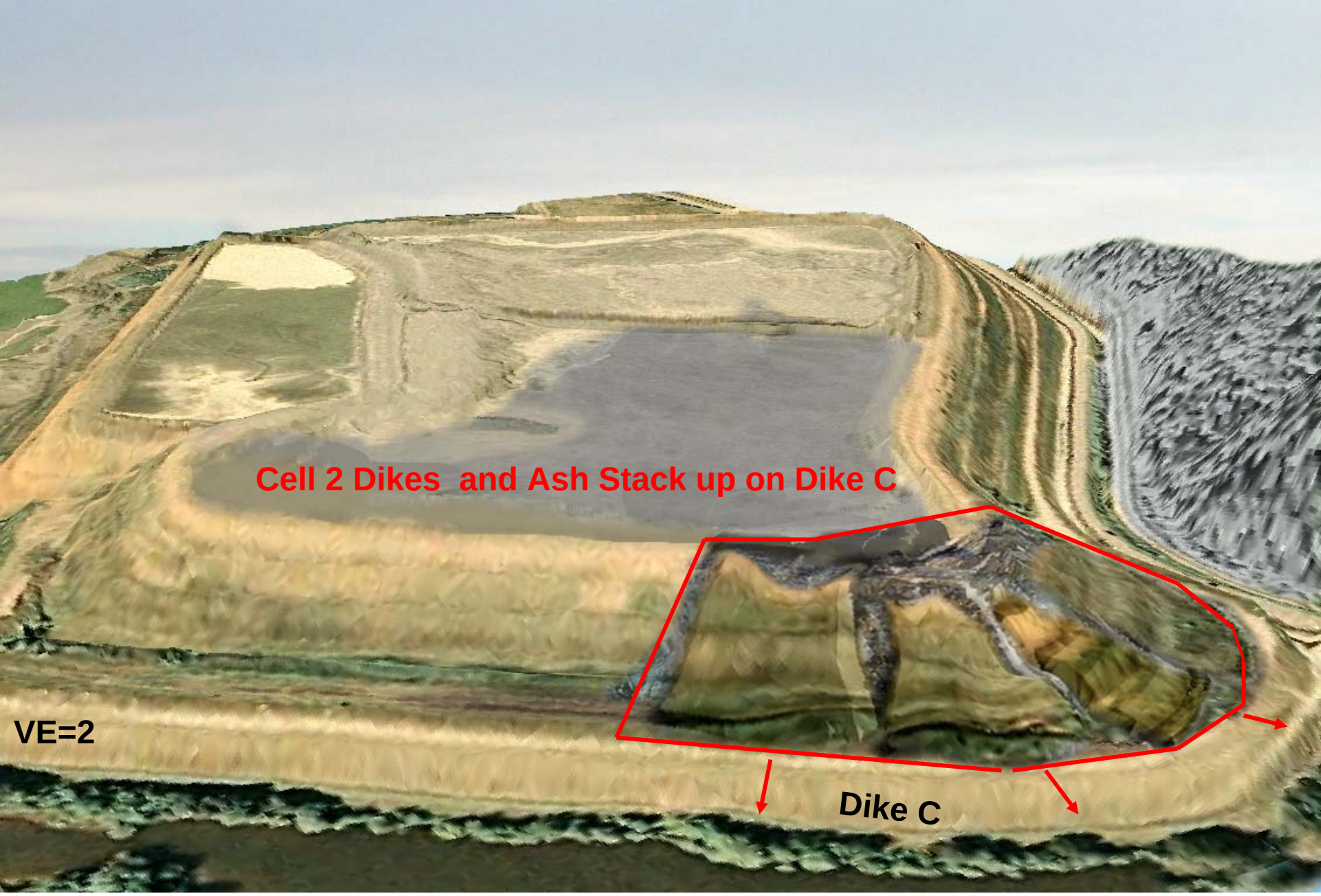


December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

Stage 2 – Ash & Dikes A thru D2 Pile Up Against Dike C. This Surcharge and increased Ash Pressure Causes Dike C to Fail

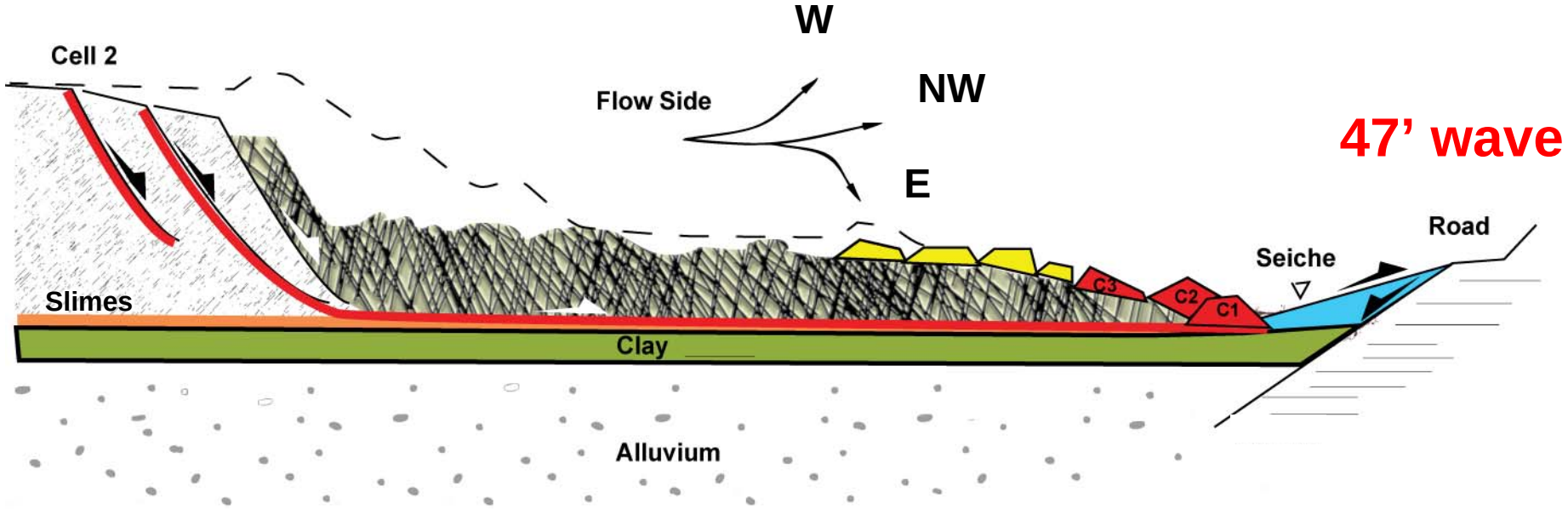


Looking West



December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

Stage 3 – Progressive Failure Southward that Fails North and West Dikes A thru D2 Back to Cell 1 Di Dike. 5.4 Million CY Fill Sloughs and Reservoir



Looking West

December 22, 2008 Expected Failure Mode at NW Corner of Cell 2

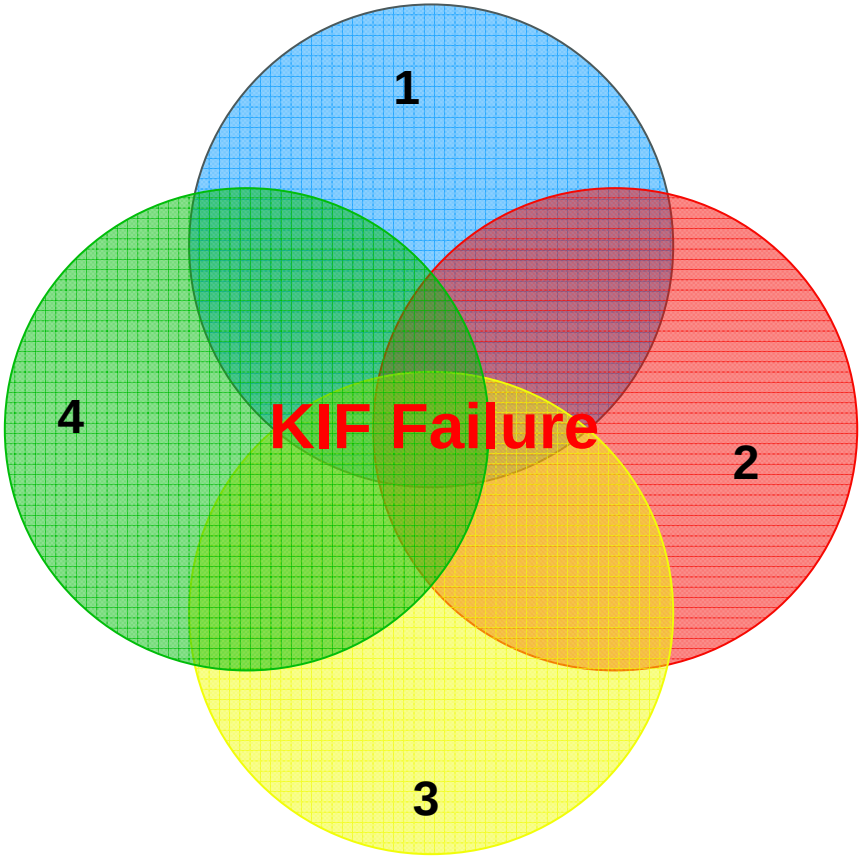
December 23, 2008 Post Failure Photo Overlaid on TVA Surveys

Kingston Dredge Cell Failure Conditions

AECOM Report

Increased Loads Due to Higher Fill

Hydraulically Placed Loose Wet Ash



Fill Geometry & Setbacks

<u>Unusually</u> Weak Slimes Foundation