2005 Tri-Service Infrastructure Systems Conference & Exhibition

St. Louis, MO
"Re-Energizing Engineering Excellence"

2-4 August 2005

Agenda

Panel*:* The Future of Engineering and Construction

- LTG Carl A. Strock, Commander, USACE
- Dr. James Wright, Chief Engineer, NAVFAC

Panel*:* USACE Engineering and Construction

- Dr. Michael J. O'Connor, Director, R&D

Panel*:* Navy General Session

- Mr. Steve Geusic, Engineering Criteria & Programs NAVFAC Atlantic

Introduction to Multi-Disciplinary Tracks, by Mr. Gregory W. Hughes
Engineering Circular: Engineering Reliability Guidance for Existing USACE Civil Works Infrastructure, by Mr. David M. Schaaf, PE, LRD Regional Technical Specialist, Navigation Engineering Louisville District
MILCON S&A Account Study, by Mr. J. Joseph Tyler, PE, Chief, Programs Integration Division, Directorate of Military Programs HQUSACE
Financial Justification on Bentley Enterprise License Agreement (ELA)

Track 1

- The Chicago Shoreline Storm Damage Reduction Project, by Andrew Benziger
- Protecting the NJ Coast Using Large Stone Seawalls, by Cameron Chasten
- Cascade: An Integrated Coastal Regional Model for Decision Support and Engineering Design, by Nicholas C. Kraus and Kenneth J. Connell
- Modeling Sediment Transport Along the Upper Texas Coast, by David B. King Jr., Jeffery P. Waters and William R. Curtis
- Sediment Compatibility for Beach Nourishment in North Carolina, by Gregory L. Williams
- Evaluating Beachfill Project Performance in the USACE Philadelphia District, by Monica Chasten and Harry Friebel
- US Army Corps of Engineers' National Coastal Mapping Program, by Jennifer Wozencraft
- Flood Damage Reduction Project Using Structural and Non-Structural Measures, by Stacey Underwood
- Shore Protection Project Performance Improvement Initiative (S3P2I), by Susan Durden
- Hurricane Isabel Post-Storm Assessment, by Jane Jablonski
- US Army Corps of Engineers Response to the Hurricanes of 2004, by Rick McMillen and Daniel R. Haubner
- Increased Bed Erosion Due to Increased Bed Erosion Due to Ice, by Decker B. Hains, John I. Remus, and Leonard J. Zabilansky
- Mississippi Valley Division, by James D. Gutshall
- Impacts to Ice Regime Resulting from Removal of Milltown Dam, Clark Fork River, Montana, by Andrew M. Tuthill and Kathleen D. White, and Lynn A. Daniels
- Carroll Island Micromodel Study: River Miles 273.0-263.0, by Jasen Brown
- Monitoring the Effects of Sedimentation from Mount St. Helens, by Alan Donner, Patrick O'Brien and David Biedenharn
  Watershed Approach to Stream Stability and Benefits Related to the Reduction of Nutrients, by John B. Smith
- A Lake Tap for Water Temperature Control Tower Construction at Cougar Dam, Oregon, by Stephen Schlenker, Nathan Higa and Brad Bird
- San Francisco Bay Mercury TMDL – Implications for Constructed Wetlands, by Herbert Fredrickson, Elly Best and Dave Soballe
- Abandoned Mine Lands: Eastern and Western Perspectives, by Kate White and Kim Mulhern
  Translating the Hydrologic Tower of Babel, byDan Crawford
- Demonstrating Innovative River Restoration Technologies: Truckee River, Nevada, by Chris Dunn
- System-Wide Water Resource Management – Tools of the Trade

Track 2

- Ecological and Engineering Considerations for Dam Decommissioning, Retrofits, and Reoperations, by Jock Conyngham
- Hydraulic Design of tidegates and other Water Control structures for Ecosystem Restoration projects on the Columbia River estuary, by Patrick S. O'Brien
- Surface Bypass & Removable Spillway Weirs, by Lynn Reese
- Impacts of using a spillway for juvenile fish passage on typical design criteria, by Bob Buchholz
- Howard Hanson Dam: Hydraulic Design of Juvenile Fish Passage Facility in Reservoir with Wide Pool Fluctuation, by Dennis Mekkers and Daniel M. Katz
- Current Research in Fate Current Research in Fate & Transport of Chemical and Biological Contaminants in Water Distribution Systems, by Vincent F. Hock
- Regional Modeling Requirements, by Maged Hussein
- Tools for Wetlands Permit Evaluation: Modeling Groundwater and Surface Water Interaction, by Cary Talbot
- Ecosystem Restoration for Fish and Wildlife Habitat on the UMRS, by Jon Hendrickson
- Missouri River Shallow Water Habitat Creation, by Dan Pridal
- Aquatic Habitat Restoration in the Lower Missouri River, by Chance Bitner
- Transition to an Oracle Based Data System (Corps Water Management System, CWMS), by Joel Asunskis
- RiverGages.com: The Mississippi Valley Division Water Control Website, by Rich Engstrom
- HEC-ResSim 3.0: Enhancements and New Capabilities, by Fauwaz Hanbali
- Hurricane Season 2004 – Not to Be Forgotten, by Jacob Davis
- Re-Evaluation of a Flood Control Project, by Ferris W. Chamberlin
- Helmand Valley Water Management Plan, by Jason Needham
- A New Approach to Water Management Decision Making, by James D. Barton
- Developing Reservoir Operational Plans to Manage Erosion and Sedimentation during Construction – Willamette Temperature
- Control, Cougar Reservoir 2002-2005, by Patrick S. O'Brien
- Improved Water Supply Forecasts for the Kootenay Basin, by Randal T. Wortman
- ResSIM Model Development for Columbia River System, by Arun Mylvahanan
- Prescriptive Reservoir Modeling and the ROPE, by Jason Needham
- Missouri River Basin Water Management, by Larry Murphy

Track 3

- Corps Involvement in FEMA's Map Modernization Program, by Kate White, John Hunter and Mark Flick
- Innovative Approximate Study Method for FEMA Map Moderniation Program , by John Hunter
- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by Fred Pinkard
- Integrating Climate Dynamics Into Water Resources Planning and Management, by Kate White
- Hydrologic and Hydraulic Contributions to Risk and Uncertainty Propagation Studies, by Robert Moyer
- Uncertainty Analysis: Parameter Estimation, by Jackie P. Hallberg
- Geomorphology Study of the Middle Mississippi River, by Eddie Brauer
- Bank Erosion and Morphology of the Kaskaskia River, by Michael T. Rodgers
- Degradation of the Kansas City Reach of the Missouri River, by Alan Tool
- Sediment Impact Assessment Model (SIAM), by David S. Biedenharn and Meg Jonas
- Mississippi River Sedimentation Study, by Basil Arthur
- Sediment Model of Rivers, by Charlie Berger
- East Grand Forks, MN and Grand Forks, ND Local Flood Damage Reduction Project, by Michael Lesher
- Hydrologic and Hydraulic Analyses, by Thomas R. Brown
- Hydrologic and Hydraulic Modeling of the Mccook and Thornton Tunnel and Reservoir Plans, by David Kiel
- Ala Wai Canal Project, by Lynnette F. Schaper
- Missouri River Geospatial Decision Support Framework, by Bryan Baker and Martha Bullock
- Systemic Analysis of the Mississippi & Illinois Rivers Upper Mississippi River Comprehensive Plan, by Dennis L. Stephens

Section 227: National Shoreline Erosion Control Demonstration and Development Program Annual Workshop

- Workshop Objectives
- Section 227: Oil Piers, Ventura County, CA, by Heather Schlosser
- An Evaluation of Performance Measures for Prefabricated Submerged Concrete Breakwaters: Section 227 Cape May Point, New Jersey Demonstration Project, by Donald K Stauble, J.B. Smith and Randall A. Wise
- Bluff Stabilization along Lake Michigan, using Active and Passive Dewatering Techniques, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew, Amanda Brotz and Jim Selegean
- Storm Damage at Cape Lookout
- Branchbox Breakwater Design at Pickleweed Trail, Martinez, CA
- Section 227: Miami, FL
- Section 227: Sheldon Marsh Nature Preserve
- Section 227: Seabrook, New Hampshire
- Jefferson County, TX – Low Volume Beach Fill
- Sacred Falls, Oahsacred Falls, Oahu Section 227 Demonstration Project

Track 4

- Fern Ridge LakFern Ridge Lake Hydrologic Aspects of Operation during Failure, by Bruce J Duffe
- A Dam Safety Study Involving Cascading Dam Failures, by Gordon Lance
- Spillway Adequacy Analysis of Rough River Lake Louisville District, by Richard Pruitt
- Water Management in Iraq: Capability and Marsh Restoration, by Fauwaz Hanbali
- Iraq Ministry of Water Resources Capacity Building, by Michael J. Bishop, John W. Hunter, Jeffrey D. Jorgeson, Matthew M. McPherson, Edwin A. Theriot, Jerry W. Webb, Kathleen D. White, and Steven C. Wilhelms

- HEC Support of the CMEP Program, by Mark Jensen
- Geospatial Integration of Hydrology & Hydraulics Tools for Multi-Purpose, Multi-Agency Decision Support, by Timothy Pangburn, Joel Schlagel, Martha Bullock, Michael Smith, and Bryan Baker
- GIS & Surveying to Support FEMA Map Modernization and Example Bridge Report, by Mark Flick
- High Resolution Bathymetry and Fly-Through Visualization, by Paul Clouse
- Using GIS and HEC-RAS for Flood Emergency Plans, by Stephen Stello
- High Resolution Visualizations of Multibeam Data of the Lower Mississippi River, by Tom Tobin and Heath Jones
- System Wide Water Resources Program Unifying Technologies Geospatial Applications, by Andrew J. Bruzewicz
- Raystown Plate Locations
- Hydrologic Engineering Center: HEC–HMS Version 3.0 New Features, by Jeff Harris
- SEEP2D & GMS: Simple Tools for Solving a Variety of Seepage Problems, by Clarissa Hansen, Fred Tracy, Eileen Glynn, Cary Talbot and Earl Edris
- Sediment and Water Quality in HEC-RAS, by Mark Jensen
- Advances to the GSSHA Model, by Aaron Byrd and Cary Talbot
- Watershed Analysis Tool: HEC-WAT Program, by Chris Dunn
- Little Calumet River UnsteadLittle Calumet River Unsteady Flow Model Conversion UNET to HEC-RAS, by Rick D. Ackerson
  Kansas River Basin Model, by Edward Parker
- Design Guidance for Breakup Ice Control Structures, by Andrew M. Tuthill
- Computational Hydraulic Model of the Lower Monumental Dam Forebay, by Richard Stockstill, Charlie Berger, John Hite, Alex Carrillo, and Jane Vaughan
- Use of Regularization as a Method for Watershed Model Calibration, by Brian Skahill
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 5

- Walla Walla District Northwestern Division, by Robert Berger
- Best Practices for Conduits through Embankment Dams, by Chuck R. Cooper
- Design, Construction Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- 2-D Liquefaction Evaluation with Q4Mesh, by David C. Serafini
- Unlined Spillway Erosion Risk Assessment, by Johannes Wibowo, Don Yule, Evelyn Villanueva and Darrel Temple
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Evaluation, Conceptual Design and Design, by Lee Wooten and Ben Foreman
- Seismic Remediation of the Clemson Upper and Lower Diversion Dams; Deep Soil Mix Construction, by Lee Wooten and Ben Foreman
- Historical Changes in the State of the Art of Seismic Engineering and Effects of those changes on the Seismic Response Studies of Large Embankment Dams, by Sam Stacy
- Iwakuni Runway Relocation Project, by Vincent R. Donnally
- Internal Erosion & Piping at Fern Ridge Dam, by Jeremy Britton
- Rough River Dam Safety Assurance Project, by Timothy M. O'Leary
- Seepage Collection & Control Systems: The Devil is in the Details , by John W. France
- Dewey Dam Seismic Assessment, by Greg Yankey
- Seismic Stability Evaluation for Ute Dam, New Mexico, by John W. France
- An Overview of Criteria Used by Various Organizations for Assessment and Seismic Remediation of Earth Dams, by Jeffrey S. Dingrando
- A Review of Corps of Engineers Levee Seepage Practices and Proposed Future Changes, by George Sills
- Ground-Penetrating Radar Applications for the Assessment of Pavements, by Lulu Edwards and Don R. Alexander
- Peru Road Upgrade Project, by Michael P. Wielputz
- Slope Stability Evaluation of the Baldhill Dam Right Abutment, by Neil T. Schwanz
- Design and Construction of Anchored Bulkheads with Synthetic Sheet Piles Seabrook, New Hampshire, by Siamac Vaghar and Francis Fung
- Characterization of Soft Claya Case Study at Craney Island, by Aaron L. Zdinak
- Dispersive ClayDispersive Clays – Experience andHistory of the NRCS (Formerly SCS), by Danny McCook
- Post-Tensioning Institute, by Michael McCray
- Demonstration Program Urban Flooding and Channel Restoration in Arid and Semi-Arid Regions (UFDP), by Joan Pope, Jack Davis, Ed Sing, John Warwick, Meg Jonas

Track 6

- State of the Art in Grouting: Dams on Solution Susceptible or Fractured Rock Foundations, by Arthur H. Walz
- Specialty Drilling, Testing, and Grouting Techniques for Remediation of Embankment Dams, by Douglas M. Heenan
- Composite Cut-Offs for Dams, by Dr. Donald A. Bruce and Trent L. Dreese
- State of the Art in Grout Mixes, by James A. Davies
- State of the Art in Computer Monitoring and Analysis of Grouting, by Trent L. Dreese and David B. Wilson
- Quantitatively Engineered Grout Curtains, by David B. Wilson and Trent L. Dreese
- Grout Curtains at Arkabutla Dam: Outlet Monolith Joints and Cracks using Chemical Grout, Arkabutla Lake, MS, by Dale A. Goss
- Chicago Underflow Plan – CUP: McCook Reservoir Test Grout Program, by Joseph A. Kissane
- Clearwater Dam: Sinkhole Repair Foundation Investigation and Grouting Project, by Mark Harris
- Update on the Investigation of the Effects of Boring Sample Size (3" vs 5") on Measured Cohesion in Soft Clays, by Richard Pinner and Chad M. Rachel
- Soil-Bentonite Cutoff Wall Through Free-Product at Indiana Harbor CDF, by Joe Schulenberg and John Breslin
- Soil-Bentonite Cutoff Wall Through Dense Alluvium with Boulders into Bedrock, McCook Reservoir, by William A. Rochford
- Small Project, Big Stability Problem the Block Church Road Experience, by Jonathan E. Kolber
- Determination of Foundation Rock Properties Beneath Folsom Dam, by Michael K. Sharp, José L. Llopis and Enrique E. Matheu
  Waterbury Dam Mitigation, by Bethany Bearmore
- Armor Stone Durability in the Great Lakes Environment, by Joseph A. Kissane
- Mill Creek - An Urban Flood Control Challenge, by Monica B. Greenwell
- Next Stop, The Twilight Zone, by Troy S. O'Neal
- Limitations in the Back Analysis of Shear Strength from Failures, by Rick Deschamps and Greg Yankey
- Reconstruction of Deteriorated Concrete Lock Walls After Blasting and Other Demolition Removal Techniques, by Stephen G. O'Connor

- Flood Fighting Structures Demonstration and Evaluation Program (FFSD), by George Sills
- Innovative Design Concepts Incorporated into a Landfill Closure and Reuse Design Portsmouth Naval Shipyard, Kittery, Maine, by Dave Ray and Kevin Pavlik
- Laboratory Testing of Flood Fighting Structures, by Johannes L. Wibowo, Donald L. Ward and Perry A. Taylor
- Bluff Stabilization Along Lake Michigan, Using Active and Passive Dewatering Techniques, Allegan Co. Michigan, by Rennie Kaunda, Eileen Glynn, Ron Chase, Alan Kehew and Jim Selegean

Track 7

- Case History: Multiple Axial Statnamic Tests on a Drilled Shaft Embedded in Shale, by Paul J. Axtell, J. Erik Loehr, Daniel L. Jones
- The Sliding Failure of Austin Dam Pennsylvania - Revisited, by Brian H. Greene
- M3 –Modeling, Monitoring and Managing: A Comprehensive Approach to Controlling Ground Movements for Protection of Existing Structures and Facilities, by Francis D. Leathers and Michael P. Walker
- Time-Dependent Reliability Modeling for Use in Major Rehabilitation of Embankment Dams and Foundation, by Robert C. Patev
- Lateral Pile Load Test Results Within a Soft Cohesive Foundation, by Richard J. Varuso
- Engineering Geology Challenge Engineering Geology Challenges During Design and Construction of the Marmet Lock Project, by Ron Adams and Mike Nield
- Mill Creek Deep Tunnel Geologic Conditions and Potential Impacts on Design/Construction, by Kenneth E. Henn III
- McAlpine Lock Replacement Instrumentation: Design, Construction, Monitoring, and Interpretation, by Troy S. O'Neal
- Geosynthetics and Construction of the Second Powerhouse Corner Collector Surface Flow Bypass Project, Bonneville Lock and Dam Project, Oregon and Washington, by Art Fong
- McAlpine Lock Replacement Project Foundation Characteristics and Excavation, by Kenneth E. Henn III
- Structural and Geotechnical Issues Impacting The Dalles Spillwall Construction and Bay 1 Erosion Repair, by Jeffrey M. Ament
  Rock Anchor Design and Construction: The Dalles Dam Spillwalls, by Kristie M. Hartfeil
- The Future of the Discrete Element Method in Infrastructure Analysis, by Raju Kala, Johannes L. Wibowo and John F. Peters
- Sensitive Infrastructure Sites - Sonic Drilling Offers Quality Control and Non-Destructive Advantages to Geotechnical Construction Drilling, by John P. Davis

Track 8

- Evaluation of The Use of LithiuEvaluation of The Use of Lithium Compounds in Controlling ASR in Concrete Pavement, by Mike Kelly
- Roller Compacted Concrete for McAlpine Lock Replacement, by David E. Kiefer
- Soil-Cement for Stream Bank Stabilization, by Wayne Adaska
- Using Cement to Reclaim Asphalt Pavements, by David R. Luhr
- Valley Park 100-Yr Flood Protection Project: Use of 'Engineered Fill' in the Item IV-B Levee Core, by Patrick J. Conroy
- Bluestone Dam: AAR –A Case Study, by Greg Yankey
- USDA Forest Service: Unpaved Road Stabilization with Chlorides, by Michael R. Mitchell
- Use of Ultra-Fine Amorphous Colloidal Silica to Produce a High-Density, High-Strength Grout, by Brian H. Green
- Modular Gabion Systems, by George Ragazzo
- Addressing Cold Regions Issues in Pavement Engineering, by Edel R. Cortez and Lynette Barna
- Geology of New York Harbor: Geological and Geophysical Methods of Characterizing the Stratigraphy for Dredging Contracts, by Ben Baker, Kristen Van Horn and Marty Goff
- Rubblization of Airfield Concrete Pavements, by Eileen M. Vélez-Vega
- US Army Airfield Pavement Assessment Program, by Haley Parsons, Lulu Edwards, Eileen Velez-Vega and Chad Gartrell
- Critical State for Probabilistic Analysis of Levee Underseepage, by Douglas Crum,
- Curing Practices for Modern Concrete Production, by Toy Poole
- AAR at Carters Dam: Different Approaches, by James Sanders
- Concrete Damage at Carters Dam, by Toy Poole
  Damaging Interactions Among Concrete Materials, by Toy Poole
- Economic Effects on Construction of Uncertainty in Test Methods, by Toy Poole
- Trends in Concrete Materials Specifications, by Toy Poole
- Spall and Intermediate-Sized Repairs for PCC Pavements, by Reed Freeman and Travis Mann
- Acceptance Criteria Acceptance Criteria for Unbonded Aggregate Road Surfacing Materials, by Reed Freeman, Toy Poole, Joe Tom and Dale Goss
- Effective Partnering to Overcome an Interruption In the Supply of Portland Cement During Construction at Marmet Lock and Dam, by Billy D. Neeley, Toy S. Poole and Anthony A. Bombich

Track 10

- Marmet Lock &Dam: Automated Instrumentation Assessment, Summer/Fall 2004, by Jeff Rakes and Ron Adams
  Success Dam Seismic Remediation

Track 9

- Fern Ridge Dam, Oregon: Seepage and Piping Concerns (Internal Erosion)

Track 11

- Canton Dam Spillway Stability: Is a Test Anchor Program Necessary?, by Randy Mead
- Dynamic Testing and Numerical Correlation Studies for Folsom Dam, by Ziyad Duron, Enrique E. Matheu, Vincent P. Chiarito, Michael K. Sharp and Rick L. Poeppelman

Status of Portfolio Risk Assessment, by Eric Halpin
- Mississinewa Dam Foundation Rehabilitation, by Jeff Schaefer
- Wolf Creek Dam Seepage Major Rehabilitation Evaluation, by Michael F. Zoccola
- Bluestone Dam DSA Anchor Challenges, by Michael McCray
- Clearwater Dam Major Rehab Project, by Bobby Van Cleave
- Design, Construction and Seepage at Prado Dam, by Douglas E. Chitwood
- Seven Oaks Dam: Outlet Tunnel Invert Damage, by Robert Kwan
- An Overview of An Overview of the Dam Safety ProgramManagement Tools (DSPMT), by Tommy Schmidt

Track 12

- Greenup L&D Miter Gate Repair and Instrumentation, by Joseph Padula, Bruce Barker and Doug Kish
- Marmet Locks and Dam Lock Replacement Project, by Jeffrey S. Maynard,
- Status of HSS Inspections in The Portland District, by Travis Adams
- Kansas City District: Perry Lake Project Gate Repair, by Marvin Parks
- Mel Price – Auxiliary Lock Downstream Miter Gate Repair, by Thomas J. Quigley, Brian K. Kleber and Thomas R. Ruf
- J.T. Myers Lock Improvements Project Infrastructure Conference, by David Schaaf and Greg Werncke
- J.T. Myers Dam Major Rehab, by David Schaaf, Greg Werncke and Randy James
- Greenup L&D, by Rodney Cremeans
- McAlpine Lock Replacement Project, by Kathy Feger
- Roller Compacted Concrete Placement at McAlpine Lock, by Larry Dalton
- Kentucky Lock Addition Downstream Middle Wall Monolith Design, by Scott A. Wheeler
- London Locks and Dam Major Rehabilitation Project, by David P. Sullivan
- Replacing Existing Lock 4: Innovative Designs for Charleroi Lock, by Lisa R. Pierce, Dave A. Stensby and Steve R. Stoltz
- Olmsted L&D, Dam In-the-wet Construction, by Byron McClellan, Dale Berner and Kenneth Burg
- Olmsted Floating Approach Walls, by Terry Sullivan
- John Day Navigation Lock Monolith Repair, by Matthew D. Hanson
- Inner Harbor Navigation Canal (IHNC) Lock Replacement, by Mark Gonski
- Comite River Diversion Project, by Christopher Dunn
- Waterline Support Failure: A Case Study, by Angela DeSoto Duncan
- Public Appeal of Major Civil Projects: The Good, the Bad and the Ugly, by Kevin Holden and Kirk Sunderman
- Chickamauga Lock and Dam Lock Addition Cofferdam Height Optimization Study, by Leon A. Schieber
- Des Moines Riverwalk, by Thomas D. Heinold

Track 13

- Folsom Dam Evaluation of Stilling Basin Performance for Uplift Loading for Historic Flows and Modification of Folsom Dam
- Stilling Basin for Hydrodynamic Loading, by Rick L. Poeppelman, Yunjing (Vicky) Zhang, and Peter J. Hradilek
- Seismic Stress Analysis of Folsom Dam, by Enrique E. Matheu
- Barge Impact Analysis for Rigid Lock Walls ETL 1110-2-563, by John D. Clarkson and Robert C. Patev
- Belleville Locks & Dam Barge Accident on 6 Jan 05, by John Clarkson
- Portugues Dam Project Update, by Alberto Gonzalez, Jim Mangold and Dave Dollar
- Portugues Dam: RCC Materials Investigation, by Jim Hinds
- Nonlinear Incremental Thermal Stress Strain Analysis Portugues Dam, by David Dollar, Ahmed Nisar, Paul Jacob and Charles Logie
- Seismic Isolation of Mission-Critical Infrastructure to Resist Earthquake Ground Shaking or Explosion Effects, by Harold O. Sprague, Andrew Whitaker and Michael Constantino
- Obermeyer Gated Spillway S381, by Michael Rannie
- Design of High Pressure Vertical Steel Gates Chicago Land Underflow Plan McCook Reservoir, by Henry W. Stewart, Hassan Tondravi, Lue Tekola,
- Development of Design Criteria for the Rio Puerto Nuevo Contract 2D/2E Channel Walls, by Janna Tanner, David Shiver, and Daniel Russell
- Indianapolis NortIndianapolis North Phase 3A Warfleigh Section
- Design of Concrete Lined Tunnels in Rock CUP McCook Reservoir Distribution Tunnels Contract, by David Force

Track 14

- GSA Progressive Collapse Design Guidelines Applied to Concrete Moment-Resisting Frame Buildings, by David N. Bilow and Mahmoud E. Kamara,
- UFC 4-023-02 Retrofit of Existing Buildings to Resist Explosive Effects, by Jim Caulder
- Summit Bridge Fatigue Study, by Jim Chu
- Quality Assurance for Seismic Resisting Systems, by John Connor
- Seismic Requirements for Arch, Mech, and Elec. Components, by John Connor
- SBEDS - (Single degree of freedom Blast Effects Design Spreadsheets), by Dale Nebuda,
- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke,
- Fatigue and Fracture Assessment, by Jesse Stuart
- Unified Facilities Criteria: Seismic Design for Buildings, by Jack Hayes
- Evaluation and Repair Of Blast Damaged Reinforced Concrete Beams, by MAJ John L. Hudson
- Building an In-house Bridge Inspection Program
- United Facilities CriteriUnited Facilities Criteria Masonry Design for Buildings, by Tom Wright
- USACE Homeland Security Portal, by Michael Pace
- Databse Tools for Civil Works Projects

- Standard Procedure for Fatigue Evaluation of Bridges, by Phil Sauser
- Consolidation of Structural Criteria for Military Construction, by Steven Sweeney
- Cathodic Protectionfor the South Power Plant Reinforcing Steel, Diego Garcia, BIOT, by Thomas Tehada and Miki Funahashi

Track 15

- Engineering Analysis of Airfield Lighting System Lightning Protection, by Dr. Vladimir A. Rakov and Dr. Martin A. Uman
- Dr. Martin A. Uman
- Charleston AFB Airfield Lighting Vault
- UNIFIED FACILITIES CRITERIA (UFC) UFC 3-530-01 Design: Interior, Exterior Lighting and Controls, by Nancy Clanton and Richard Cofer
- Electronic Keycard Access Locks, by Fred A Crum
- Unified Facilities Criteria (UFC) 3-560-02, Electrical Safety, by John Peltz and Eddie Davis
- Electronic Security SystemElectronic Security Systems Process Overview
- Lightning Protection Standards
- Electrical Military Workshop
- Information Technology Systems Criteria, by Fred Skroban and John Peltz
- Electrical Military Workshop
- Electrical Infrastructure in Iraq- Restore Iraqi Electricity, by Joseph Swiniarski

Track 16

- BACnet® Technology Update, by Dave Schwenk
- The Infrastructur Conference 2005, by Steven M. Carter Sr. and Mitch Duke
- Design Consideration for the Prvention of Mold, by K. Quinn Hart
- COMMISSIONING, by Jim Snyder
- New Building Commissioning , by Gary Bauer
- Ventilation and IAQ TheNew ASHRAE Std 62.1, by Davor Novosel
- Basic Design Considerations for Geothermal Heat Pump Systems, by Gary Phetteplace
- Packaged Central Plants
- Effective Use Of Evaporative Cooling For Industrial And Institutional/Office Facilities, by Leon E. Shapiro
- Seismic Protection For Mechanical Equipment
- Non Hazardous Chemical Treatments for Heating and Cooling Systems, by Vincent F. Hock and Susan A. Drozdz
- Trane Government Systems & Services
- LONWORKS Technology Update, by Dave Schwenk
- Implementation of Lon-Based Specifications by Will White and Chris Newman

Track 17

- Utility System Security and Fort Future, by Vicki Van Blaricum, Tom Bozada, Tim Perkins, and Vince Hock
- Festus/Crystal City Levee and Pump Station
- Chicago Underflow Plan McCook Reservoir (CUP) Construction of Distribution Tunnel and Pumps Installation
- Technological Advances in Lock Control Systems, by Andy Schimpf and Mike Maher
- Corps of Engineers in Iraq Rebuilding Electrical Infrastructure, by Hugh Lowe
- Red River of the North at East Grand Forks, MN & Grand Forks, ND: Flood Control Project – Armada of Pump Stations Protect Both Cities, by Timothy Paulus
- Lessons Learned for Axial/Mixed Flow Propeller Pumps, by Mark A. Robertson
- Creek Automated Gate Considerations, by Mark A. Robertson
- HydroAMP: Hydropower Asset Management, by Lori Rux
- Acoustic Leak Detection for Water Distribution Systems, by Sean Morefield, Vincent F. Hock and John Carlyle
- Remote Operation System, Kaskaskia Dam Design, Certification, & Accreditation, by Shane M. Nieukirk
- Lock Gate Replacement System, by Shaun A. Sipe and Will Smith

Track 20

- “Re-Energizing Medical Facility Excellence”, by COL Rick Bond
- Rebuilding and Renovating The Pentagon , by Brian T. Dziekonski,
- Resident Management System
- Design-Build and Army Military Construction, by Mark Grammer
- Defense Acquisition Workforce Improvements Act - Update, by Mark Grammer
- Construction Management @ Risk: Incentive Price Revision – Successive Targets, by Christine Hendzlik
- Construction Reserve Matrix, by Christine Hendzlik
- Award contingent on several factors..., by Christine Hendzlik
- 52.216-17 Incentive Price Revision--Successive Targets (Oct 1997) - Alt I (Apr 1984), by Christine Hendzlik
- Preconstruction Services, by Christine Hendzlik
- Proposal Evaluation Factors, by Christine Hendzlik
- MILCON Transformation in Support of Army Transformation, by Claude Matsui
- Construction Practices in Russia, by Lance T. Lawton

- Partnering as a Best Practice, by Ray Dupont
- USACE Tsunami Reconstruction for USAID, by Andy Constantaras

Track 21

- Dredging Worldwide, by Don Carmen
- SpecsIntact Editor, by Steven Freitas
- SpecsIntact Explorer, by Steven Freitas
- American River Watershed Project, by Steven Freitas
- Unified Facilities Guide Specifications (UFGS) Conversion To MasterFormat 2004, by Carl Kersten
- Unified Facilities Guide Specifications (UFGS) Status and Direction , by Jim Quinn

Workshops

- Design of Buildings to Resist Progressive Collapse UFC 4-023-03, by Bernie Deneke
- Security Engineering and at Unified Facility Criteria (UFC), by Bernie Deneke, Richard Cofer, John Lynch and Rudy Perkey
- Packaged Central Plants, by Trey Austin

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

NDIA

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

2005 Tri-Service Infrastructure Systems Conference & Exhibition

"Re-Energizing Engineering Excellence"

ON-SITE AGENDA

The America's Center
St. Louis Convention Center
St. Louis, MO
August 2-4, 2005
Event # 5150

ISC
Tri-Service Infrastructure Systems Conference & Exposition 2005

2005 Tri-Service Infrastructure Systems Conference & Exhibition

AGENDA

Monday, August 1, 2005

8:00 AM-9:00 PM	Exhibit Move-In
12 Noon-5:00 PM	Registration

Tuesday, August 2, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-8:15 AM Ferrara Theatre	Welcome and Introduction
8:15 AM-9:00 AM Ferrara Theatre	The Future of Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *LTG Carl A. Strock, Commander, USACE* *Dr. James Wright, Chief Engineer NAVFAC*
9:00 AM-9:45 AM Ferrara Theater	Keynote Address The Lord of the Things: The Future of Infrastructure Technologies *Mr. Paul Doherty, AIA, Managing Director,* *General Land Corporation*
9:45 AM-10:15 AM	Break
10:15 AM-11:15 AM Ferrara Theatre	USACE Engineering and Construction Panel Moderator: *Mr. Don Basham, Chief, Engineering & Construction, USACE* Panelists: *MG Donald T. Riley, Director, Civil Works, USACE* *BG Bo M. Temple, Director, Military Programs, USACE* *Dr. Michael J. O'Connor, Director, R&D*
10:15 AM-11:15 AM Room 225	Navy General Session
11:00 AM - 7:00 PM	Exhibits Open
11:15 AM-1:00 PM	Lunch in Exhibit Hall (on your own)
11:15 AM-1:00 PM Washington G	Women's Career Lunch Session (Bring your lunch from Exhibit Hall) Moderator: *Ms. Demi Syriopoulou, HQ USACE* Opening Remarks: *LTG Carl A. Strock, Commander, USACE* Presentations & Discussion: *Dwight Beranek, Kristine Allaman, Donald Basham, HQ USACE*
1:00 PM-1:55 PM Ferrara Theatre	Introduction to Multi-Disciplinary Tracks

Tuesday, August 2, 2005

2:00 PM-2:50 PM — 1st Round of Multi-Disciplinary Concurrent Sessions (Continued)

Track 1: Acquisition Strategies for Civil Works
Room 230
Walt Norko

Track 2: Risk and Reliability Engineering
Room 231
Anjana Chudgar
David Schaaf

Track 3: Portfolio Risk Assessment
Room 232
Eric Halpin

Track 4: Hydrology, Hydraulics and Coastal Engineering
Room 240 Support for USACE
Jerry Webb
Darryl Davis

Track 5: Civil Works R&D Forum
Room 241
Joan Pope

Track 6: Civil Works Security Engineering
Room 242
Joe Hartman
Bryan Cisar

Track 7: Building Information Model Applications
Room 226
Brian Huston
Daniel Hawk

Track 8: Design Build for Military Projects
Room 220
Mark Grammer

Track 9: Army Transformation/Global Posture Initiative/
Room 221 Force Modernization
Al Young
Claude Matsui

Track 10: Force Protection - Army Access Control Points
Room 222
John Trout

Track 11: Cost Engineering Forum on Government Estimates
Room 227 vs. Actual Costs
Ray Lynn *Jack Shelton* *Kim Callan*
Miguel Jumilla *Ami Ghosh* *Joe Bonaparte*

Track 12: Engineering & Construction Information Technology
Room 228
MK Miles

Track 13: Sustainable Design
Room 223
Harry Goradia

Track 14: ACASS/CCASS/CPARS
Room 224
Ed Marceau
Marilyn Nedell

Track 15: Whole Building Design Guide
Room 229
Earle Kennett

Tuesday, August 2, 2005

2:50 PM-3:30 PM	Break in Exhibit Hall
3:30 PM-4:20 PM	2nd Round of Multi-Disciplinary Sessions
4:30 PM-5:20 PM	3rd Round of Multi-Disciplinary Sessions
5:30 PM-7:00 PM	Ice Breaker Reception in Exhibit Hall

Wednesday, August 3, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
9:00 AM	Exhibit Hall Opens
9:30 AM-10:30 AM	Break in Exhibit Hall
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
12:00 Noon-1:30 PM	Lunch in Exhibit Hall
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on the Following Pages)
3:00 PM-4:00 PM	Break in Exhibit Hall
4:00 PM-5:30 PM	Concurrent Sessions
5:00 PM	Exhibit Hall Closes

Thursday, August 4, 2005

7:00 AM-8:00 AM	Registration and Continental Breakfast
8:00 AM-9:30 AM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
9:30 AM-10:30 AM	Break in Exhibit Hall (Last Chance to view Exhibits)
10:30 AM-12:00 Noon	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
12:00 Noon-1:30 PM	Lunch (On your own)
12:00 Noon-6:00 PM	Exhibits Move-Out
1:30 PM-3:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on Following Pages)
3:00 PM-3:30 PM	Break
3:30 PM-5:00 PM	Concurrent Sessions (Please Refer to Concurrent Session Schedule on following pages)

Wednesday, August 3, 2005 Concurrent Sessions

HH&C Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1 Coastal Structures** Session 1A	Protecting the NJ Coast using large stone seawalls — *Cameron Chasten*	Chicago shoreline storm damage reduction project — *Andrew Bezinger*	Risk and reliability in coastal structure design — *Jeffrey Melby*	**TRACK 1 Coastal Regional Manangement** Session 1B	Cascade: An integrated regional model for decision support — *Nicholas Kraus*	Upper Texas coast sediment transport modeling & sediment budgets — *David King*	Sediment compatibility for beach nourishment in North Carolina — *Gregory Williams*
Room 221	**TRACK 2 Ecological Engineering & Design** Session 2A	Ecological and engineering considerations for dam decommissioning, retrofits and operations — *Jock Conyngham*	Hydraulic design of tidegates and other water control structures for ecosystem restoration on the Columbia Estuary — *Patrick O'Brien*	Innovative Integration of engineering and biological tools aids hydraulic structure design for restoring T&E fish — *Andrew Goodwin*	**TRACK 2 Ecological Engineering & Design** Session 2B	Innovative hydraulic structure design at Lower Granite Dam: design that saves water and salmon — *Lynn Reese*	Impacts of using a spillway for juvenile fish passage on typical design criteria — *Robert Buchholz*	Hydraulic design of juvenile fish passage facility for reservoir with wide range of pool elevation - Hanson Dam — *Dennis Mekkers*
Room 222	**TRACK 3 Modeling** Session 3A	Corps involvement in the FEMA map modernization program — *Kete White*	Innovative approximate study method for FEMA map modernization program — *John Hunter*	Flood fight structures demonstration evaluation program — *Fred Pinkard*	**TRACK 3 Modeling** Session 3B	Integrating climate dynamics into water resources planning and management — *Kate White*	Risk and uncertainty in flood damage reduction studies — *Rob Moyer*	Uncertainty analysis and stochastic simulation — *Jacke Hallberg*
Room 223	**TRACK 4 H&H Aspects of Dam Safety** Session4A	Hydrologic aspects of operating in failure mode: Fern Lake — *Bruce Duffe*	Dam safety study with cascading failures — *Gordon Lance*	Rough river spillway capacity — *Richard Pruitt*	**TRACK 4 International/ Military H&H** Session 4B	Capability restoration and historic marsh restoration — *Fauwaz Hanbali*	USACE capacity building effort for Iraq MoWR — *Steven Wilhelms*	USACE support of CMEP in 2004 — *Mark Jensen*

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 220	**TRACK 1 Coastal Sediments** Session 1C	Evaluating beachfill project performance in the NAP — *Monica Chasten*	USACE's regional coastal mapping program — *Jennifer Wozencraft*	US Naval Academy flood damage reduction project using structural and non-structural measures — *Stacey Underwood*	**TRACK 1 Shore Protection Projects** Session 1D	Hurricane Isabel effects on communities — *Jane Jablonski*	Repair of the shore protection projects adversly affected by the hurricanes of 2004 — *Rick McMillen*	Shore protection project performance assessmet — *Sharon Haggett*
Room 221	**TRACK 2 Modeling Ecological Restoration/Systems Assessment** Session 2C	Regional modeling requirements for ecosystem restoration — *Maged Hussein*	Tools for wetlands permit evaluation: Modeling groundwater and surface water distribution systems — *Cary Talbot*	Current research in fate and transport of chemical and biological contaminants in water distribution systems — *Mark Ginsberg*	**TRACK 2 Ecosystem Habitat Restoration** Session 2D	Aquatic habitat restoration in the lower Missouri River — *Chance Bittner*	Missouri River restoration: shallow water habitat creation — *Daniel Pridal*	Ecosystem restoration for fish and wildlife habitat on the upper Mississippi River — *Jon Hendrickson*
Room 222	**TRACK 3 River Morphology** Session 3C	Geomorphology study of the Mississippi river — *Edward Braurer*	Bank erosion and morphology of the Kaskaskia river — *Michael Rodgers*	Sediment movement at Kansas City from water years 1920 to 2004 — *Alan Tool*	**TRACK 3 Modeling River Sedimentation** Session 3D	Sediment impact assessment model (SIAM) — *David Biedenharn*	Sediment modeling of MS River, Cairo to Gulf — *Basil Arthur*	Sediment modeling of rivers — *Charlie Berger*
Room 223	**TRACK 4 GIS and Surveying** Session 4C	GIS tools available now to support HHC — *Timothy Pangburn*	High resolution bathymetry and fly-through visualization — *Paul Clouse*	GIS & surverying to support national FEMA — *Mark Flick*	**TRACK 4 GIS and Surveying** Session 4D	Update flood emergency plans with GIS and HEC-RAS — *Stephen Stello*	High resolution visualizations of multibeam data: lower Mississippi River — *Thomas Tobin*	GIS in SWWRP — *Andrew Bruzewicz*

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Geotechnical Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 226	**TRACK 5**	Levee lowering for the Lewis & Clark bi-centennial celebration	Conduits through embankment dams - best practices for design, construction, problem id and evaluation, inspection, maintenance, renovation & repair		2-D liquefaction evaluation with q4MESH	Unlined spillway erosion risk assessment	Seismic remediation of the Clemson upper and lower diversion dams: evaluation, conceptal design and design (P1)
	Session 5A	***Robert Berger***	***Dave Pezza***	***Douglas Chitwood***	**Session 5B** ***David Serafini***	***Johannes Wibowo***	***Ben Foreman***
Room 227	**TRACK 6**	USACE dams on solution susceptible or highly fractured rock foundations	Special drilling and grouting techniques for remedial work in embankment dams	Composite grouting & cutoff wall solutions	State of the art in grout mixes	State of the art in computer monitoring, control, and analysis of grouting	Quantitatively engineered grout courtains
	Session 6A	***Art Walz***	***Doug Heenan***	***Donald Bruce***	**Session 6B** ***James Davies***	***Trent Dreese***	***David Wilson***
Room 228	**TRACK 7**	Case history: multiple axial statnamic test on a drilled shaft embedded in shale	Austin Dam, Pennsylvania: the sliding failure of a concrete gravity dam revisited	M^3 (Modeling, Monitoring and Manufacturing) - a comprehensive approach to controlling ground movements for protecting existing structures and facilities	Controlled modulus columns: A ground improvement technique	Time-dependent reliability models for use in major rehabilitation of embankment dams and foundations	Engineering geology design challenges at the Soo Lock replacement project
	Session 7A	***Paul Axtell***	***Brian Greene***	***Michael Walker***	**Session 7B** ***Martin Taube***	***Robert Patev***	***Mike Nield***
Room 229	**TRACK 8**	Evaluation of the use of lithium nitrate in controlling alkali-silica reactivity in an existing concrete pavement	Use of self-consolidating concrete in the installation of bulhead slots - Lessons learned in the use of this innovative concrete material	Roller compacted concrete for McAlpine lock walls	Soil-cement for stream bank stabilization	Using cement to reclaim asphalt pavements	Valley park 100-year flood protection project: use of "engineered fill" in item 4b levee core
	Session 8A	***Mike Kelly***	***Darrell Morey***	***David Kiefer***	**Session 8B** ***Wayne Adaska***	***David Luhr***	***Patrick Conroy***

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 226	**TRACK 5**	Seismic remediation of the Clemson upper and lower diversion dams: deep soil mix construction	Historical changes in the state-of-the-art of seismic engineering & effects of those changes on the seismic response studies of large embankement dams	New Iwakuni runway	Internal erosion and piping at Fern Ridge dam: Problems and solutions	Rough river dam safety assurance project	Seepage collection and control systems: The devil is in the details
	Session 5C	***Ben Foreman***	***Samuel Stacy***	***Vincent Donnally***	**Session 5D** ***Jeremy Britton, Ph.D.***	***Timothy O'Leary***	***John France***
Room 227	**TRACK 6**	Grout courtains at Arkabutla Dam outlet monolith joints using chemical grout to seal joints, Arkabutla, MS	Results from a large-scale grout test program, Chicago underflow plan (CUP) McCook Reservoir	Clearwater Dam - foundation drilling and grouting for repair of sinkholes	Update on the investigation of the effects of boring sample size (3' vs 5") on measured cohesion in soft clays	Soil-bentonite cutoff wall through free-product at Indiana Harbor CDF	Soil-bentonite cutoff wall through dense alluvium with boulders into bedrock, McCook Reservoir
	Session 6C	***Dale Goss***	***Joseph Kissane***	***Mark Harris***	**Session 6D** ***Richard Pinner***	***Joseph Schulenberg***	***William Rochford***
Room 228	**TRACK 7**	Engineering geology during design and construction of the Marmet lock project	Mill Creek deep tunnel - Geological affects on proposed structures and construction techniques	Earth pressure loads behind the new McAlpine Lock replacement project	Geosynthetics and construction of the Bonneville lock and dam second powerhouse corner collector surface flow bypass project	McAlpine lock replacement - foundation characteristics and excavation	
	Session 7C	***Michael Nield***	***Tres Henn***	***Troy O'Neal***	**Session 7D** ***Art Fong***	***Kenneth Henn***	
Room 229	**TRACK 8**	What to do if your dam is expanding: a case study	Unpaved road stabilization with chlorides	Use of ultra-fine amorphous colloidal silica to produce a high-density, high-strength rock-matching grout for instrumentation grouting	Innovative techniques in the Gabion system	Addressing cold regions issues in pavement engineering	Geology of New York Harbor - geological and geophysical methods of characterizing the stratigraphy for dredging contracts
	Session 8C	***Greg Yankey***	***Michael Mitchell***	***Brian Green***	**Session 8D** ***George Ragazzo***	***Lynette Barna***	***Ben Baker***

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Structural Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 240	**TRACK 12 Civil Works Structural**	Recent changes to Corps guidance on steel hydraulic structures	Crack repairs and instrumentation of Greenup L&D miter gate	Recent hydraulic steel structures findings in the Portland district	**TRACK 12 Civil Works Structural**	Perry Lake gate repair	Mel Price auxiliary lock gate repair	Mel Price auxiliary lock gate repair (Continued)
	Session 12A	*Joe Padula*	*Doug Kish*	*Travis Adams*	**Session 12B**	*Marvin Parks*	*Andrew Schimpf*	*Andrew Schimpf*
Room 241	**TRACK 13 Civil Works Structural**	Folsom Dam evaluation of stilling basin performance for uplift loading for historic flows	Rehabilitation of Folsom Dam stilling basin	Seismic stability evaluation of Folson Dam	**TRACK 13 Civil Works Structural**	Seismic stress analysis of Folsom Dam	Barge impact guidance for rigid lock walls, ETL 110-2-563 and probalistic barge impact analysis	Belleville barge accident
	Session 13A	*Rick Poeppelman*	*Rick Poeppelman*	*Enrique Matheu*	**Session 13B**	*Enrique Matheu*	*John Clarkson*	*John Clarkson*
Room 242	**TRACK 14 Bridges/ Buildings**	The USACE bridge management system	Standard procedures for fatigue evaluation of bridges	Fatigue and fracture assessment of Jesse Stuart Highway Bridge	**TRACK 14 Bridges/ Buildings**	Building an in-house bridge inspection program	Fatigue analysis of Summit bridge	Consolidation of Structural criteria for military construction
	Session 14A	*Phil Sauser*	*Phil Sauser*	*John Jaeger*	**Session 14B**	*Jennifer Laning*	*Jim Chu*	*Steve Sweeney*

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 240	**TRACK 12 Civil Works Structural**	Overview of John T. Myers locks improvements project	John T. Myers rehabilitation study	Ohio River Greenup Lock extension	**TRACK 12 Civil Works Structural**	McAlpine lock replacement project, project summary and status of construction	Results of Roller Compacted concrete placement at the McAlpine lock replacement project	Tennessee Valley authority Kentucky lock addition downstream middle wall monoliths
	Session 12C	*Greg Werncke*	*Greg Werncke*	*Rodney Cremeans*	**Session 12D**	*Kathleen Feger*	*Larry Dalton*	*Scott Wheeler*
Room 241	**TRACK 13 Civil Works Structural**	Portugues Dam, Ponce, Puerto Rico project update	Portugues Dam, Ponce, Puerto Rico, RCC design and testing program	Portugues Dam, Ponce, Puerto Rico, Thermal analysis of hydration and subsequent cooling of RCC	**TRACK 13 Civil Works Structural**	Miter gate anchorage design	Obermeyer gated spillway project - S381	McCook Reservoir design of high pressure steel gates
	Session 13C	*Jim Mangold*	*Jim Hinds*	*Ahmed Nisar*	**Session 13D**	*Andy Harkness*	*Michael Rannie*	*Luelseged Tekola*
Room 242	**TRACK 14 Brigdes/ Buildings**	Unified facilities criteria seismic design for buildings	Seismic requirements for architectural, mechanical and electrical components	Quality assurance for seismic resisting systems	**TRACK 14 Bridges/ Buildings**	Unified facilities criteria masonry structural design for buildings	Cathodic protection of building reinforcing steel (in Diego Garcia)	USACE Homeland security web portal
	Session 14C	*Jack Hayes*	*John Connor*	*John Connor*	**Session 14D**	*Tom Wright*	*Thomas Tehada*	*Mike Pace*

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Dam Safety Track & Construction Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10 Dam Safety**	Tuttle Creek warning and alert systems	Lessons from the dam failure warning system exercise - Tuttle Creek	Tuttle Creek ground modification treatability program	**TRACK 10 Dam Safety**	Dam safety analysis of Cannelton Dam	John Martin Dam, CO - Dam safety structural upgrades	Vesuvius Lake Dam rehabilitation
	Session 10A	***Bill Empson***	***Bill Empson***	***Bill Empson***	**Session 10B**	***Terry Sullivan***	***George Diewald***	***Susan Peterson***
Room 225	**TRACK 11 Dam Safety**	Canton lake spillway stabilization project: IS a test anchor program NECESSARY?	Dynamic testing and numerical correlation studies for Folsom dam	Status of portfolio risk assessment	**TRACK 11 Dam Safety**	Mississinewa Dam remediation	Wolf creek seepage history	Blue dam major rehabilitation
	Session 11A	***Randy Mead***	***Ziyad Duron***	***Eric Halpin***	**Session 11B**	***Jeff Schaefer***	***Michael Zoccola***	***Michael McCray***
Room 230	**TRACK 19 Construction**	RMS Update	RMS Update (Continued)	Updated CQM for Contractors Course	**TRACK 19 Construction**	Lessons learned on major construction projects	Update on safety issues - Safety manual 385-1-1	Update on safety issues - safety manual 385-1-1 (continued)
	Session 19A	***Haskell Barker***	***Haskell Barker***	***Walt Norko***	**Session 19B**	***Jim Cox***	***Charles Ray Waits***	***Charles Ray Waits***
Room 231	**TRACK 20 Construction**	Construction methods in Russia	Construction methods in Russia (Continued)	Renovating the Pentagon using Design/Build delivery	**TRACK 20 Construction**	Completion of the Olmsted approach walls	Completion of the Olmsted approach walls (Continued)	Construction management at risk
	Session 20A	***Lance Lawton***	***Lance Lawton***	***Brian Dziekonski***	**Session 20B**	***Dale Miller***	***Dale Miller***	***Christopher Prinslow***

Break in Exhibit Hall

12 Noon **Lunch in Exhibit Hall**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	4:00 PM	4:30 PM	5:00 PM
Room 224	**TRACK 10 Dam Safety**	Project specific risk analysis - Success Dam	Dam safety lessons learned, Winter storm 2005, Muskingum & Scioto Basins	Dam security and Dams Government Coordinating Council	**TRACK 10 Dam Safety**	Prompton Dam hydrologic deficiency and spillway modification	"Well, that's water over the dam" - Rough River spillway adequacy design	Roller-compacted concrete for dam spillways and overtopping protection
	Session 10C	***Ronn Ross***	***Charles Barry***	***Roy Braden***	**Session 10D**	***Troy Cosgrove***	***Richard Pruitt***	***Fares Abdo***
Room 225	**TRACK 11 Dam Safety**	Clearwater Dam major rehabilitation	Success dam seismic dam safety modification	Problems on the Santa Ana River - Prado Dam	**TRACK 11 Dam Safety**	Problems on the Santa Ana River - Seven Oaks Dam	Dam safety program management tools	
	Session 11C	***Bobby Van Cleave***	***Norbert Suter***	***Douglas Chitwood***	**Session 11D**	***Robert Kwan***	***Tommy Schmidt***	
Room 230	**TRACK 19 Construction**	3D Modeling and impact on constructability	3D Modeling and impact on constructability (Continued)	Construction in Iraq & Afganistan	**TRACK 19 Construction**	Air Force streamlining Design/Build	Air Force streamlining Design/Build (Continued)	Sustainable design requirements & construction implementation
	Session 19C	***Gary Cough***	***Gary Cough***	***Walt Norko***	**Session 19D**	***Joel Hoffman***	***Joel Hoffman***	***Harry Goradia***
Room 231	**TRACK 20 Construction**	Tsunami reconstruction	Tsunami reconstruction (Continued)	Military construction transformation in support of Army transformation	**TRACK 20 Construction**	MEDCOM Construction Issues	MEDCOM Construction Issues (Continued)	*TBA*
	Session 20C	***Andy Constantaras***	***Andy Constantaras***	***Sally Parsons***	**Session 20D**	***Rick Bond***	***Rick Bond***	

Break in Exhibit Hall

Wednesday, August 3, 2005 Concurrent Sessions

Electrical & Mechanical Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room A	**TRACK 15 Military Electrical**	Tri-Service Electrical Criteria Overview -	Tri-Service Electrical Criteria Overview - (Continued)	Tri-Service Electrical Criteria Overview -(Continued)	**TRACK 15 Military Electrical**	Interior/Exterior and security lighting criteria	Information technology systems criteria	Information technology systems criteria (Continued)
	Session 15A	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***	**Session 15B**	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***
Room B	**TRACK 16 Military Mechanical**	Building Commissioning	HVAC Commissioning	Ventilation and indoor air quality	**TRACK 16 Military Mechanical**	Ventilation and indoor air quality (Continued)	Refrigerant implications for HVAC specifications, selection, and o&m - now and future	Refrigerant implications for HVAC specifications, selection, and o&m - now and future (Continued)
	Session 16A	***Dale Herron***	***Dale Herron***	***Davor Novosel***	**Session 16B**	***Davor Novosel***	***Mike Thompson***	***Mike Thompson***
Room D	**TRACK 17 Military Mechanical / Electrical**	Sustainable design update			**TRACK 17 Military Mechanical / Electrical**	Utility systems security and fort future	Acoustic leak detection for utilities distribution systems	Acoustic leak detection for utilities distribution systems (Continued)
	Session 17A	***Harry Goradia***			**Session 17B**	***Vicki L. Van Blaricum***	***Sean Morefield***	***Sean Morefield***
Room E	**TRACK 18 Civil Mechanical**	Emsworth Dam vertical lift gate hoist replacement	Hydraulic drive for Braddock Dam	John Day navigation lock upstream lift gate wire rope failure	**TRACK 18 Civil Mechanical**	Overhead bulkhead at Olmstead Lock	Replacement of gate # 5 intermediate gear and pinion at RC Byrd Lock and Dam	Mechanical design issues during construction of McAlpine Lock
	Session 18A	***John Nites***	***Janine Krempa***	***Ronald Wridge***	**Session 18B**	***Rick Schultz***	***Brenden McKinley***	***Richard Nichols***

Break in Exhibit Hall

12 Noon — **Lunch in Exhibit Hall**

	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM	5:00 PM
Room A	**TRACK 15 Military Electrical**	Mass notification system	Mass notification system (Continued)	Electronic card access locks	**TRACK 15 Military Electrical**	Lightning protection standards	Lightning and surge protection	Lightning and surge protection (Continued)
	Session 15C	***Tri-Service Panel***	***Tri-Service Panel***	***Fred Crum***	**Session 15D**	***Richard Bouchard***	***Tri-Service Panel***	***Tri-Service Panel***
Room B	**TRACK 16 Military Mechanical**	Basic design considerations for geothermal heat pump systems	Basic design considerations for geothermal heat pump systems (Continued)	Pentagon renovation	**TRACK 16 Military Electrical**	Effective use of evaporative cooling for industrial and institutional/office facilities	Efective use of evaporative cooling for industrial and institutional/office facilities (Continued)	Non-hazardous chemical treatments for heating and cooling systems
	Session 16C	***Gary Phetteplace***	***Gary Phetteplace***	***Mitch Duke***	**Session 16D**	***Leon Shapiro***	***Leon Shapiro***	***Vincent Hock***
Room D	**TRACK 17 Civil Mechanical / Electrical**	Hydropower asset management partnership (hydroAMP)	New gas fueled/diesel fueled turbine powered electrical generating station in Iraq	The construction of distribution tunnels and pump installation for the metropolitan Chicago sewer systems	**TRACK 17 Civil Mechanical / Electrical**	The Festus/Crystal City levee and pump station project	Remote operations for Kaskaskia Dam	Technological advances in lock control systems
	Session 17C	***Lori Rux***	***Lester Lowe***	***Ernesto Go***	**Session 17D**	***Stephen Farkas***	***Shane Nieukirk***	***Andy Schimpf***
Room E	**TRACK 18 Civil Mechanical**	New coating products for civil works structures	New guide specification for procurement of turbine oils	Synchronous condensing with large Kaplan turbine - A case study	**TRACK 18 Civil Mechanical**	Acquifer storage and recovery (ASR) system	Wastewater infrastructure improvements in Appalachia	Storm water pumps
	Session 18C	***Al Beitelman***	***John Micetic***	***Brian Moentenich***	**Session 18D**	***Gerald Deloach***	***James Sadler***	***Thomas Jamieson***

Break in Exhibit Hall

Thursday, August 4, 2005 Concurrent Sessions

HH&C Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 220	**TRACK 1 Sedimentation & New Concepts** Session 1E	Ice jams, contaminated sediment and structures Clark Fork River, MT — *Andrew Tuthill*	Increased bed erosion due to ice — *John Hains*	Monitoring the Mississippi River using GPS coordinated video — *James Gutshall*	**TRACK 1 Sedimentation, Case Examples** Session 1F	Watershed approach to stream stability the reduction of nutrients — *John B. Smith*	Monitoring the effects of sedimentation from Mount St. Helen — *Alan Donner*	Navigation and environmental interests in alleviating repetitive dredging — *Jason Brown*
Room 221	**TRACK 2 Water Management** Session 2E	Enhancements and new capabilities of HEC-ResSim 3.0 — *Fauwaz Hanbali*	Transition to Oracle based data system — *Joel Asunskis*	Accessing real time Mississippi Valley water level data — *Rich Engstrom*	**TRACK 2 Water Management** Session 2F	Hurricane Season 2004 — *Susan Sylvester*	Reevaluation of a project's flood control benefits — *Ferris Chamberlin*	Helmand Valley water management plan — *Jason Needham*
Room 222	**TRACK 3 Case Studies** Session 2E	Red River of the north flood protection project — *Michael Lesher*	Southeast Arkansas flood control & water supply feasibility study — *Thomas Brown*	McCook and Thorton tunnel and reservoir modeling — *David Kiel*	**TRACK 3 Case Studies** Session 3F	Ala Wai Canal Project, Honolulu, Oahu, Hawaii — *Lynnette Schapers*	Missouri River geospatial decision support framework — *Brian Baker*	Systemic analysis of the Mississippi & Illinois Rivers — *Dennis Stephens*
Room 223	**TRACK 4 Modeling** Session 4E	Hydrologic models supported by ERDC — *Robert Wallace*	HEC-HMS Version 3.0 new features — *Jeff Harris*	SEEP2D & GMS: Simple tools for solving a variety of seepage problems — *Clarissa Hansen*	**TRACK 4 Modeling** Session 4F	Water quality and sediment transport in HEC-RAS — *Mark Jensen*	Advances to the GSSHA program — *Aaron Byrd*	Software integration for watershed studies HEC-WAT — *Chris Dunn*

Break in Exhibit Hall

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 220	**TRACK 1 Water Quality Management** Session 1G	San Francisco Bay Mercury TMDL-Implications for constructed wetlands — *Herb Fredrickson*	Abandoned mine land: Eastern and Western perspectives — *Kate White*	A lake tap for temperature control tower construction at Cougar Dam — *Steve Schlenker*	**TRACK 1 Watershed Management** Session 1H	Demonstrating innovative river restoration technologies: Truckee River, NV — *Chris Dunn*	Comprehensive watershed restoration in the Buffalo district — *Anthony Friona*	Translating the hydrologic tower of Babel — *Dan Crawford*
Room 221	**TRACK 2 Water Management** Session 2G	Developing reservoir operation plans to manage erosion — *Patrick O'Brien*	New approaches to water management decision making — *James Barton*	Improved water supply forecasts for Kooteny basin using principal components regression — *Randal Wortman*	**TRACK 2 Water Management** Session 2H	Prescriptive reservoir modeling and ROPE study — *Jason Needham*	Missouri River mainstem operations — *Larry Murphy*	Res-Sim model for the Columbia River — *Arun Mylvahanan*
Room 222	**TRACK 3 Section 227** Session 3G	Section 227 Workshop/ Program Review — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	**TRACK 3 Section 227** Session 3H	Section 227 Workshop/ Program Review — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*	Section 227 Workshop/ Program Review (Continued) — *William Curtis*
Room 223	**TRACK 4 Modeling** Session 4G	Little Calumet River unsteady flow model conversion — *Rick Ackerson*	Kansas City River basin model — *Edward Parker*	Design guidance for breakup ice control — *Andrew Tuthill*	**TRACK 4 Modeling** Session 4H	Forebay flow simulations using Navier-Stokes code — *Charlie Berger*	Use of regularizatino as a method for watershed model calibration — *Brian Skahill*	Demonstration program in the arid southwest — *Margaret Jonas*

Break

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 226	**TRACK 5**	Dynamic deformation analyses Dewey Dam Huntintong District Corps of Engineers	Seismic stability evaluation for Ute Dam, NM	An overview of criteria used by various organizations for assessments and seismic remediation of earth dams	**TRACK 5**	USACE seepage berm design criteria and district practices	Ground penetrating radar applications for the assessment of airfield pavements	Challenges of the Fernando Belaunde Terry road upgrade Campanillia to Pizana - Peru road project
	Session 5E	***Greg Yankey***	***John France***	***Sean Carter***	**Session 5F**	***George Sills***	***Lulu Edwards***	***Michael Wielputz***
Room 227	**TRACK 6**	Small geotechnical project, big stability problem - The Block Church Road experience	Geophysical investigation of foundation conditions beneath Folsom Dam	Bioengineering slope stabilization techniques coupled with traditional engineering applications - The result a stable slope	**TRACK 6**	Shoreline armor stone quality issues	Mill Creek - An urban flood control challenge	Next stop, The Twilight Zone
	Session 6E	***Jonathan Kolber***	***Jose Llopis***	***Bethany Bearmore***	**Session 6F**	***Joseph Kissane***	***Monica Greenwell***	***Troy O'Neal***
Room 228	**TRACK 7**	The geotechnical and structural issues impacting the Dalles spillway construction	The Dalles spillway engineering and design	The future of the discrete element method in infrastructure analysis	**TRACK 7**	Evaluating the portable falling weight deflectometer as a low-cost technique for posting seasonal load restrictions on low volume payments	Soil structure interaction effects in the seismic evaluation of success dam control tower	Olmsted locks and Dam project geotechnical/construction issues
	Session 7E	***Kristie Hartfeil***	***Kristie Hartfeil***	***Raju Kala***	**Session 7F**	***Maureen Kestler***	***Michael Sharp***	***Jeff Schaefer***
Room 229	**TRACK 8**	Rubblization of airfield concrete pavement	US Army airfield pavement assessment program	Critical state for probabilistic analysis of levee underseepage	**TRACK 8**	Curing practices for modern concrete construction	AAR at Carters Dam, a different approach	Concrete damage at Carters Dam, GA
	Session 8E	***Eileen Velez-Vega***	***Haley Parsons***	***Douglas Crum***	**Session 8F**	***Toy Poole***	***James Sanders***	***Toy Poole***

Break in Exhibit Hall

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 226	**TRACK 5**	Slope stability evaluation of the Baldhill Dam right abutment	Lateral pile load test results within a soft cohesive foundation	Design and construction of anchored bulheads for river diversion, Seabrook, NH	**TRACK 5**	Characterization of soft marine clays - A case study at Craney Island	50 years of NRSC experience with engineering problems caused by dispersive clays	Changes in the post-tensioning institutes new (4th Ed. 2004) "Recommendations for prestressed rock and soil anchors"
	Session 5G	***Neil Schwanz***	***Richard Varuso***	***Siamac Vaghar***	**Session 5H**	***Aaron Zdinak***	***Danny McCook***	***Michael McCray***
Room 227	**TRACK 6**	Perils in back analysis failures	Reconstruction of deteriorated lock walls concrete after blasting and other demolition removal techniques	Flood fighting structures demonstrations and evaluation program	**TRACK 6**	Innovative design concepts incorporated into a landfill closure and reuse design	Laboratory testing of flood fighting structures	Bluff stabilization along Lake Michigan using active and passive dewatering techniques
	Session 6G	***Greg Yankey***	***Steve O'Connor***	***George Sills***	**Session 6H**	***Dave Ray***	***Johannes Wibowo***	***Eileen Glynn***
Room 228	**TRACK 7**	Geotechnical instrumentation and foundation re-evaluation of John Day lock and Dam, Columbia River, Oregon-Washington	A study of the long term performance of seepage cutoff barriers in dams	Design, construction, and performance of seepage barriers for Guanella Dam, near Empire, CO	**TRACK 7**	Sensitive infrastructure sites and structures - Sonic drilling offers quality control and non-destructive advantages to geotechnical construction drilling	Subgrade failure criteria according to soil type and moisture condition	The automated stability monitoring of the Mississippi River levees using the range scan system
	Session 7G	***David Scofield***	***John Rice***	***John France***	**Session 7H**	***John Davis***	***Edel Cortez***	***Robert Jolissian***
Room 229	**TRACK 8**	Damaging interactions among concrete materials	Economic effects on construction of uncertainty in test methods	Major issues in materials specifications	**TRACK 8**	Spall and intermediate-sized repairs for PCC pavements	Acceptance criteria for unbonded aggregate road surfacing materials	Effective partnering to overcome an interruption in the supply of Portland cement during construction of Marmet lock and Dam
	Session 8G	***Toy Poole***	***Toy Poole***	***Toy Poole***	**Session 8H**	***Reed Freeman***	***Reed Freeman***	***Billy Neeley***

Break

Thursday, August 4, 2005 Concurrent Sessions

Geotechnical, Specifications, Electrical & Mechanical Engineering & Construction Tracks

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 225	**TRACK 9 Geotechnical**	Seepage Committee Meeting	Seepage Committee Meeting (Continued)	Seepage Committee Meeting (Continued)			
	Session 9E	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***			
Room 232	**TRACK 21 Specifications**	SpecsIntact-Demonstration of the SI explorer, publishing to PDF and Word	SpecsIntact - Demonstration of the SI editor, UMRL and reference wizard	UFGS status and direction			
	Session 21E	***Patricia Robinson***	***Patricia Robinson***	***Jim Quinn***			
Room A	**TRACK 15 Military Electrical**	Electronic Security	Electronic Security (Continued)	AIRFIELD lightning protection & grounding and lighting			
	Session 15E	***Tri-Service Panel***	***Tri-Service Panel***	***Tri-Service Panel***			
Room B	**TRACK 16 Military Mechanical**	Lon works technology update	BACnet Technology Update	Implementation of Lon-based specifications			
	Session 16E	***David Schwenk***	***David Schwenk***	***Will White***			
Room D	**TRACK 17 Civil Mechanical**	Lessons learned on flood water pump stations	Armada of pump stations, Grand Forks and East Grand Forks	Various screen equipment selection guide			
	Session 17E	***Mark Robertson***	***Timothy Paulus***	***Sara Benier***			
Room 230	**TRACK 19 Construction**	NAVFAC Construction scheduling	NAVFAC Construction scheduling (Continued)	ACASS/CASS - CPARS			
	Session 19E	***Glenn Saito***	***Glenn Saito***	***Ed Marceau***			
Room 231	**TRACK 20 Construction**	Update on DAWIA and Facilities Engineering	Update on DAWIA and Facilities Engineering (Continued)	Partnering as a best practice			
	Session 20E	***Mark Grammer***	***Mark Grammer***	***Ray DuPont***			
				Break in Exhibit Hall			
Room 225					**TRACK 9 Geotechnical**	GMCoP Forum	GMCoP Forum (Continued)	GMCoP Forum (Continued)
					Session 9F	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***
Room 232					**TRACK 21 Specifications**	UFGS transitin to Master-Format 2004	Project specifications for the upper tier Folsom outlet works modifications	UFGS dredging
					Session 21F	***Carl Kersten***	***Steve Freitas***	***Don Carmen***
Room A					**TRACK 15 Military Electrical**	Electrical safety and arc flash UFC	Electrical safety and arc flash UFC (Continued)	Electrical infrastructure in Iraq - Restore Iraqi electricity
					Session 15F	***Tri-Service Panel***	***Tri-Service Panel***	***Joseph Swiniarski***
Room B					**TRACK 16 Military Mechanical**	Prefabricated Chiller Plants	Seismic for ME systems	Design considerations for the prevention of mold
					Session 16F	***Trey Austin***	***Greg Stutts***	***Quinn Hart***
Room D					**TRACK 17 Civil Mechanical**	Lock gate replacement system	Lock gate replacement system (Continued)	Automated closure gate design for Duck creek flood control
					Session 17F	***Will Smith***	***Will Smith***	***Mark Robertson***
Room 230					**TRACK 19 Construction**	Self-consolidating concrete	Self-consolidating concrete (Continued)	
					Session 19F	***Beatrix Kerhoff***	***Beatrix Kerhoff***	
Room 231					**TRACK 20 Construction**	S&A Update	Construction Issues Open Forum (Q&A)	Construction Issues Open Forum (Q&A) (Continued)
					Session 20F	***Harry Jones***	***Don Basham***	***Don Basham***

12 Noon — **Lunch**

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 225	**TRACK 9 Geotechnical**	Seismic Manual	Seismic Manual (Continued)	Seismic Manual (Continued)			
	Session 9G	***GROUP DISCUSSION***	***GROUP DISCUSSION***	***GROUP DISCUSSION***			

Thursday, August 4, 2005 Concurrent Sessions

Dam Safety Track & Structural Engineering Track

	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:30 AM	11:00 AM	11:30 AM
Room 224	**TRACK 10** Dam Safety	Seepage and stability, final evaluation for reservoir pool raising project, Terminus Dam, Kaweah River, CA	Initial filling plan, Terminus dam spillway enlargement, Terminus Dam, Kaweah River, CA	Hydrologic aspects of operating in a "failure mode" - Fern Ridge Lake, OR			
	Session 10E	*Michael Ramsbotham*	*Michael Ramsbotham*	*Bruce Duffe*			
Room 240	**TRACK 12** Civil Works Structural	London lock and dam, West Virginia major rehabilitation project	Replacing existing lock 4-Innovative designs for Charleroi lock	Use of non-linear incremental structural analysis in the design of the Charleroi lock			
	Session 12E	*David Sullivan*	*Steveb Stoltz*	*Randy James*			
Room 241	**TRACK 13** Civil Works Structural	Chicago shoreline project	Structural assessment of Bluestone Dam	Duck Creek, OH local flood protection projection phase III Culvert damage			
	Session 13E	*Jan Plachta*	*Robert Reed*	*Jeremy Nichols*			
Room 242	**TRACK 14** Bridges/ Buildings	Urban search & rescue program overview	Evaluation and repair of blast damaged reinforced concrete beams	Single degree of freedom blast effects spreadsheets			
	Session 14E	*Tom Niedernhofer*	*John Hudson*	*Dale Nebuda*			
				Break in Exhibit Hall			
Room 224	**TRACK 10** Dam Safety				A dam safety study involving cascading dam failures		The relationship of seismic velocity to the erodibility index
	Session 10F				*Gordon Lance*		*Joseph Topi*
Room 240	**TRACK 12** Civil Works Structural				Olmsted dam in-the-wet construction methods	Completion of the Olmstead approach walls	John Day lock monolith repair
	Session 12F				*Lynn Raque*	*Terry Sullivan*	*Mathew Hanson*
Room 241	**TRACK 13** Civil Works Structural				Development of design criteria for the Rio Puerto Nuevo contract 2D/2E channel wall	Design of concrete lined tunnels in rock	Indianapolis north phase IIIA project
	Session 13F				*Jana Tanner*	*David Force*	*Gene Hoard*
Room 242	**TRACK 14** Bridges/ Buildings				UFC 4-023-02 Structural design to resist explosive effects for existing buildings	Progressive collapse UFC requirements	U.S. general services admnistrative progressive collapse design guidelines applied to concrete moment-resisting frame buildings
	Session 14F				*Jim Caulder*	*Brian Crowder*	*David Billow*

12 Noon — **Lunch**

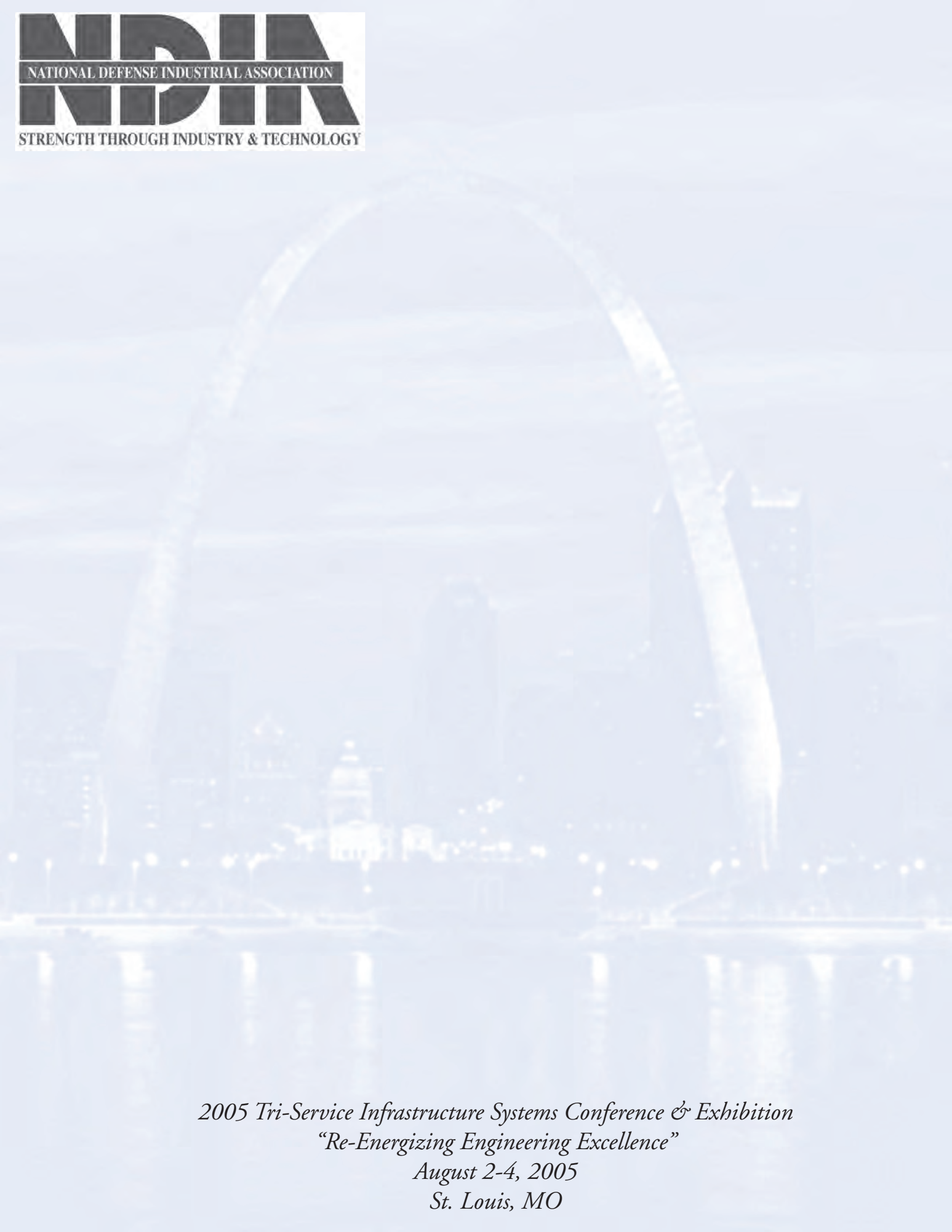
	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 224	**TRACK 10** Dam Safety	Dam safety instrumentation data management utilizing WinIDP to aid data collection and evaluation	Automated instrumentation assessments at Marmet lock & Dam	Potential failure mode analysis of Eau Galle Dam			
	Session 10G	*Travis Tutka*	*Ronald Rakes*	*David Rydeen*			
Room 240	**TRACK 12** Civil Works Structural	Inner Harbor navigation canal and lock structure	Design features and challenges of the Comite River diversion project	Waterline support failure on the Harvey canal: A case study			
	Session 12G	*Mark Gonski*	*Christopher Dunn*	*Angela DeSoto Duncan*			
				Break			
Room 224	**TRACK 10** Dam Safety				Dam safety officers panel - The Good	Dam safety officers panel - The Bad	Dam safety officers panel - The Ugly
	Session 10H				*Bruce Murray*	*Bruce Murray*	*Bruce Murray*
Room 240	**TRACK 12** Civil Works Structural				Public appeal of major civil projects- The good, the bad and the ugly	Des Moines Riverwalk	Chickamauga lock and Dam height optimization study using Monte Carlo simulation
	Session 12H				*Kevin Holden*	*Thomas Heinold*	*Leon Schieber*

Thursday, August 4, 2005 Concurrent Workshops

	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM
Room 241	**Workshop 1** DoD Security Engineering	Security planning & minimum standards	Security planning & minimum standards (Continued)	Security planning & minimum standards (Continued)	Security design manuals	Security design manuals (Continued)	Security design manuals (Continued)
	Session 1A	*Curt Betts*	*Curt Betts*	*Curt Betts*	**Session 1B**	*Bernie Deneke*	*Bernie Deneke*	*Bernie Deneke*
Room 231	**Workshop 2** Electrical Workshop	National Electrical Code 2005 Changes	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)	National Electrical Code 2005 Changes (Continued)
	Session 2A	*Mark McNamara*	*Mark McNamara*	*Mark McNamara*	**Session 2B**	*Mark McNamara*	*Mark McNamara*	*Mark McNamara*
Room 242	**Workshop 3** Mechanical Engineering	Design and application of packaged central cooling plants	Design and application of packaged central cooling plants (Continued)	Design and application of packaged central cooling plants (Continued)	Improving dehumidification in HVAC systems	Improving dehumidification in HVAC systems (Continued)	Improving dehumidification in HVAC systems (Continued)
	Session 3A	*The Trane Company*	*The Trane Company*	*The Trane Company*	**Session 3B**	*The Trane Company*	*The Trane Company*	*The Trane Company*
Room 230	**Workshop 4** Construction	Construction Community of Practice Forum	Construction Community of Practice Forum (Continued)	Construction Community of Practice Forum (Continued)			
	Session 4A	*Walt Norko*	*Walt Norko*	*Walt Norko*			
Room 232	**Workshop 5** Specifications	Open Meeting of Corps Specifications Steering Committee	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)	Open Meeting of Corps Specifications Steering Committee (Continued)
	Session 5A	*Robert Iseli, et al.*	*Robert Iseli, et al.*	*Robert Iseli, et al.*	**Session 5B**	*Robert Iseli, et al.*	*Robert Iseli, et al.*	*Robert Iseli, et al.*

Break

NOTES



2005 Tri-Service Infrastructure Systems Conference & Exhibition
"Re-Energizing Engineering Excellence"
August 2-4, 2005
St. Louis, MO

Structural and Geotechnical Issues Impacting The Dalles Spillwall Construction and Bay 1 Erosion Repair

Jeffrey M. Ament, PE
U.S. Army Corps of Engineers,
Portland District
(503) 808-4950
Jeffrey.M.Ament@usace.army.mil

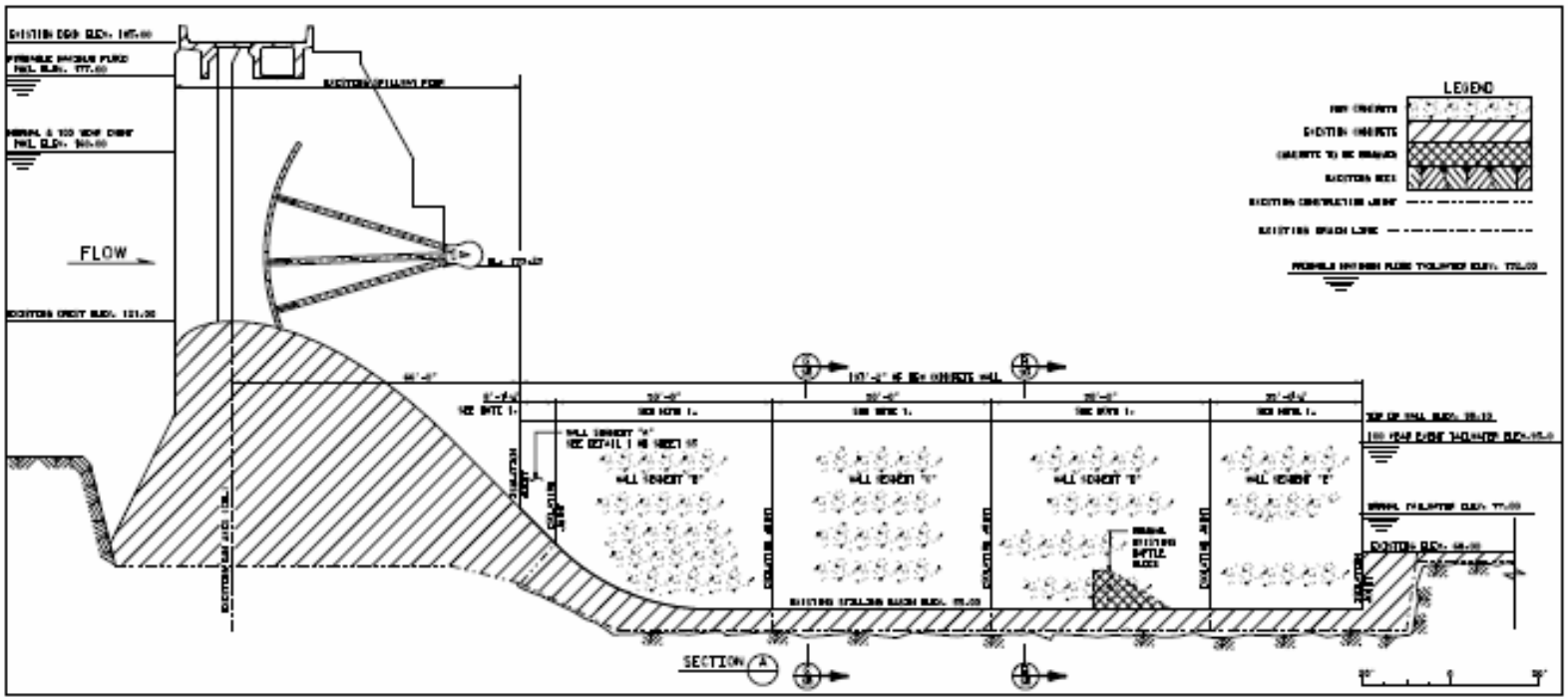
Reason for the Spillwall

- Juvenile Fish Passage through spillway
- Predator habitat to the South
- Spill only in northern bays
- Lateral flow and retention time not acceptable
- Need to separate spilling bays from non-spilling bays with a training wall



Spillwall Requirements

- Wall width: must match existing 10’ Pier width
- Wall height: 43’
- Wall length: 193’



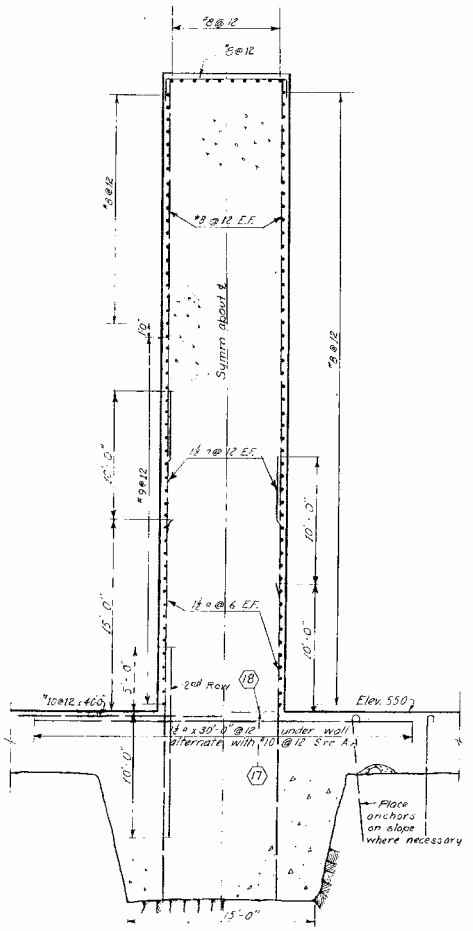
Structural Design

- Load
  - Design load occurred at a River flow of 1050 kcfs and assumed spill on only one side
    - Overturn Moment – 1083.6 ft-kips/ft of wall
    - Shear – 62.1 kips/ft of wall



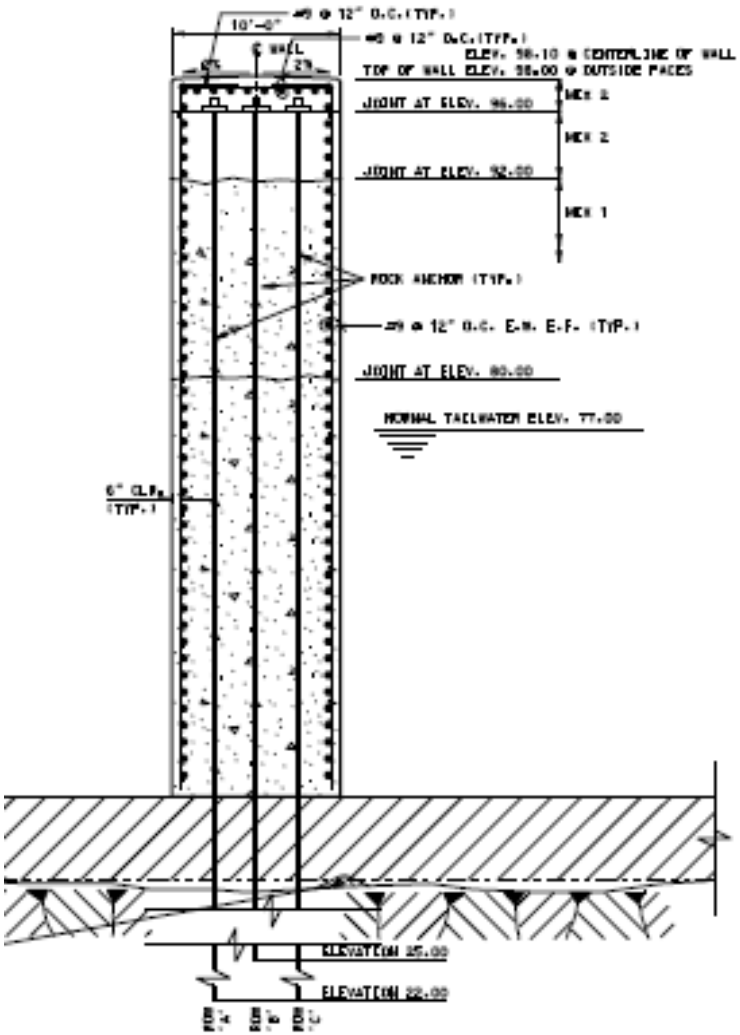
Typical Existing Wall

- Foundation below stilling basin slab
- Design would be very difficult to add to the existing structure



Construction Method

- Construct Wall first
  - Tremie placed concrete
- Construct Foundation last
  - Post-tension wall to rock using rock bolts
- Requires 3 rock bolts evenly spaced across the width (2.5’ o.c.) every 3’ o.c. the entire length
- Each rock bolt post-tensioned to 545 kips



Construction

- In-Water Work Period
  - Minimal Fish in the River System
  - November 1, 2003 – February 28, 2004



Underwater (Tremie) Placed Concrete



Rock Bolt Ducts

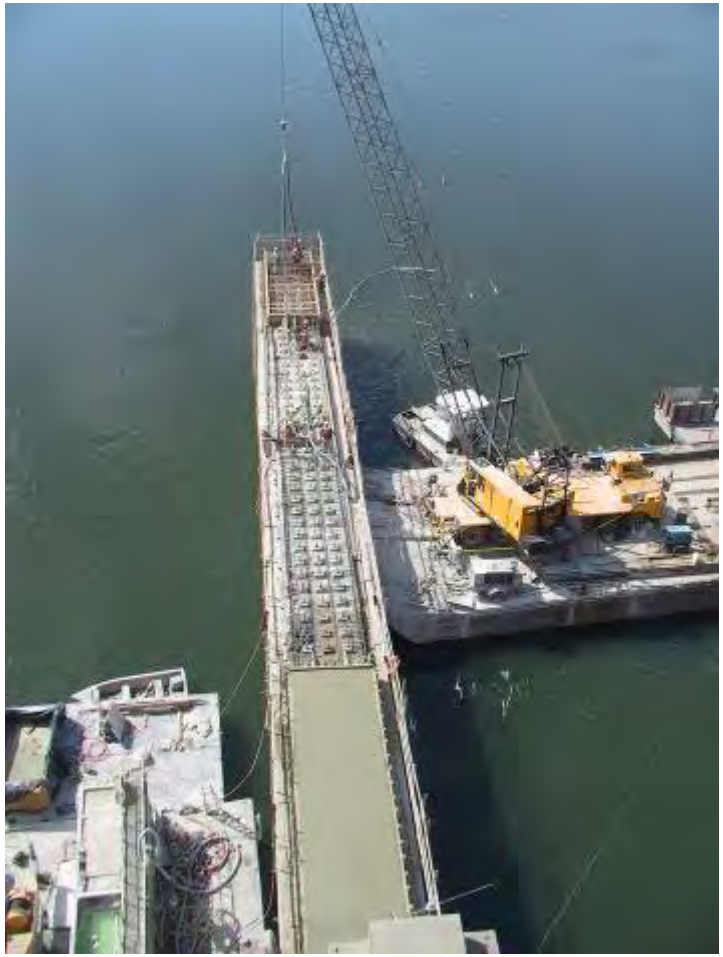
- Spiral wound steel ducts, used in prestressed concrete industry, specified as option for contractor
- Difficult to hold alignment during concrete placements
- Lesson learned: not a good choice for drilling through



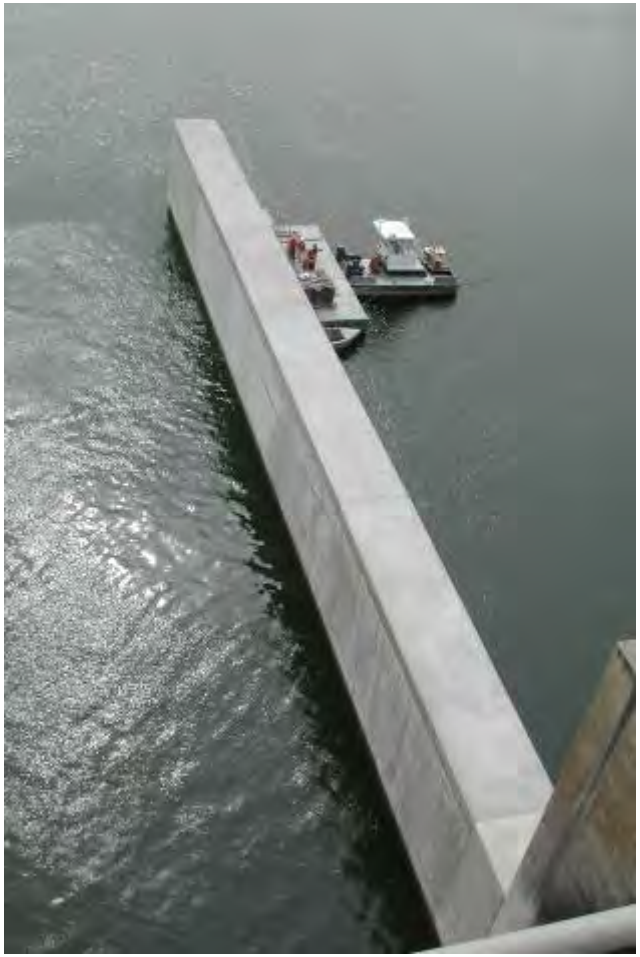
Concrete Formwork



Cap Placement



Completed Spillwall



Spillwall in Action



New Spill Pattern

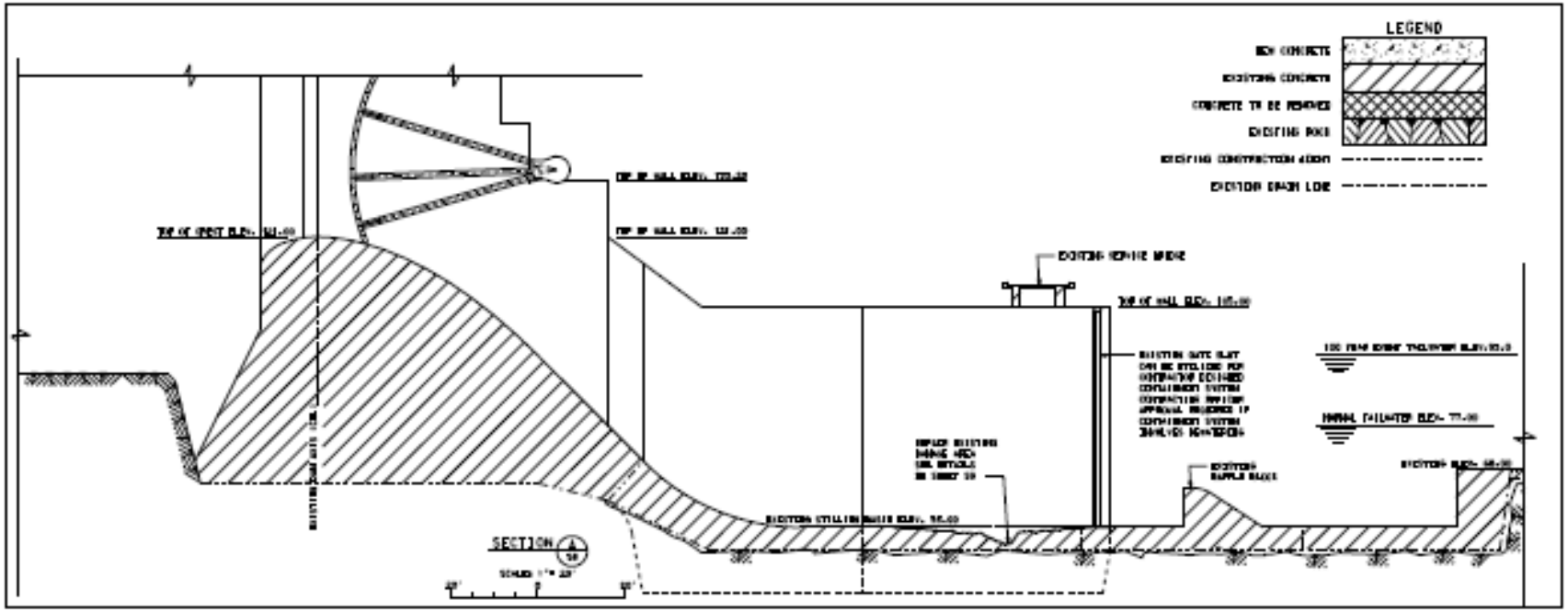


Bay 1 Erosion Hole Repair



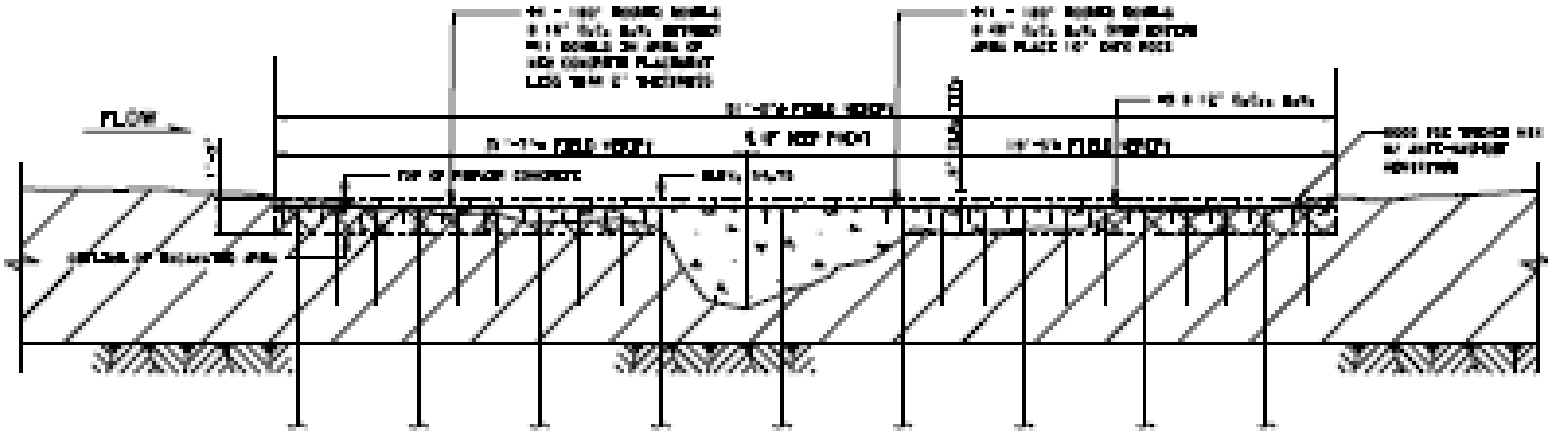
Bay 1 Stilling Basin Erosion Hole Repair

- 4’ Deep Hole in 5’ Stilling Basin Slab



Repair Design

- Excavate out concrete to 15” minimum depth
- Replace #11 dowels into rock
- Add #4 dowels into existing concrete
- Place #9 mat each way to help in load transfer



Contractor Chose to Dewater

- Very difficult to dewater
- Water coming in from:
  - Wall joints
  - Floor joints, Floor slab drains pressurized with tailwater
  - Contractor Temporary Bulkhead





Causes of Erosion

- Not likely ball milling from large objects
- Possible erosion from
  - Small particles
  - Hydraulic conditions around wall
  - Poor initial concrete placement



Dowels into Rock

- Holes drilled into rock giving water
- Grout socks used to enable placement of dowels – providing mechanical anchorage
- Dowels still gave water
- Average dowel tested – withstood ~10 kips before hook bent and test suspended, dowels declared acceptable



Dowels into Concrete

- Some holes penetrated slab and geysered
- Switched from cementious grout to epoxy grout to shorten embedment length
- Geysering holes capped with PVC pipe to divert water out of concrete placement area



Concrete Placement Plan

- Due to dewatering problems
  - Flood bay to within 1’-3’ of tailwater (to keep bulkhead from blowing off)
  - Build a 4”-high form around placement area to account for poor surface concrete
  - Tremie place concrete using antiwash-out admix using direct pump method directed by diver
  - Cure for 1 week underwater, then dewater and remove excess 4” over-placement

Bay 1 Dewatered after Concrete Placement

- Diver had difficulties seeing
- Possible Incompatibility between High Range Water Reducer Admix and Antiwash-out Admix reduced the slump
- 4’ high mound formed that now had to be removed
- Some leaks existed
- Some low spots existed





Excess Concrete Removal

- Contractor attempted using:
  - Jackhammers
  - Concrete Saws
  - Backhoe
- USACE authorized use of a Bobcat Planer





Additional Repairs Made

- Pressure inject grout into leaks – assumed to be from water around dowels washing out concrete during placement
- Patch low spots
- Taper all edges to minimize any negative hydraulic effects





Final Repair Completed

- Final Repair was to stilling basin elevation +/- 3”
- Spill occurred from April 14, 2004 to August 31, 2004
  - Diver inspected in November 2004 – no signs of erosion
- Spill occurred from April 10, 2005 to present
  - Diver inspected June 21, 2005 – no signs of erosion



Case History: Multiple Axial Statnamic Tests on a Drilled Shaft Embedded in Shale

Paul J. Axtell[1], P.E.

J. Erik Loehr[2], Ph.D., P.E.

Daniel L. Jones[1], P.E.

1. Geotechnical Engineer, U.S. Army Corps of Engineers, Kansas City District
2. Associate Professor, University of Missouri-Columbia

Project Overview

1. A flood control project on the Blue River in Kansas City, Missouri began in 1983.

2. Currently, the reconstruction of two railroad bridges that cross the Blue River are under construction.

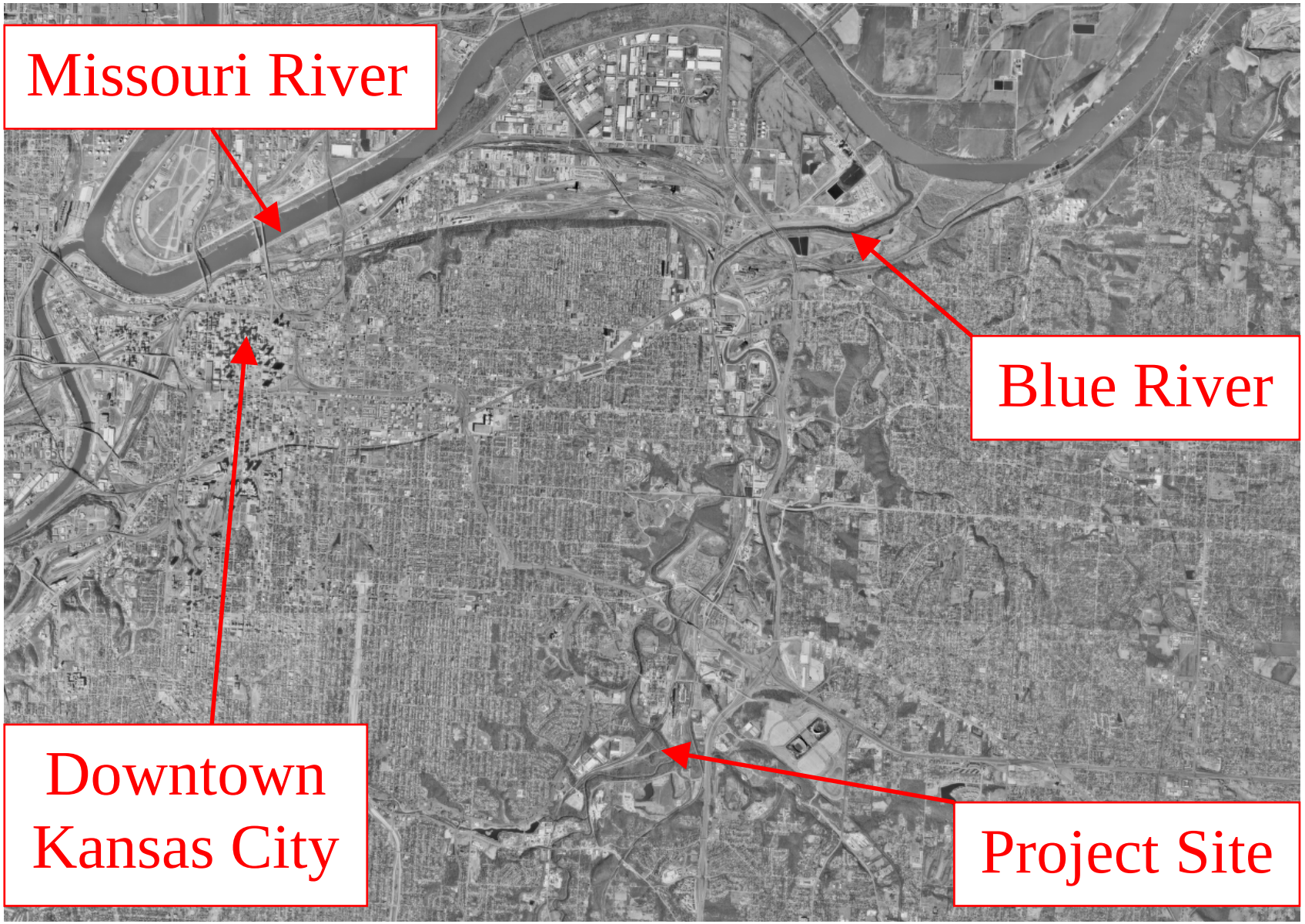
3. The bridge bents are founded on drilled shafts.

Test Objectives

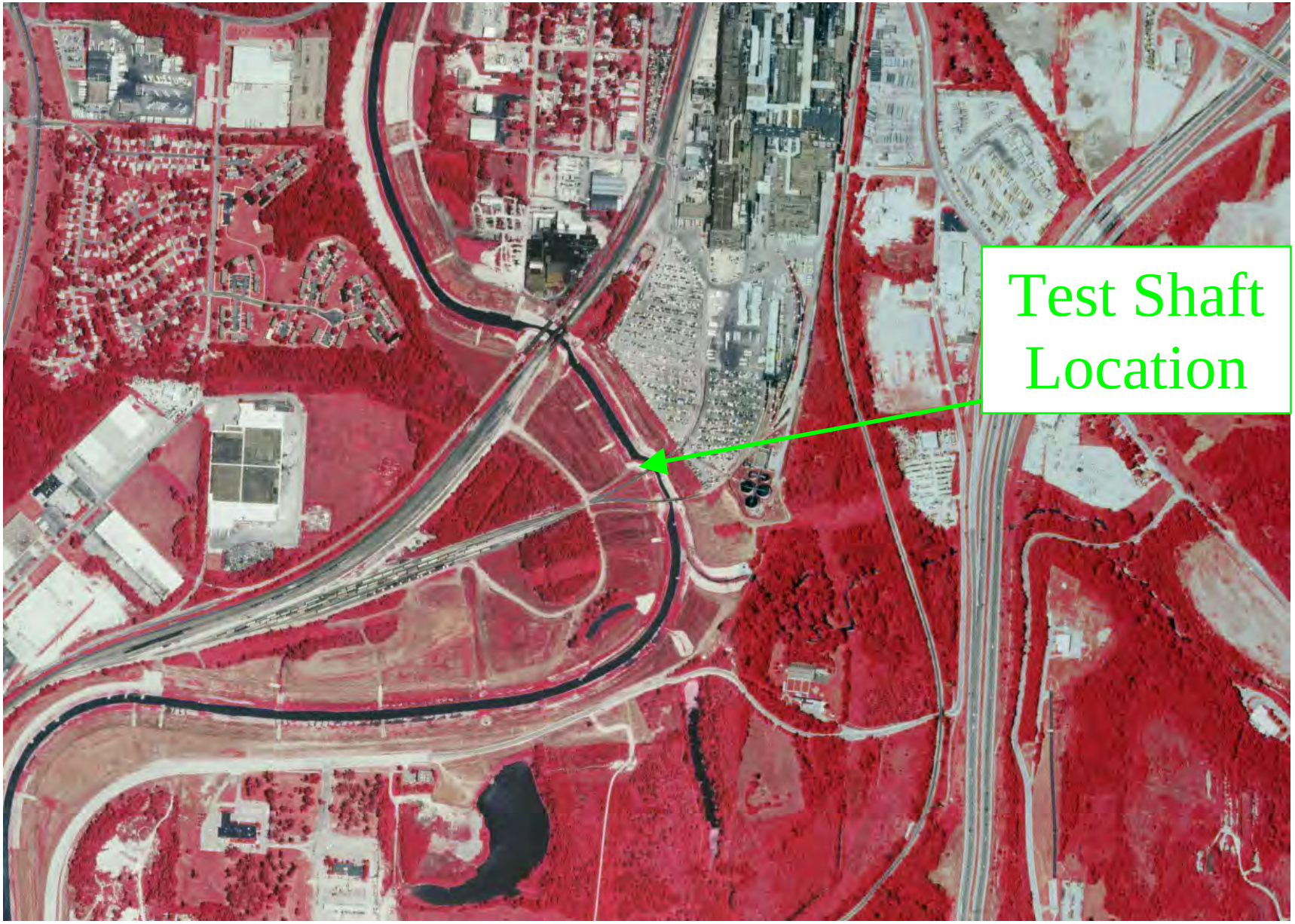
A Statnamic load test program was developed to:

1. ensure adequate capacity and acceptable deflections under anticipated loads.
2. potentially reduce the size (cost) of the foundations.
3. evaluate the drilled shaft design methodologies.
4. create a local load-test database, particularly with foundations embedded in shale.

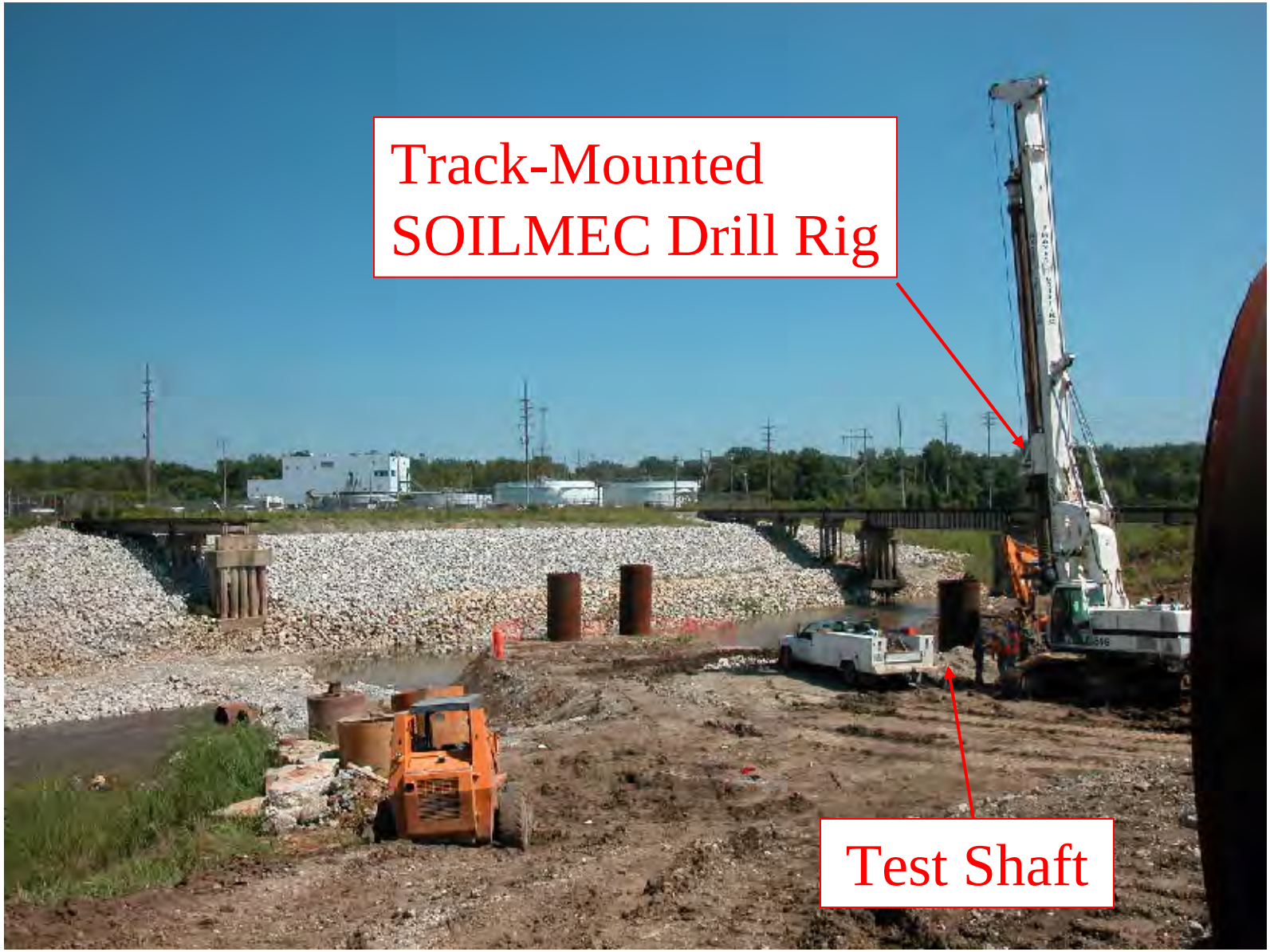
Project Vicinity



General Project Location



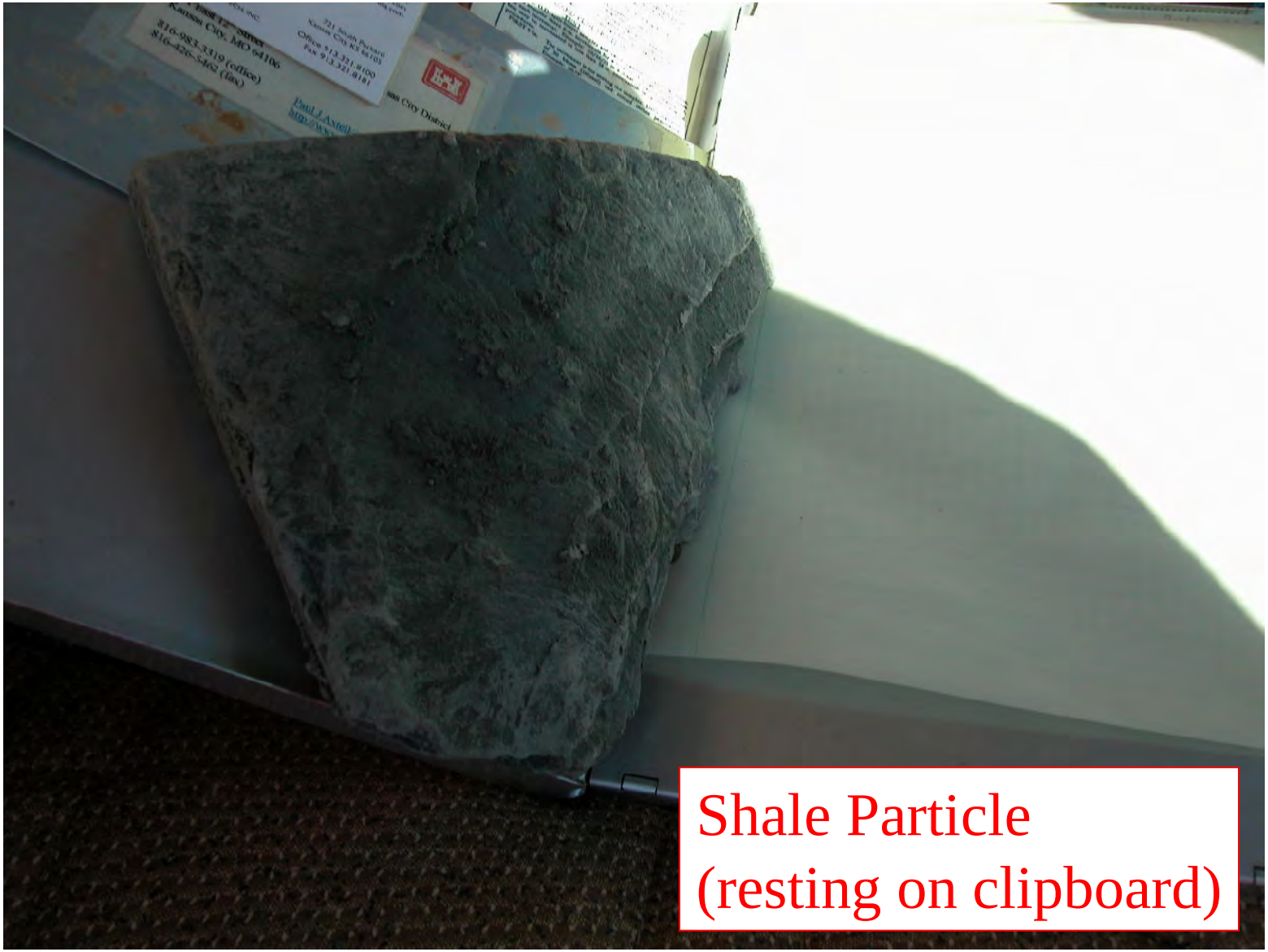
Test Shaft Location



Pleasanton Shale Drilling Spoils



Pleasanton Shale



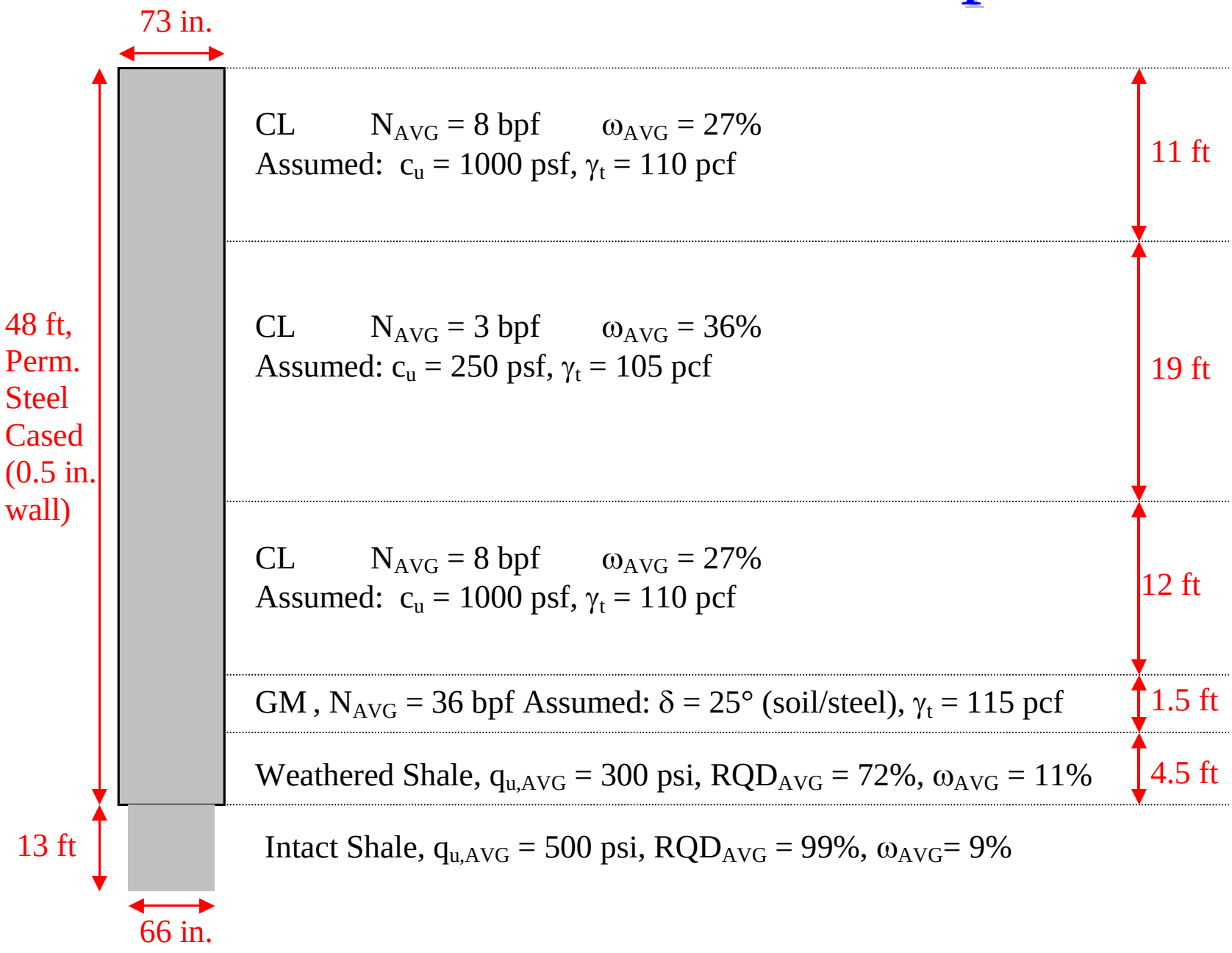
Reinforcing Cage



Concrete Placement



Shaft and Soil/Shale Properties



Design Side Resistance

1. CL: $\alpha = 0.55$ (O'Neill, 2001)

2. GM: $K = 0.8$ (Assumed)

3. Shale: $f_{max}/p_a = \Omega\,(q_u/2p_a)^{0.5}$

   (O'Neill, 2001 after Kulhawy and Phoon, 1993)

   where: f_{max} = max skin friction, psf

   $p_a = 2{,}116$ psf

   $\Omega = 1$ (smooth rock socket)

Design Side Resistance

Stratum I CL: side resistance = 116 kips

Stratum II CL: side resistance = 50 kips

Stratum III CL: side resistance = 126 kips

Stratum IV GM: side resistance = 27 kips

Stratum V-a Shale: side resistance = 581 kips

Stratum V-b Shale: side resistance = 1960 kips

Total Side Resistance = 2860 kips

Design Tip Resistance

$$q_{max} = 4.83(q_u)^{0.51}$$

(O'Neill and Reese, 1999, for intermediate geomaterials, cohesive rock with RQD between 70 and 100)

where: q_{max} = max tip resistance (MPa)

q_u = 3.45 MPa (72,000 psf)

Stratum V-b Shale: tip resistance = <u>4505 kips</u>

Design Capacity

Side Resistance + Tip Resistance = Capacity

2860 + 4505 = **7365 kips**

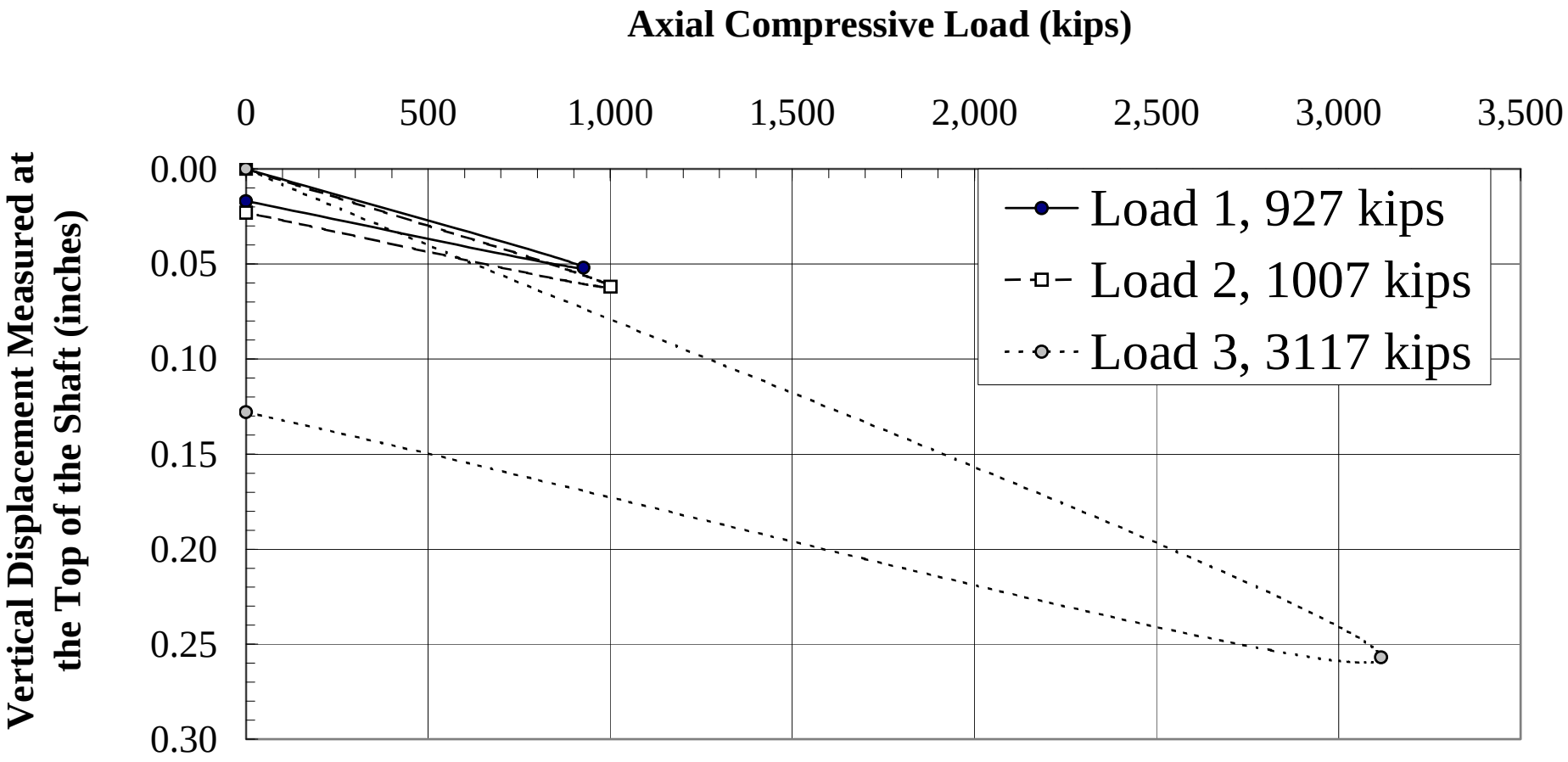
General Statnamic Test Set-Up



Statnamic Test in Progress



Test Results



Proof-Test Problem

1. Statnamic loads were not sufficient to reach the capacity of shaft. Direct comparison of measured and calculated capacities is therefore not possible.

2. Evaluation of estimated design capacity can be accomplished based on Statnamic results by utilizing normalized load transfer relations presented by the Federal Highway Administration (O'Neill and Reese, 1999).

3. Such comparisons require *extrapolation* of the data measured in the Statnamic tests following typical load-displacement response.

Required Data to use Normalized Curves

Δ_L = elastic change in member length

k = 0.5 (all load transferred in side resistance), 0.67 (portion of the load transferred in base resistance)

$\delta_s = k\,\Delta_L$ (δ_s is the compression within the drilled shaft due to column action)

w_T = maximum movement measured during each test

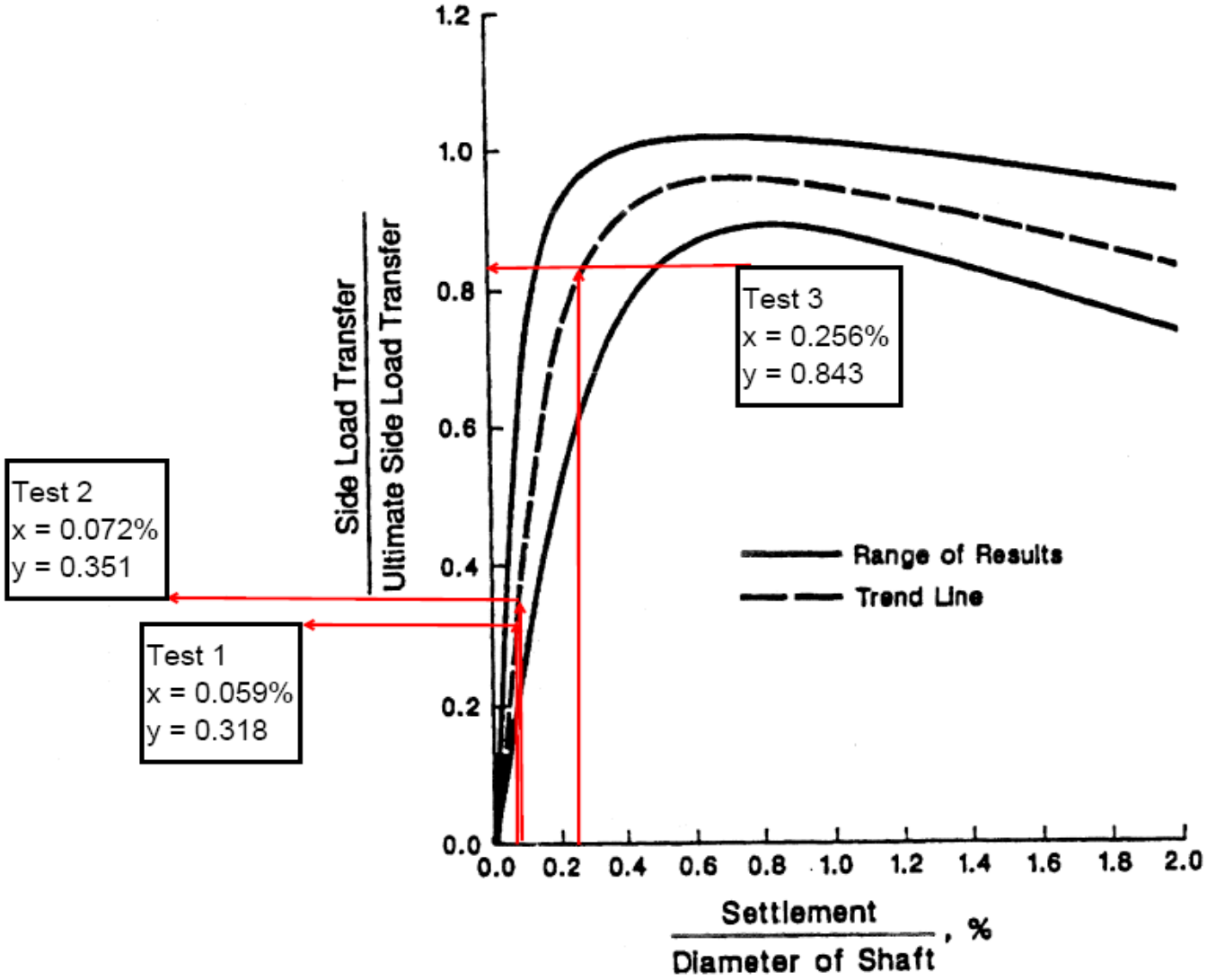
$w_s = w_T - 0.5\delta_s$ (w_s is the movement at the center of the shaft assuming uniform side load transfer rate)

$w_b = w_T - \delta_s$ (w_b is the settlement at the base)

Required Information for Use of FHWA Normalized Curves

Test	Δ_L (inches)	k	δ_s (inches)	w_T (inches)	w_s (inches)	w_b (inches)	w_s/71.5 in. (%)	w_b/66 in. (%)
1	0.039	0.5	0.020	0.052	0.043	0	0.059	0
2	0.042	0.5	0.021	0.062	0.052	0	0.072	0
3	0.131	0.67	0.088	0.257	0.213	0.169	0.298	0.256

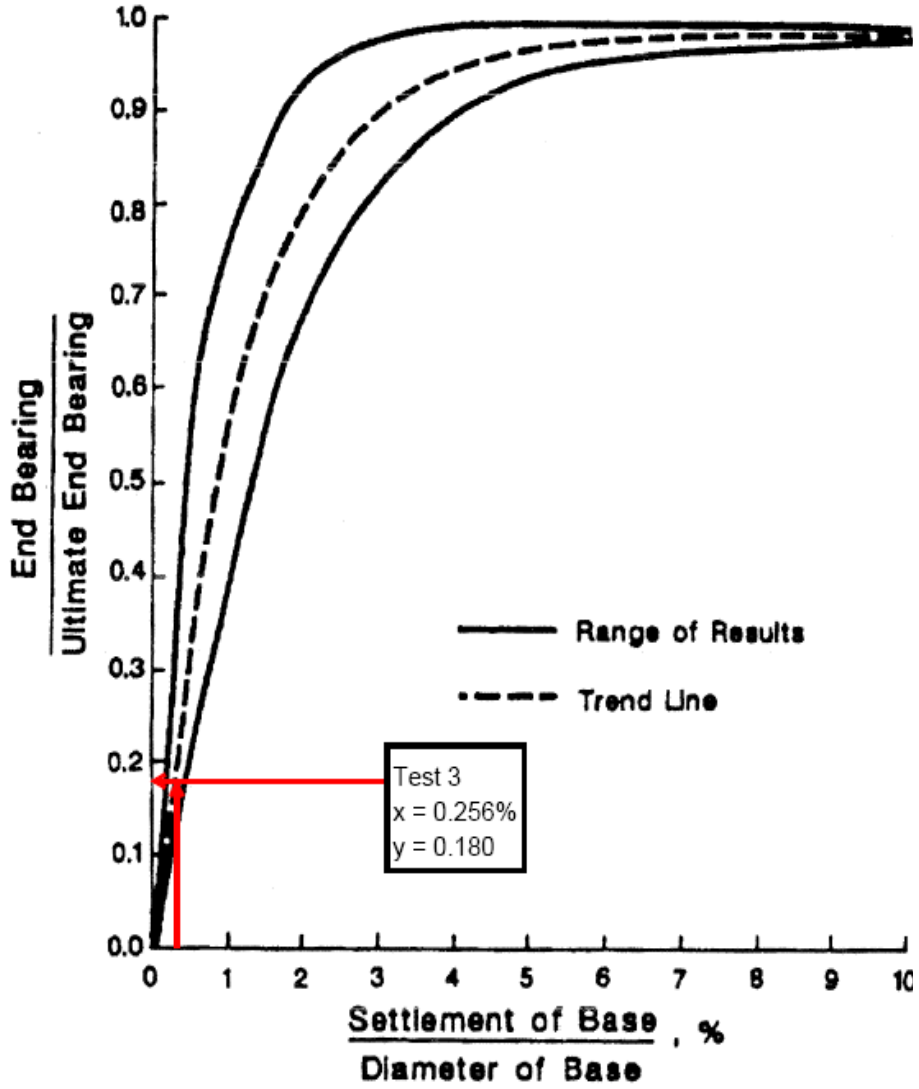
Normalized Curves for Side Resistance in Cohesive Soils



Evaluation of Side Resistance

1. Assume no load applied in Tests 1 and 2 reaches the tip
2. Ultimate side load transfer (USLT) estimated using normalized curves.
3. Entering the side resistance plot with the settlement-diameter ratio of 0.059 for Test 1, the USLT computed is 2915 kips (927/0.318).
4. Similarly, the USLT computed form Test 2 data is 2868 kips (1007/0.351).
5. The average USLT from Tests 1 and 2 is 2892 kips. This agrees very well with the design skin friction, which was 2860 kips (a difference of about 1 percent).

Normalized Curves for Base Resistance in Cohesive Soils



Evaluation of Base Resistance

1. Assuming the USLT determined in Tests 1 and 2 is accurate, the curves can be used to evaluate the base resistance using results from Test 3.
2. Based on Test 3 results, approximately 84% of the USLT is mobilized in side shear in Test 3, or 2438 kips (2892 x 0.843).
3. The remaining 679 kips (3117-2438) is therefore mobilized in end bearing.
4. Curves indicate approximately 18% of the ultimate end bearing (UEB) load is mobilized in Test 3.
5. If 679 kips are transferred in end bearing, the UEB based on the curves is 3772 kips (679/0.18).
6. Extrapolated UEB is 16% lower than the design tip resistance of 4505 kips, but within the range of variability expected of the extrapolation procedure.

Comparison

Sum of the extrapolated USLT and UEB is 6664 kips (2892+3772).

This underestimates the design capacity of 7365 kips by 10 percent.

Conclusions - 1

1. Kulhway and Phoon (1993) adequately estimates the side resistance of drilled shafts in Pleasanton shale rock sockets, assuming a smooth socket.
2. O'Neill and Reese (1999) adequately estimates the base resistance of drilled shafts in Pleasanton shale, assuming intermediate geomaterials and cohesive rock with RQD between 70 and 100.

Conclusions - 2

3. Based on Statnamic testing at varying loads and normalized curves, the contribution of side resistance to the capacity of a deep foundation can be determined assuming negligible load is transferred to the base during lower magnitude testing.
4. Normalized curves for cohesive soils appear to adequately model the load-settlement behavior of drilled shafts embedded in Pleasanton shale bedrock.

Conclusions - 3

5. No measurable rebound was observed at the conclusion of any of the three tests, perhaps suggesting plastic behavior of the shale, as opposed to elastic behavior. More data is required on this topic.

Completed Bridge



Contact Information

- Paul J. Axtell, P.E., 816-983-3319, U.S. Army Corps of Engineers, Kansas City District, paul.j.axtell@usace.army.mil

- J. Erik Loehr, Ph.D., P.E., 573-882-6380, University of Missouri-Columbia, eloehr@missouri.edu

- Daniel L. Jones, P.E., 816-983-3603, U.S. Army Corps of Engineers, Kansas City District, daniel.l.jones@usace.army.mil

Sensitive Infrastructure Sites - Sonic Drilling Offers Quality Control and Non-Destructive Advantages to Geotechnical Construction Drilling

J.P. Davis[1] August 4, 2005

Abstract

The use of conventional circulatory air rotary and fluid rotary, cased and uncased drilling methods in the vicinity of sensitive infrastructure can have deleterious effects on the ground conditions surrounding and supporting structures. Furthermore, the use of these methods offers little valuable information, while numerous production boreholes are advanced, regarding the actual subsurface conditions that exist which can be used to evaluate actual conditions and progress during construction. This paper will discuss the history and properties of Sonic drilling and explore case histories of Sonic drilling use to advance boreholes within vulnerable structures and on sensitive sites for several recent infrastructure projects – a tunnel and railroad project, a dam grout curtain project and a bridge micropile exploration project. Project summaries will discuss the advantages realized when the application of Sonic drilling techniques demonstrated superior accuracy, quality control, efficiency, productivity, penetrability, waste minimization and adaptability when drilling adjacent to or within infrastructure. Sonic drilling was used to install casings at over 2,000 locations within the active train track structure at Boston's South Station on the jacked-tunnel, ground freezing subcontract to the Central Artery/Tunnel Project. The paper will also discuss the benefits of using Sonic drilling to advance grout curtain boreholes through overburden within sensitive earthen dam structures, such as the recent application at Clearwater Dam in Missouri. The paper will then address the on-going exploration of a Pennsylvania bridge overpass experiencing settlement due to deep Karstic solution features. Finally, suggestions will be made regarding the application of Sonic drilling for future use in the installation of micropiles (*SonicPiles*[SM]), earth retention and grouting where the quality control benefits provided by the inherent soil cores, measurement while drilling systems and non-destructive production drilling features will be advantageous.

Introduction

Drilling within the vicinity of existing infrastructure often requires a non-destructive method to facilitate careful exploration or geotechnical construction. Conventional air rotary and fluid rotary, cased and uncased, circulatory drilling practices have resulted in disturbance to ground and subsequent damage to existing structures or ground conditions. Particularly vulnerable structures and sensitive soil conditions can be adversely affected by the use of such methods that circulate air or water, even when advancing a cased borehole and can have deleterious effects on ground conditions, including hydraulic fracturing and undermining.

Furthermore, if geological and infrastructure conditions are of a complex, vulnerable or sensitive nature, quality control is of paramount importance. Beyond the typical quality

[1] Construction Drilling Division Manager, Boart Longyear Company, P.O. Box 15010, Cincinnati, OH 45215-0010 U.S.A., Phone: (800) 422-6552, Fax: (320) 632-2915, jdavis@boartlongyear.com

control practices which are commonly performed subsequent to the installation of geotechnical elements, *measurement while drilling* (MWD) is now possible through the use of computerized instrumentation installed on the Sonic drill rig. This process can be used as a comparative mechanism for exploration and evaluation across a given site, as well as to determine if construction practices are achieving their intended goals while ground improvement or element installation is performed (i.e., micropiles, anchors, grout). MWD quality control methods can be enhanced, if a drilling method is selected which also provides soil samples.

Therefore, both records of the drilling parameters, as well as a physical record of the soil conditions are preserved across the site to evaluate the actual conditions while production is underway. The Sonic drilling method is one such approach, which can provide these and other advantages, both for the exploration phase and for the construction phase of drilling and geotechnical element installation.

Sonic Drilling History - Boart Longyear Company

Research on rotary-vibratory (Sonic) drilling techniques began in the late 1940's. The best-documented work in the U.S. was performed by the Drilling Research Institute (DRI). Russia also worked on developing Sonic drilling prior to 1950. At a meeting in 1957 at the Moscow Drilling Institute, drilling rates of three to 20 times that of conventional methods were reported. Supported by the petroleum industry, DRI started research and development in 1946 and terminated their efforts in 1958 when funding was discontinued. The goal of this effort was to speed up oil well drilling operations by adding vibrations to the rotary motion of the drill pipe and to enhance well development or rejuvenation.

In the early 1960's, an inventor in the United States, supported by Shell Oil Company, continued the research and development efforts. He developed a downhole device that used a series of eccentric weights driven by drilling fluid to generate vibration. He also developed a top-head, high horsepower vibrator to be used for pile driving and a smaller oscillator for driving smaller pilings, installing casing under roadways, and drilling seismic shot holes. This and other activity continued until the late 1960's, when Shell stopped funding the project.

A British manufacturer continued development efforts until 1983 using the inventor's prototypes. Several patents were applied for and received. All have since expired. From 1976 to 1983 when activity was suspended, the British company was successful in developing a small Sonic drill rig. They built approximately 10 drill rigs and 15 Sonic heads. These heads are some of the basic units used on the drill rigs in operation today.

North Star Drilling Company (North Star), MN, U.S.A., was the first to operate Sonic equipment in the U.S.A. for geotechnical and environmental purposes, beginning in 1985 and became a division of Boart Longyear in 1994 *(Boart Longyear Company, Environmental Drilling Division, Sonic Drilling, 2005).*

Sonic Methodology

Sonic Drilling, RotaSonic, RotoSonic, Sonicore, Vibratory or ResonantSonic Drilling, are some of the many names given to a dual cased drilling system that employs the use of high frequency mechanical vibration to continuously core overburden and most bedrock formations, and to advance casing into the subsurface. The word Sonic appears in most of these names because this drilling technique vibrates the entire drill string at a frequency rate between 50 and 150 hertz or cycles per second. This frequency falls within the lower range of sound vibration that can be detected by the human ear, thus the term Sonic has been commonly used to describe this drilling system. The Rota- or Roto- part of the drilling technique refers to the rotational power that can be applied in hard formations to slowly rotate the drill string to evenly distribute the energy and the wear at the drill bit face.

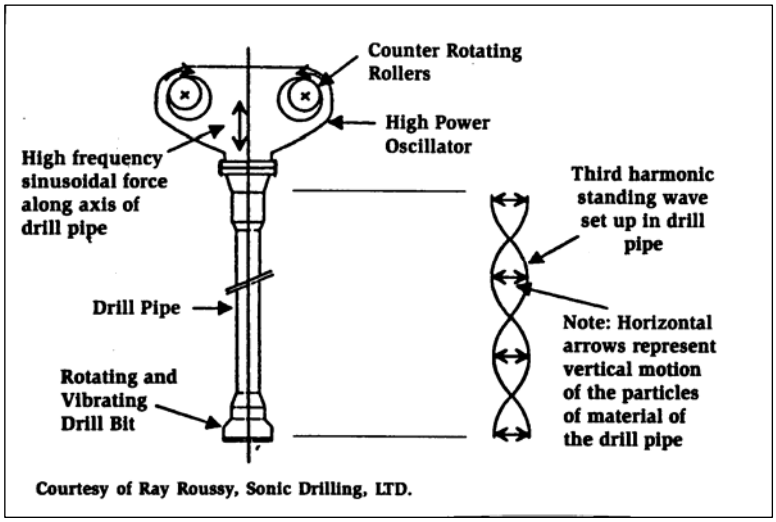


Figure 1. Principles of Sonic drilling (Roussy, 2002).

A Sonic drill rig looks and operates very much like any conventional top-drive rotary rig. The main difference is that a Sonic drill rig has a specially designed hydraulically powered drill head or oscillator, which generates adjustable high frequency vibratory forces. The Sonic head is attached directly to the core barrel, drill pipe or outer casing, sending the high frequency vibrations down through the drill steel to the face of the drill bit creating the displacement, fracturing or shearing action depending upon the foundation being drilled. The oscillator uses two eccentric, counter rotating balance weights or rollers that are timed to direct 100 percent of the vibration at 0 degrees and 180 degrees. There is an insulator to separate the vibration from the drill rig itself.

The vibratory frequency is controlled to suit operating conditions and to achieve optimum drilling rates. When the vibrations coincide with the natural resonate frequency of the steel drill rod or casing a natural phenomenon called “resonance” occurs, therefore the word resonant is used. A complete or detailed discussion of resonance is beyond the scope of this article. However, with regard to the Sonic drilling system, resonance can

briefly be explained as allowing the rig to transfer timed vibratory energy into the top of the drill string, utilizing the natural stored energy of the steel, to cause the drill string to act like a flywheel or a spring delivering tremendous amounts of energy directly to the bit face. In many overburden formations, a Sonic drill rig can achieve rates of one foot per second *(Boart Longyear Company, Environmental Drilling Division, Sonic Drilling, 2005)*.

Though the Sonic rig differs significantly in design from conventional rigs, there are enough similarities built into the equipment by certain operators and manufacturers to promote versatility across several drilling methods and configurations. Such versatility is offered by the ability to quickly alternate between Sonic and conventional fluid rotary, air rotary and high-speed coring methods. Additionally, certain operators have configured equipment for a range of strokes depending on the production requirements and access issues of sites, as well as provided the equipment on skids, crawlers (tracks), all-terrain carriers (rubber-tires), high-rail undercarriages (railroad), turn-tables, heli-portable modules, barges and climate-controlled enclosed-trailers. Sonic drilling may be performed from vertical to horizontal orientations.

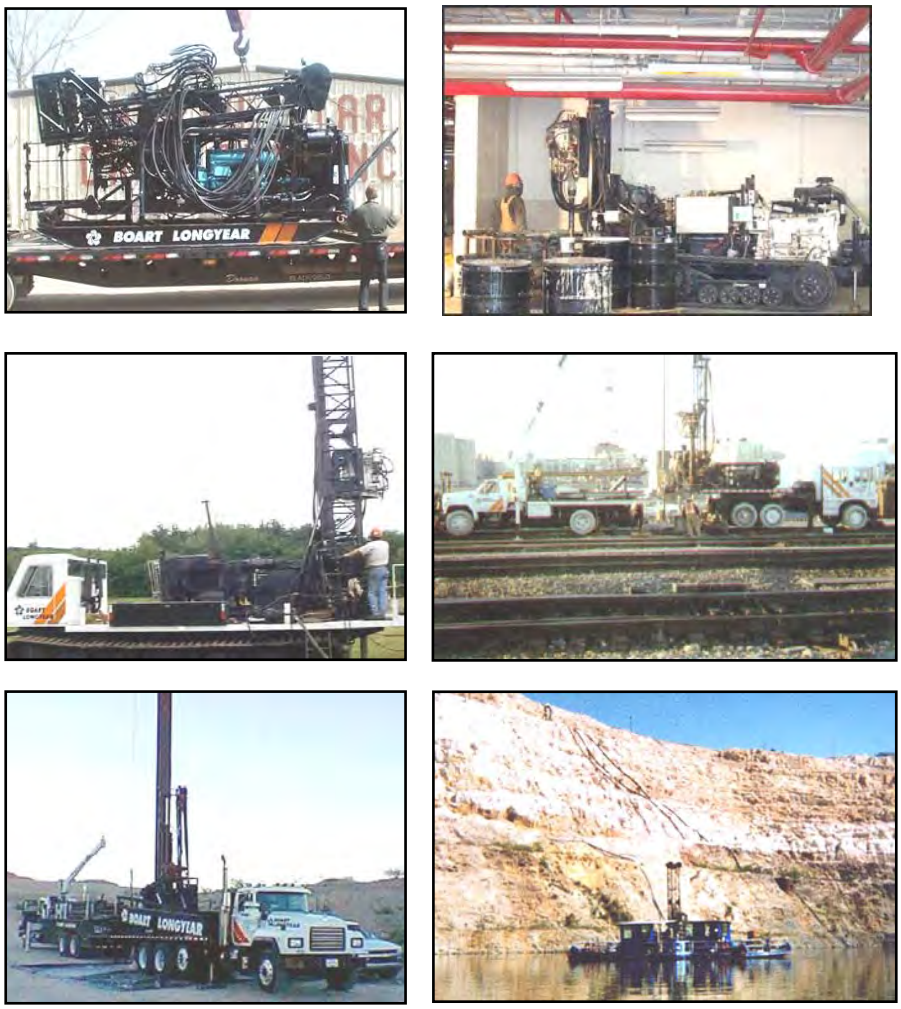


Figure 2. Common Sonic Rig Configurations (Boart Longyear Company)

Sonic Drilling Process

The processes resulting in borehole advancement are fracturing, shearing and displacement. Drilling through cobbles, boulders, fill and bedrock is caused by fracturing of the material by the inertial moment of the drill bit. Shearing takes place in dense silts, clay and shales, provided the amplitude of the drill bit is high enough to overcome the elasticity of the formation material. Displacement occurs when unconsolidated formation material is moved away by the vibrating drill bit. Boart Longyear has developed three basic drill bit face designs:

1) "Crowd in" - moves all the bit face material into the core barrel.
2) "Crowd out" - moves all the bit face material into the borehole wall.
3) "Neutral" - lets the bit face material seek the path of least resistance.

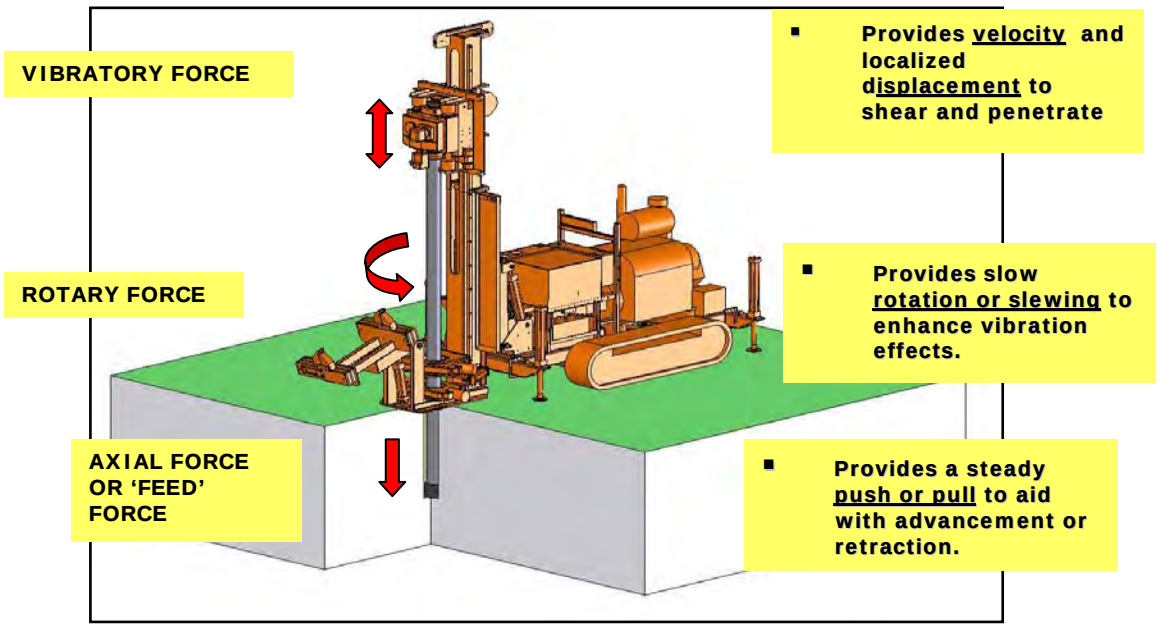


Figure 3. Illustrated principals of Sonic operation *(Boart Longyear Company, 2002)*.

Very few, if any, drill cuttings are conveyed to the surface, except for the core sample itself. As a result the volume of drill cuttings generated during Sonic drilling is in most cases only 10% to 20% of the volume created by hollow stem auger, rotary, or cable tool methods. Optimum penetration rates are obtained when the vibration frequency and down-pressure work in harmony. Experienced drillers monitor the oil pressure gauges in the system to adjust the frequency, the rotation, or the down pressure for the conditions encountered. *(Boart Longyear Co., Environmental Drilling Div., Sonic Drilling, 2005)*

As discussed, the Sonic drilling system employs simultaneous, high-frequency, vibratory energy and the optional/adjustable application of low speed rotational motion and down-pressure to advance the cutting edge of a Sonic drill bit. This action produces a uniform borehole while providing continuous, representative, relatively undisturbed core samples of both overburden and most bedrock formations. The Sonic system has many

advantages, but the most unique is the inherent ability to obtain large diameter (three inch to ten inch) continuous core samples of almost any overburden formation without the use of air, fluid or additive circulation, and with or without rotation. Sonic can also drill and sample through boulders, wood, concrete and other construction debris which with conventional rigs usually causes refusal and necessitates moving and re-drilling.

The Sonic system can drill and sample softer bedrock formations such as sandstone, limestone, shale and slate with excellent results. Harder bedrock such as granite can be drilled and sampled, though the costs are higher due to excessive wear on bits, drill pipe and the drill head. If large amounts of hard bedrock need to be drilled and sampled the Sonic rig can be quickly adapted for diamond wire-line or air hammer drilling. Most bedrock drilling and sampling requires the addition of water or air or both to remove drill cuttings as with any other rock drilling system. However, this does not imply that Sonic requires "circulation" through this addition of water, but rather lubrication and cleansing of the bit generally with low volumes and pressures, which generally dissipate into the formation easily.

A Sonic drill rig advances a three-inch to ten inch diameter (nominal) core barrel for sampling and can advance up to a twelve-inch diameter outer casing for the construction of wells, casings, micropiles (***SonicPiles***[SM]), anchors and grout holes. When drilling, the core barrel is advanced ahead of the outer casing, micropile or anchor in one to thirty foot increments. The outer casing can be advanced down over the inner drill rods and core barrel, to collect a relatively undisturbed core sample as an inherent part of the drilling process. The outer casing can be advanced completely dry in most situations, or it can be advanced with water, air or drilling fluid additives, depending upon the formations being drilled, the depth and the diameter of the borehole. Nominal outer casing diameters are 3.5-inch, 4.5-inch, 5.5-inch, 7.5-inch, 8.5-inch, 10.5-inch and 12.5-inch, although a variety of casing sizes and combinations are possible. *(Boart Longyear Company, Environmental Drilling Division, Sonic Drilling, 2005)*

Quality Control, Sonic Soil Cores and Monitoring While Drilling

Every production hole has the potential to be a valuable source of information for engineers to determine if the actual subsurface matches the theoretical intentions of the borehole or geotechnical element. This confirmation of the subsurface may be accomplished during the construction drilling process at each of the many locations across a given site. Enhanced quality control is therefore possible through the inherent production of a Sonic core (soil, rock or obstruction) along every foot of the subsurface drilled allowing for a detailed record of subsurface conditions and anomalies, concurrent with geotechnical construction and installation.

Since historically a relatively few preliminary geotechnical soil borings are performed across a given site prior to the production phase of construction, augmentation of the approach to ground treatment while grouting, installing micropiles (***SonicPile***[SM]) and applying earth retention (anchors, ground freezing) is thereby possible using Sonic production drilling through the evaluation of real-time data using soil cores and

monitoring while drilling systems. Site engineers may review soil data and core samples to determine if, for instance, the micropile (***SonicPile***[SM]) has truly encountered the required thickness of the intended bearing zone or if the soils are appropriate for the intended compaction or permeation grouting requirements.

Data may be converted into specific energy through the use of calculations incorporating thrust (kN), cross sectional area of the borehole (m^2), rotational speed (revolutions per second), torque (kN)-m) and penetration rate (m/second), *(Weaver, 1991; Bruce, D.A. and Davis, J.D., 2004)*. MWD-equipped Sonic drilling equipment can offer both drilling parameter data as well as actual soil cores to corroborate with data. This dual quality control method can enable a more efficient approach to the construction process, which will help avoid the pitfalls occasionally experienced due to previously unknown variations in geology. More precise construction and installation is thereby possible on the more critical, vulnerable and sensitive sites and structures.

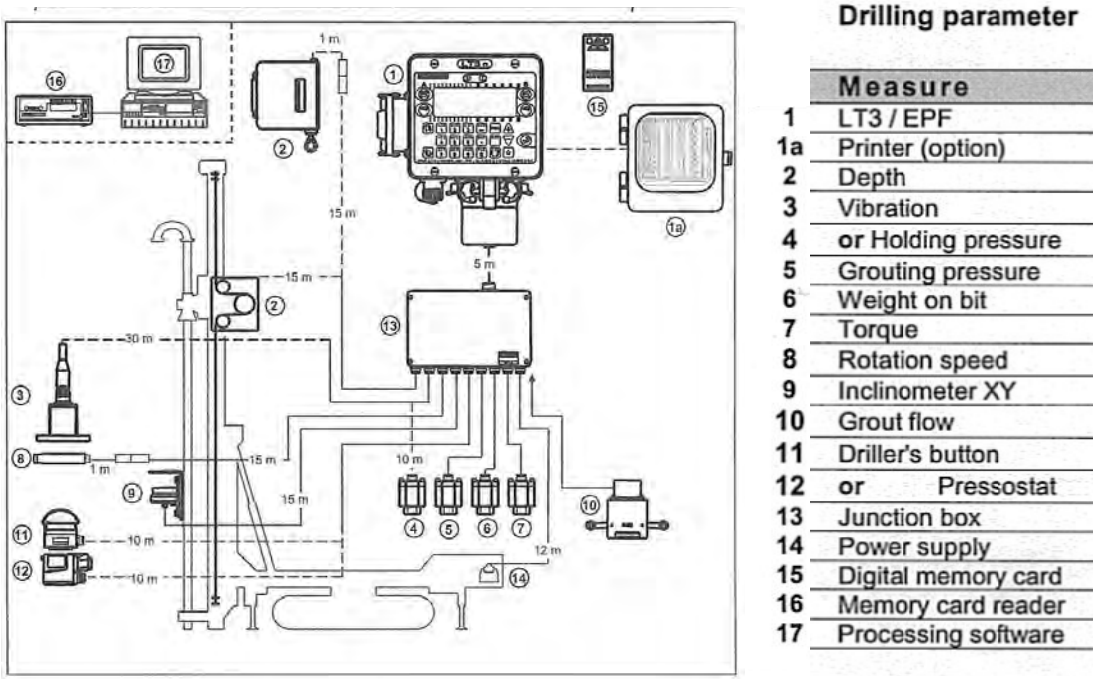


Figure 4. *Jean Lutz, S.A.* Measurement While Drilling System (Davey Kent Inc.).

Advantages of the Sonic Method for Geotechnical Construction

Sonic methods allow for a number of advantages. High penetration rates are possible through conditions, such as loose flowing soils, sands and clays. In addition, mixed fill is penetrable, such as steel reinforcements, concrete foundations and wooden timber piles. Natural obstructions are also penetrable, such as boulders and bedrock. Sonic drilling provides advantages in extraordinarily challenging conditions:

- Existing foundations
- Wood
- Metals
- Voids

- Unconsolidated formations that risk undermining
- Karstic solution features
- Boulders
- Bedrock

There is a reduced risk of over excavation and undermining through the elimination of air and water circulation. The Sonic method does not rely on air or water circulation. Where resistance is met through such elements as dense formations, obstructions, boulders or bedrock, low volumes of water may be added to cleanse the drilling face of cuttings. Where permissible, low volumes of drilling mud may be added to the water to increase productivity. However, the method can be performed without the addition of water, although this will at times be at the expense of depth, diameter and productivity.

Accurate drilling tolerances are possible in both vertical and horizontal orientations, since the Sonic method may be performed with a minimal annular area around the outer casing. An annulus is often responsible for the deviation of conventional drilling methods. Additionally, most conventional drilling methods rely on rotation speed and bit pressure, among other factors to advance in soil and rock. However, rotation and bit pressure can contribute to borehole deviation. Deviation is usually in the direction of rotation. Bit pressure can contribute to the degree of deviation where variations in soil or rock resistance and features will offer the bit a path of least resistance.

Finally, where an annulus above or behind the drill bit exists, the degree of bit pressure and drill string rigidity can allow the drill string to key into the borehole or outer casing inner wall causing the trajectory of the bit to deviate. Stabilizers may minimize this deviation, although any annular area will result in the potential for inner bit or outer casing movement off of its intended path. Tight tolerances between Sonic inner and outer casings, as well as special bits with minimal exterior gauge, allow for less opportunity for deviation due to a reduction in the annular space surrounding the casing. Controlled drilling is also possible since the method does not rely on high rotation speeds and down pressure. Additionally, Sonic energy causes a gentle, push/pull, spring action at the bit face, which allows the bit to carve through soils and rock using rotation, at the operator's discretion, to distribute bit wear. Each of these features promotes greater accuracy and tighter tolerances.

Other sites which benefit are active sites such as railroads, light rails and over-water projects. When using conventional air rotary or fluid rotary, direct or reverse circulation, cased or uncased methods, the circulatory effect on unconsolidated soils can be substantial. Less dense soils have the potential to wash-out and erode with fluid rotary methods and over excavation and hydraulic fracturing can result. Short-circuiting is possible outside of the temporary or outer casing or through weak soils to grade. Hydraulic fracturing may take place due to soil properties in combination with circulation pressure.

Air rotary techniques do not offer the fluid weight and balance features against unconsolidated formations or voided rock that fluid methods offer. Therefore, air rotary

techniques can be far more deleterious due to high pressure and volume circulation, which can greatly disturb, erode and undermine.

Neither method offers the benefits of Sonic drillingwhich relieves the formation of the negative properties brought about by circulation. Less drilling waste is also possible with the Sonic method, resulting in a substantially cleaner construction site of up to a 75% reduction in drilling waste. These features are also important on sensitive ecological and environmentally contaminated projects.

Examples of Sonic Drilling on Vulnerable Structures and Sensitive Sites

Tunnel/Railroad: Casing Installation, Central Artery/Tunnel Project, Boston (1997)

Casing installations (2,200 locations for 110,000 linear-feet total) for a ground freezing system were performed in an active track structure through railroad ballast, historical fill, reinforced concrete slabs and granite seawalls using high-rail, turn-table mounted Sonic rigs for Boston CA/T Project CO9A4. As part of the process of installing three jacked-tunnels under the 13 railroad tracks at South Station in Boston, MA, a specialized casing installation method was required. The drilling process would need to be fast, nimble and capable of advancing through many obstructions with tight tolerances and no disturbance to the live track structure.

A significant challenge was that the 4-1/2 inch (11.43 cm) outer diameter casings had to be installed to depths from 40 to 140 feet in an active train station, where hundreds of thousands of people commuted daily. The drilling was performed through some of the most horrific combinations of historical fill materials – steel rails, brick tanks, wood piles, granite seawalls, depressed concrete slabs, track ballast crushed rock, clay, stratified sands, till and weathered bedrock. All of the holes had to be installed within a strict tolerance vertically to allow for equal spacing for the ground freeze migration. Each location was verified with down-hole survey equipment. The Sonic drilling method was selected due to its ability to penetrate through the obstructions, maintain high production, perform nimbly and efficiently when surrounded by train traffic, maintain 1% tolerances, and preserve the track ballast in an undisturbed state.

The elimination of air and water circulation in the Sonic drilling process allowed the drilling to be performed without the risk of undermining the track structure and without producing any waste or fouling of the track ballast that is used to level the tracks. Two Sonic drill rigs were specially modified with rail gear to work on the tracks. The rigs were able to detach from an active borehole and rotate away on a turntable within just a few minutes, on a regular basis, to allow trains to pass. The crews also performed void testing and void grouting. None of the casings necessitated relocation due to obstructions using Sonic drilling.



High-rail, turn-table mounted Sonic rigs



Buried steel railroad rails cored with Sonic



Figure 5. Penetration of Sonic drilling directly through wood piles, granite seawalls and brick foundations, Central Artery/Tunnel Project, Boston, MA (Boart Longyear, 1999)

Earthen Dam: Grout Curtain Pre-drilling for Sink Hole, Clearwater Dam, MO (2004)

Sonic drilling was used to drill 15-degree battered grout holes through embankment fill. In January 2003, a 10-foot (3.05 m) diameter, 8-foot (2.44 m) deep sinkhole developed suddenly, near the crest on the upstream side of Clearwater Dam in Missouri. Its appearance prompted action for immediate subsurface investigation and, in turn, to affect a remedial plan involving a grout curtain installation. The project required a drilling method with multiple capabilities. It must have the ability to penetrate and sample both the body of the dam and its foundation without the use of air or water circulation. The core of the dam's body was comprised of materials, which ranged from heavy cobbles and rip rap to gravel and boulders. As the Sonic borehole approached the foundation, it would advance through an interface layer of hard clay, before terminating in Dolomitic bedrock, which offered occasional Karst characteristics and Chert layers.

Avoiding the use of air and water circulation prevented the potential for hydraulic fracturing of the sensitive dam prior to grouting. Sonic drilling was selected from a range of proposed drilling methods due to its versatility in both drilling (rate of penetration) and its sampling capabilities through a diverse array of materials and geology. Sonic was also preferred due to its non-invasive drilling properties which use limited or no fluids and low amplitude vibration to advance the cased boring. In addition, Sonic offers the ability to drill on a batter (angle) with accurate tolerances on a closely spaced grout hole alignment. The unique ability of Sonic to recover a complete, continuous sample through each of the various materials, provided the data necessary to accurately identify

questionable dam interfaces and highlight locations of piping and/or erosion of the foundation materials. In the initial phase, a grid of 37 borings was drilled through the dam's body and into the underlying rock foundation. The objectives of the drilling were twofold.

The first objective was to delineate the dam's stratigraphy by drilling deep into the dam's foundation to retrieve samples for laboratory testing and analysis. The samples were used to determine the mechanism for sinkhole development. Secondly, the borings were utilized as pilot holes necessary for the construction of a bedrock grout curtain installation. The Sonic borings were accurately drilled at an angle of 15 degrees off of vertical. The 15 degree angle was necessary to maximize the number of intersections with foundation crevices, thus increasing the effectiveness of the grout curtain.

The borings were advanced through the gravel- to cobble-sized materials in the dam's body to an average depth of 135 feet (41.15 m) and then, through the underlying 65-foot (19.81 m) thick hard clay layer, and finally through an additional 5 feet (1.52 m) into bedrock (using PQ size coring tools). After each borehole was drilled, a 4-inch (10.16 cm) PVC pipe was installed and grouted full depth. A partner contractor then drilled each borehole to a depth of 195 feet (59.44 m) into the bedrock for the construction of the grout curtain.



Figure 6. Long-stroke, truck-mounted rigs and tenders were used to pre-drill for the grout curtain at Clearwater Dam, MO (Boart Longyear Company, 2004)

Bridge: Karstic Limestone Drilling, PennDOT, SR-33, Stockertown, PA (2005)

An exploratory investigation of new micropiles and subsurface conditions is currently being performed at a bridge overpass north of Allentown, PA for the Pennsylvania Department of Transportation. The new overpass has been experiencing unacceptable settlement. Potentially, this settelement is due to Karstic solution features surrounding the supportive 7-inch micropiles, which extend to a maximum of 350 linear-feet below grade. In the past, settlement has lead to the shut-down of the highly traveled bridge and highway. Drilling is being performed with multiple rigs from each side of the stream embankment which the bridge overpass crosses. Vertical and battered Sonic drilling is being used to parallel micropiles to depths of over 450-ft through alternating Karstic limestone and voids containing silt, sand and clay. Sonic rigs are able to alternate

between Sonic, PQ high-speed coring and air rotary under-reaming depending on the subsurface conditions and the intention of the boreholes. Sonic casing and coring diameters of 10.5-inch, 8.5-inch, 7.5-inch, 6-inch, 5.5-inch and 4.5-inch are being used to strategically case-off unstable subsurface strata and aid in advancing through numerous Karstic layers and highly variable rock depths without opening additional voids and pathways within the rock.

Sonic enables the advancement of a stable, cased borehole, which provides for the installation of inclinometer instrumentation in each borehole. This is achieved through the alternating soils and rock layers to depths of over 450 feet and with tight tolerances.

By limiting or eliminating the use of air and water circulation, large diameter Sonic cores are clearly demonstrating the location of Karstic voids and defining the actual rock profile below the bridge. Further, sinkholes are being avoided by using Sonic rather than air rotary methods, as performed previously during the micropile installation or wash methods, as performed previously during investigations.

In the past, the use of air rotary at the site has resulted in promoting large sinkholes by opening and over-excavating silt and clay filled Karstic pathways and voids. The Sonic method has minimized the deleterious effects of conventional drilling practices and the risk to further damaging the vulnerable bridge structure and worsening the sensitive subsurface conditions.

The success of the use of Sonic in this capacity suggests great promise for its future use to install micropiles (***SonicPiles***^{SM}), earth retention anchors and grout curtain holes for remedial measures on similar vulnerable structures and geologically sensitive sites.



Figure 7. The use of Sonic methods to explore alternating Karstic voids to 450-ft below a bridge overpass foundation at PennDOT SR-33 (Boart Longyear Company, 2005)

New Applications in Construction

The use of Sonic drilling methods offers quality control in conjunction with production installation of geotechnical construction elements. It is now being recognized that where best value practices are required for the performance of construction on vulnerable structures and sensitive sites, Sonic drilling can offer quality control information and a less invasive approach. The following geotechnical practices are now being met with Sonic drilling methods, measurement while drilling (MWD) data and appropriately matched drill rig configurations (i.e., crawler-mounted and other rigs):

- Micropile installation (***SonicPiles***[SM])
- Grout injection
- Soil and rock anchors
- Temporary earth retention (i.e., ground freezing)
- Pre-drilling
- Exploratory soil sampling
- Confirmation coring



Figure 8. New crawler-mounted modular Sonic rigs (Boart Longyear, 2004)

Summary

Sonic is beneficial to the drilling process and geotechnical conditions on sensitive infrastructure projects. Low amplitude and high frequency Sonic energy can limit the impact to structures. Penetration and productivity are increased by the cutting and coring action of the bit and casing. By simultaneously coring and casing with Sonic methods, without the use of air or water circulation, problems associated with undermining, over-excavation and hydraulic fracturing that are common to conventional external flush and eccentric air rotary drilling techniques within or below sensitive structures, are eliminated.

The continuous Sonic coring and casing process provides quality control with precise core observation of the strata for simultaneous confirmation of micropile and anchor bond zones or grout application. Measurement while drilling (MWD) computers and instrumentation are now being added to the Sonic rigs to provide comparative data acquisition for evaluation across large sites while production is underway. Air and water circulatory elimination also minimizes waste production and waste handling by up to 75%, allowing for a cleaner construction site and increased savings on handling and disposal costs. This feature is additionally significant to ecologically restrictive and environmental contaminated sites.

Accurate tolerances are achieved by the elimination of a casing annulus for vertical, inclined and horizontal orientations. Numerous crawler-mounted, compact drill rigs, are now available for operation in areas with 8-ft of overhead clearance and for use on rough terrain using crawlers. Vertical, inclined and horizontal drilling capabilities are now possible for use in installing geotechnical elements or battered grout holes. Conversion of rigs to air rotary, fluid rotary or high-speed rock coring is also possible in order to combine methodologies on complex and multi-faceted drilling projects. Finally, simplicity is permitted in challenging, complex and variable conditions through the use of a single drilling system – Sonic Drilling.

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Dustman, J., R. Davis, and T, Oothoudt. (1992). "Soil, Bedrock, and Groundwater Sampling using RotaSonic Drilling Techniques." *Proceedings of the Sixth National Outdoor Action Conference on Aquifer Restoration, Ground Water Monitoring, Geophysical Methods*, National Ground Water Association, Las Vegas, NV, pp. 179-187.

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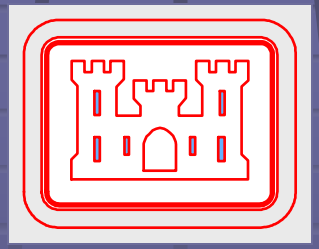
John P. Davis, M.Sc.(Eng) August 4, 2005
Manager, Construction Division
Boart Longyear Company

John Davis began his career twenty-years ago in the eastern United States working in the construction industry as a laborer, supervisor and manager on the building of water supply sources, water treatment systems, environmental remediation systems and various other types of heavy construction and geotechnical projects. He later earned his Master of Science degree from the Engineering Department of Tufts University. From the mid-1990's through 2002, he functioned as a construction project manager for Moretrench American Corporation on several large infrastructure projects, including the ground stabilization (ground freezing) contract to the world's three largest jacked-tunnels for the Central Artery/Tunnel Project in Boston, Massachusetts (The Big Dig) and on another ground stabilization contract for the Narragansett Bay CSO Tunnel Project in Providence, Rhode Island. It was during this time that he had his first introduction to Boart Longyear Company, a subcontractor to Moretrench American. Boart Longyear is a 7,000 person international drilling contractor and manufacturer owned by Advent International, providing services to the mining, construction, geotechnical, environmental, oil & gas and water supply market sectors. Mr. Davis now manages Boart Longyear's growing venture into the specialized geotechnical construction drilling market in the United States, focusing primarily on such projects as dams, tunnels, bridges and other critical infrastructure sites.

Boart Longyear Company
Drilling Services Group
Construction Division
PO Box 15010
Cincinnati, Ohio 45215-0010
(513) 532-4490/cell
(513) 233-7693/office
(513 948-0811/fax

GEOSYNTHETICS AND CONSTRUCTION OF THE SECOND POWERHOUSE CORNER COLLECTOR SURFACE FLOW BYPASS PROJECT

BONNEVILLE LOCK AND DAM PROJECT
OREGON AND WASHINGTON



US Army Corps of Engineers

Portland District

By: Art Fong

Geotechnical Design Section

Hydraulics, Hydrology, and Geotechnical Design Branch

TOPIC: Geotechnical Engineering and Use of Geosynthetic Fabrics, Geogrids, Geofoam, and Geocomposite Wall Drains.

Geosynthetics were used for Foundation Improvement, Reinforced Embankments and Slopes, minimizing Lateral Earth Pressures, providing subsurface drainage path for the Transportation Channel wall, and for materials separation.

Project used Geosynthetic materials to:

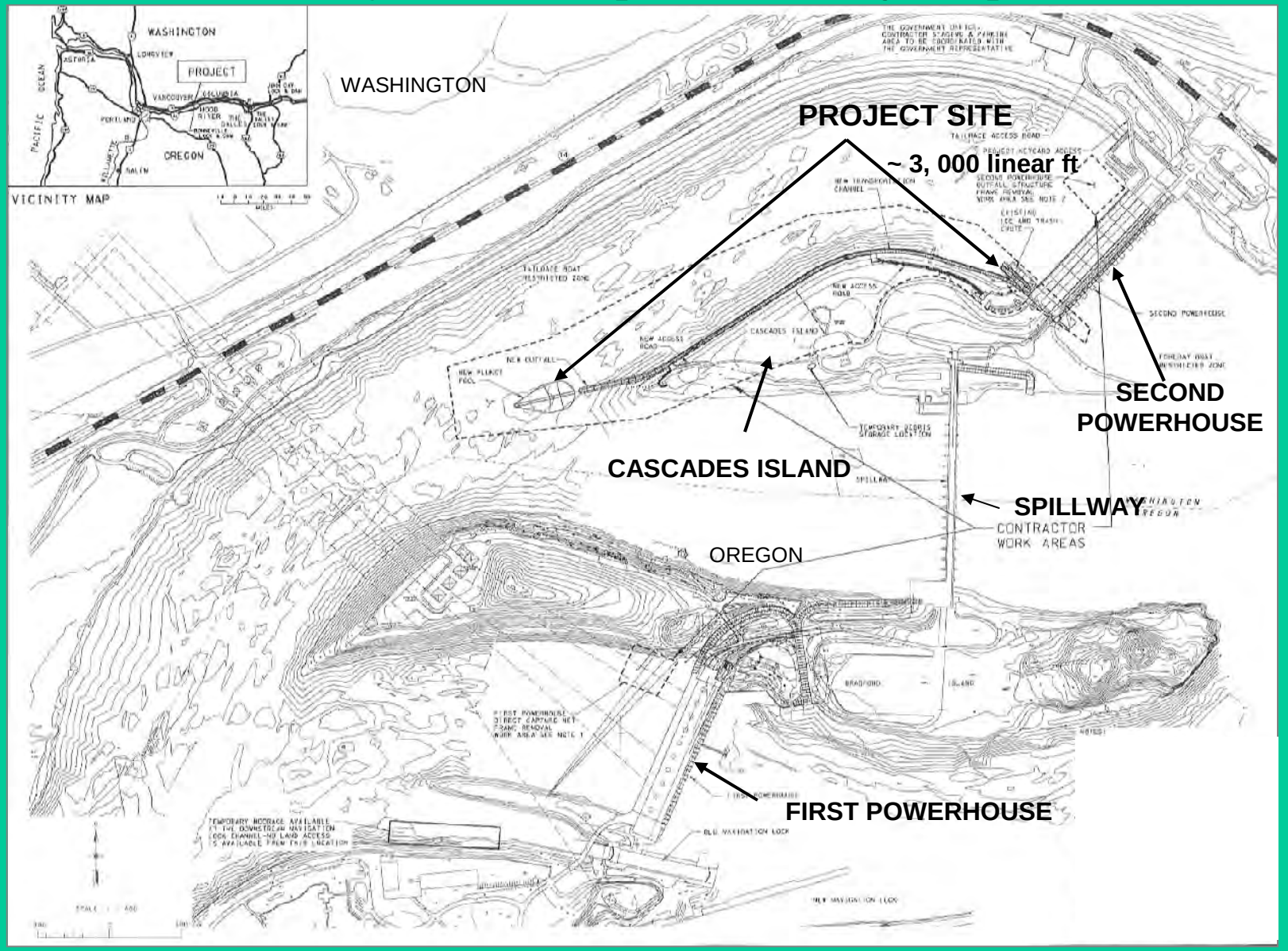
- Contain (separate) and Improve foundation materials
- Distribute loading under the Transportation Channel slab
- Provide strength and stability using Geogrids in reinforced soil embankments
- Provide drainage from upslope
- Provide scour protection in the Plunge Pool area

Contract type was “Best Value” evaluated on construction planning, schedule, and cost. Project was completed in 2004.

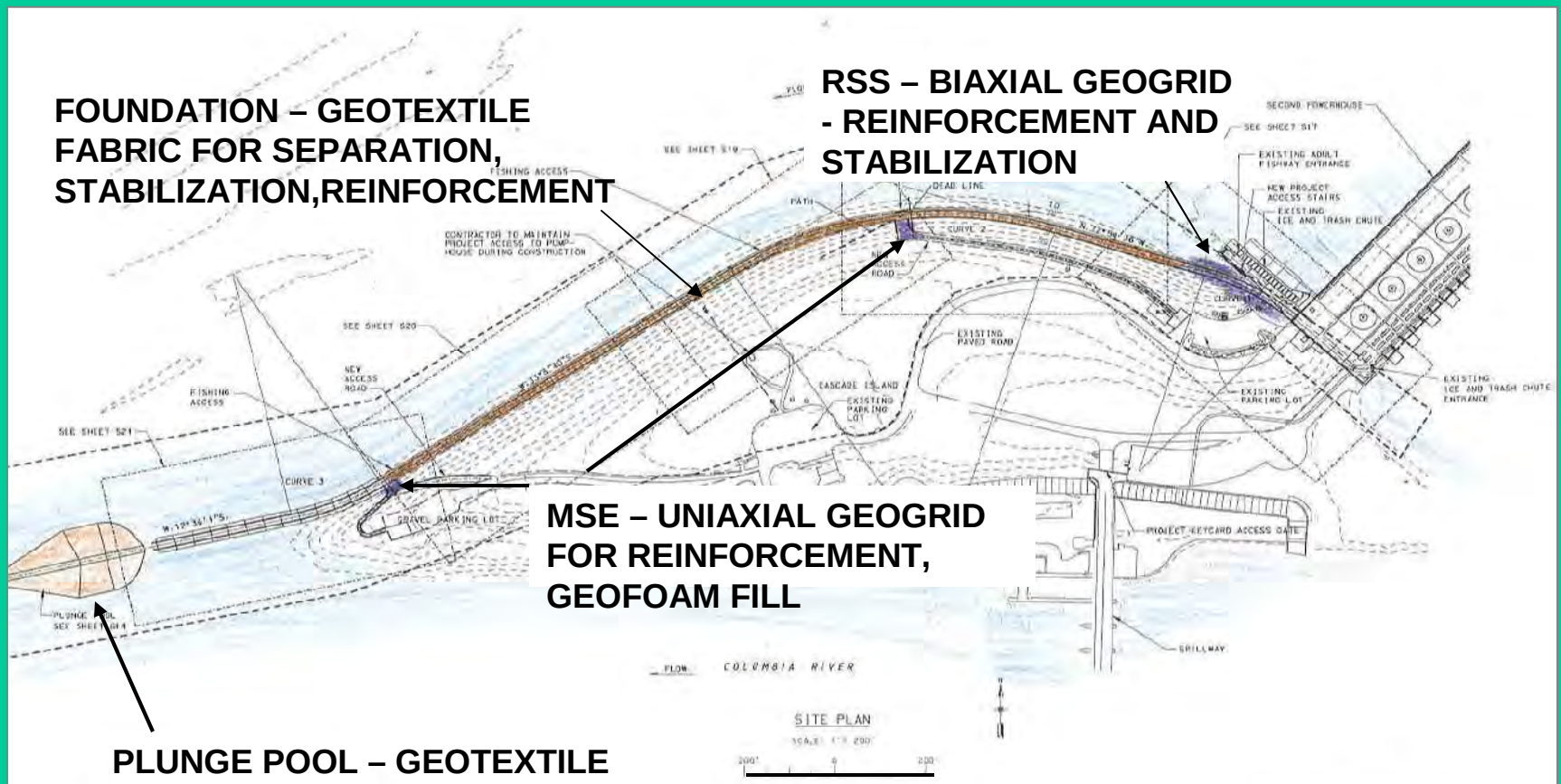
Contractor for the Second Powerhouse Corner Collector Surface Bypass Project was:

Kiewit-Manson, Joint Venture

Project Site Map and Vicinity Map



Feature Map


FOUNDATION – GEOTEXTILE FABRIC FOR SEPARATION, STABILIZATION,REINFORCEMENT
RSS – BIAXIAL GEOGRID - REINFORCEMENT AND STABILIZATION
MSE – UNIAXIAL GEOGRID FOR REINFORCEMENT, GEOFOAM FILL
PLUNGE POOL – GEOTEXTILE FABRIC FOR SEPARATION UNDER CONCRETE MATTRESSES
VARIOUS FOUNDATION AREAS – GEOTEXTILE FABRIC WITH ROCK - FOR STABILIZATION, REINFORCEMENT, AND SEPARATION
GEOCOMPOSITE DRAIN USE ALONG BACKFILLED TRANSPORTATION CHANNEL
SITE PLAN
COLUMBIA RIVER
SECOND POWERHOUSE
EXISTING ADULT FISHWAY ENTRANCE
NEW PROJECT ACCESS STAIRS
EXISTING ICE AND TRASH CHUTE
EXISTING PAVED ROAD
EXISTING PARKING LOT
CASCADE ISLAND
GRAVEL PARKING LOT
PROJECT KEYCARD ACCESS GATE
SPILLWAY
FISHING ACCESS
CONTRACTOR TO MAINTAIN PROJECT ACCESS TO PUMP-HOUSE DURING CONSTRUCTION

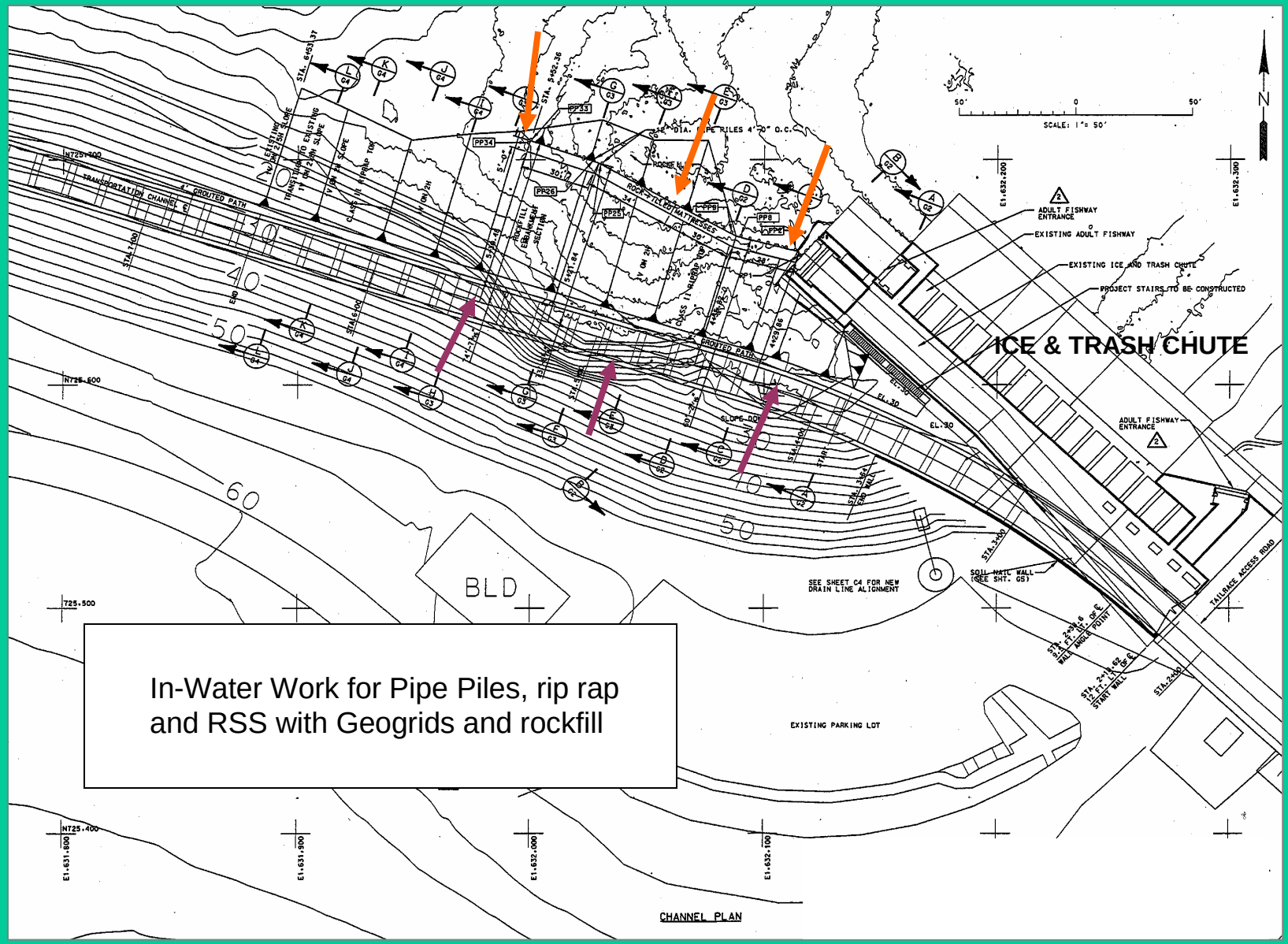
Bonneville Second Powerhouse
Cascades Island site of the Transportation Channel



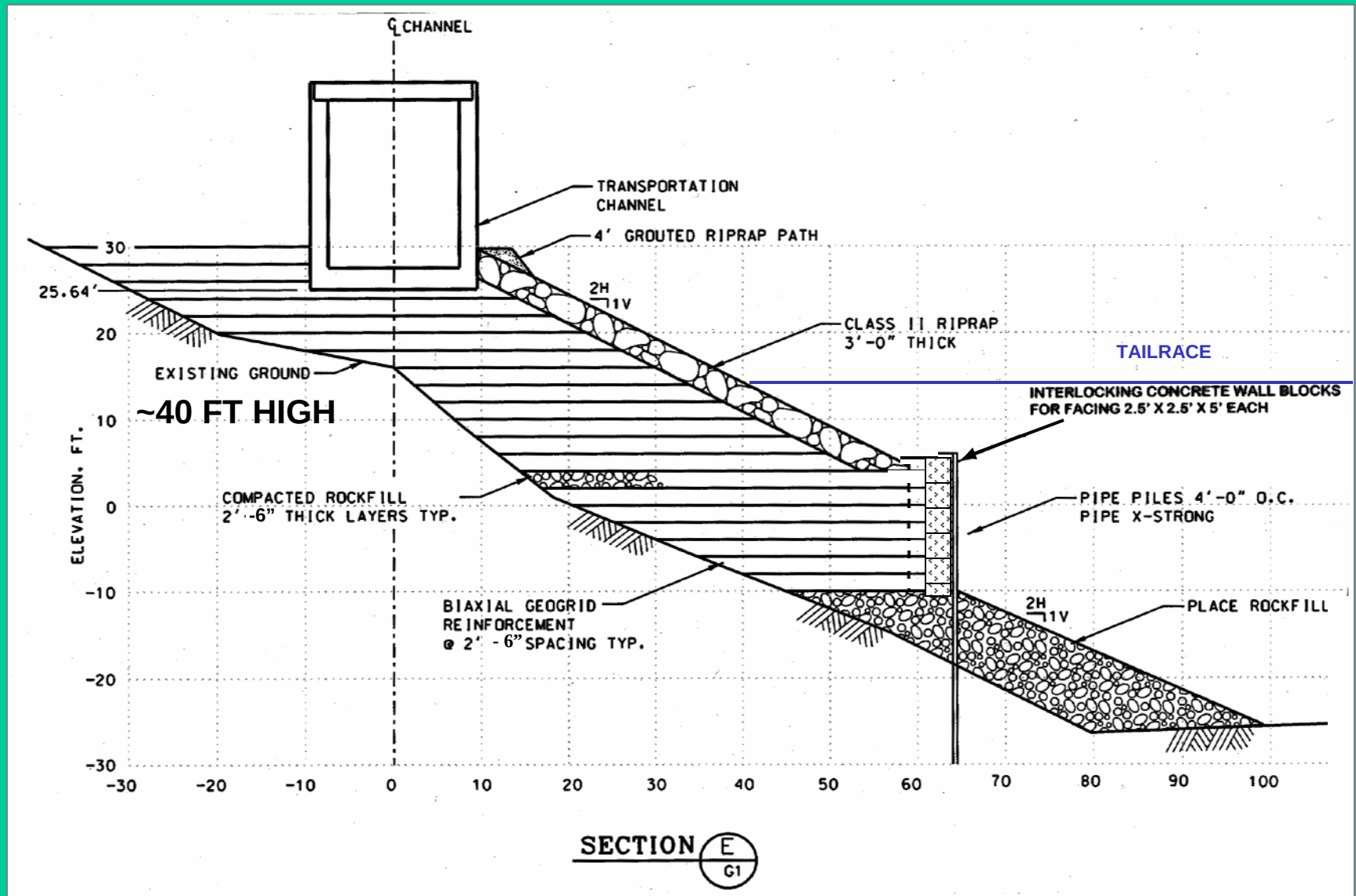
Geotextile fabric over soft foundation sands - covered with rock for foundation improvement



Upstream Plan View – Rockfill RSS



RSS Cross Section



Construction of the Rockfill RSS Embankment Alignment piles, Concrete Block Facing, and Geogrid Reinforcement.





Construction of the RSS Embankment - Layered Bi-Axial Geogrids with Rockfill



To provide separation, improve foundation bearing, and drainage for the Transportation Channel slab, a compacted bedding gravel layer on a Geotextile Fabric was constructed.

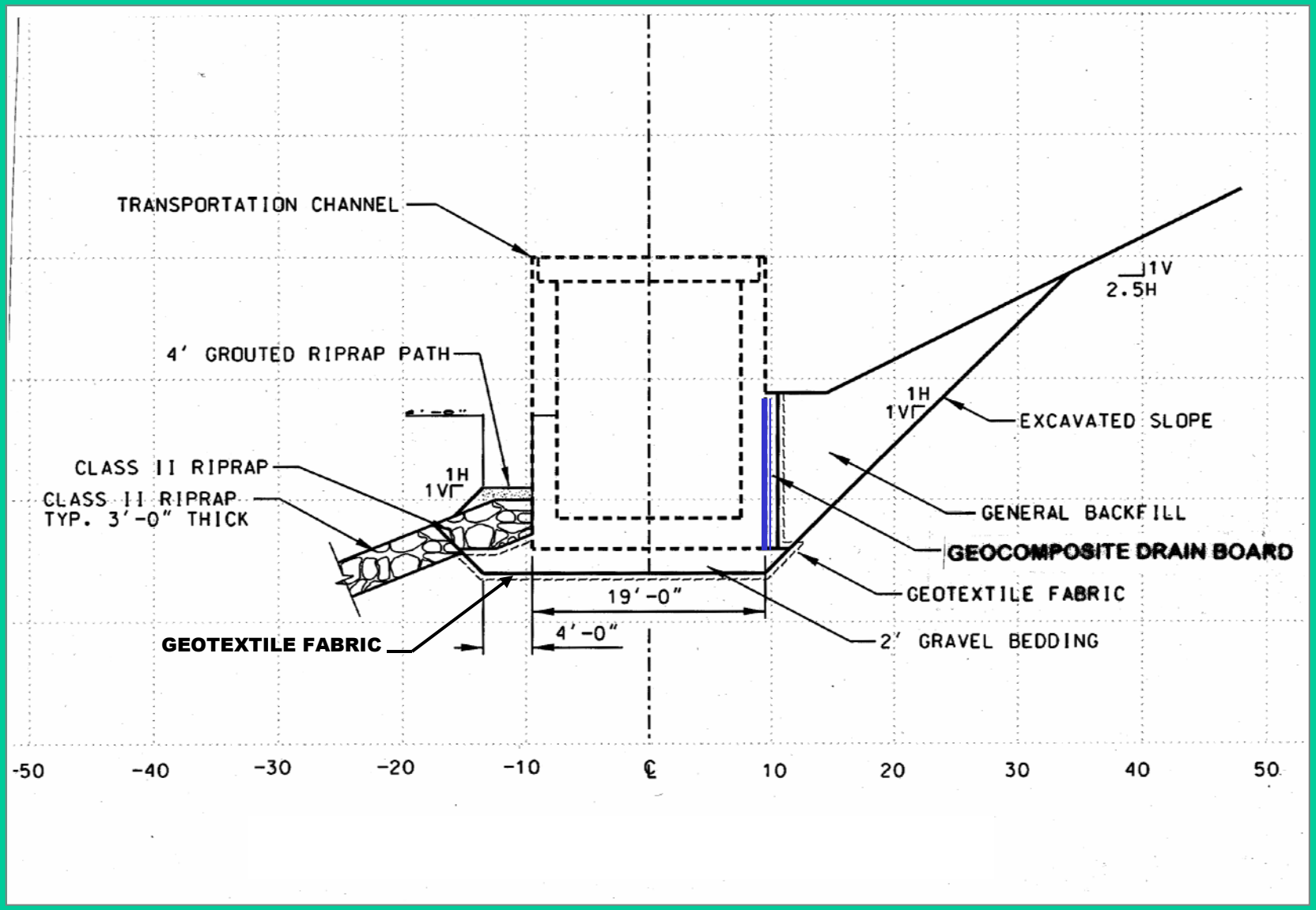
The Transportation Channel slab was then formed and placed on the bedding.

Geotextile fabric installed and 2-foot thick gravel layer was placed and compacted.





Geotextile Fabric and Geocomposite Drain



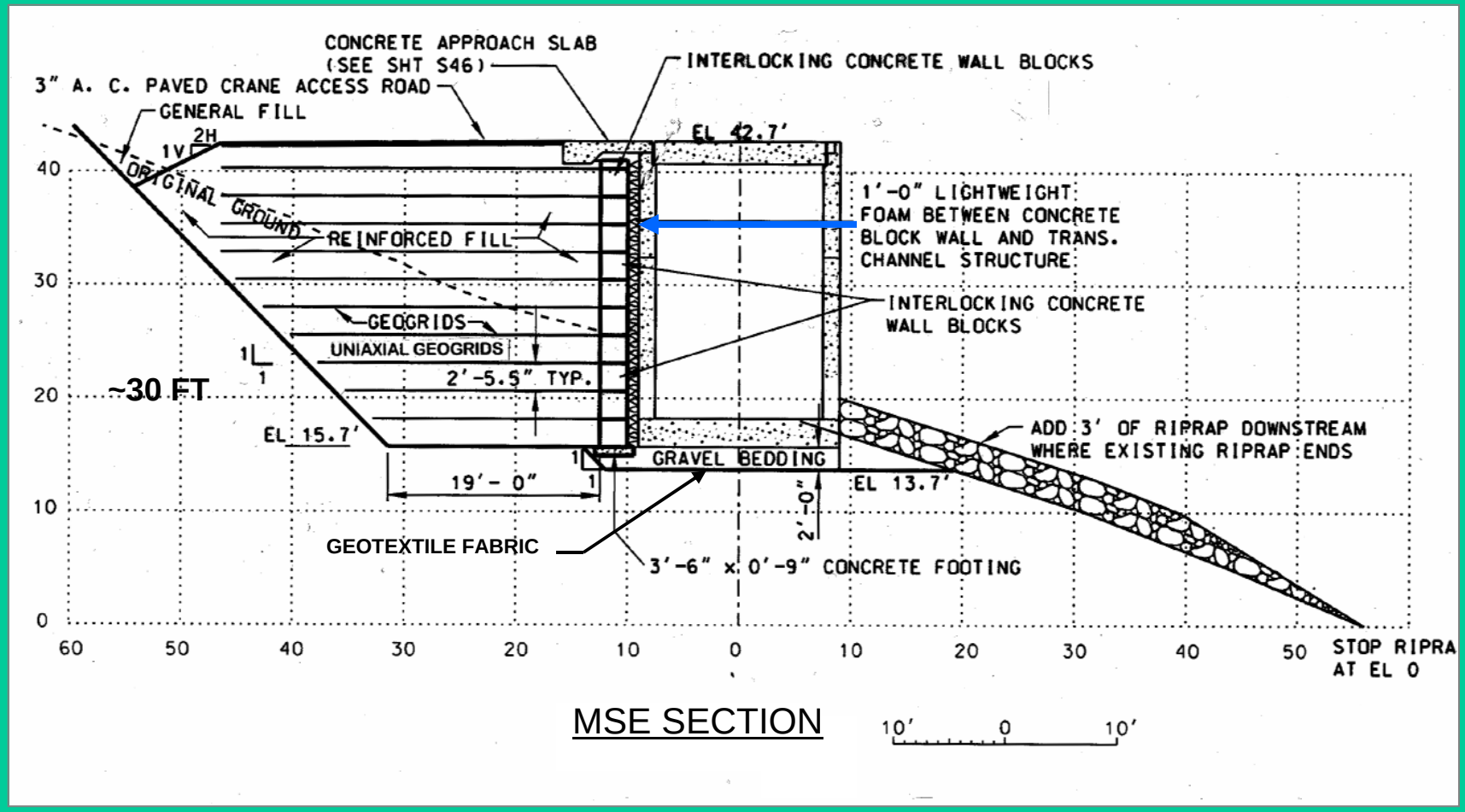
Geocomposite Drain on Transportation Channel Wall
Geocomposite Drain ran full length of the wall



To provide access to the top of the Transportation Channel, two Mechanically Stabilized Embankments (MSE) fills were constructed using Geogrids and compacted gravel.

One-foot thick Geofoam was placed against the Channel wall prior to start of constructing the MSE fill to reduce lateral pressures of the embankment.

Uniaxial Geogrids and Lightweight Geofoam



MSE SECTION

10' 0 10'

Geocomposite Wall Drain and Geogrid Reinforcement



Geogrid reinforced MSE embankment with concrete block facing on Geofoam against the channel wall



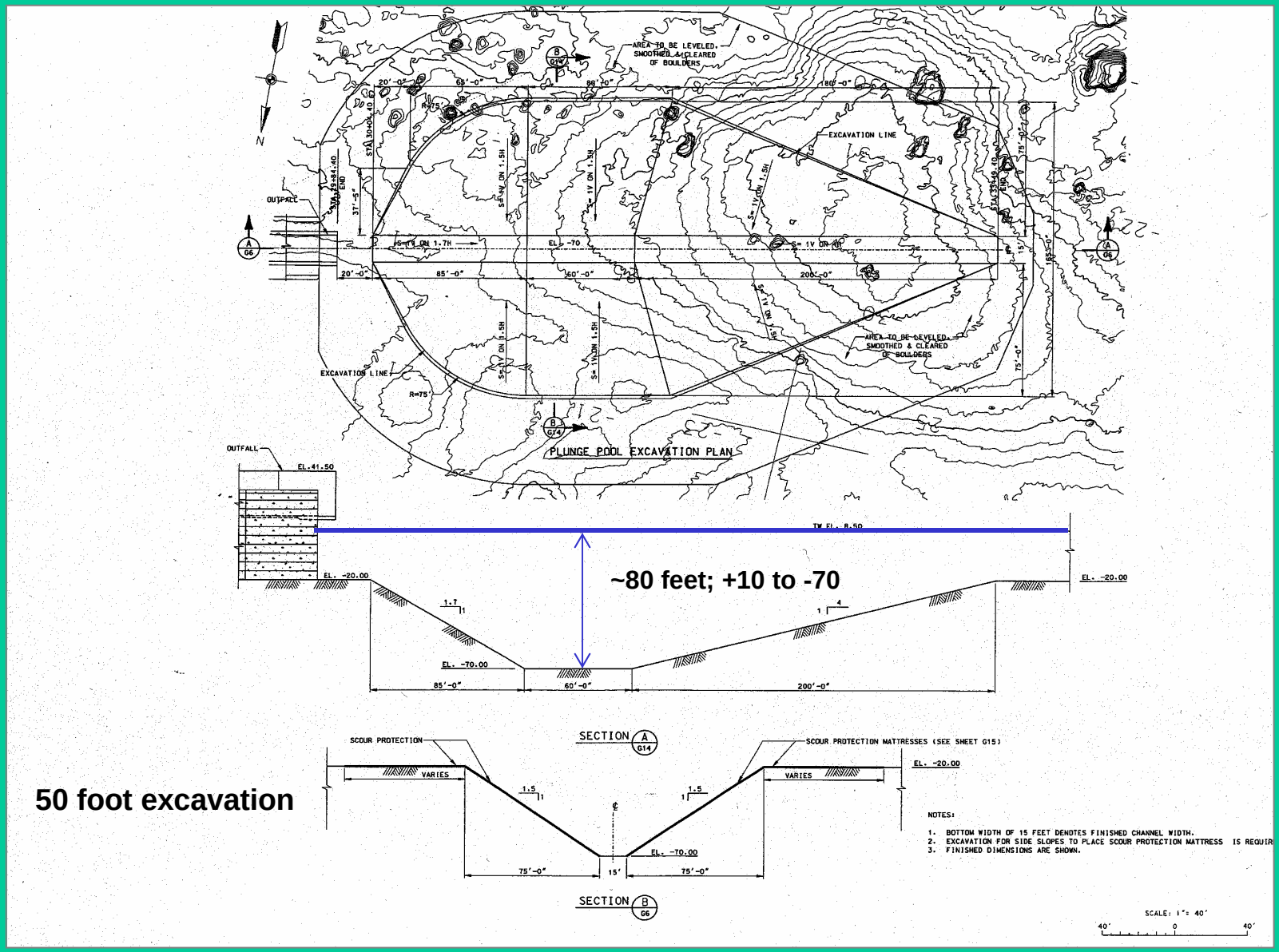
Contractor VE Proposal - use a MSE embankment to backfill an open cut was accepted for the upstream portion of the Channel wall. Originally a soil nail wall and top-down excavation had been planned - but the elected open cut remained stable.

Layered geogrids and granular backfill, wire mesh facing with geotextile fabric butted up to Geofoam on the Channel wall.

Geogrid reinforcement on backfill. Embankment facing wire mesh with the geotextile fabric against Geofoam blocks



Plunge Pool - Articulated Concrete Mattresses over Geotextile Fabric



50 foot excavation

Mattress on barge with Geotextile Fabric



Mattress and frame for placement in the water



Bypass in Operation



In Operation





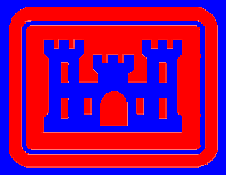
Conclusion:

Many Geosynthetic Products were used as originally designed or as proposed during construction by the Contractor.

Geosynthetics used contributed toward the successful construction and operation of the Bypass System.

Questions?

Thank You!

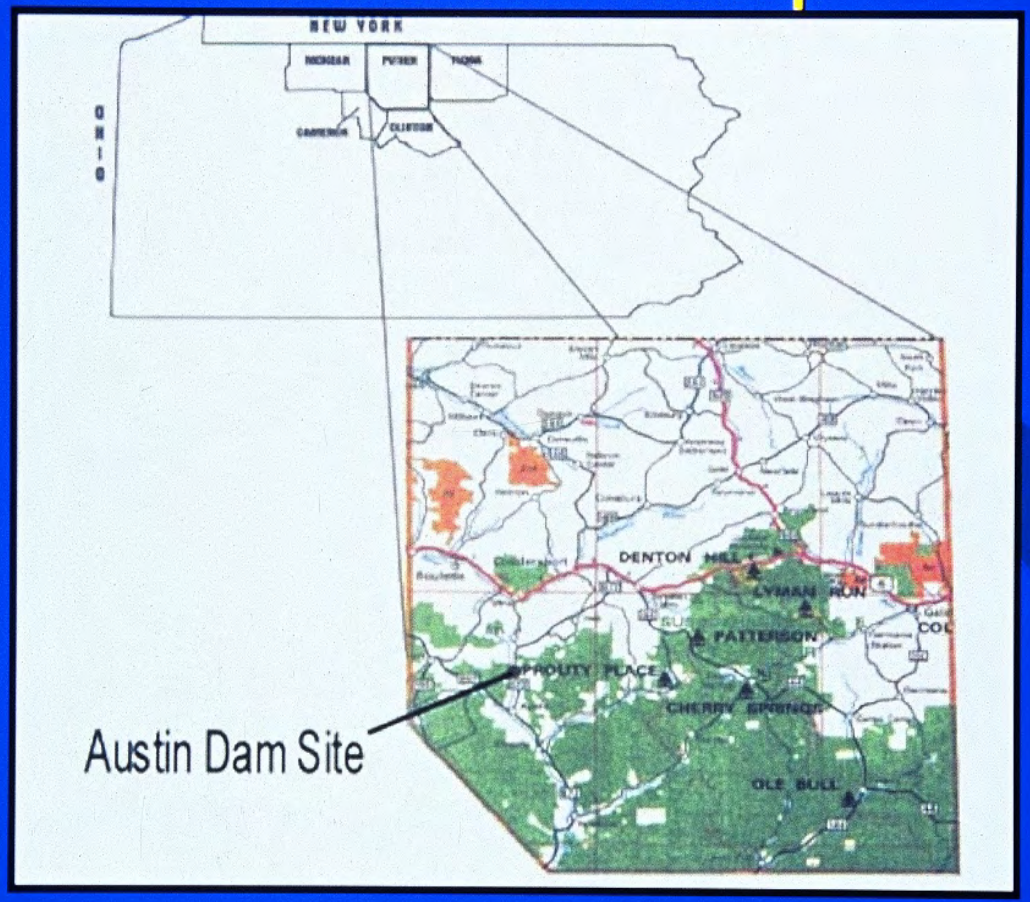


US Army Corps
of Engineers
Pittsburgh District

The Sliding Failure of Austin Dam Pennsylvania - Revisited

Brian H. Greene, Ph.D. P.G.

Location Map



The Austin dam is located 26 miles south of the New York border, and 15 miles from Coudersport, PA (county seat) on Rt. 872.

General Information

- **Type of Dam:** Concrete Gravity
- **Project Engineer:** T. Chalkley Hatton
- **Owner of Dam:** Bayless Pulp and Paper Company
  "Bayless Dam"
- **Construction Material:** Cyclopean Concrete
- **Foundation:** Horizontally bedded sedimentary rocks

- **Date Construction Completed:** December 1909
- **Date of Initial Distress:** Jan 1910 (only 6 weeks later)
- **Date of Final Failure:** September 30, 1911
- **Death Toll:** 78

Austin Dam Statistics



- 544 ft. long
- 60 ft. high(bottom to top
- 30 ft. wide at base
- Cut-off wall 4 ft.thick & 4 ft. deep
- Designed for water depth of 42.5 ft
- 1 ¼ inch steel rods installed 5 ft. inside the vertical face

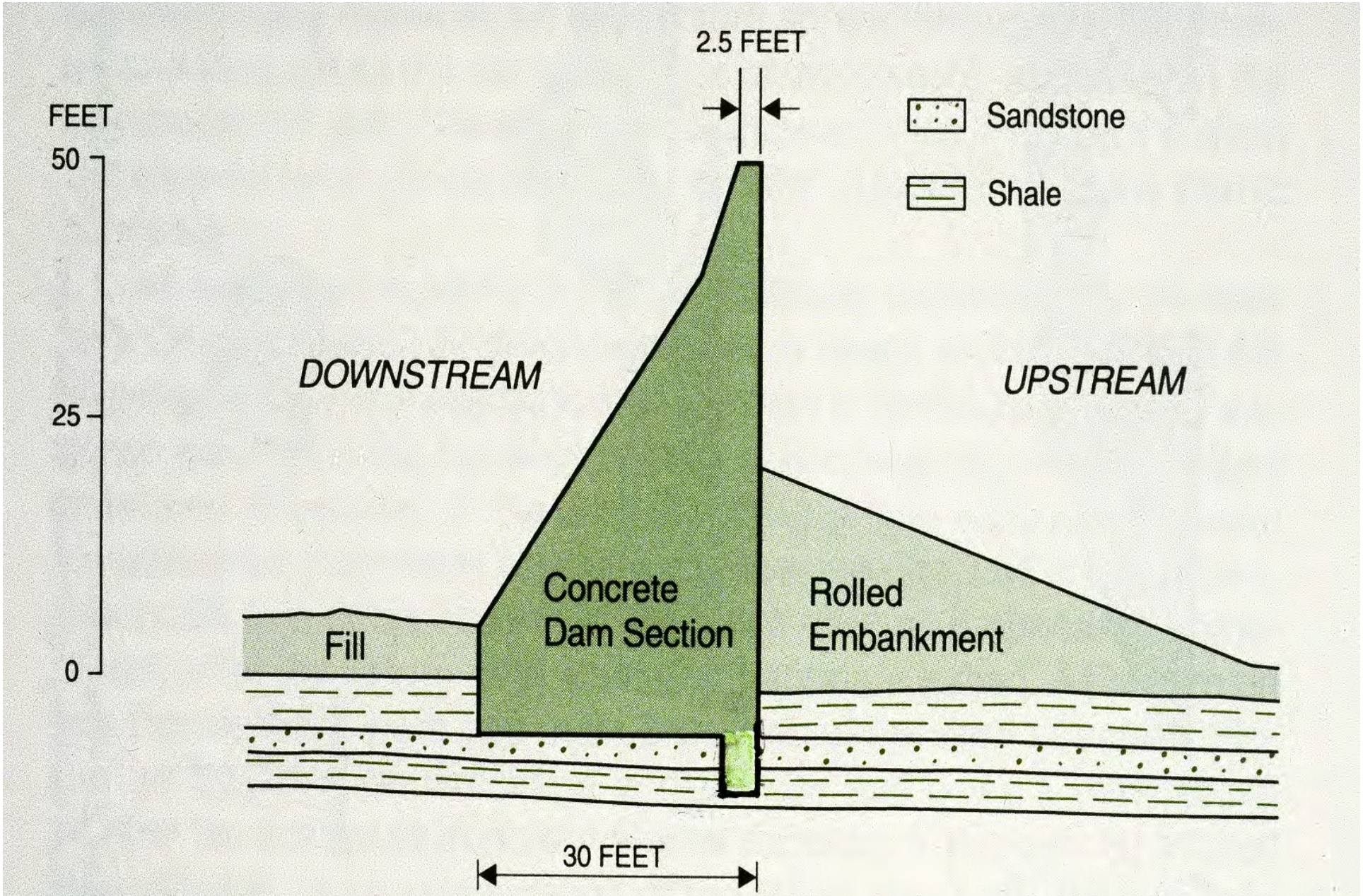


Figure 4. Prefailure cross section of Austin Dam at Block "D."

Leaking Dam



- First filling in January, 1910
- Extensive leaks developed downstream of toe and abutments
- Slid forward 18 inches at base
- Blasting used to drain water
- It was observed that the rock foundation had slid forward with the dam

View West of Sliding Failure





Boulder Dam

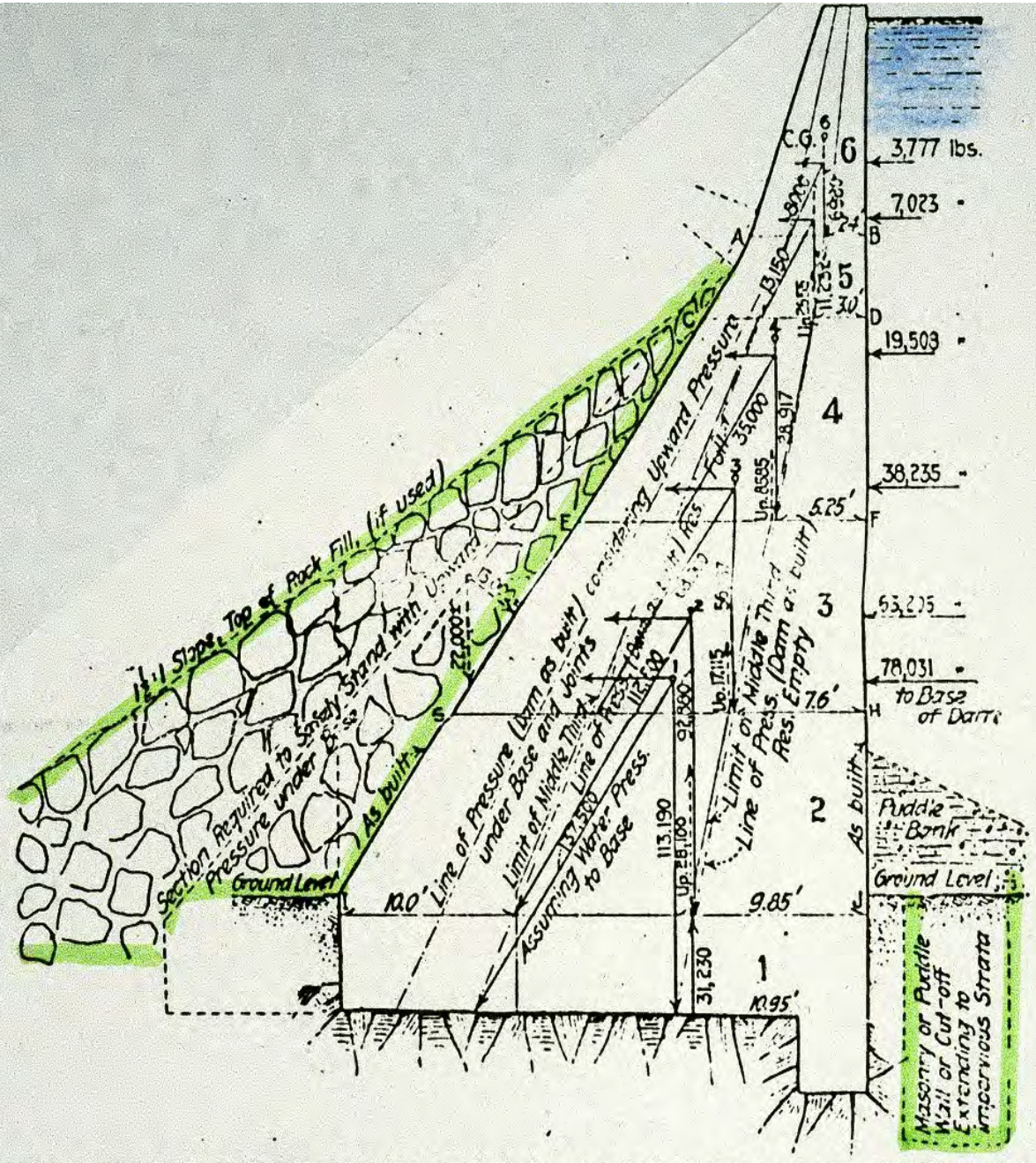


FIG. B.— STUDIES FOR REINFORCING MASONRY DAM AT AUSTIN, PA.
FEB. 14, 1910: E. WEGMANN, CONSULTING ENGINEER.

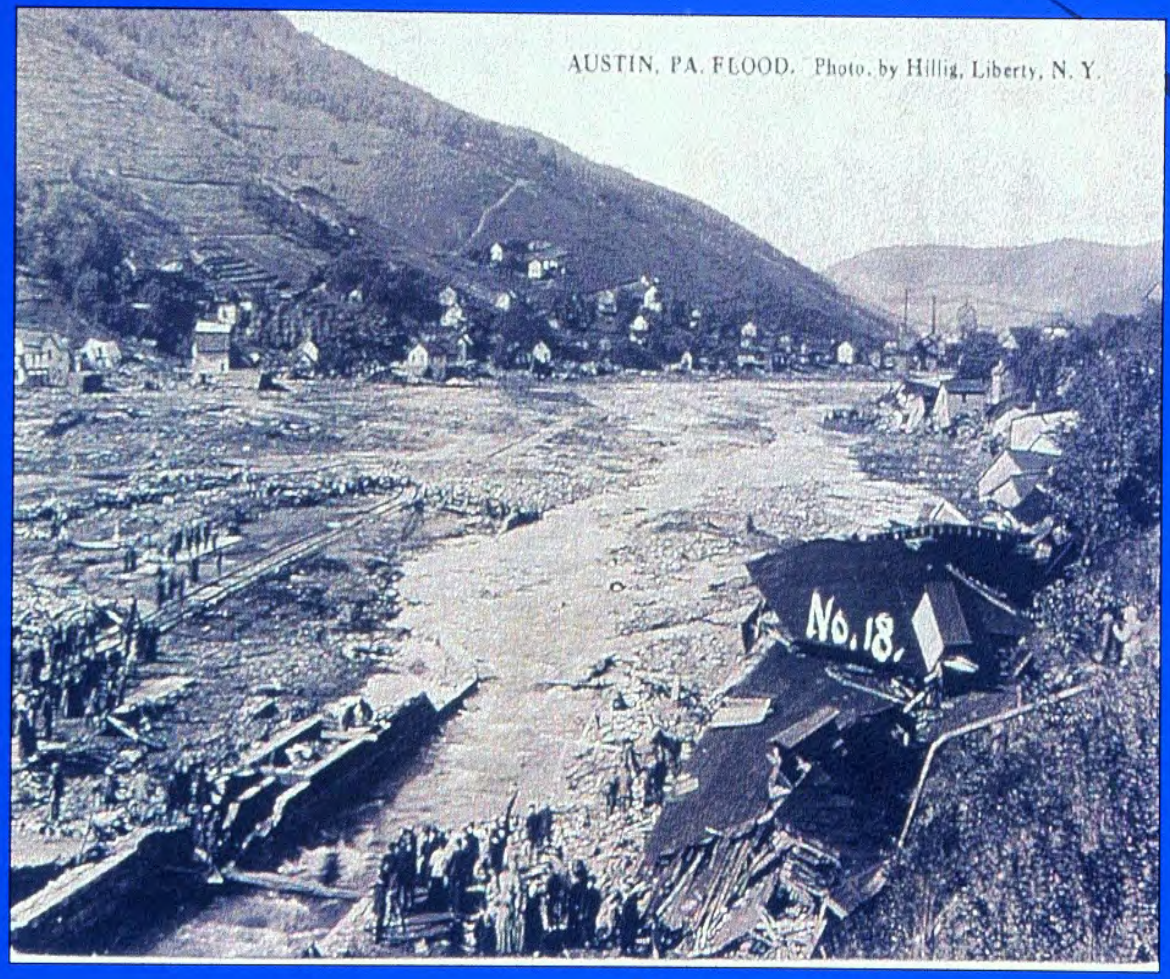




Plan and elevation of the failed dam



Freeman Run valley after failure



- Seven factories destroyed and railroad destroyed
- Damages estimated between 3 to 6 million dollars
- 78 deaths reported
- No definite cause of failure documented

Austin Town Hall after failure





2000-2005 Geotechnical Study and Reconstructed Stability Analysis

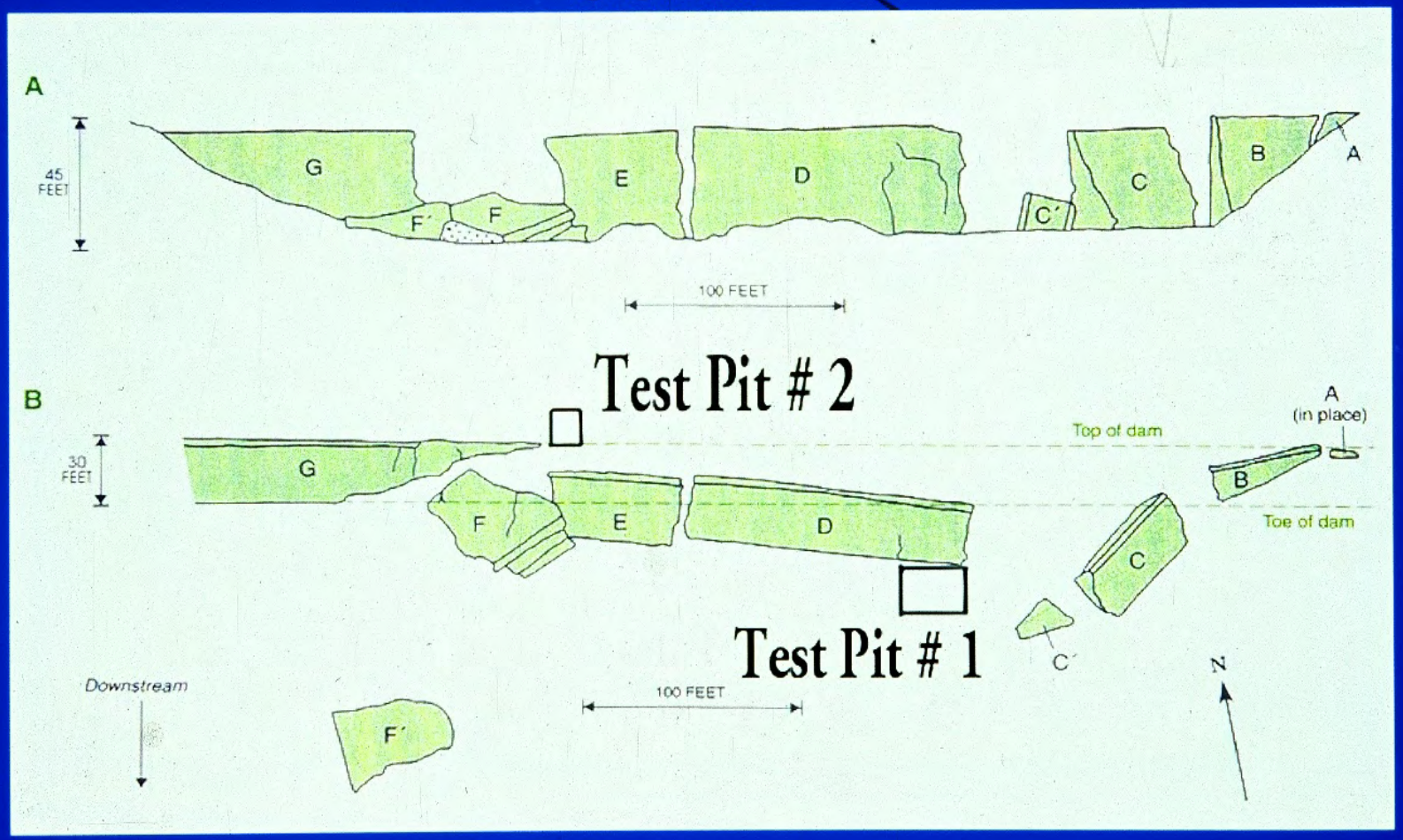
Objectives of Study

- Obtain surface and subsurface geologic information with reference to the suspected modes of failure
- Determine the engineering properties of foundation rock, aggregate, and concrete
- Using the above information, determine the most likely cause of the sliding failure of the Austin Dam
- Investigate the possibility of other modes of failure (overturning and crushing of concrete

Field Methodology

- General geologic column and description
- Description of stratigraphic section at foundation
- Detailed line survey
- Collection of concrete, aggregate, and rock samples for laboratory testing
- Test pitting to explore foundation and hydrolgic conditions

Plan and elevation of the failed dam



Test pit # 1

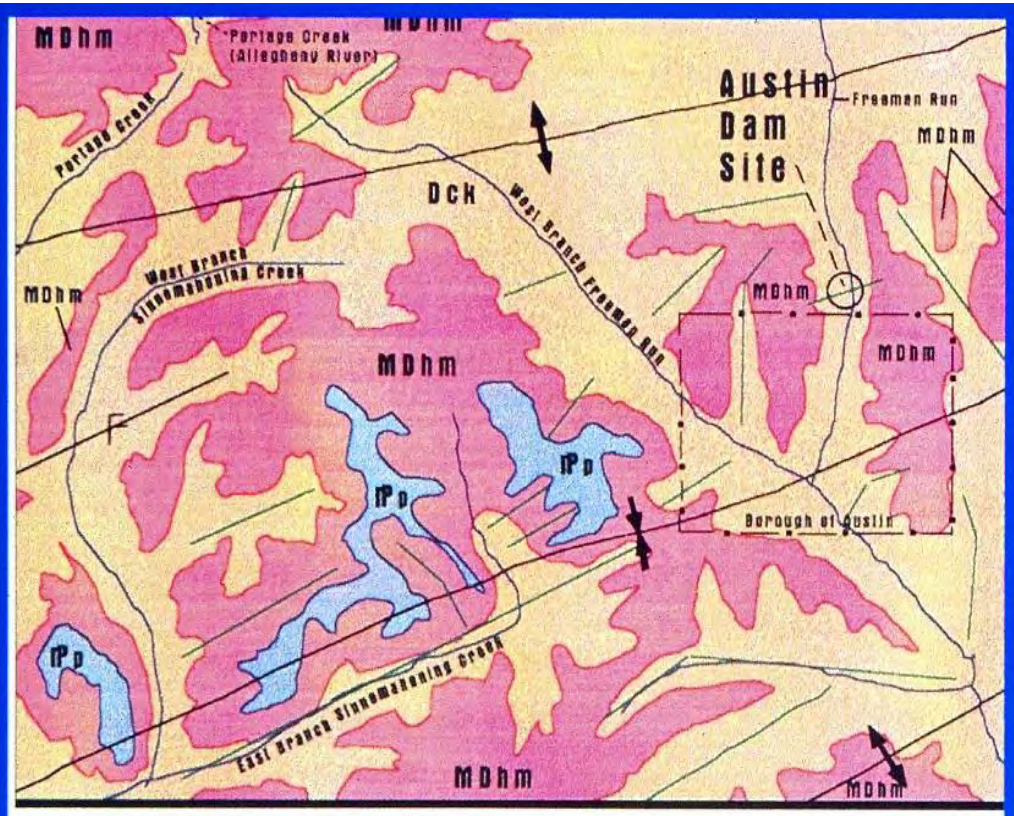


- Approx. depth of pit 12.5 ft.
- Water encountered at a depth of 2 ft.
- Sandstone (foundation material) at depth of 9.5 ft.
- Permeability of gravel and sand above sandstone approx. 2.6 cm/s (by recovery method)
- Clear water observed coming from under the dam into the pit

Test pit # 2

- Approx 8 ft. deep.
- Slow seepage of water.
- 2 ft. of sandstone encountered at an approx. depth of 5 ft.
- Shale found underneath the sandstone, shale interlayered with clay seams.





Geological Map of Austin Area
(from Berg, T.M. & Dodge, C.M., 1981)

Pennsylvanian Age Strata

Pp Pottsville Group

Mississippian and Devonian Age Strata

MDhm Huntley Mountain Formation

Devonian Age Strata

Dck Catskill Formation

F Fault

Fracture Traces

Dip & Strike

Anticline

Syncline

N

$8\frac{1}{2}$

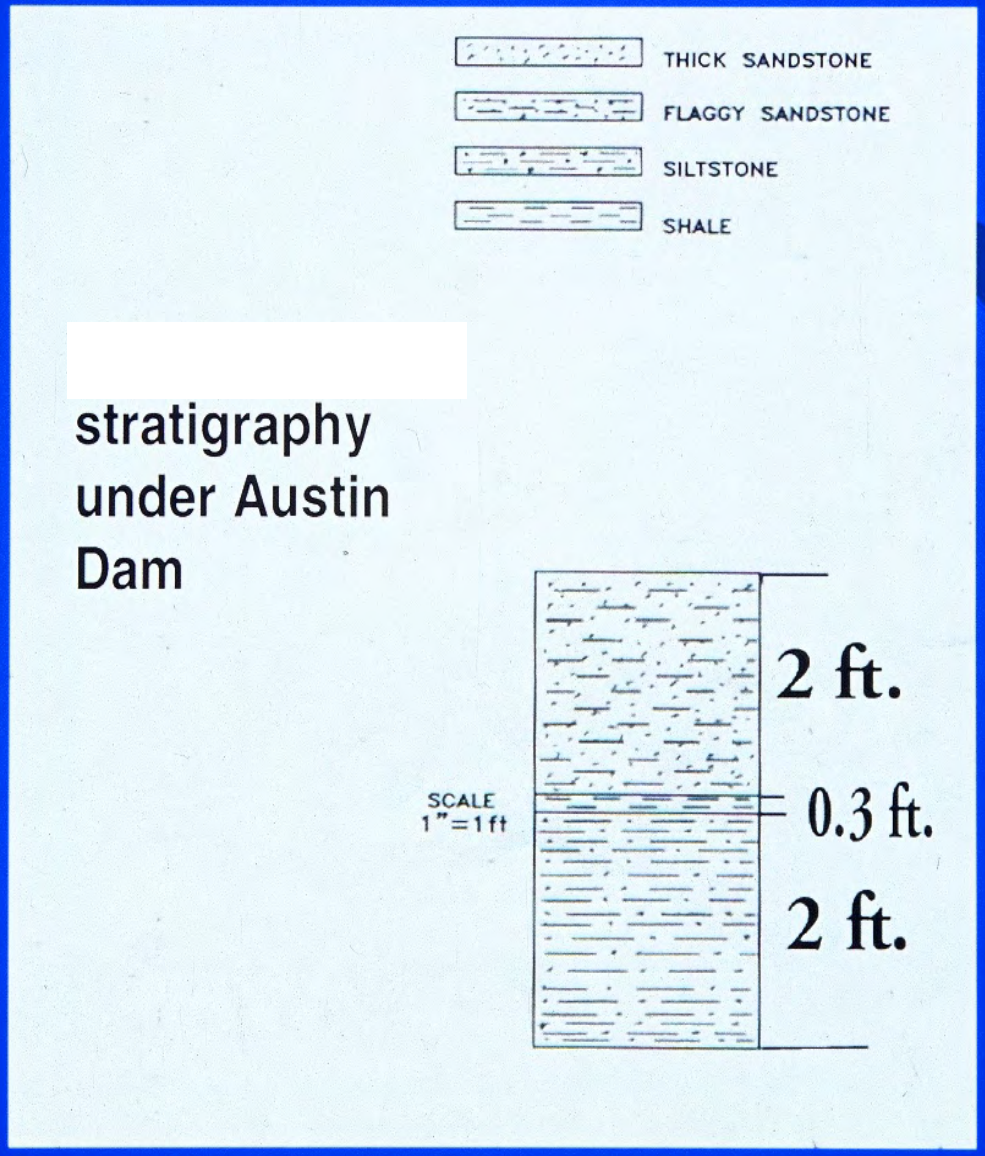
1 KM

Scale
1 in. = 1 mile

Geologic Map

- Devonian-age sedimentary rocks
- Main stream trends controlled by jointing
- Tributary stream trends in trellis pattern, and believed to follow subsurface structure

Subsurface (foundation)stratigraphy



Laboratory Methodology

- Index Tests (grain size, Atterberg limits) on soft rocks for classification
- Unconfined compression tests on concrete, foundation rock, and aggregate
- Permeability test on clay blanket
- Direct shear tests on foundation material:
  - concrete against sandstone
  - sandstone against sandstone
  - sandstone against shale
  - shale against shale

Unconfined compression test results

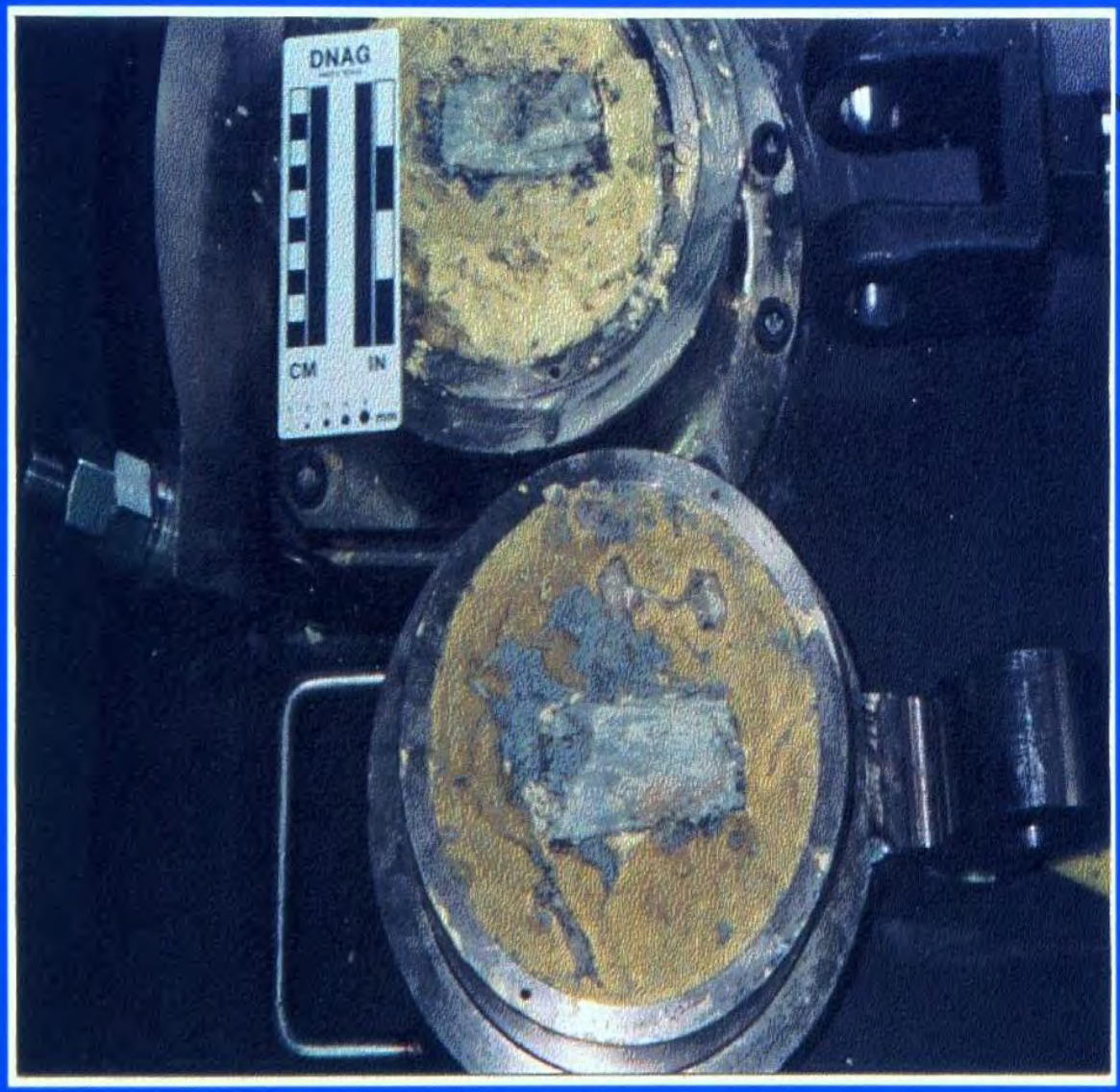
Material	Uconf. Comp. strength (psi)	Tensile Strength (psi)
Foundation sandstone	23374	
Concrete	3805	349
Cyclopean Aggregate	21107	

Direct shear testing apparatus



Structural Behavior Engineering Laboratories, Phoenix, AZ

Direct shear sample preparation

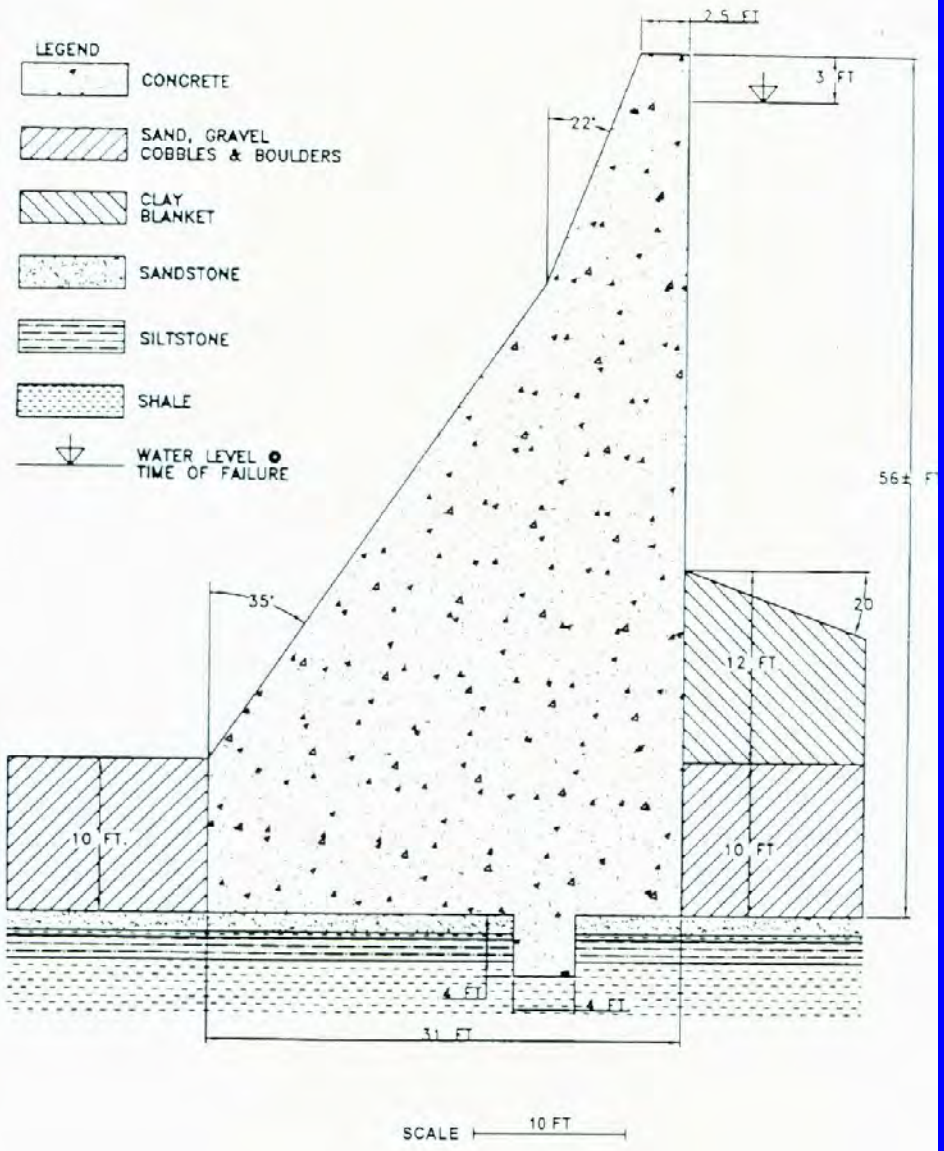


Samples tested according to their stratigraphic order in the foundation of the dam

Results of stability analysis

Shear Strength Test Results

Material	Cohes-ion (lb/ft^2)	Friction Angle (°)	
Concrete over Sandstone	15000	25	
Sandstone over Sandstone	5984	31	
Sandstone over Shale	0	25	
Shale over Shale	3371	25	


LEGEND
CONCRETE
SAND, GRAVEL
COBBLES & BOULDERS
CLAY
BLANKET
SANDSTONE
SILTSTONE
SHALE
WATER LEVEL ⊙
TIME OF FAILURE
2.5 FT
3 FT
22°
56± FT
35°
20
12 FT
10 FT.
10 FT
4 FT
4 FT
31 FT
SCALE
10 FT

Results of stability analysis

Material	Cohes-ion (lb/ft^2)	Friction Angle (°)	Factor of Safety (sliding)
Concrete over Sandstone	15000	25	8.3
Sandstone over Sandstone	5984	31	3.9
Sandstone over Shale	0	25	0.6
Shale over Shale	3371	25	2.4

Results of other stability analysis

Type of Failure	Factor of Safety
Overturning	0.88
Crushing of Concrete	Dam in tension, no crushing possible

Conclusions

- The Austin dam failed on the weak shale layers beneath the foundation sandstone
- The depth of water in the reservoir necessitated the provision of a deeper and wider key trench than was used
- The tendency to overturn (F.S.= 0.88) probably contributed to the sliding failure of the dam

“Never sacrifice safety for cost, no matter how urgent your client may become. He does not recognize the danger and you should. If you can not agree with him, resign your engagement, for sooner or later the reckoning will come.”

T. Chalkley Hatton, Project Engineer

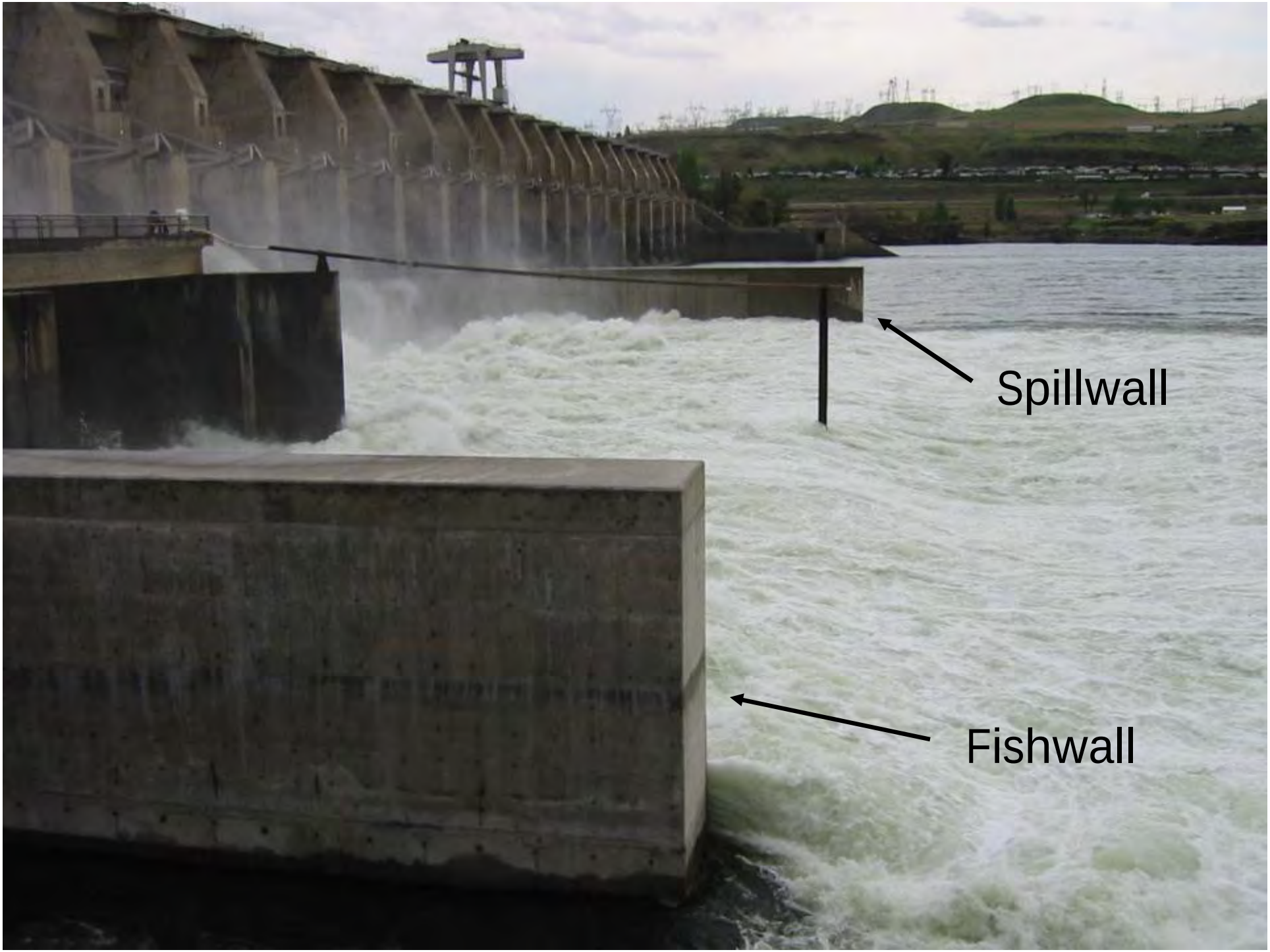
1912 in Engineering News

ROCK ANCHOR DESIGN AND CONSTRUCTION

The Dalles Dam Spillwalls

Kristie M. Hartfeil, P.E.
U.S. Army Corps of Engineers
Portland District
503-808-4861
Kristie.M.Hartfeil@usace.army.mil

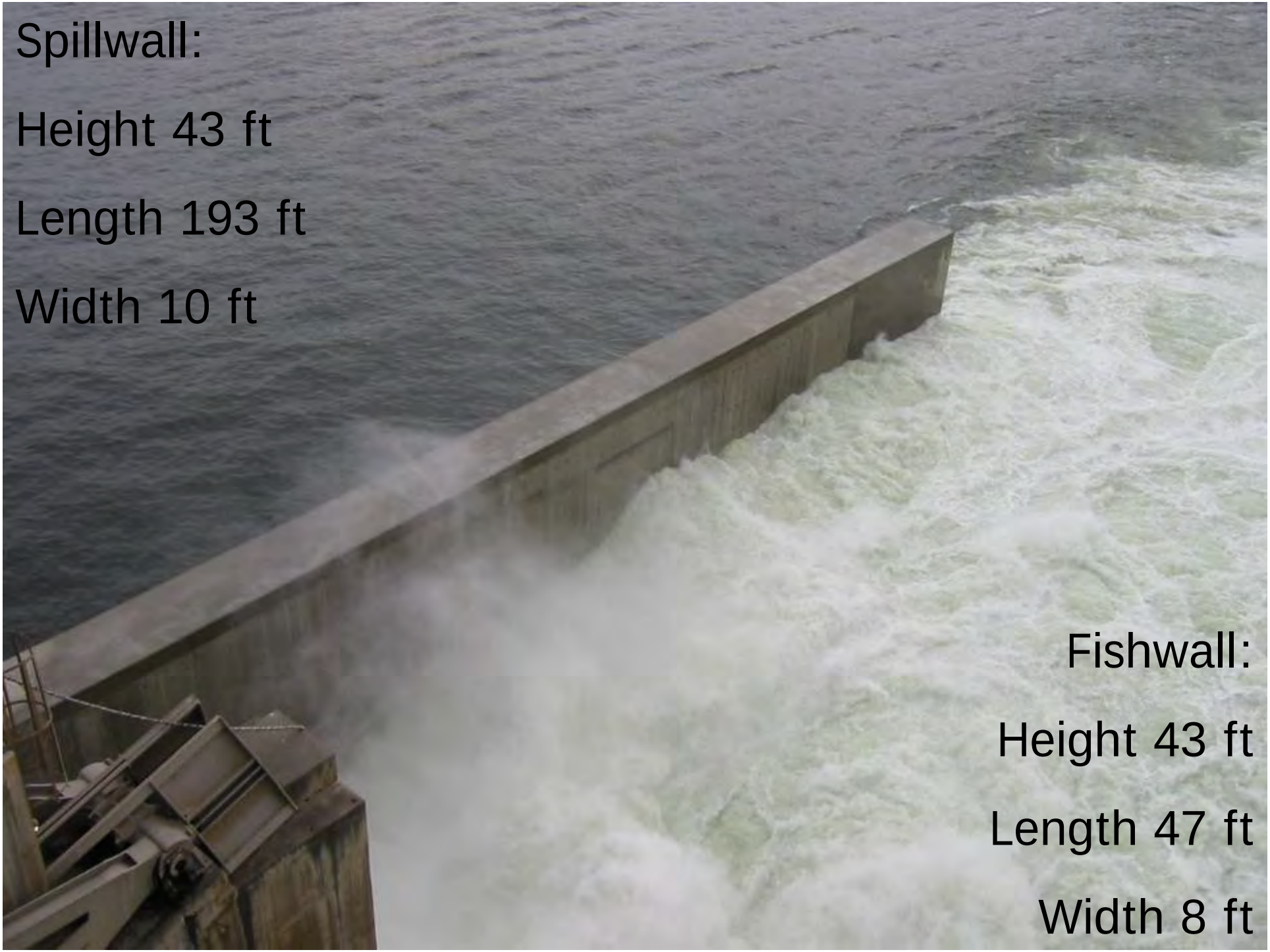

Washington
Oregon
Powerhouse
Spillway


Spillwall
Fishwall

Structural Design Load

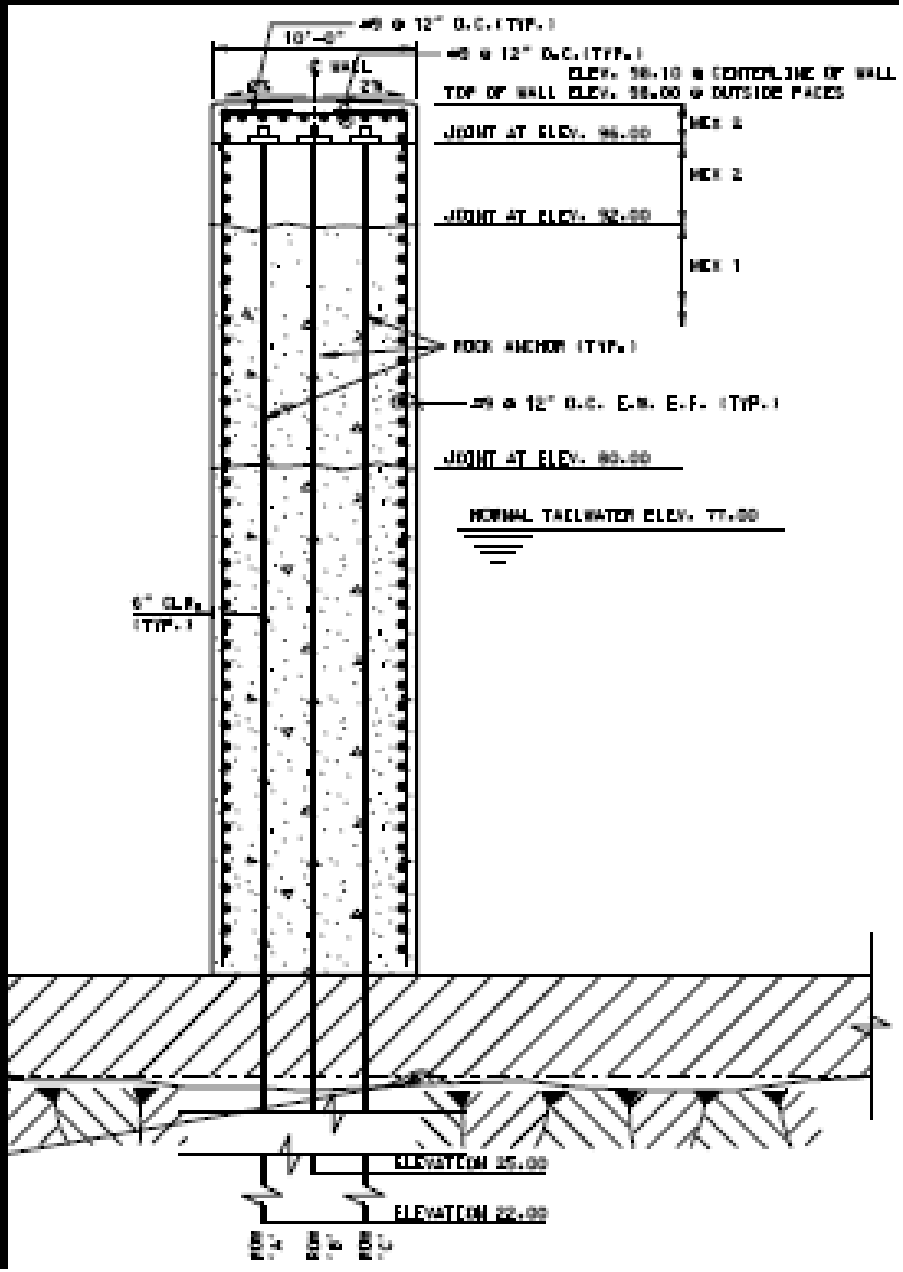


- Design load at 1,050 kcfs river flow
  - Assumed spill on one side of wall, not on the other
- Overturn Moment – 1,084 ft-kips/ft of wall
- Shear – 62.1 kips/ft of wall


Spillwall:
Height 43 ft
Length 193 ft
Width 10 ft
Fishwall:
Height 43 ft
Length 47 ft
Width 8 ft

Rock Bolt Design

- Construct Walls First
  - Tremie placed concrete
- Construct Foundation Last
  - Post-tension wall to rock using rock bolts
- Requires 3 rock bolts evenly spaced across the width (2.5 ft o.c.) every 3 ft o.c. the entire length
- Each rock bolt post-tensioned to 545 kips



Fishwall Drilling



Fishwall Drilling

- Flying lead supported down the hole hammer



Spillwall Drilling



Upstream Spillwall Drilling

- Rail supported down the hole hammer



Downstream Spillwall Drilling

Flying lead supported down the hole hammer



Rock Bolts



Lessons Learned

- Ducts Through Concrete Wall
- Complications During Anchor Drilling
- Penetration and Anchor Grouting
- Rock Bolt Installation

Ducts – Maintaining Alignment

Problem: Tie-downs not stout enough for tremie concrete placement or workers using them as ladders during forming. Duct alignment not maintained and results in problems during drilling.



Lesson:

Locate tie-downs in lower portion of form where lateral load from tremie pour is highest.

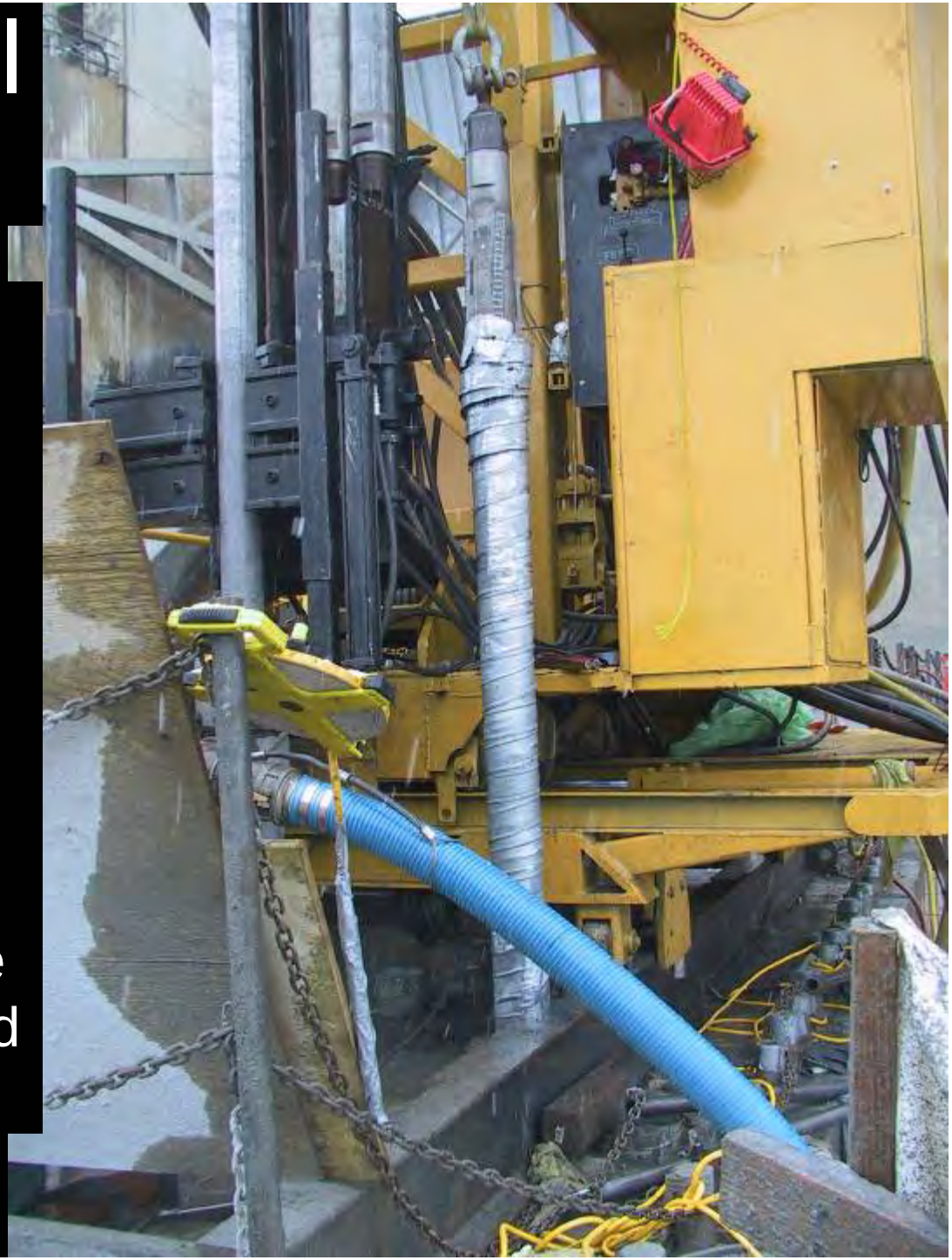
Prohibit workers from stepping on tie-downs.

Ducts – Material Selection

Problem: Duct material bowed during tremie concrete placement, then tore and shredded during drilling of bowed ducts.

Lesson:

Select duct material stiff enough for tremie concrete lateral load and won't shred during drilling.



Ducts – Material Selection



Duct material on face of button bit.

Air vents blocked and prevented proper circulation of cuttings from the bottom of the hole.

Drilling – Anchor Spacing, Staggering, and Vertical Alignment

Problem: Vertical alignment tolerances very difficult to monitor and achieve.

Lesson:

Typical vertical alignment tolerance of 1 in 100. Improved tolerance results in additional drilling and inspection costs.

Require specific alignment inspection process that is repeatable and meets alignment tolerance requirements.

Stagger anchors if elect not to inspect. Stagger interval is dependent on the depth of the anchor but not less than 5 feet.

Drilling – Anchor Spacing, Staggering, and Vertical Alignment

Problem: Very tight anchor spacing, over-drilling, short bond zone (15 feet), and difficult vertical alignment tolerances result in the contractor suggesting a 3 part stagger system.

Lesson:

Tight anchor spacing requires staggered depths.

- Use 7 -10 foot stagger due to over-drilling and alignment concerns.
- Prefer 4 part stagger because all adjacent anchors at same depth.

Drilling – Damage to Adjacent Holes

Problem: Tight anchor spacing resulted in damage to adjacent anchors during drilling - loss of sidewall material and grout infilling.

Lesson:

Assume damage to adjacent drill holes during drilling and penetration grouting will require additional drilling and grouting efforts.

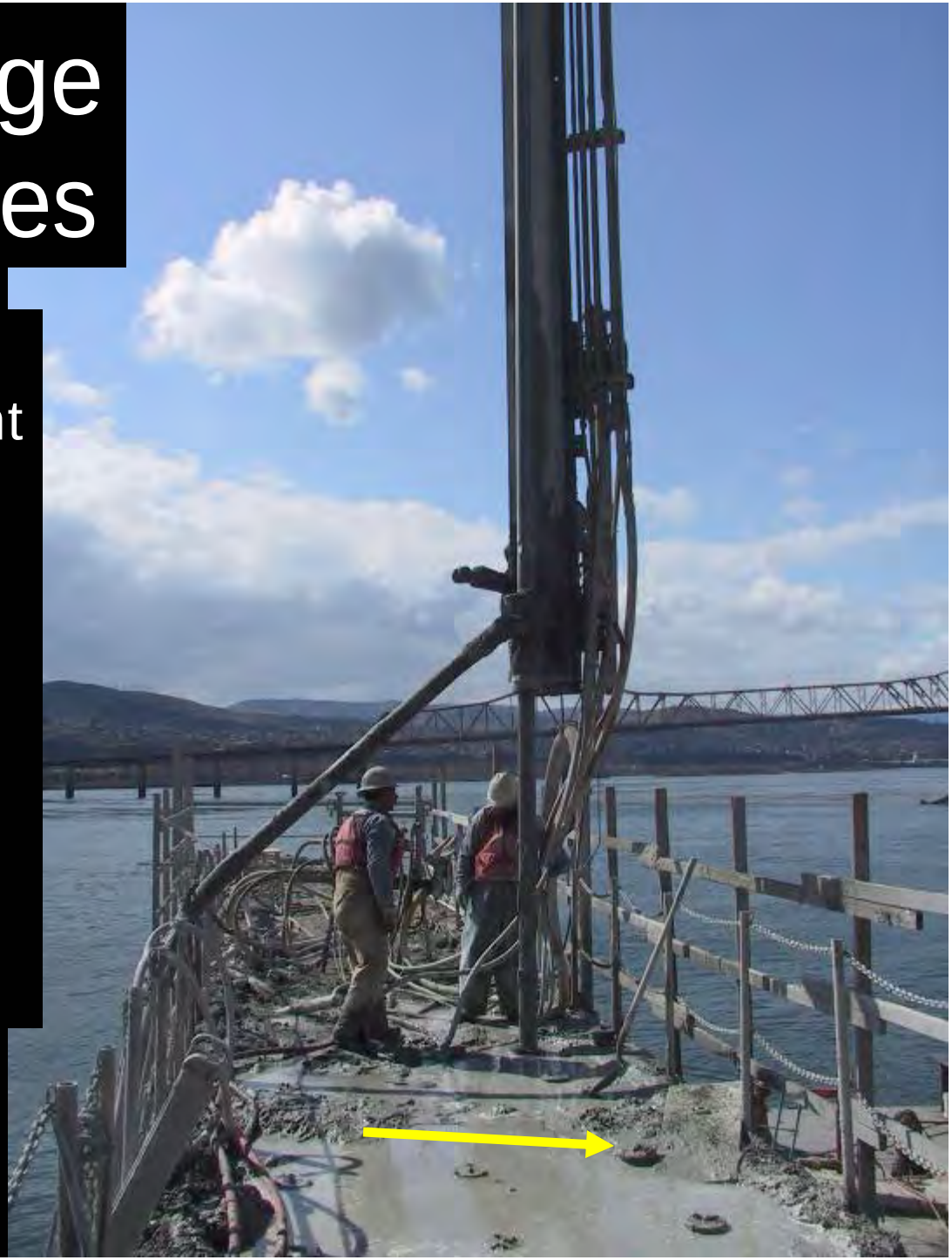


Drilling – Damage to Adjacent Holes

Problem: Drill cuttings run into uncapped adjacent completed drill holes requiring additional clean-up effort.

Lesson:

Require caps on prepped drill holes.



Drilling – Existing Features

Problem: Drilling and grouting can damage existing features – foundation drain system and concrete slab foundation.



Drilling – Existing Features

Lesson:

Evaluate proximity of existing features to drill hole locations. Select drilling method that will not cause degradation to existing features.

Monitor drilling for indications that degradation is occurring.

Contract documents should have language that indicates that drilling operations may be modified if degradation is occurring.

Grouting – Penetration Mix Design

Problem: Several different types of grout mixes were required but many did not work well during application.

Lesson:

Require specific grout mix designs that account for:

- Small or large voids
- Proximity to existing underground drains
- Long and short travel distances
- Use of slick lines
- Distance between concrete pump and grout plant

Use of fibers and anti-wash additives work, but may not be needed with proper placement method or when have 100's of feet of slick line.

Grouting – Placement Method



Grouting – Placement Method

Problem: Contractor used poor placement methods resulting in inadequate grouting in lower 5 - 10 feet of drill hole.

Lesson:

Require submittal information that includes:

- How grout flow maintained between batches
- How tremie pipe charged at start of every hole
- How grout delivered from grout plant
- How segregation will be prevented

Grouting – Placement Method

Problem: Grout flows into adjacent drill holes during penetration grouting reducing the effectiveness of the grouting.

Lesson:

Require caps on already drilled holes prior to and after grouting.



Grouting – Placement Method

Problem: Difficult to prevent water and grout that came to the surface during grouting operations from entering the river because no lip on concrete surface to contain it.

Lesson: Design over-water structures to contain water, cuttings, and grout.





Bolt Installation – Damaged Bolts

Problem: Bolts damaged during installation/ removal, indicating areas susceptible to damage.





Lesson:

Prevent damage to corrosion protection and expansion sleeves.

Bolt Installation – Jacking Pad Construction



Problem:

Grout pads cracked during bolt stressing.

Lesson:

Grout pads should be several inches larger than bearing plates or not used.

Concrete surface could be ground down for pads.

Bolt Installation – Lift-Off Testing

Problem: Lift-off test procedures modified during construction. Observed 50% of lift-off tests failed in anchors with more than 12 hours between initial lock-off and lift-off tests.

Lesson:

24-hour lift-off tests are state of practice for high capacity rock bolts.

Critical that tensioning one bolt doesn't reduce load of adjacent bolt.

Increasing initial lock-off load then lowering to final lock-off load reduces number of lift-off failures.



Questions??

US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

Mill Creek Deep Tunnel

Geologic Conditions and Potential Impacts on Design/Construction

Kenneth E. Henn III, P.G.

Presented to 2005 Tri-State Infrastructure Systems Conference & Exposition
August 3, 2005

Presentation Outline

- Tunnel Alternative Overview.
- Geological Overview of the Valley.
- Bedrock Findings & Impacts.
- Overburden Findings & Impacts.

The Tunnel Alternative

Mill Creek General Reevaluation Report (GRR) Alternatives

- **Total Relocation**
- **Non-Structural**
- **Non-Structural 2**
- **Non-Structural 3**
- **Channel Modification**
- **Channel Modification 2**
- **Floodwall & Levee**
- ***Deep Tunnel***
- **Deep Tunnel 2**

Non-Structural

Structural

Mill Creek General Reevaluation Report (GRR) Alternatives

- Total Relocation
- Non-Structural
- **Non-Structural 2**
- Non-Structural 3

Non-Structural

- Channel Modification
- **Channel Modification 2**
- Floodwall & Levee
- ***Deep Tunnel***
- Deep Tunnel 2

Structural


Legend
Hotels
Area Attractions
Shopping
FAIRFIELD
WEST CHESTER
FOREST PARK
SPRINGDALE
SHARONVILLE
WYOMING
MT. HEALTHY
BRENTWOOD
READING
MONTGOMERY
GROESBECK
NORTH COLLEGE HILL
WHITE OAK
MIAMITOWN
DEER PARK
KENWOOD
INDIAN HILL
CINCINNATI GARDENS
MADEIRA
MILFORD
CLEVES
BRIDGETOWN
NORTH BEND
ADDYSTON
LEONARD
XAVIER UNIVERSITY
HYDE PARK
UNIVERSITY OF CINCINNATI
CINCINNATI
EDEN PARK
NEWTOWN
BELLEVUE
DELHI
NEWPORT
COVINGTON
FT. THOMAS
LUNKEN AIRPORT
HEBRON
CINCINNATI NORTHERN KENTUCKY INTERNATIONAL AIRPORT
FT. WRIGHT
FT. MITCHELL
NORTHERN KENTUCKY UNIVERSITY
WITHAMSVILLE
FLORENCE
THOMAS MORE COLLEGE
OHIO
KENTUCKY
Ohio River
Columbia Pike
Ronald Reagan Hwy
Greater Cincinnati Regional Map

- Proposed Tunnel Aspects -

Approximately 16 miles long

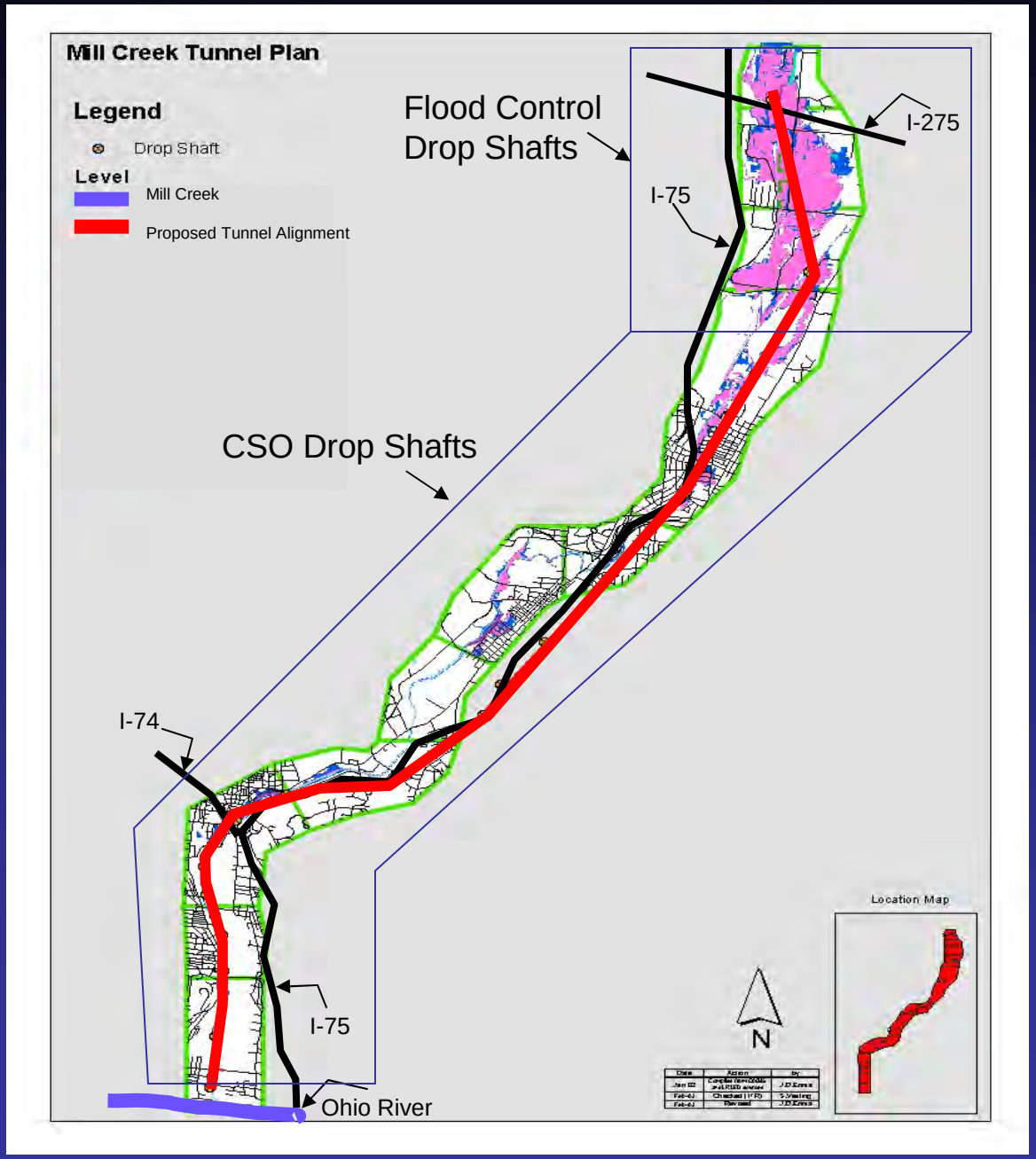
31-foot finished diameter

19 drop shafts, ranging in size from 10-feet to 24-feet in diameter.

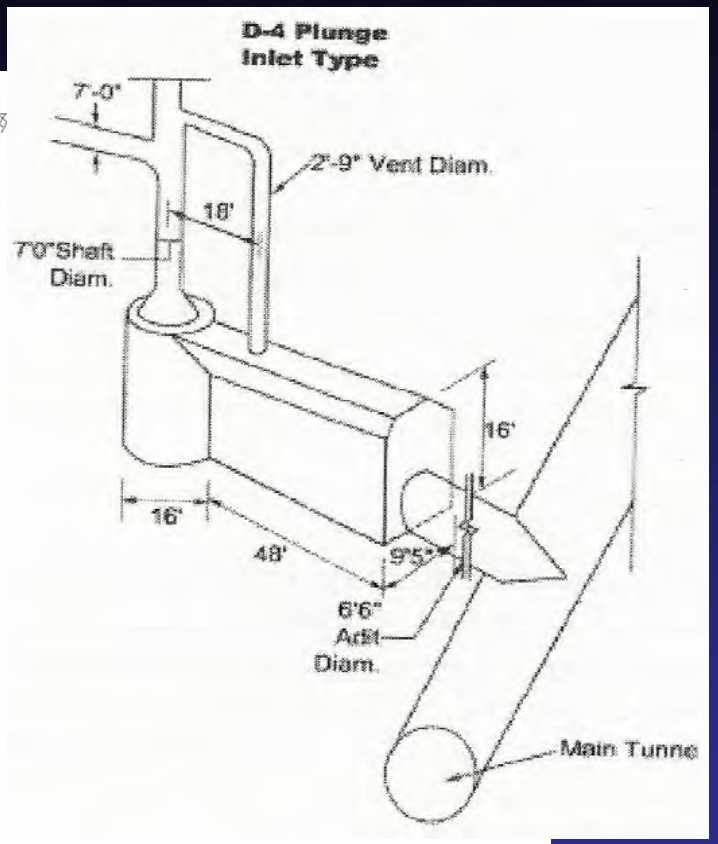
4 mining shafts, ranging in size from 30-feet to 60-feet in diameter.

19 access shafts, with 10-foot diameter

Approximately 67 combined sewer (CSO) runs for a total Of 12 miles of sewer, ranging from 3.5-feet to 10-feet in diameter

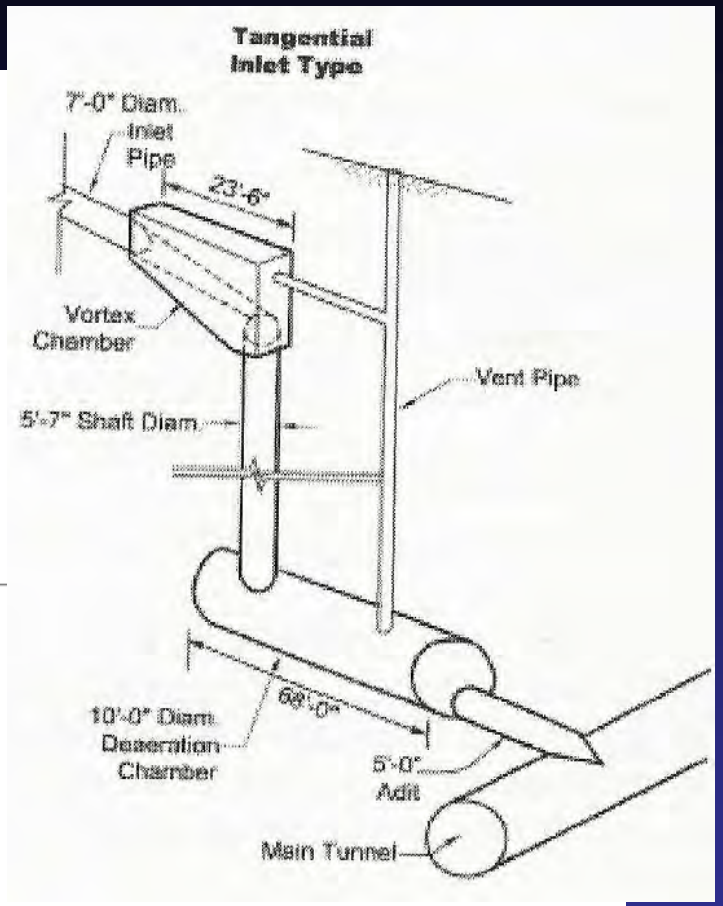


Plunge Shaft



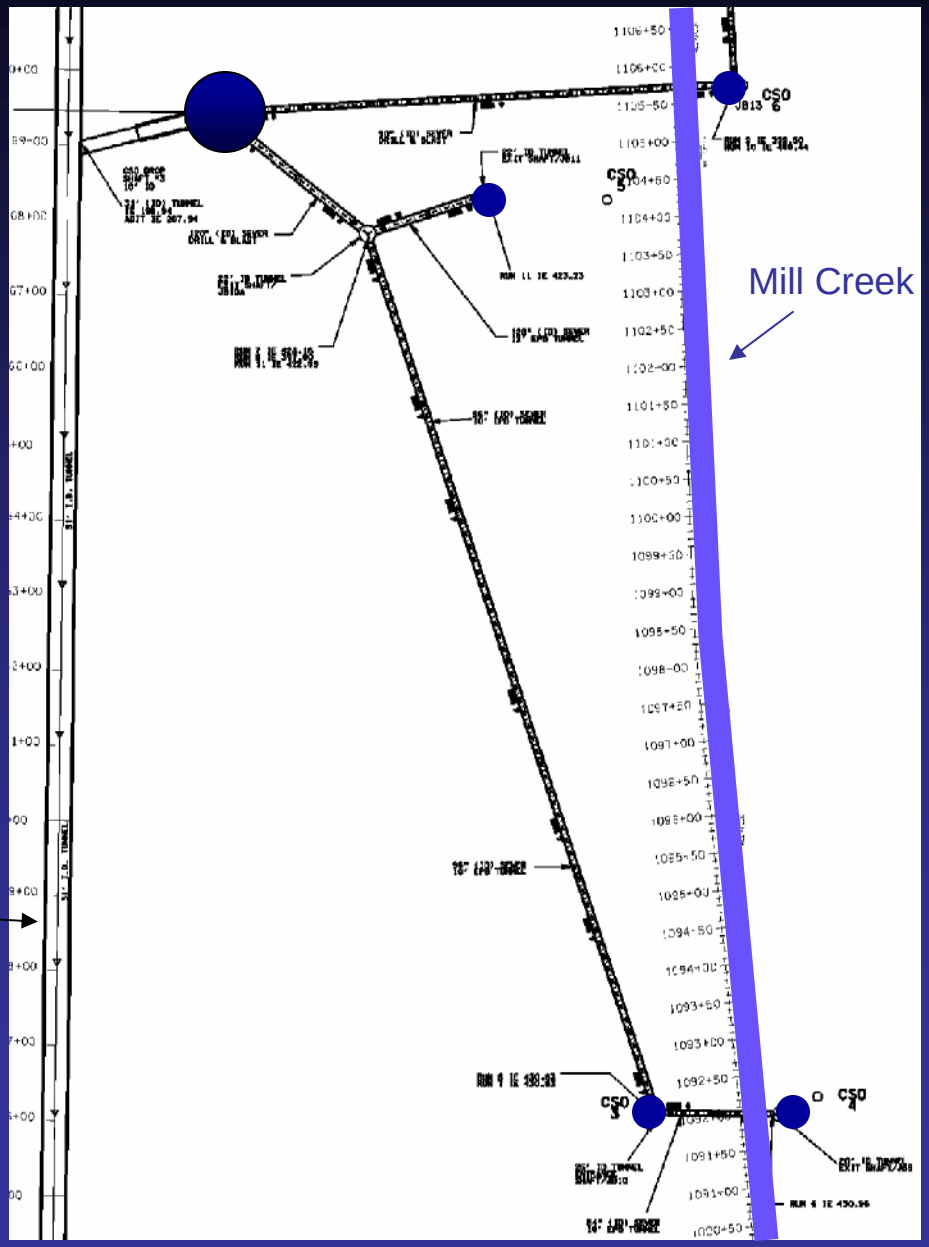
No Scale

Vortex Shaft



No Scale

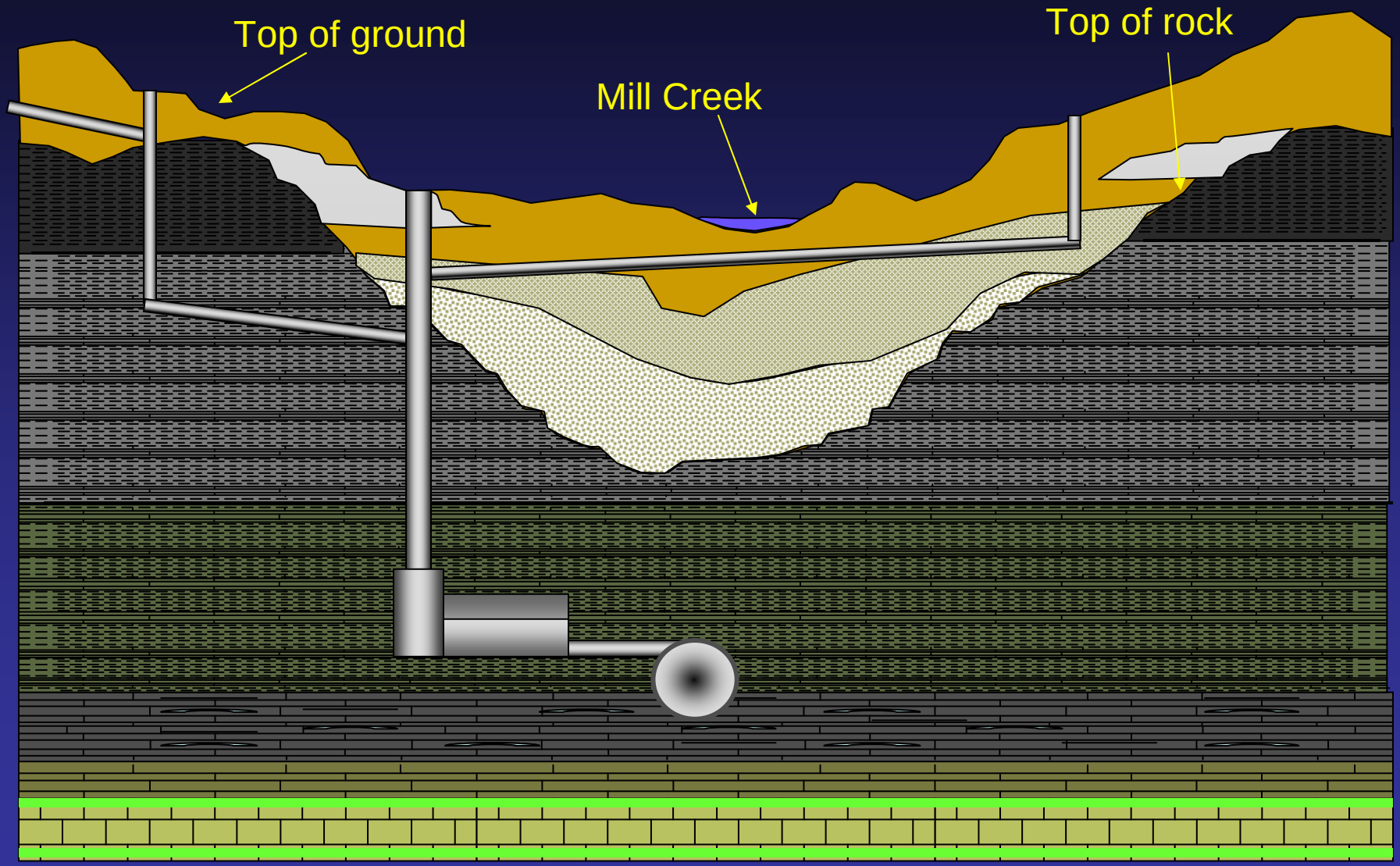
Combined Sewer Outflow (CSO) runs going to Drop Shaft



Deep Tunnel

(~300’ below ground surface)

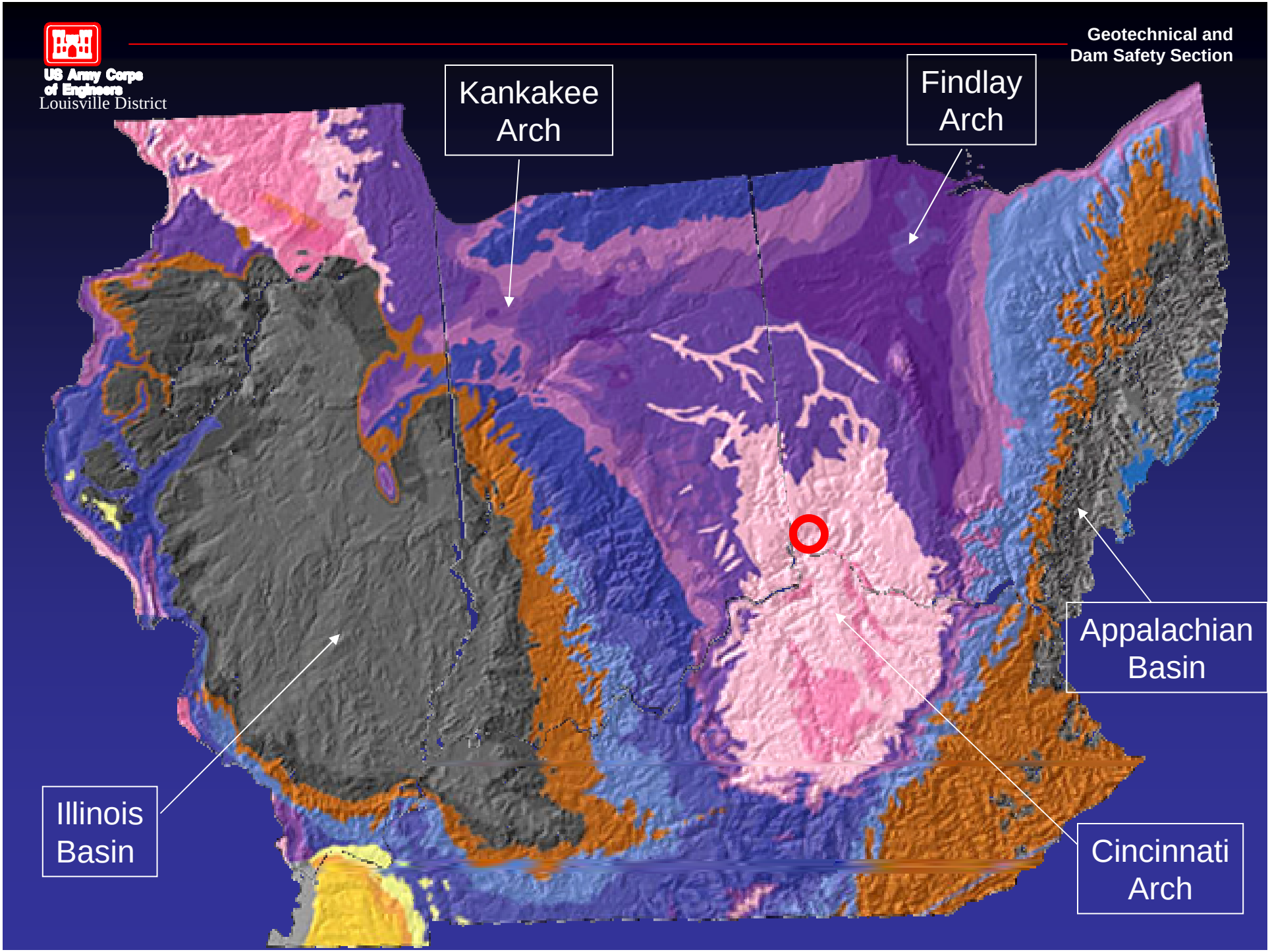
Tunnel Section

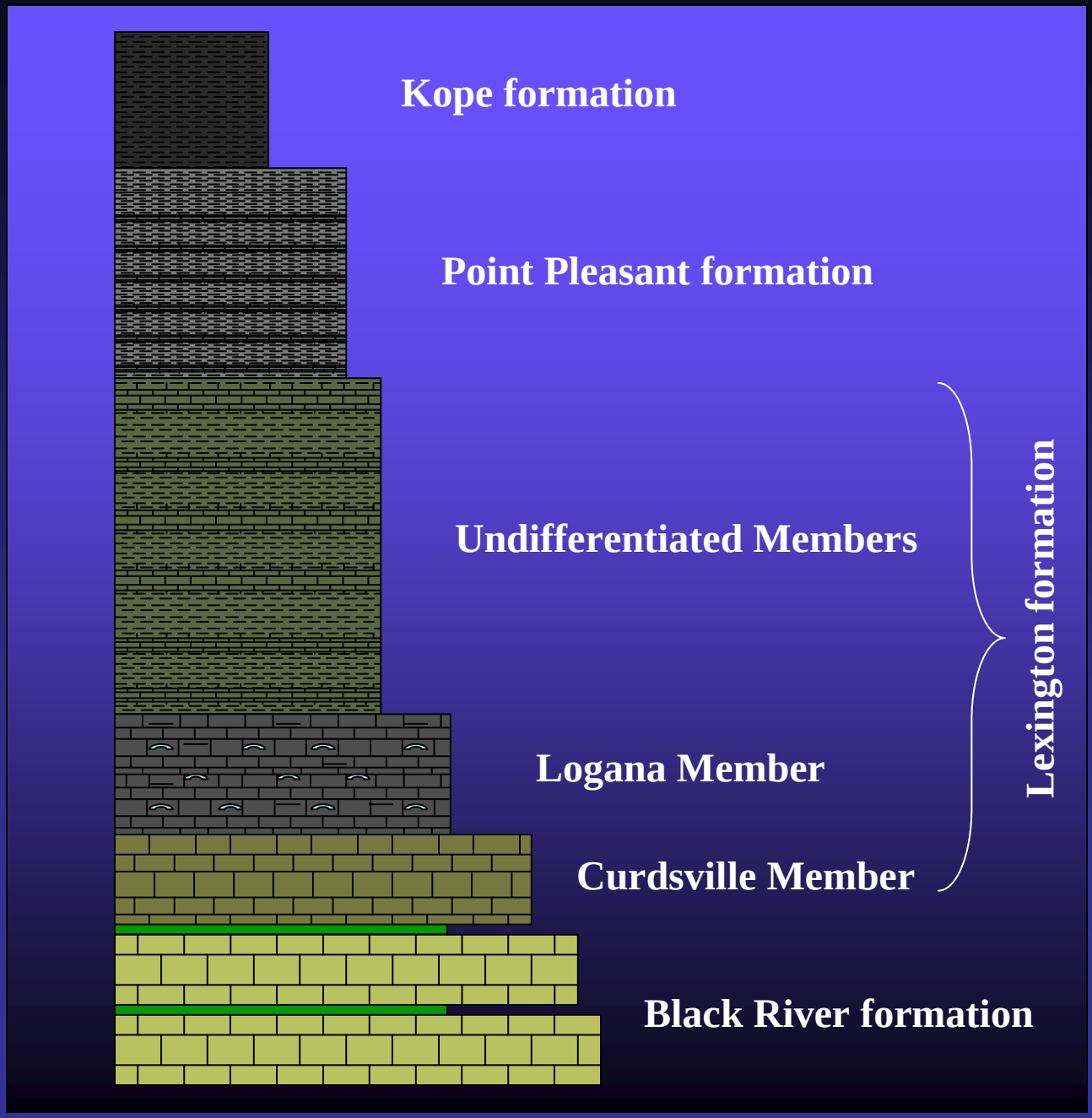


Geologic Overview

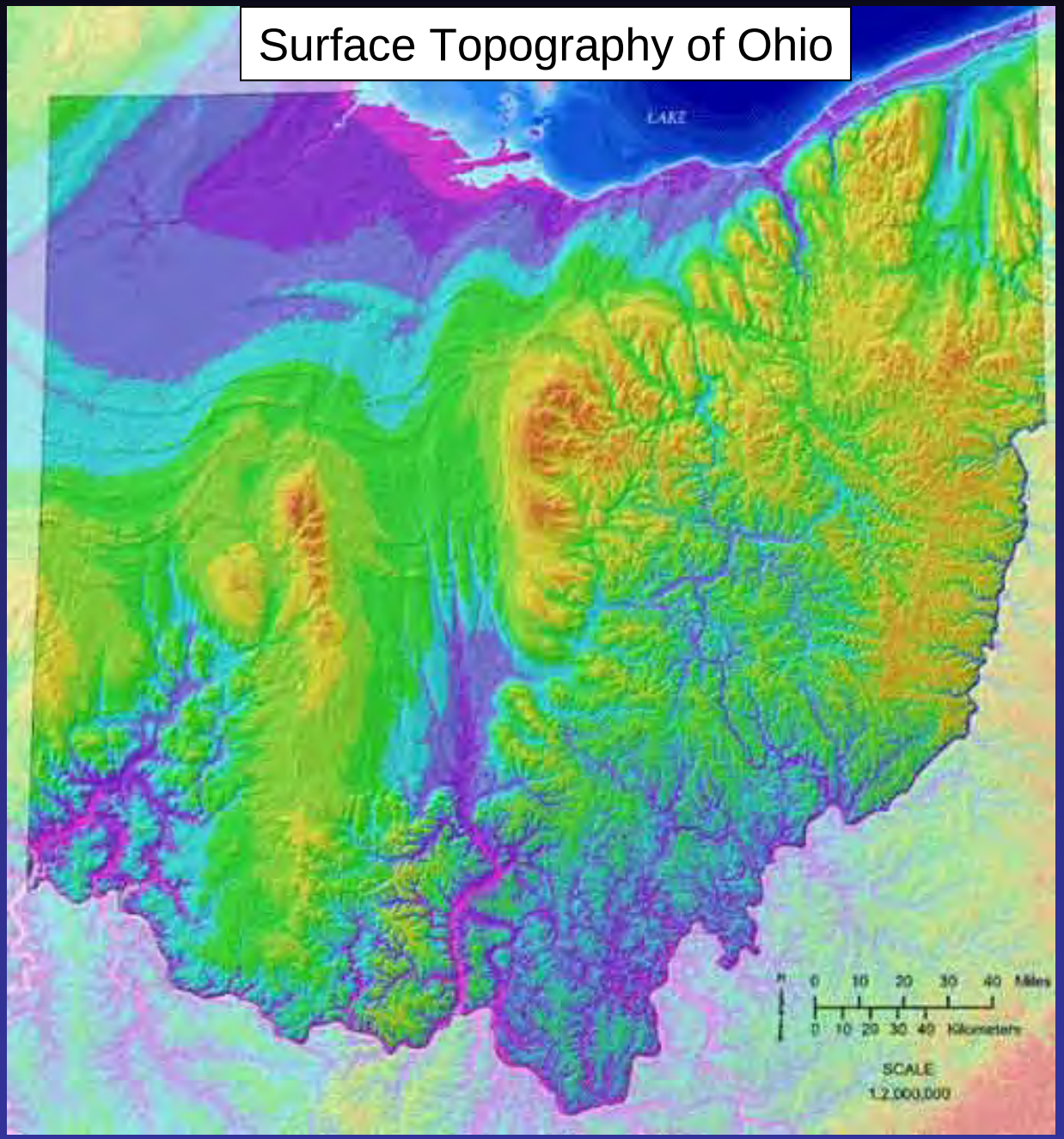
US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

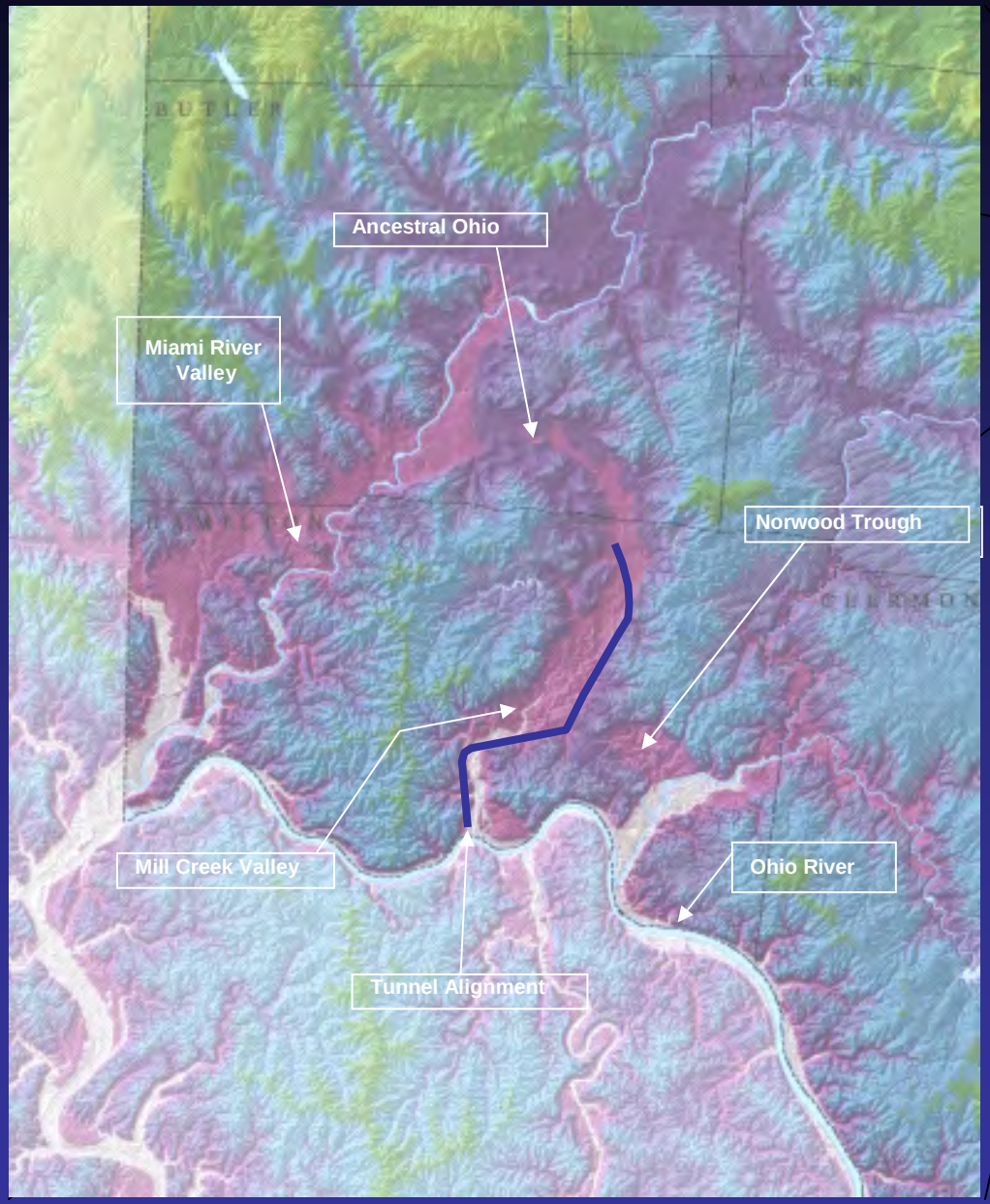


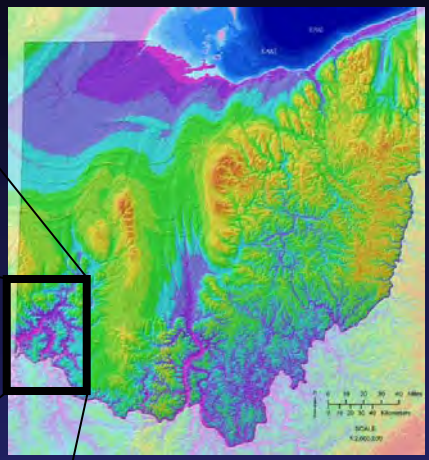

Kope formation
Point Pleasant formation
Undifferentiated Members
Logana Member
Curdsville Member
Lexington formation
Black River formation

Surface Topography of Ohio



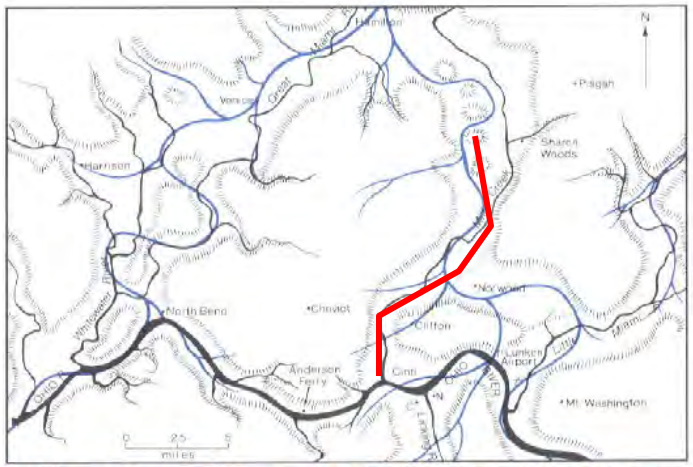
Obtained from the Ohio Geological Survey


Ancestral Ohio
Miami River Valley
Norwood Trough
Mill Creek Valley
Ohio River
Tunnel Alignment

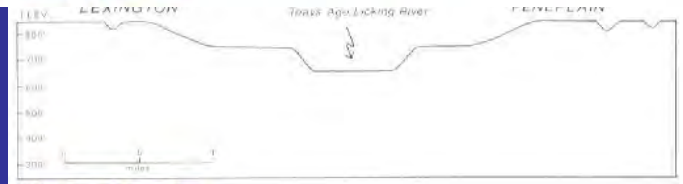


250,000 YBP



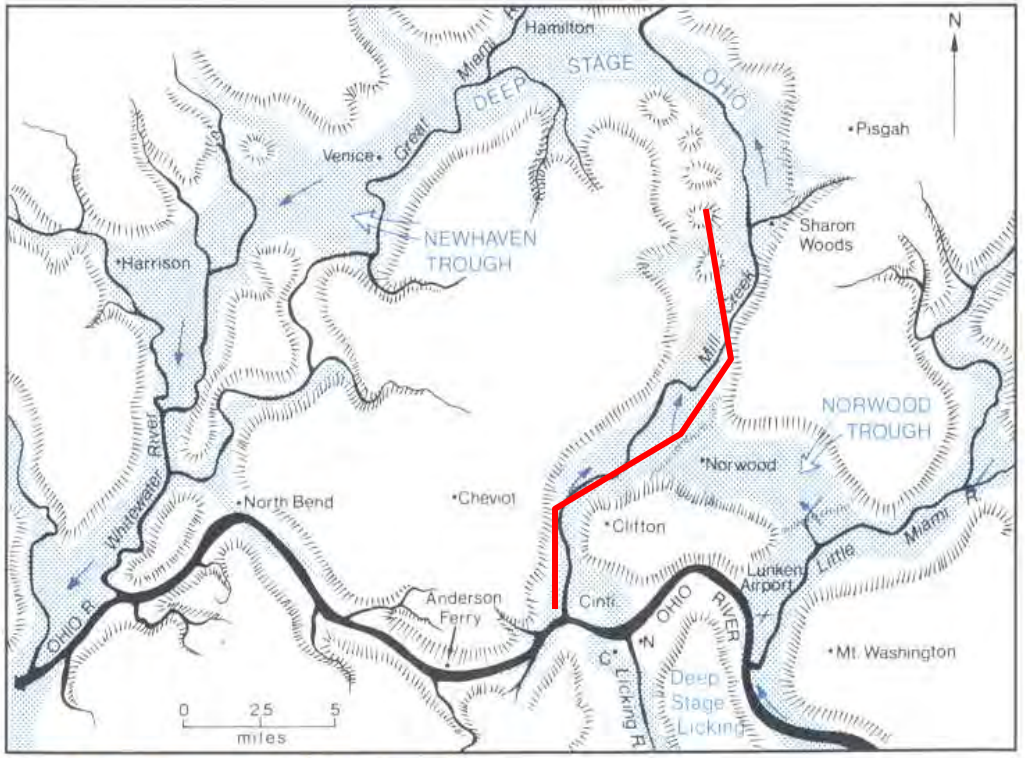


North flowing tributaries to the Teays system in blue. Modern drainage in black. Ohio River nonexistent at that time.

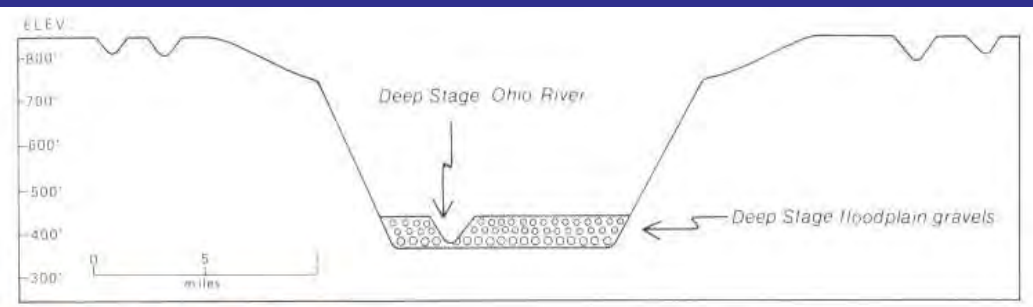


Licking River in Teays Time

Pre-Illinoian (>150,000 YBP)



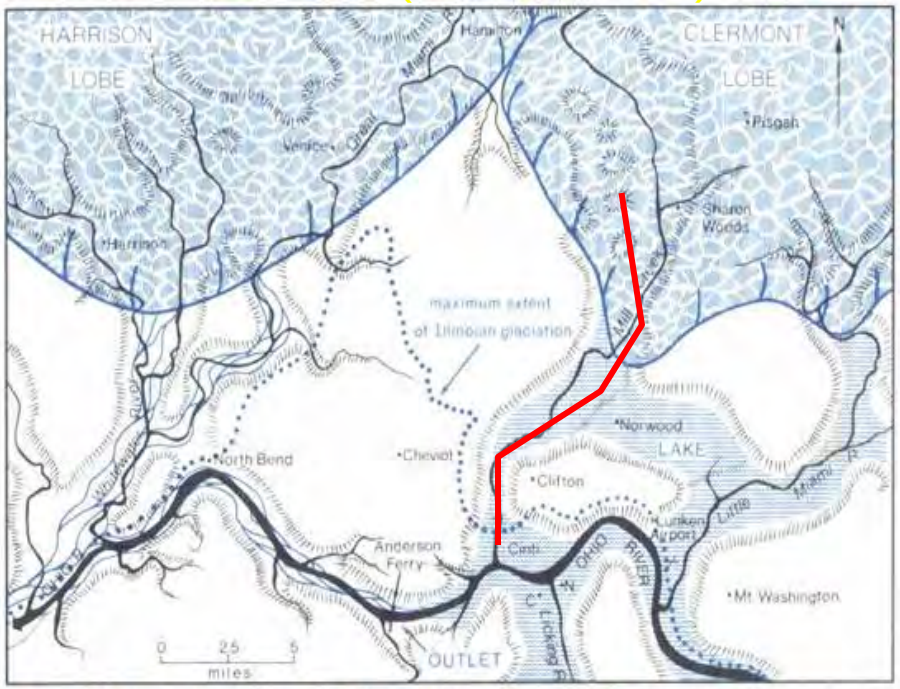
Map of Deep Stage ancestral Ohio shown by arrows.



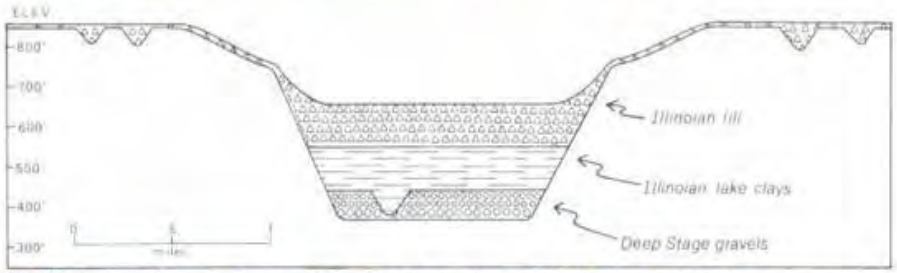
Cross section of Deep Stage Ohio.

from Durrell, 1977

Illinoian (150,000 YBP)

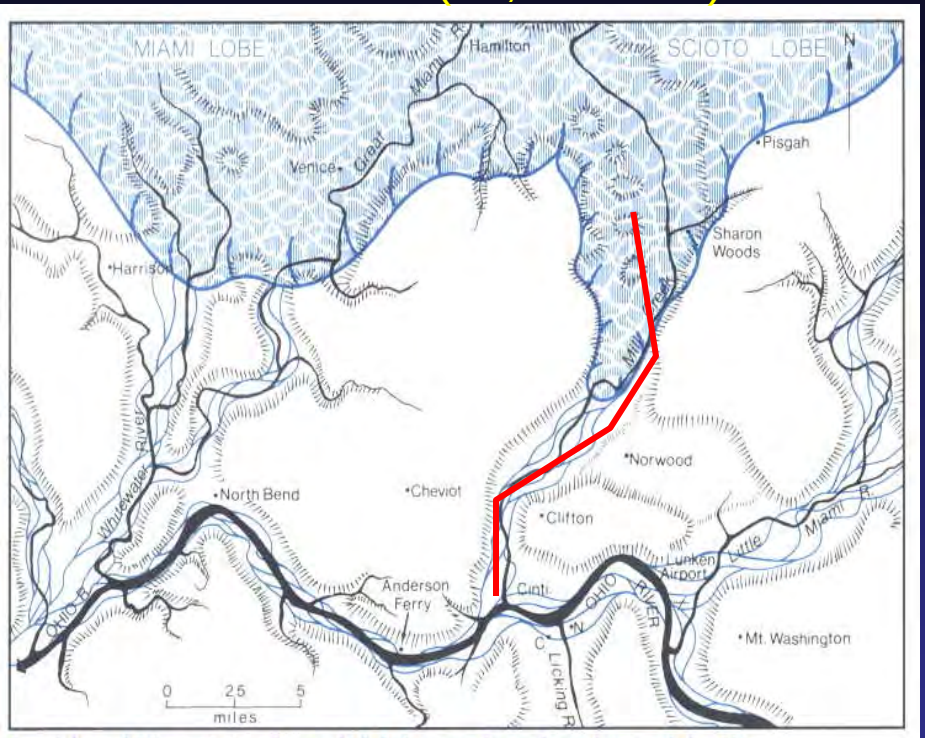


Advance of Illinoian ice ponding north flowing Licking River with the deposition of lake clay followed by over flow of a divide at Anderson Ferry to create present westward course of the Ohio River, south of Cincinnati.

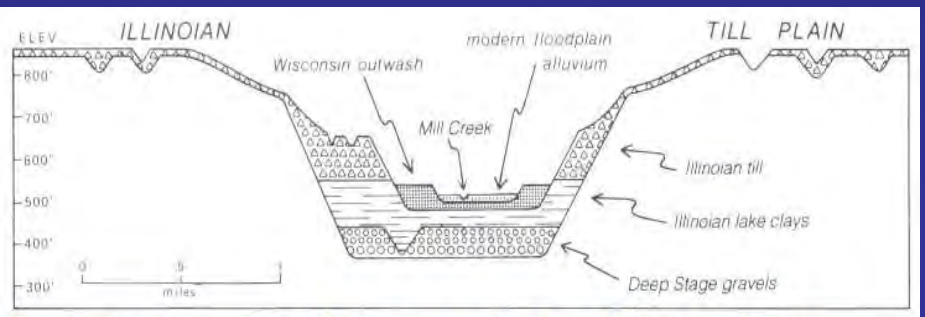


The further southward advance of the Illinoian ice deposited till over the lake clays and on the uplands.

Wisconsin (20,000 YBP)



Two lobes of Wisconsin ice sheet which fed outwash southward toward the Ohio River. Note braided stream pattern.



Cross section of two terraces in Mill Creek Valley well shown in Spring Grove Cemetery.

from Durrell, 1977

Subsurface Investigations

Bedrock Findings and Impacts on Construction Methods

The Foci of the Investigations

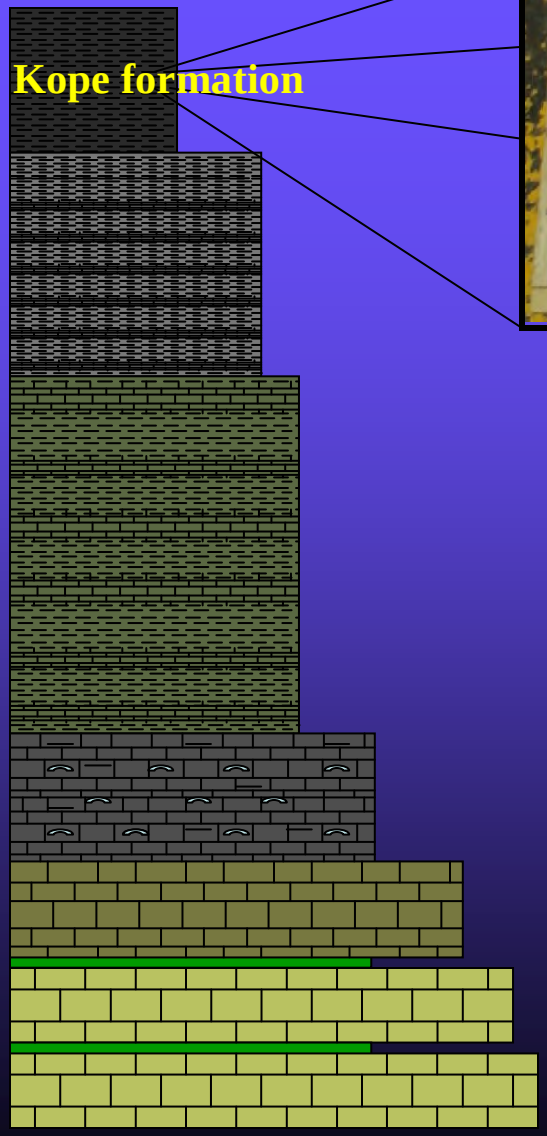
Historical and Archive Research: (~1100 historical borings) Included previous borings, research, and investigations by local, state, university, and federal entities.

Drilling Round 1: (9 borings) General characterization of the overburden and bedrock formations. Index and physical testing of soils and rock samples.

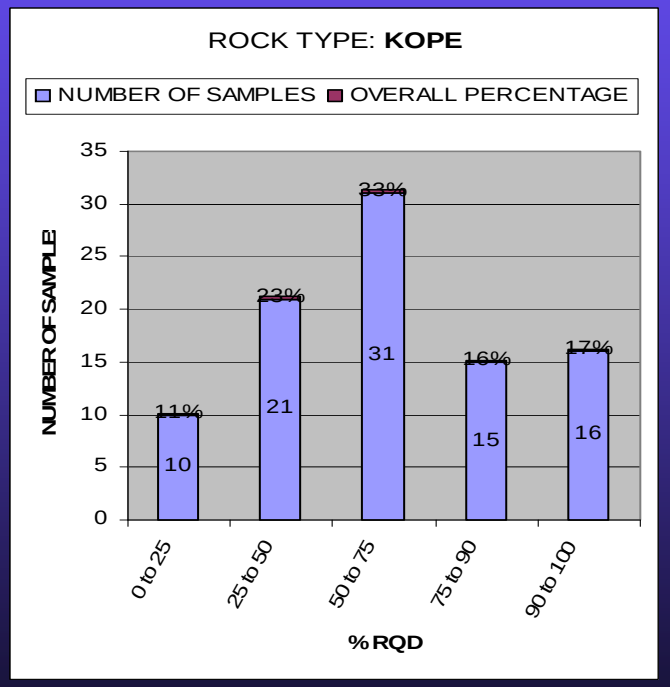
Drilling Round 2: (13 borings) Specific characterization of bedrock, including borehole geophysics, angle borings, joint orientations, etc.

Drilling Round 3: (57 borings) Top of rock verification borings to help define the buried valley geometry.

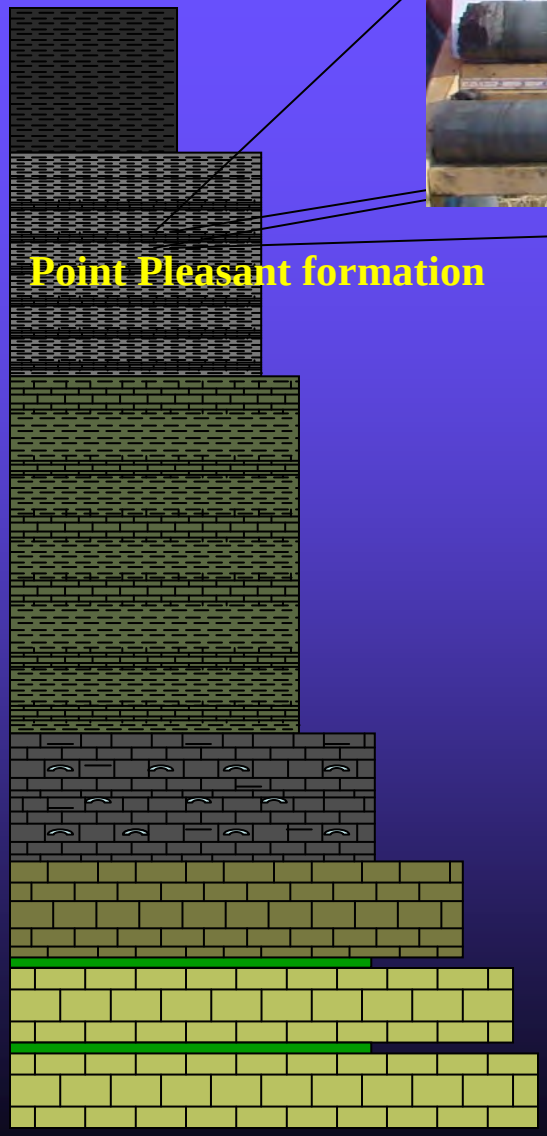
Consultant Involvement: Obtained throughout the investigation process to ensure aspects of tunnel investigations were characterized.





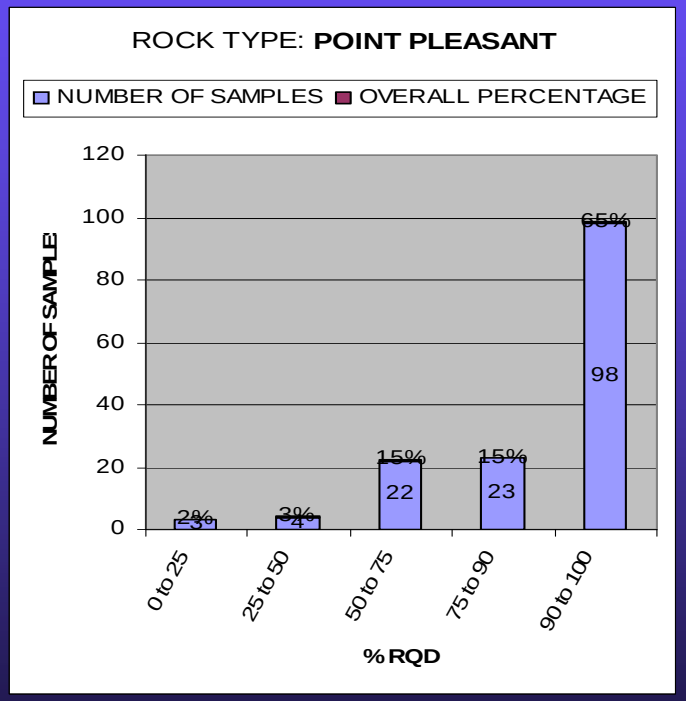


Avg. Compressive Strength: 915 psi

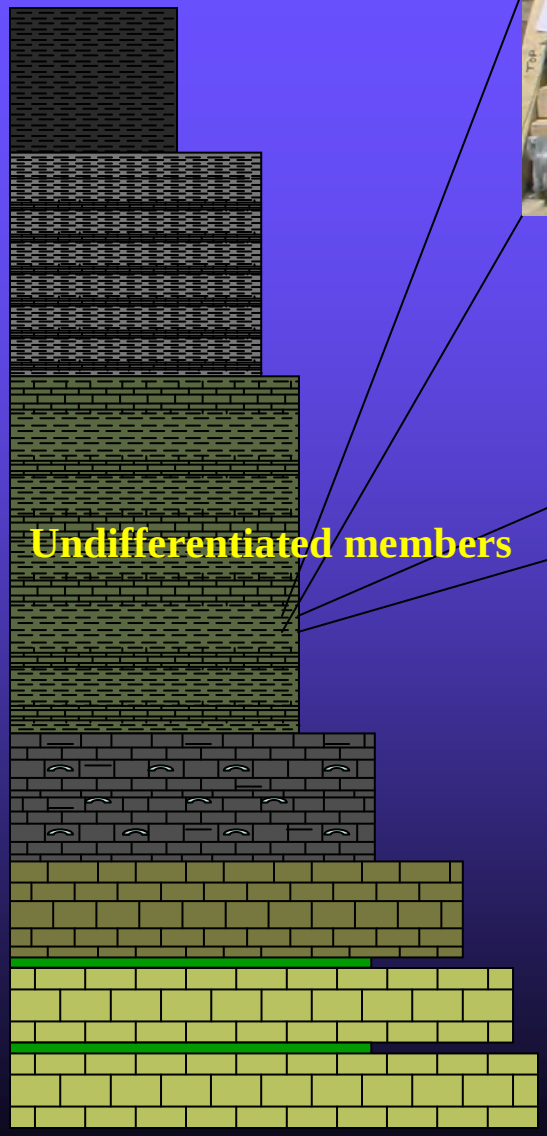


Point Pleasant formation

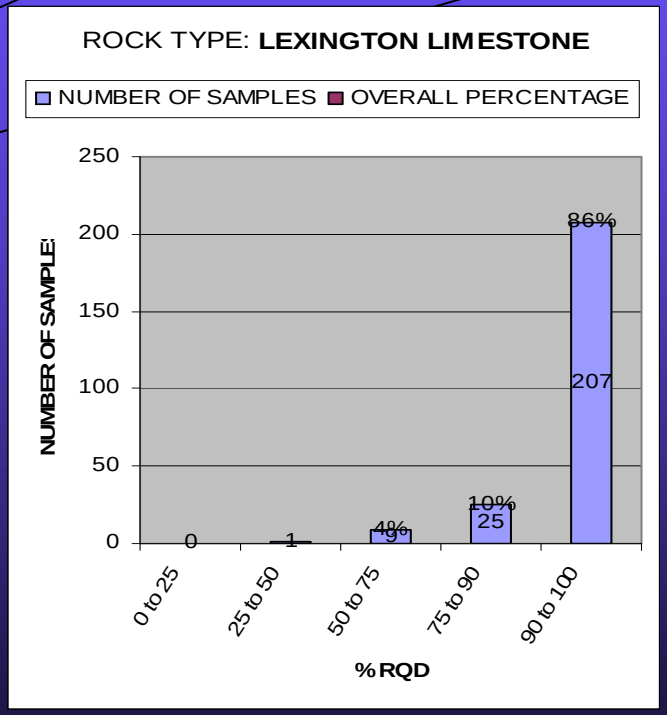




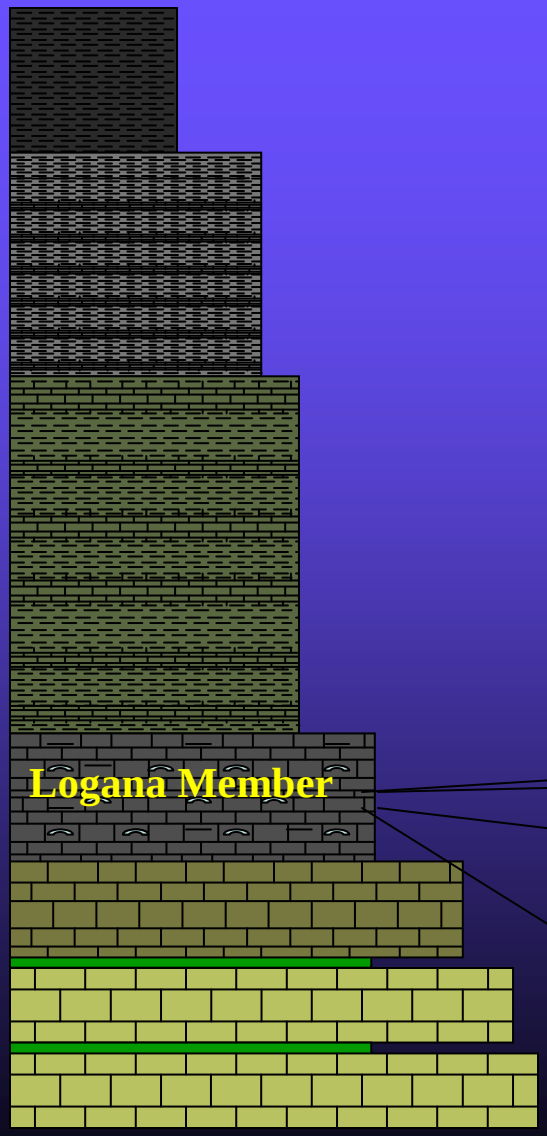
Avg. Compressive Strength: 3057 psi

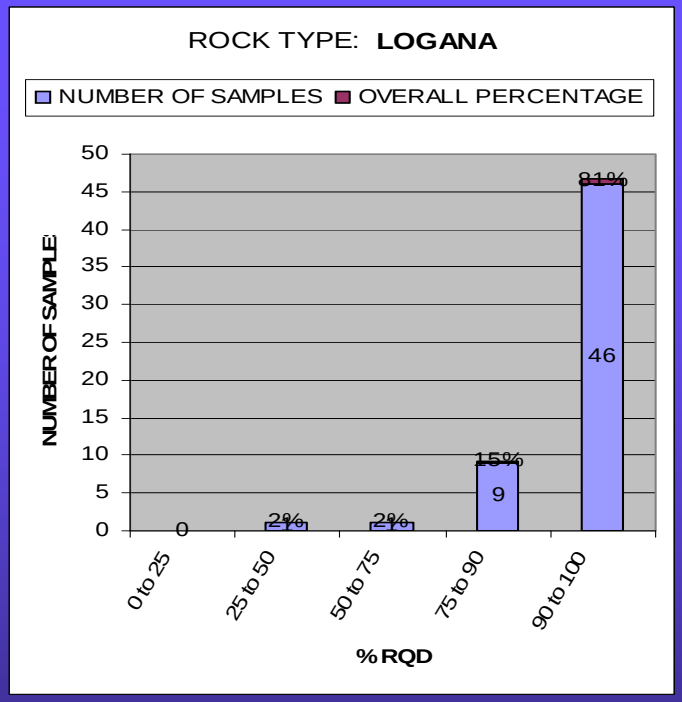


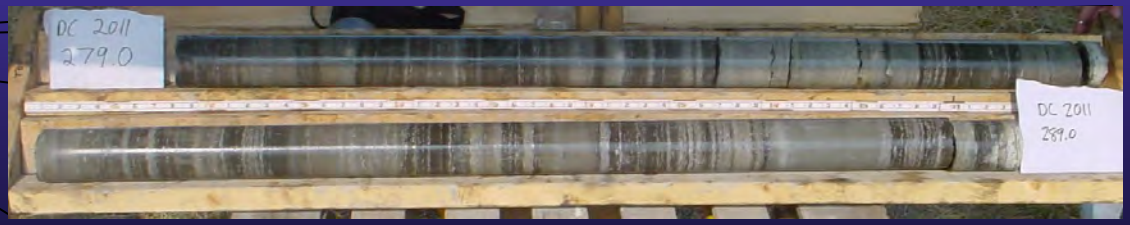




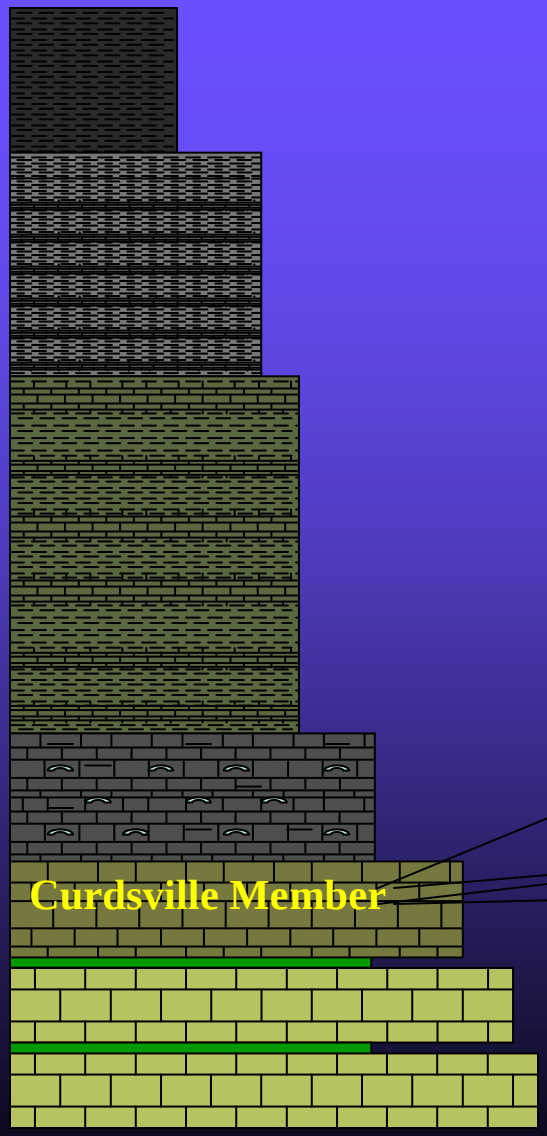
Avg. Compressive Strength: 9281 psi

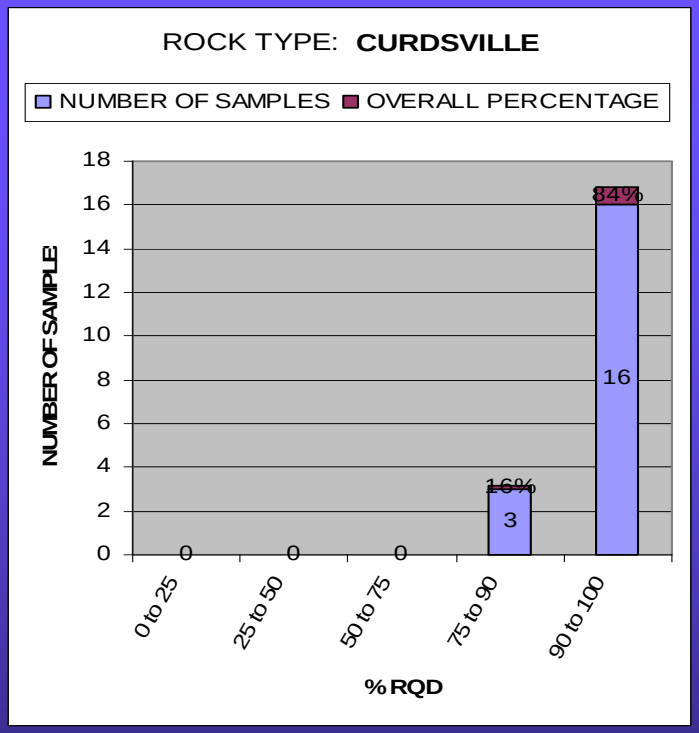






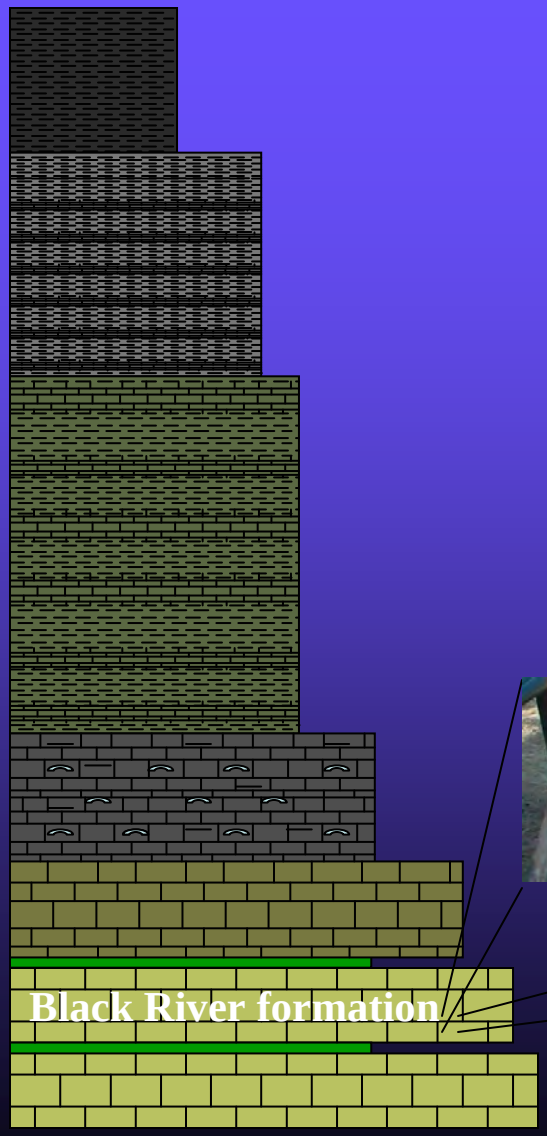
Avg. Compressive Strength: 7821 psi

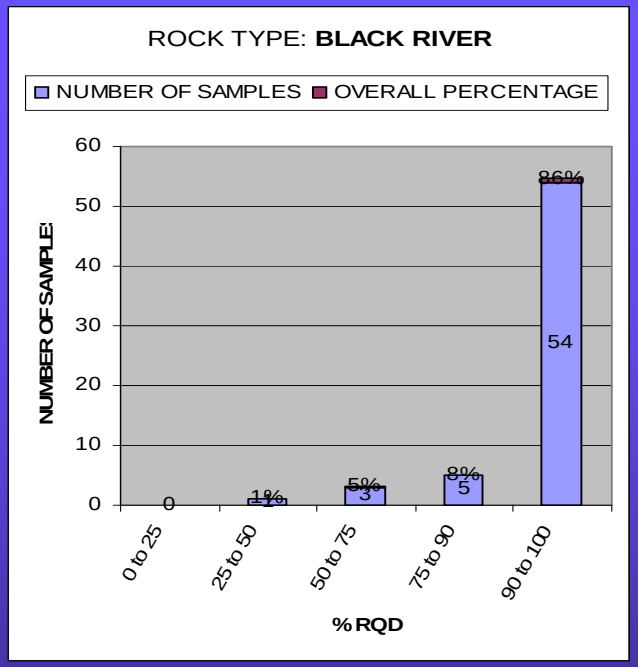






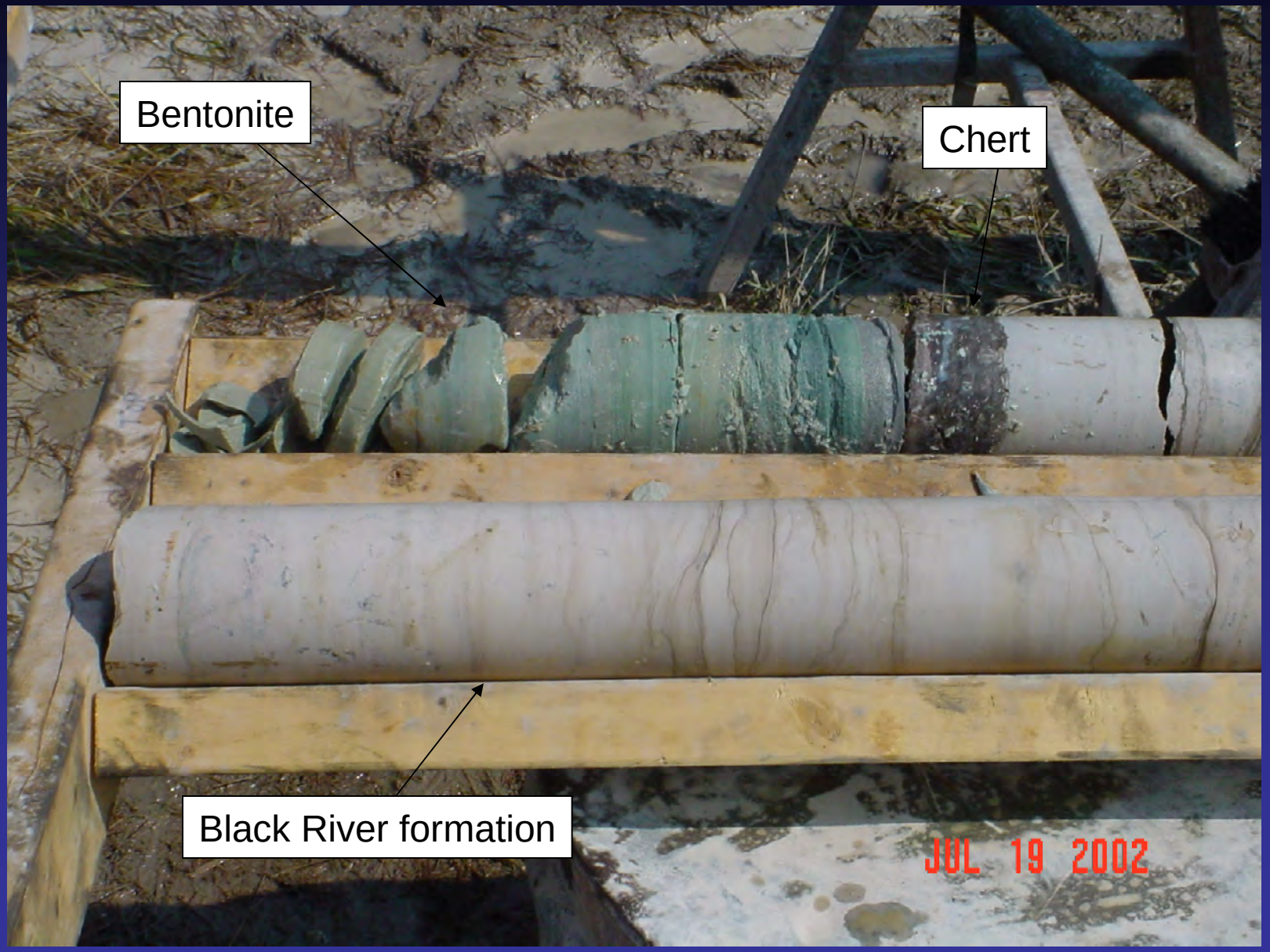
Avg. Compressive Strength: 12,988 psi

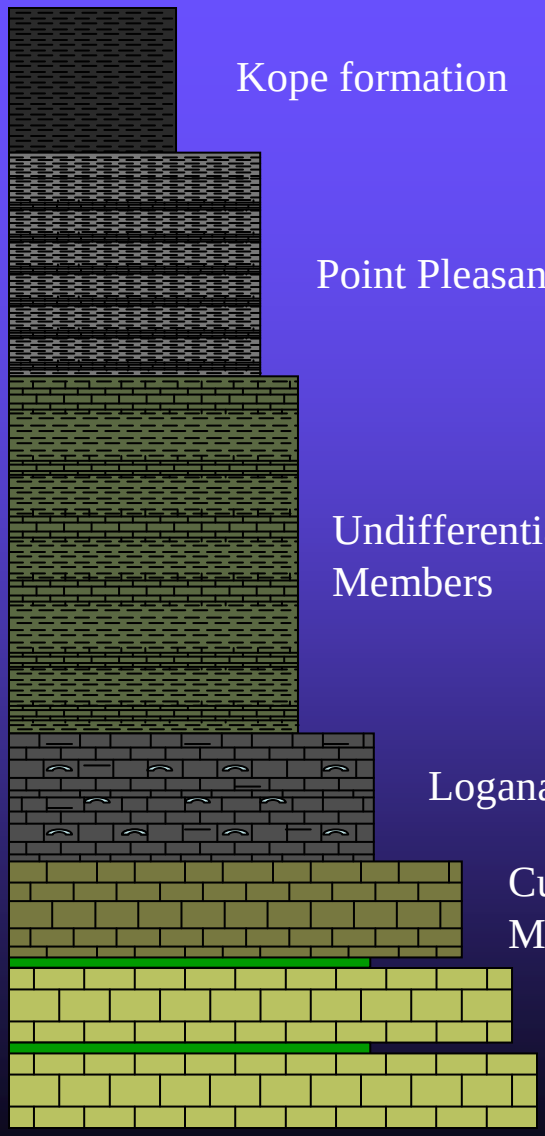






Avg. Compressive Strength: 15,719 psi


Bentonite
Chert
Black River formation
JUL 19 2002



Kope formation

Point Pleasant formation

Undifferentiated Members

Logana Member

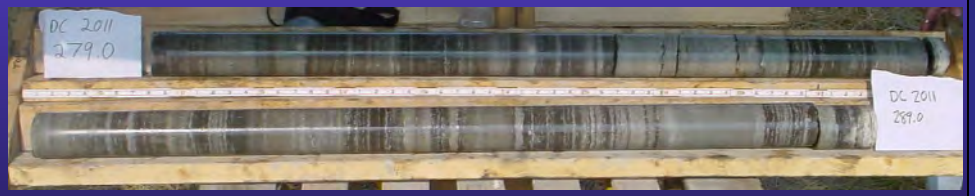
Curdsville Member

Black River formation





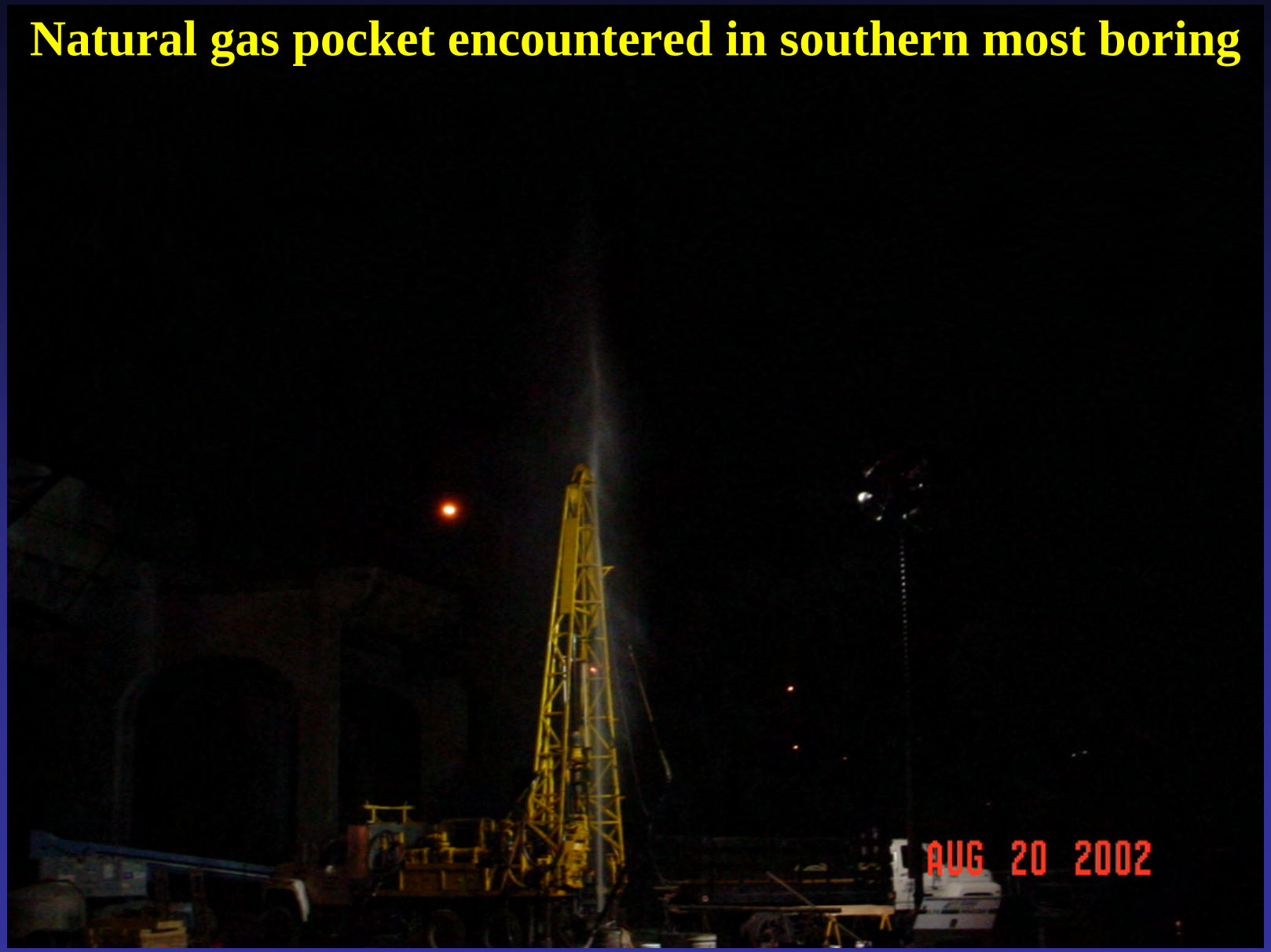








Natural gas pocket encountered in southern most boring

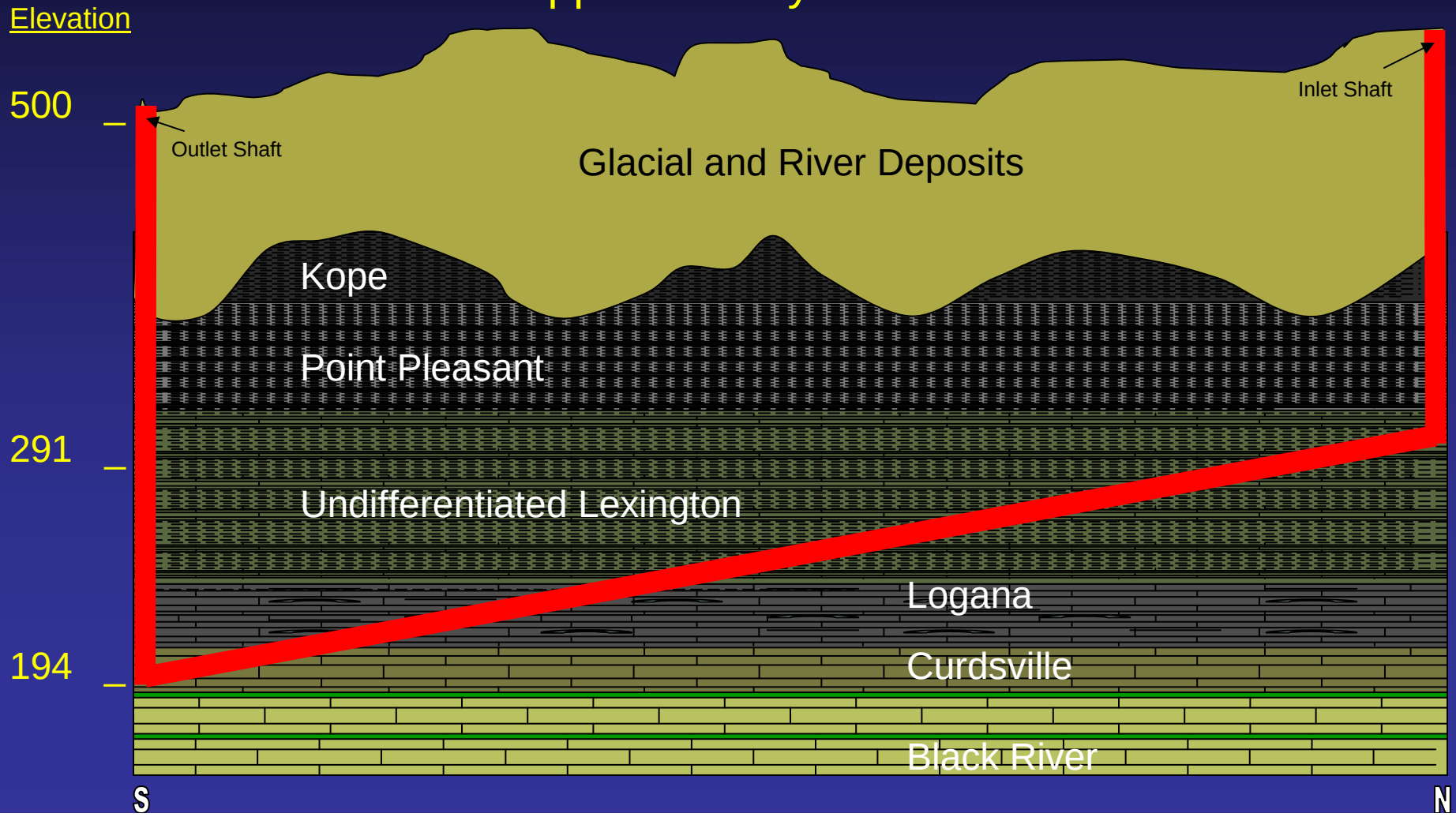


Natural gas pocket encountered in one of northern most borings

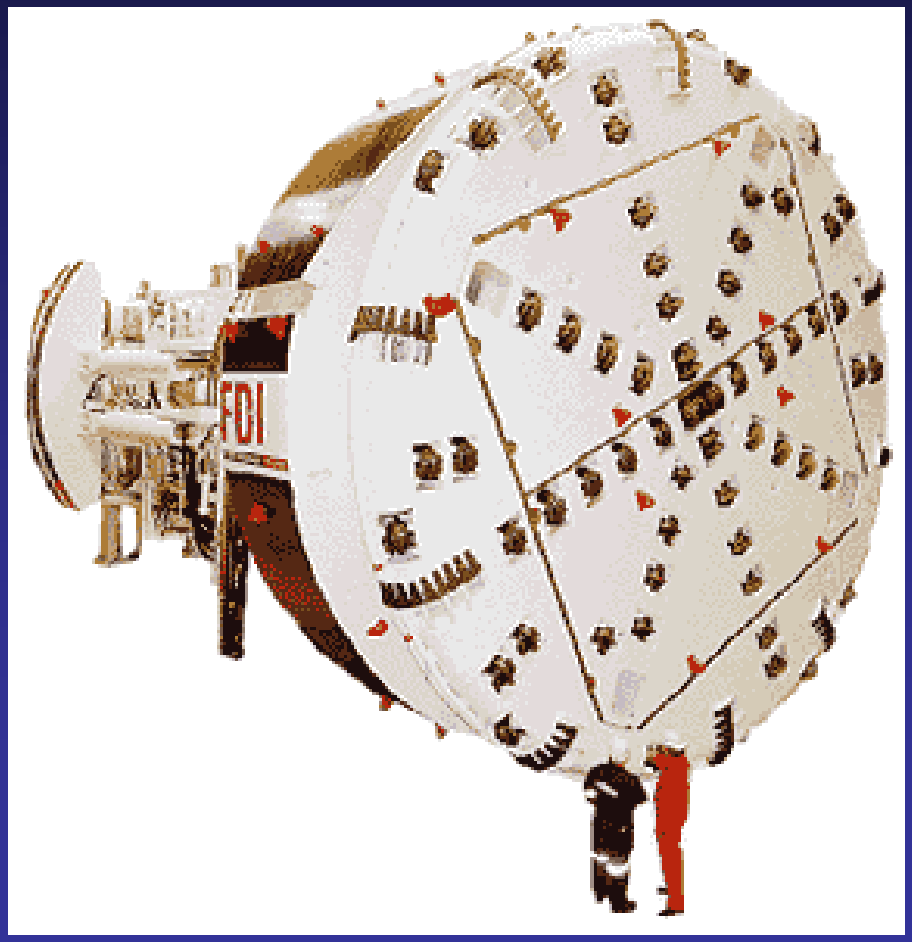


TUNNEL PROFILE

34-foot excavated diameter tunnel on a .075% grade for approximately 16-miles



Tunnel Boring Machines

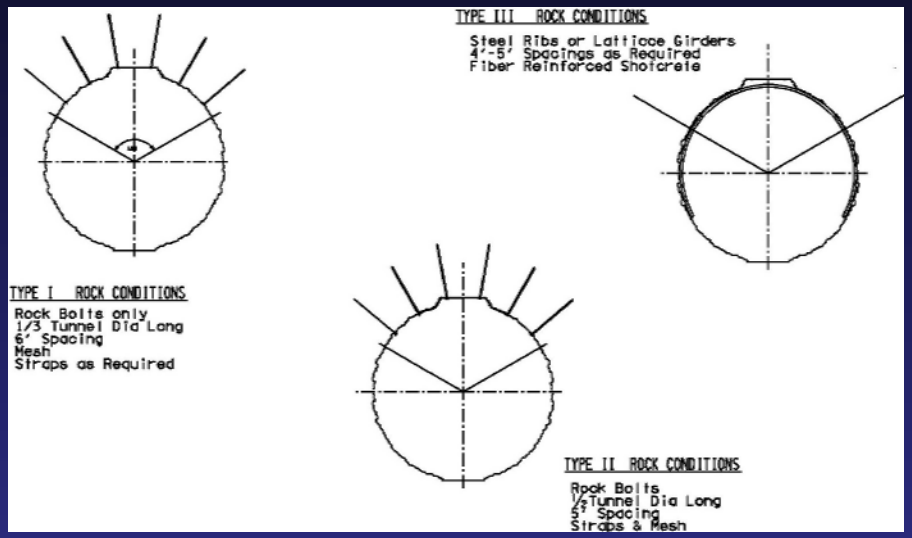






Photos taken from Robbins

Tunnel Boring Machines

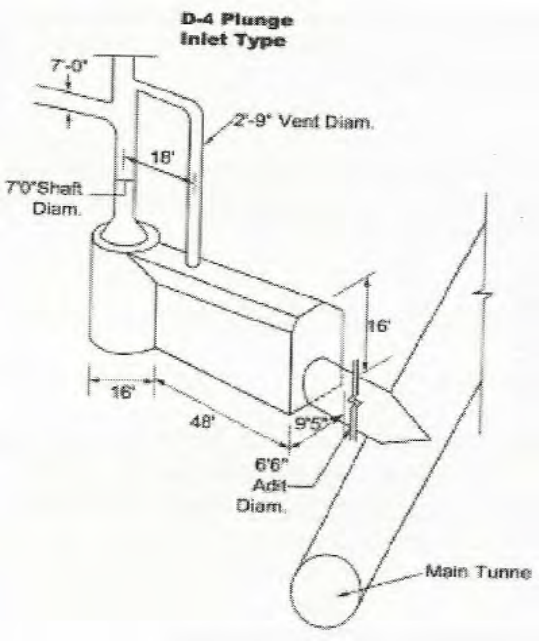




Trailing equipment will consist of rock bolt drill-rigs and possibly instrumentation to sense for high amounts of hydrogen-sulfide and methane, which automatically shuts the TBM down

Road Headers







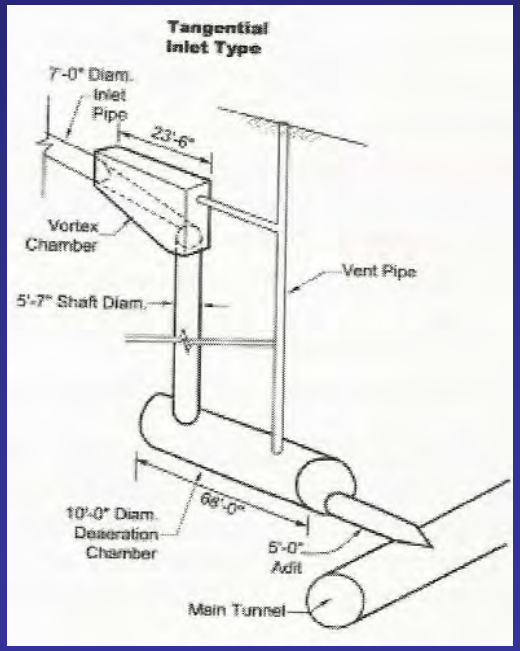


Photo taken from Lane Cove Tunnel Project

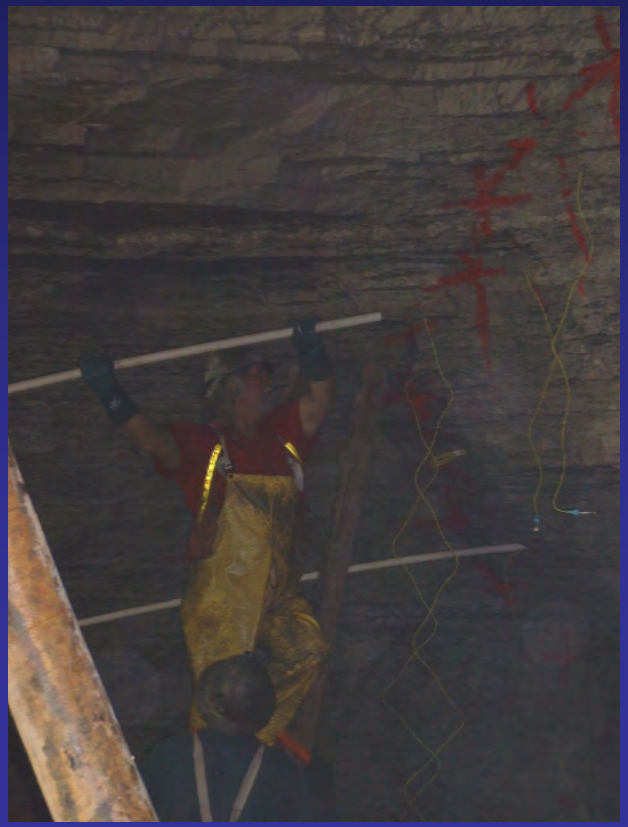
Drill & Blast

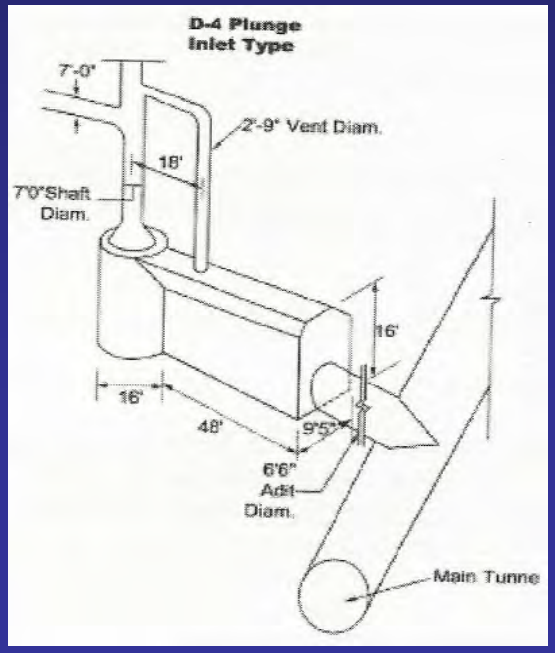


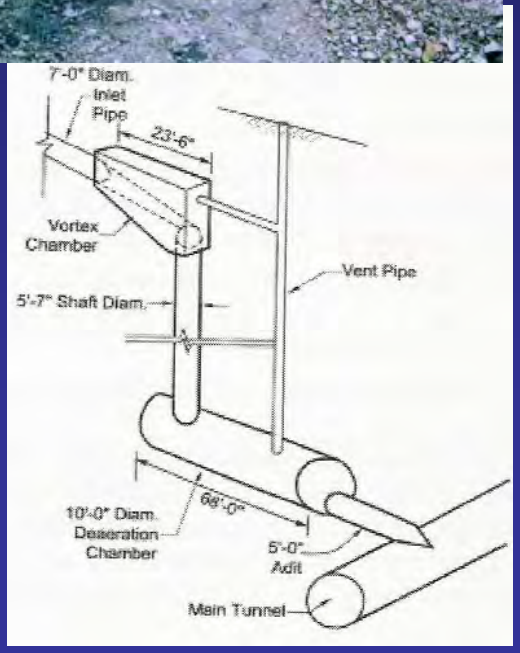
Chattahoochee Tunnel



Rescon Mapei





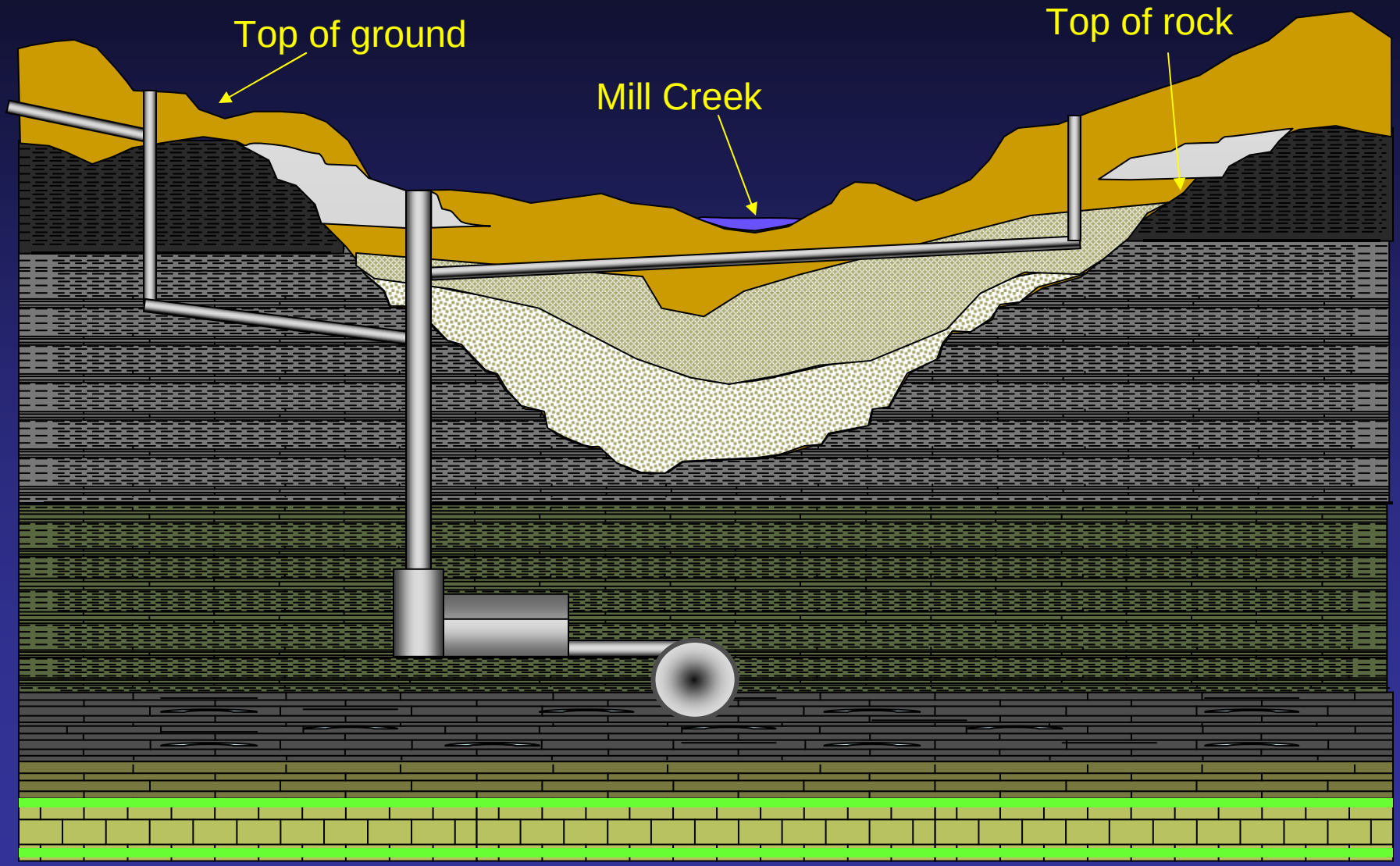


Potential Ground Improvements

- Pre- or post-grouting to help control water inflow, gas inflow, and help to stabilize loose blocks.
- Rock bolts and straps to minimize rock falls.
- Shotcrete to improve excavation stability.
- Minimize drill & blast operations, which can influence rock stability characteristics outside the lines of the excavation.

Overburden Findings and Impacts on Construction Methods

Tunnel Section



Overburden Characterization

Generalization of Subsurface Conditions at Drop Shaft Locations for GRR

Geology
- 1) Estimation of Origin

Geography
- 2) Proximity to Valley Wall
- 3) Proximity to Norwood Trough

Geology (Origin)

- Man-made
  - Artificial fill material (1)
- Riverine
  - Recent alluviums
- Glacial
  - Wisconsin outwash
  - Illinoian glacial till

  Undifferentiated (2)
  - Illinoian lacustrine sediments (3)
  - Pre-Illinoian Deep Stage sands & gravels (4)

Glacial Deposits located at Caldwell Park (eastern wall of Mill Creek valley)



From University of Cincinnati – Geology Department website

Glacial Deposits located at Caldwell Park (eastern wall of Mill Creek valley)



From University of Cincinnati – Geology Department website

Glacial Deposits located at Caldwell Park (eastern wall of Mill Creek valley)



From University of Cincinnati – Geology Department website


Project Number LX2002135
Project Name Mill Creek Deep Tunnel Project
Test ID FMSM 366
Hole Number DC2020
Depth 35.0'-37.0'
Fuller, Mossbarger, Scott and May Engineers, Inc

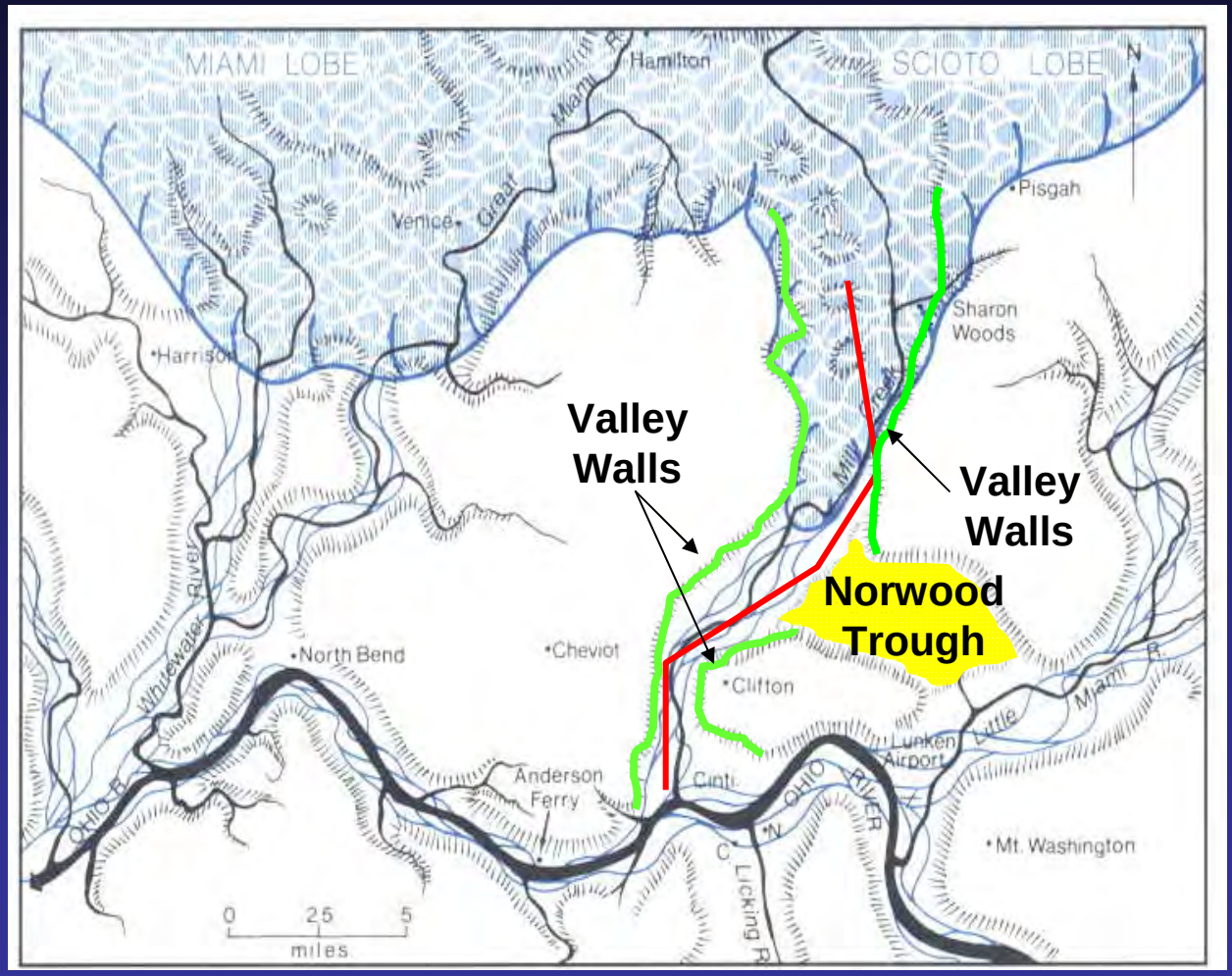
Geography

North of the Norwood Trough
- Valley Wall (1)
- Deep Valley (2)

Confluence of the Norwood Trough with the Mill Creek Valley (3)

South of the Norwood Trough
- Valley Wall (4)
- Deep Valley (5)

Geography

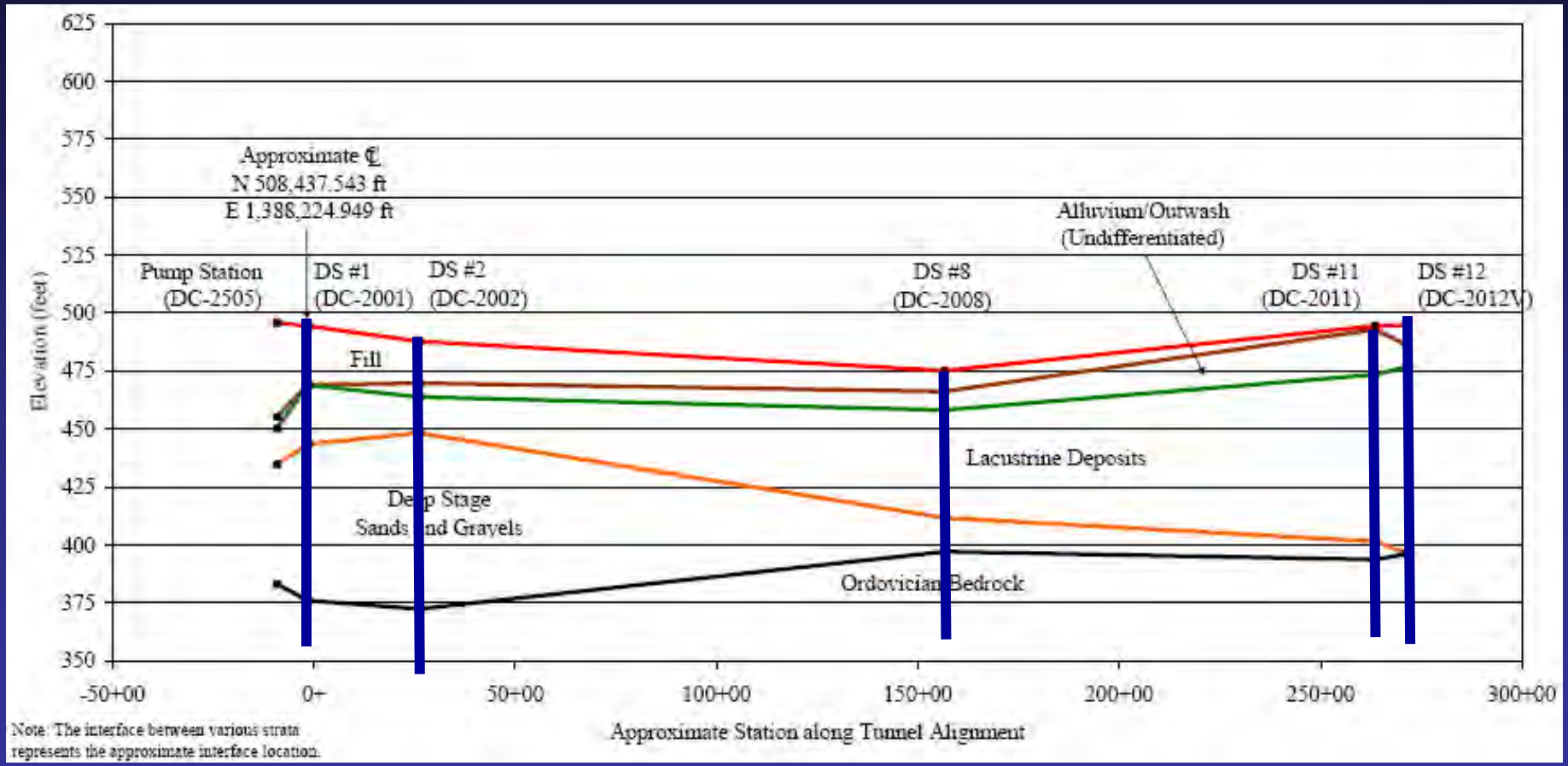


The consistency of the overburden soils was generally stiffer, and the relative density was generally higher, north of the Norwood Trough.

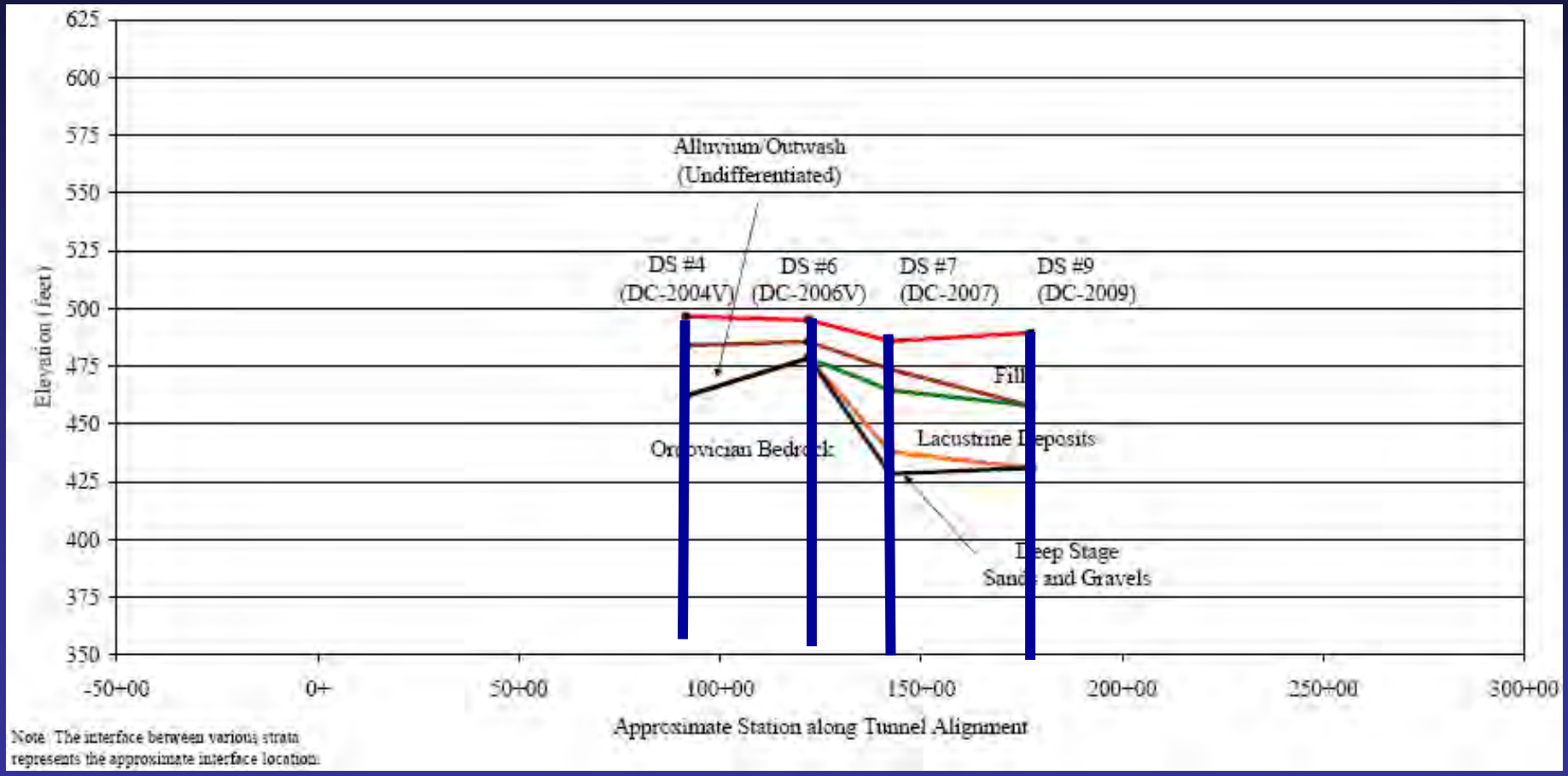
At the confluence of the Norwood Trough with the Mill Creek Valley, deep sand was encountered.

Depth to bedrock decreases near valley walls.

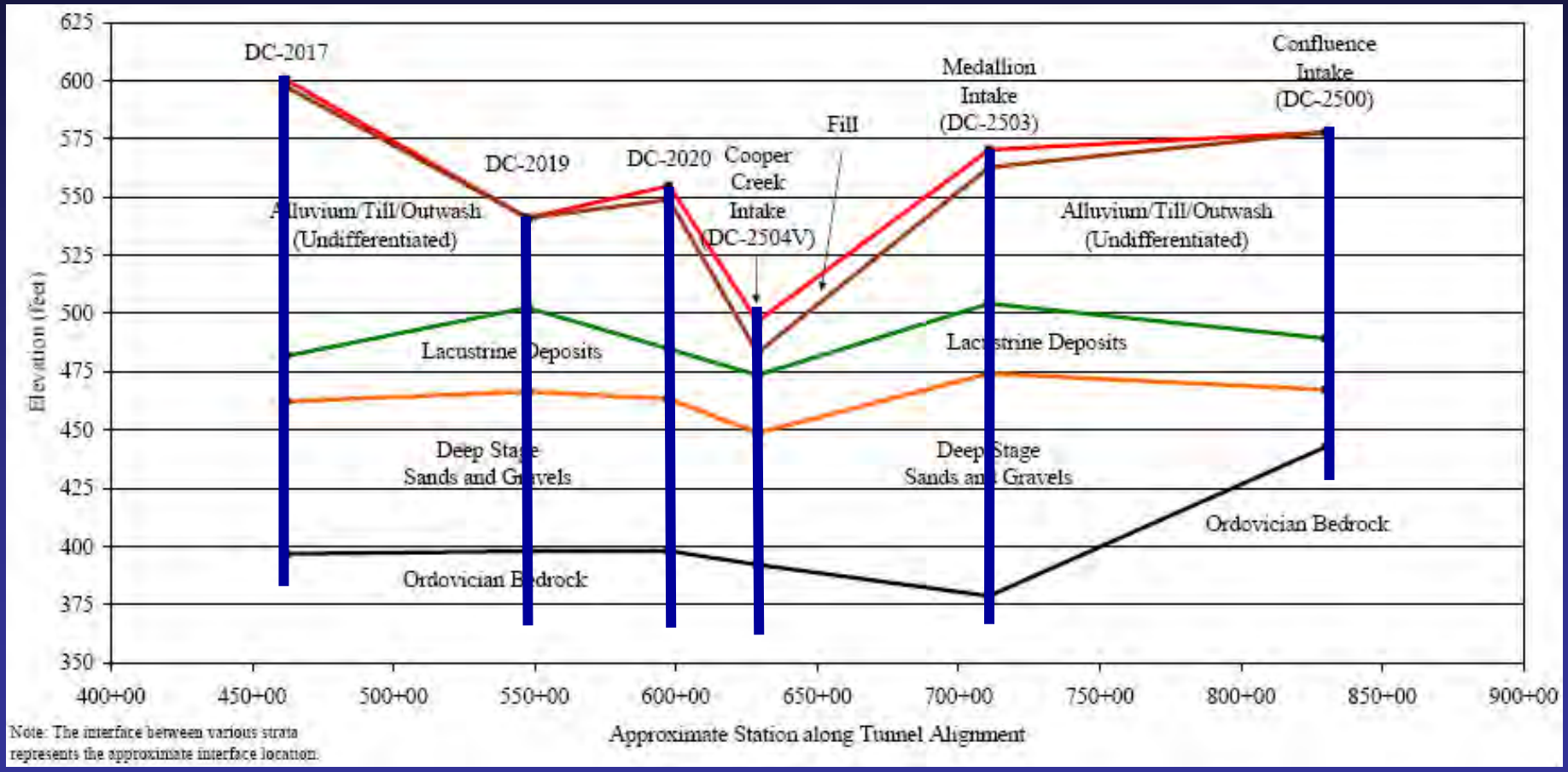
Point-to-Point Profile - Drop Shaft Locations
Deep Valley - South of Norwood Trough



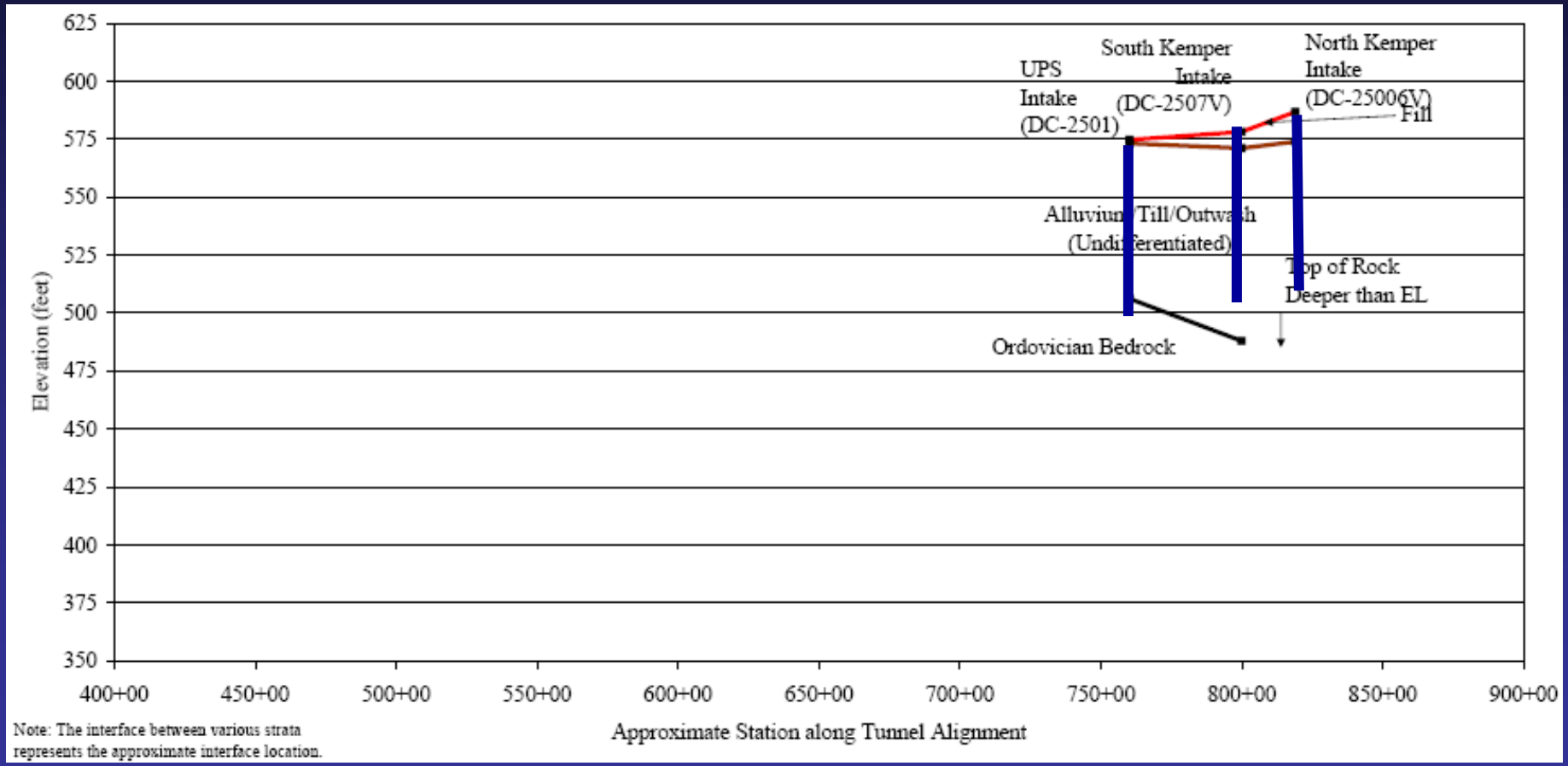
Point-to-Point Profile - Drop Shaft Locations
Valley Wall - South of Norwood Trough



Point-to-Point Profile - Drop Shaft Locations
Deep Valley - North of Norwood Trough

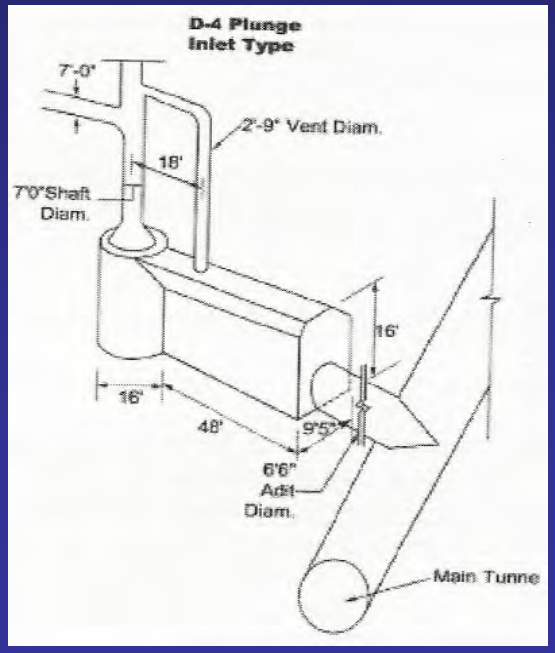


Point-to-Point Profile - Drop Shaft Locations
Valley Wall - North of Norwood Trough

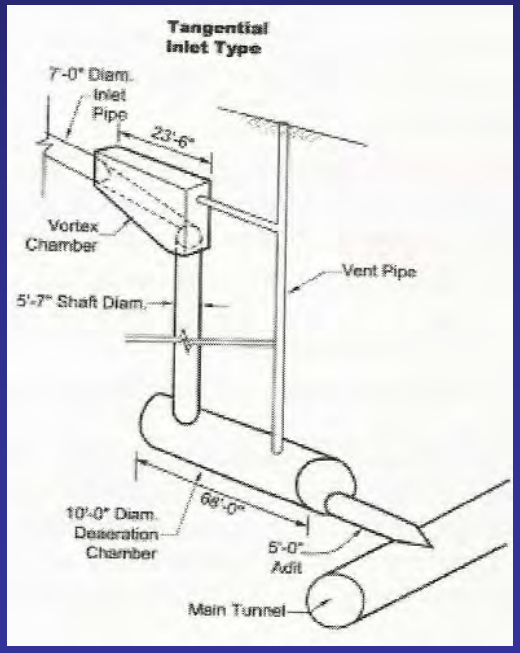


Open Excavations







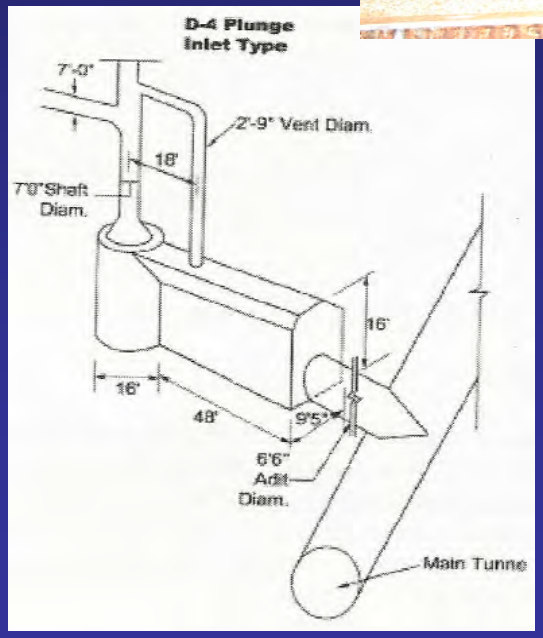


Chattahoochee River Tunnel Project

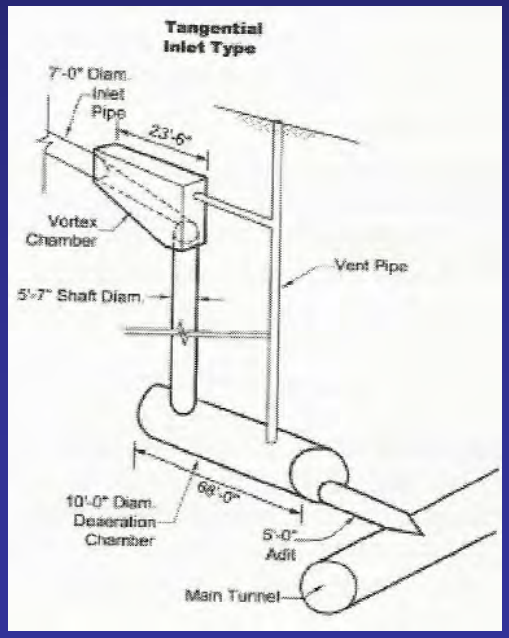
Shaft Excavations







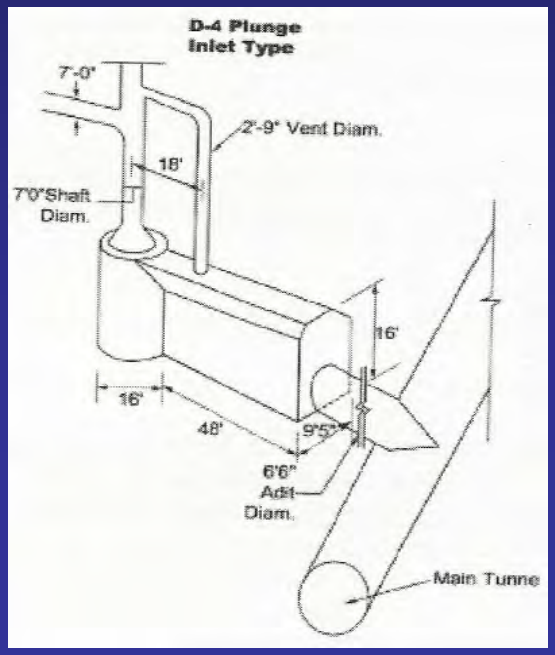




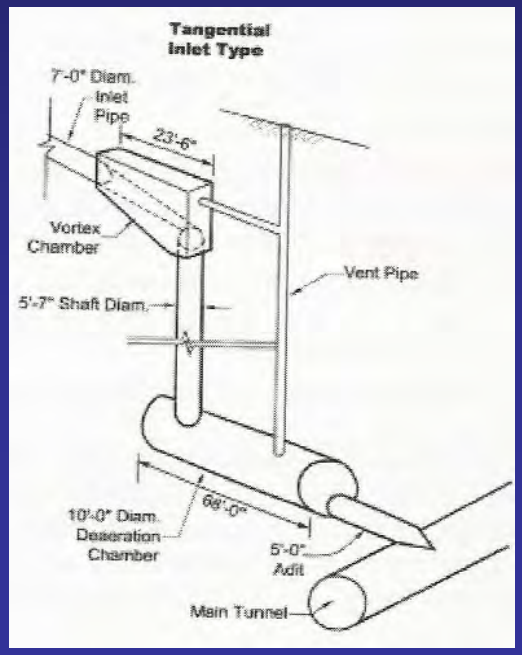
Photos from Dawn Underground Engineering Group

Earth Tunnel Excavations









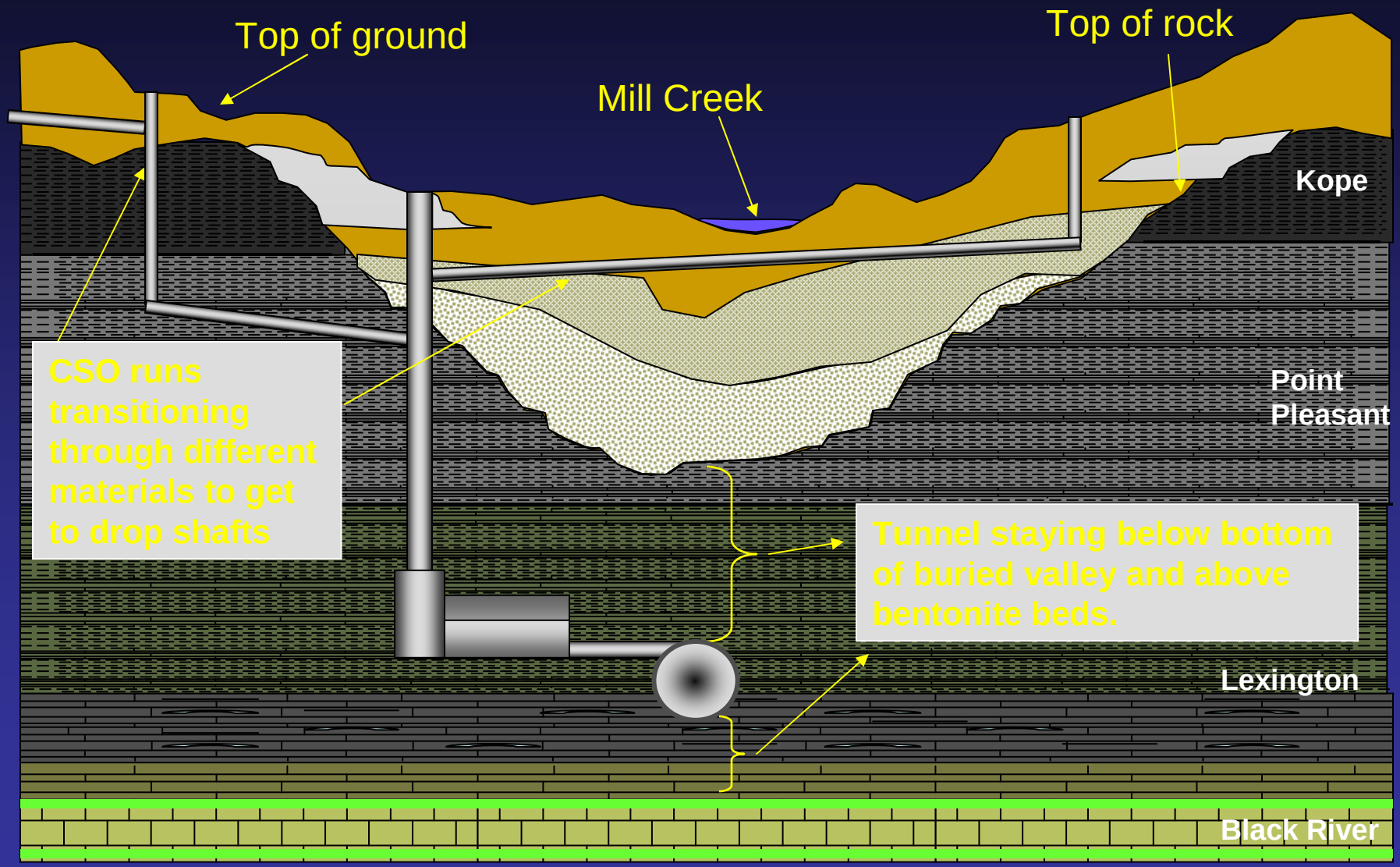
Traylor Bros.

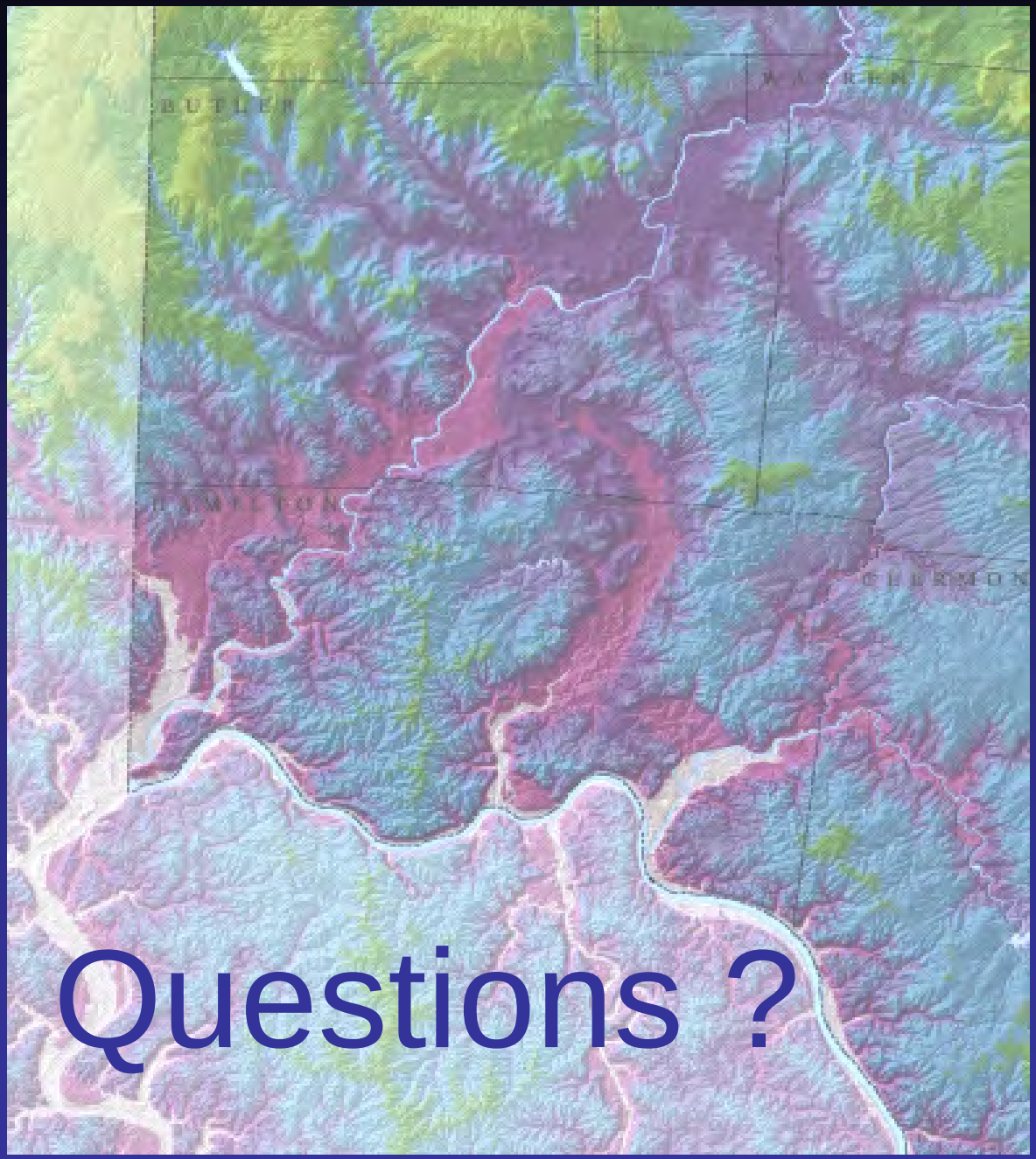
Potential Ground Improvements

- Pre-stabilization of soils to help control water inflow, help to stabilize loose and squeezing soils, and minimize surface settlement.

- Avoid boulder zones if possible.

TUNNEL SECTION





Questions ?

US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section

McAlpine Lock Replacement Project

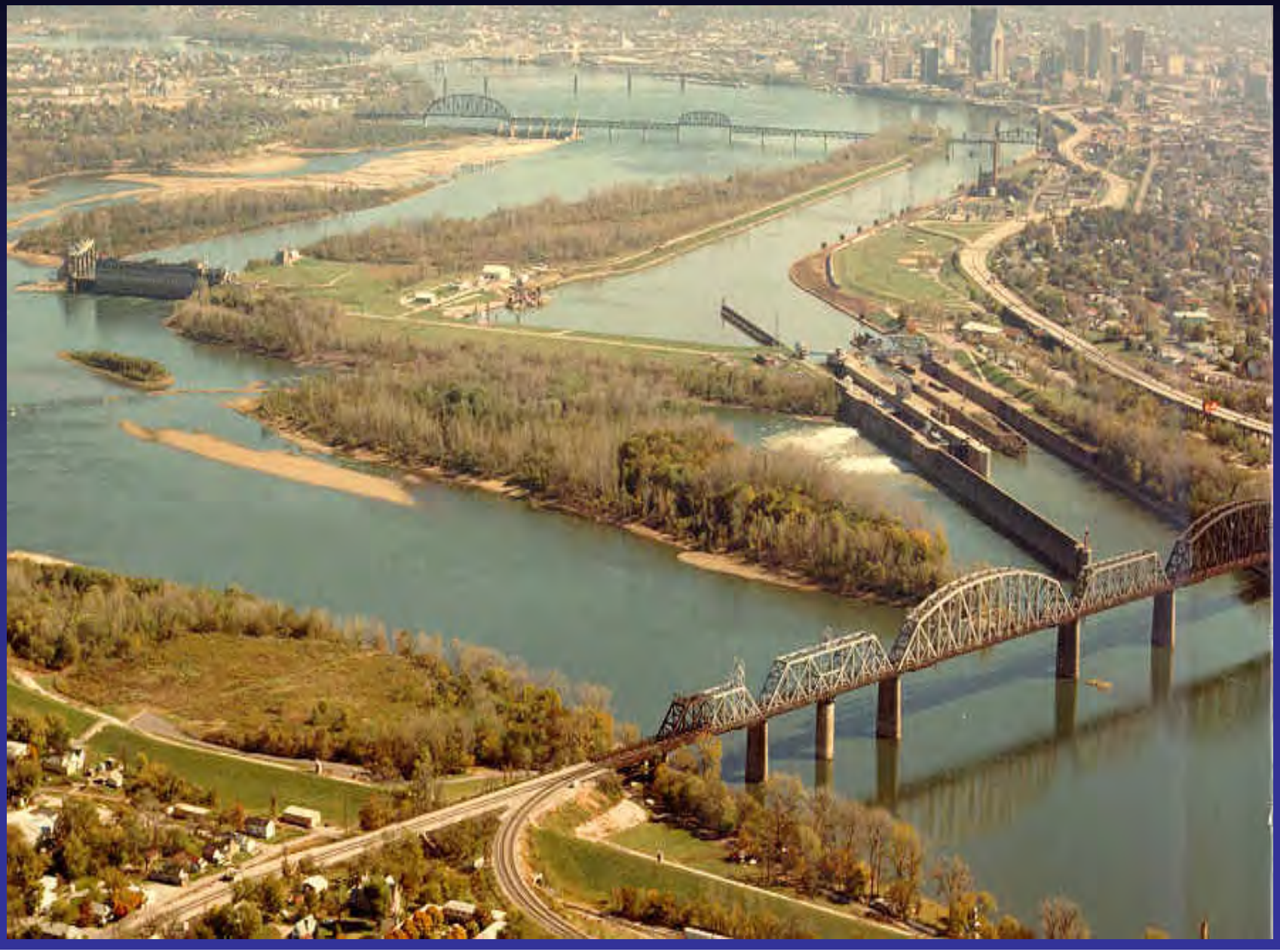
Foundation Characteristics and Excavation

Kenneth E. Henn III, P.G.

Presented to 2005 Tri-State Infrastructure Systems Conference & Exposition
August 3, 2005

Presentation Items:

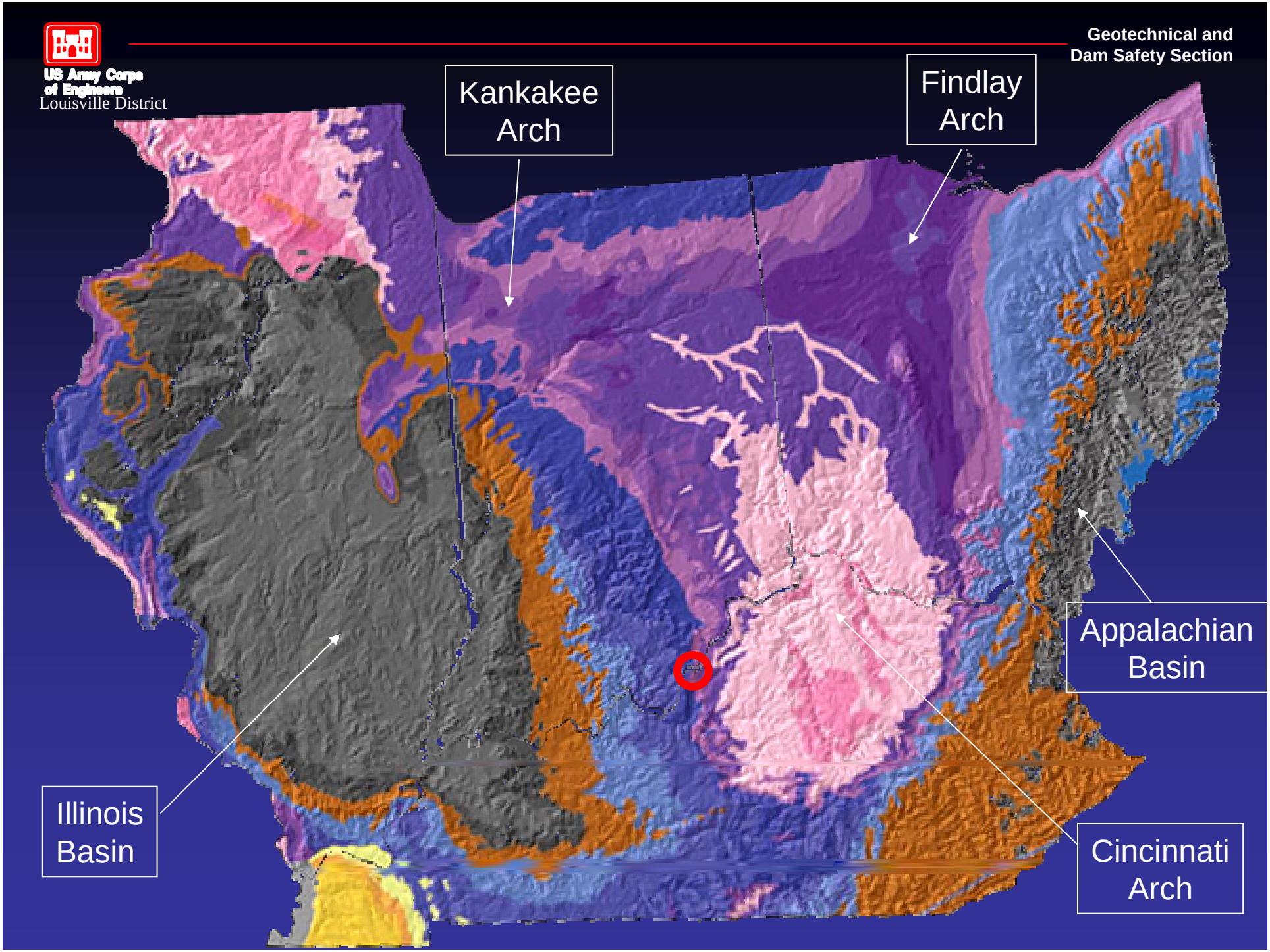
- Project History and Regional Geology
- Construction Activity and Interactions with Site Geology
- Corrective Measures Required due to Construction Activity Problems
- Disputed Issues and Lessons Learned



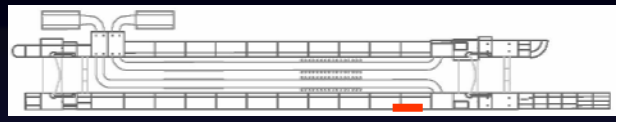
General Geologic Conditions at McAlpine

US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section



General Geology





New Albany Shale

Beechwood Limestone

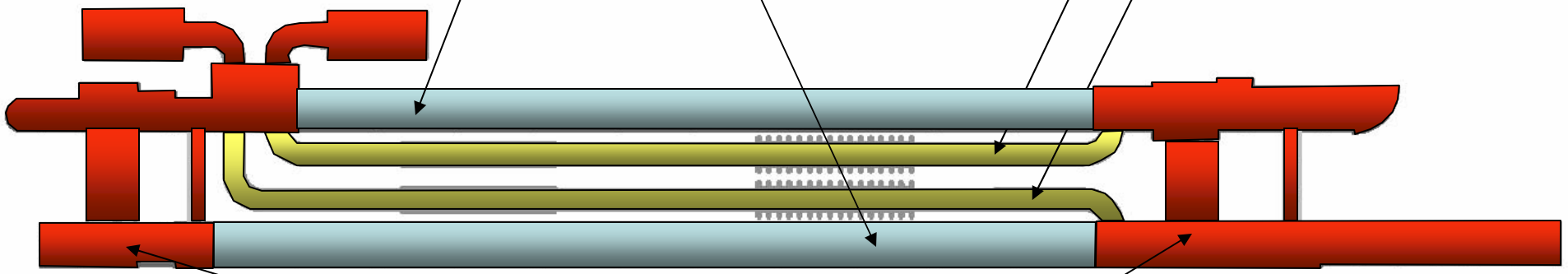
Silver Creek Limestone

Jeffersonville Limestone

General McAlpine Layout

Roller Compacted Concrete (RCC) Monoliths

Lock Floor Culverts



Conventional Concrete Monoliths

Mechanical Rock Excavation


Location of new lock extension




2000. 3. 2


2000. 3. 2

US Army Corps of Engineers
Louisville District

Geotechnical and Dam Safety Section







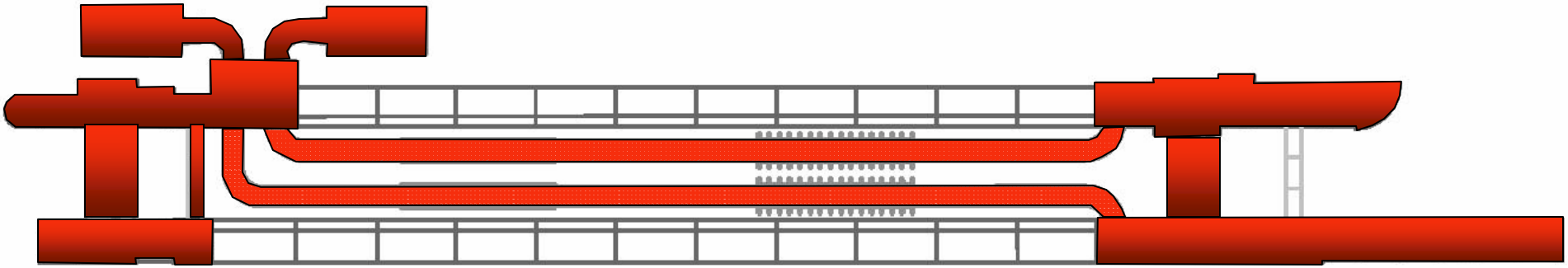




Explosive Rock Excavation

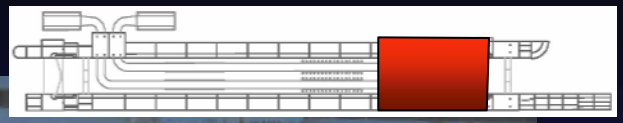


Excavations which penetrate into rock anywhere from 5-feet to 35 feet, requiring controlled blasting techniques.

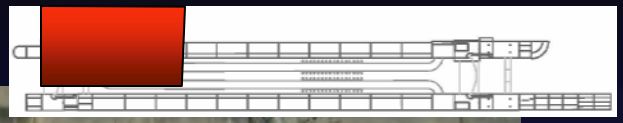









DEERE

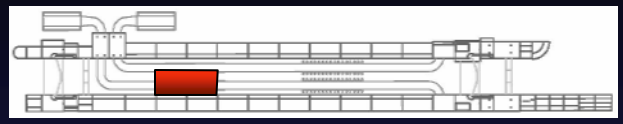




Smooth-Wall Blasting Technique




Sinking and production shots
made previous to perimeter shots





Trim Blast

Buffer Holes

Trim Holes

As a consequence of choosing a method with no perimeter control, a diligent quality control (QC) program needs to be implemented.

Without a diligent quality control (QC) program, you end up with…

Examples of back-break due to lack of perimeter control.







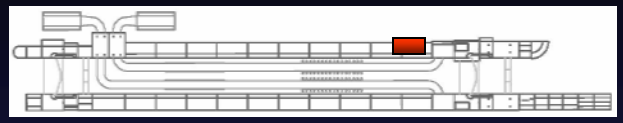

TEREX
DEERE



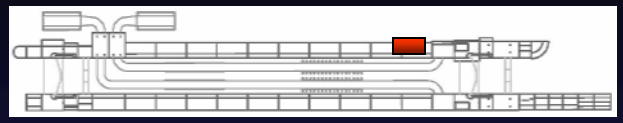


Effects of back-break on foundation integrity

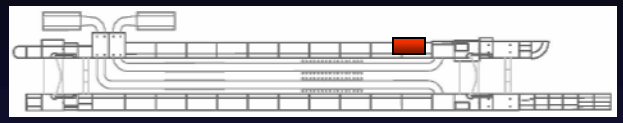
SM-17




DEERE
CAT
HOLT
450C LC



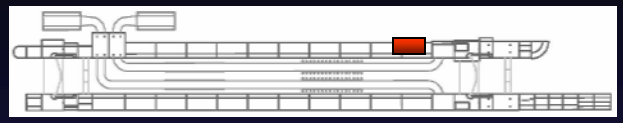

C
B
A



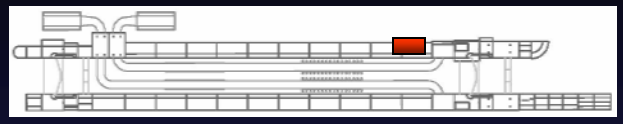

VOLVO

US Army Corps of Engineers
Louisville District

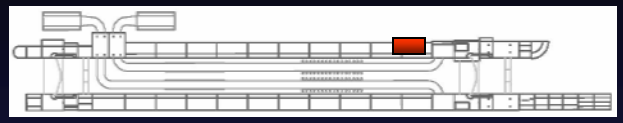
Geotechnical and Dam Safety Section



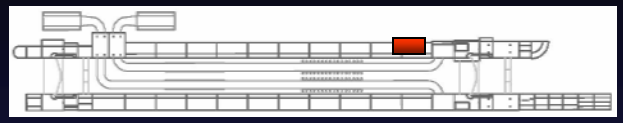




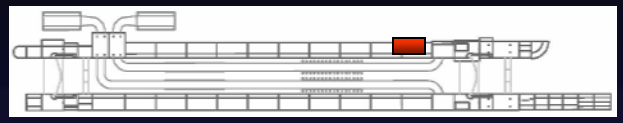














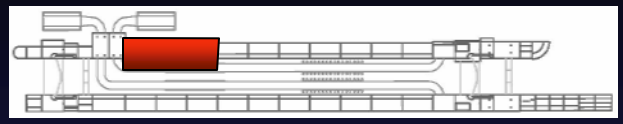
Effects of back-break on foundation integrity

SM-8 through SM-11



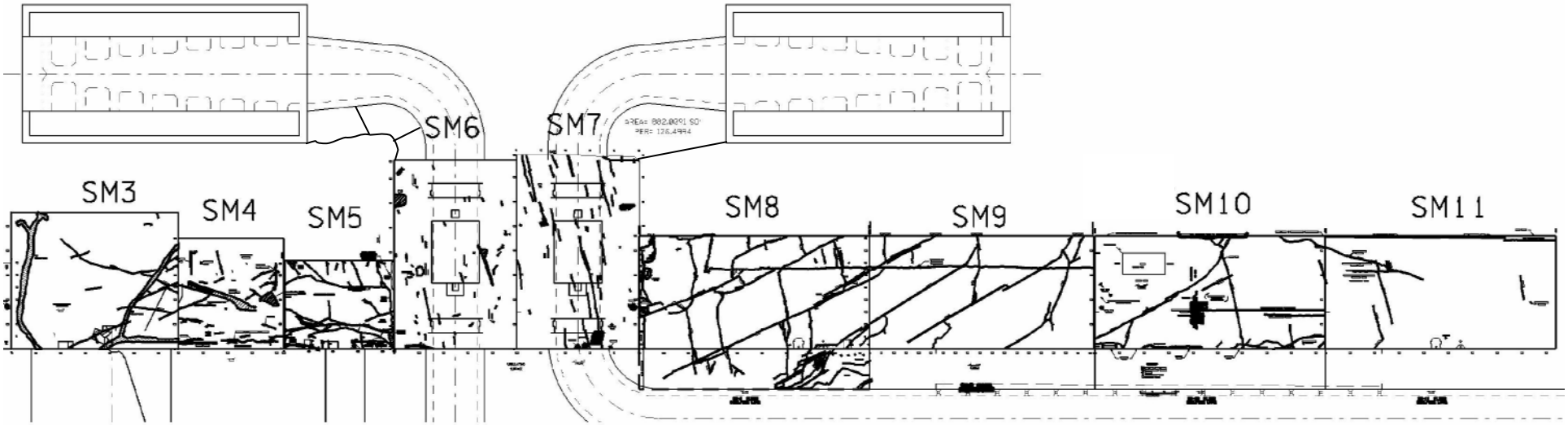


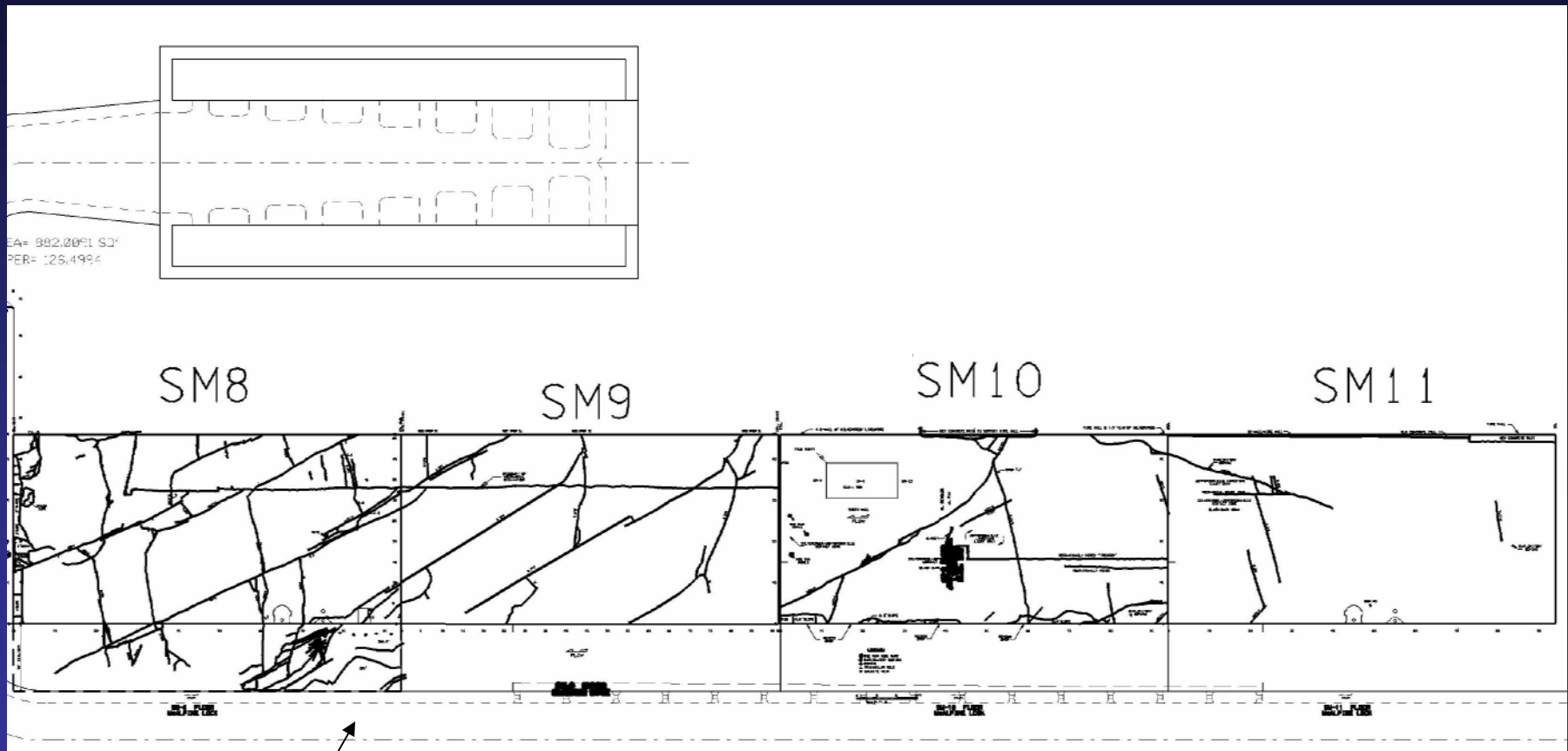









SM3
SM4
SM5
SM6
SM7
SM8
SM9
SM10
SM11


SM8
SM9
SM10
SM11
North Culvert in Lock Floor









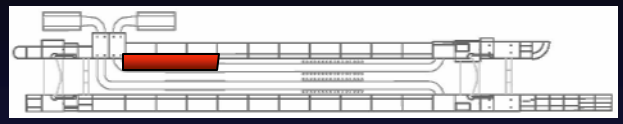


Offset boreholes observed in north face of north culvert

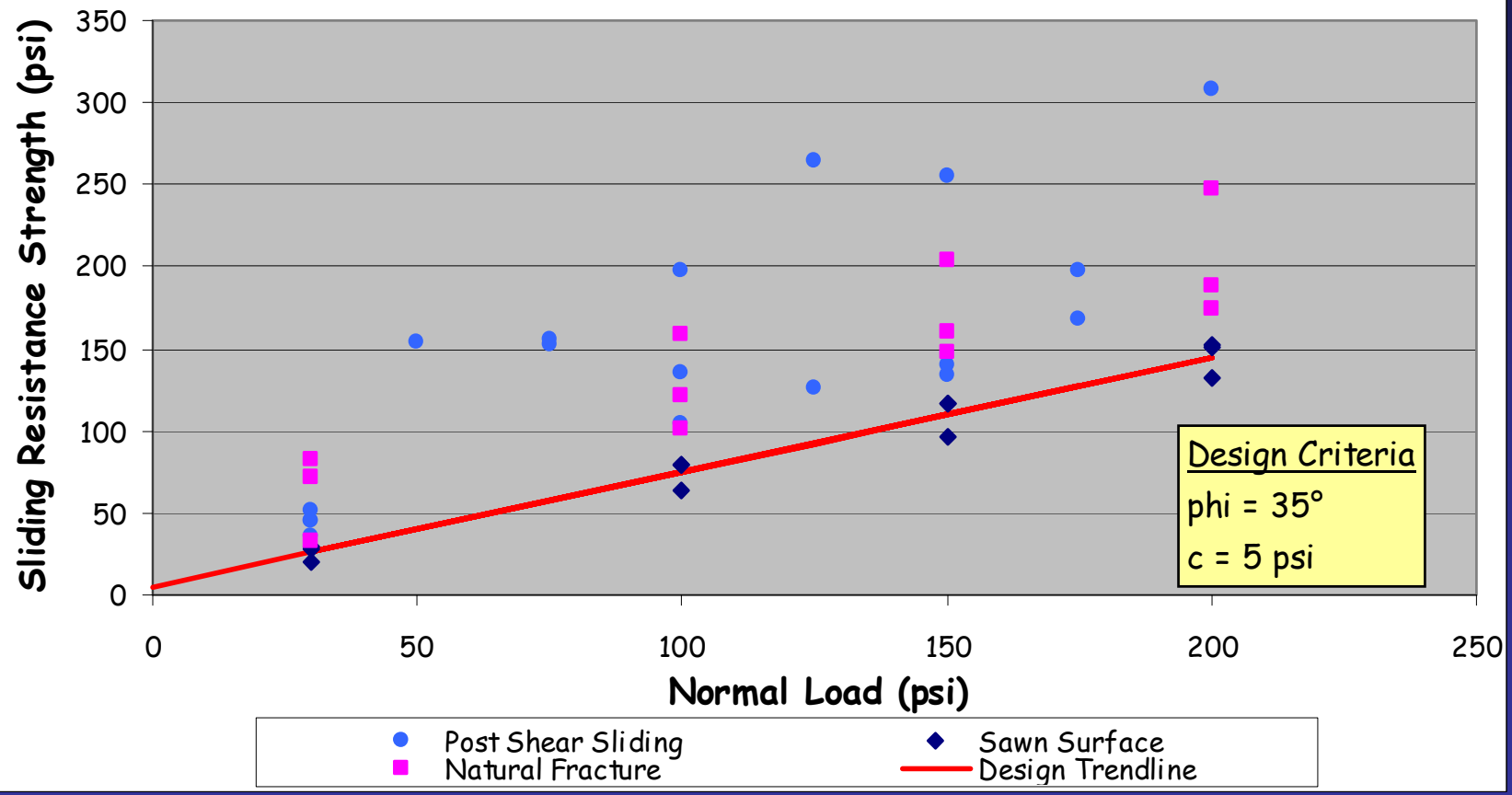




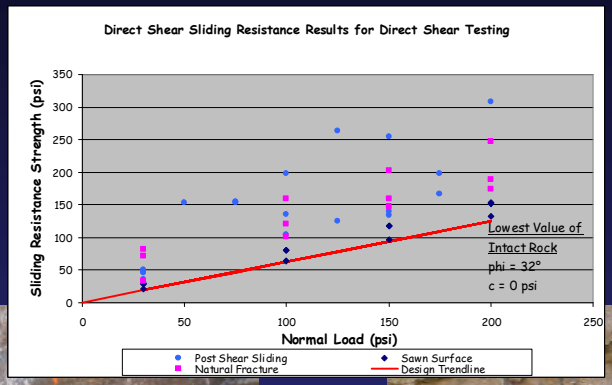




Sliding Resistance Results from Direct Shear Testing







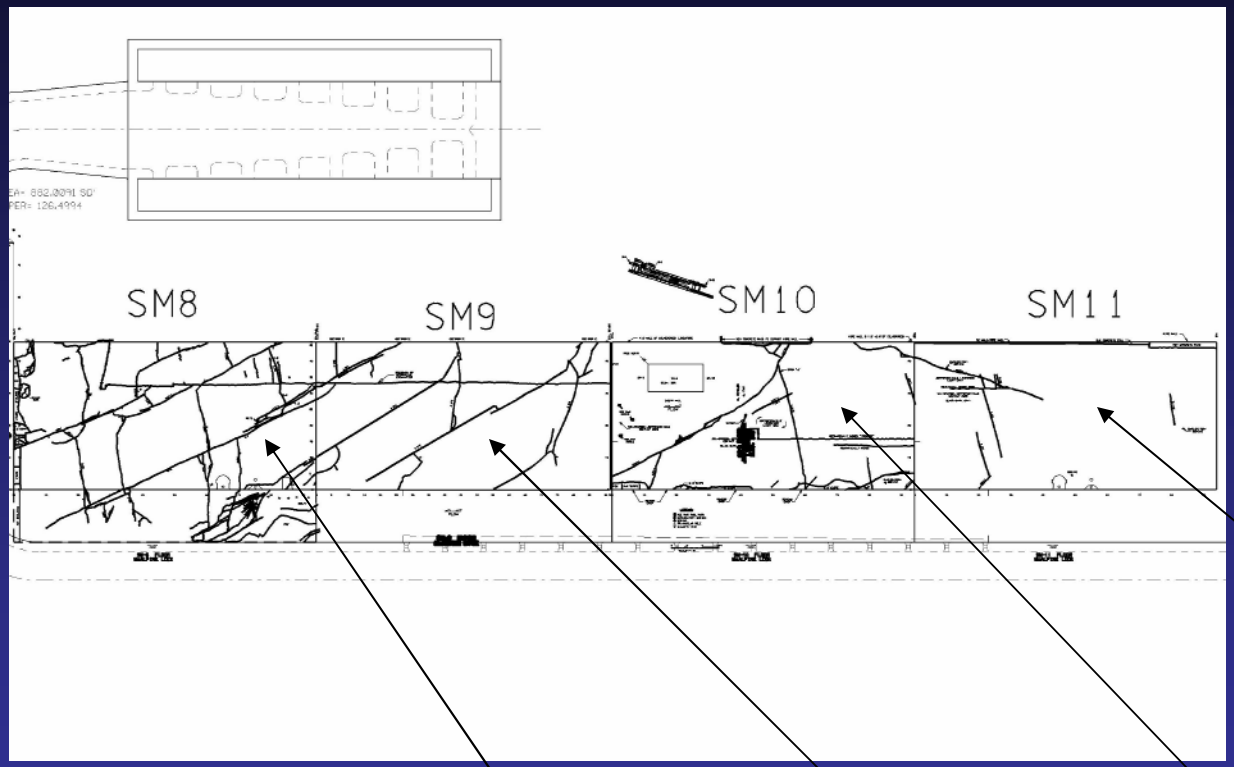




What kind of strength do you give to a seam which has been damaged and shifted?



Sliding Resistance Strength



Reduced from
phi = 35°
c = 5 psi

SM-8
phi = 22°
c = 0 psi

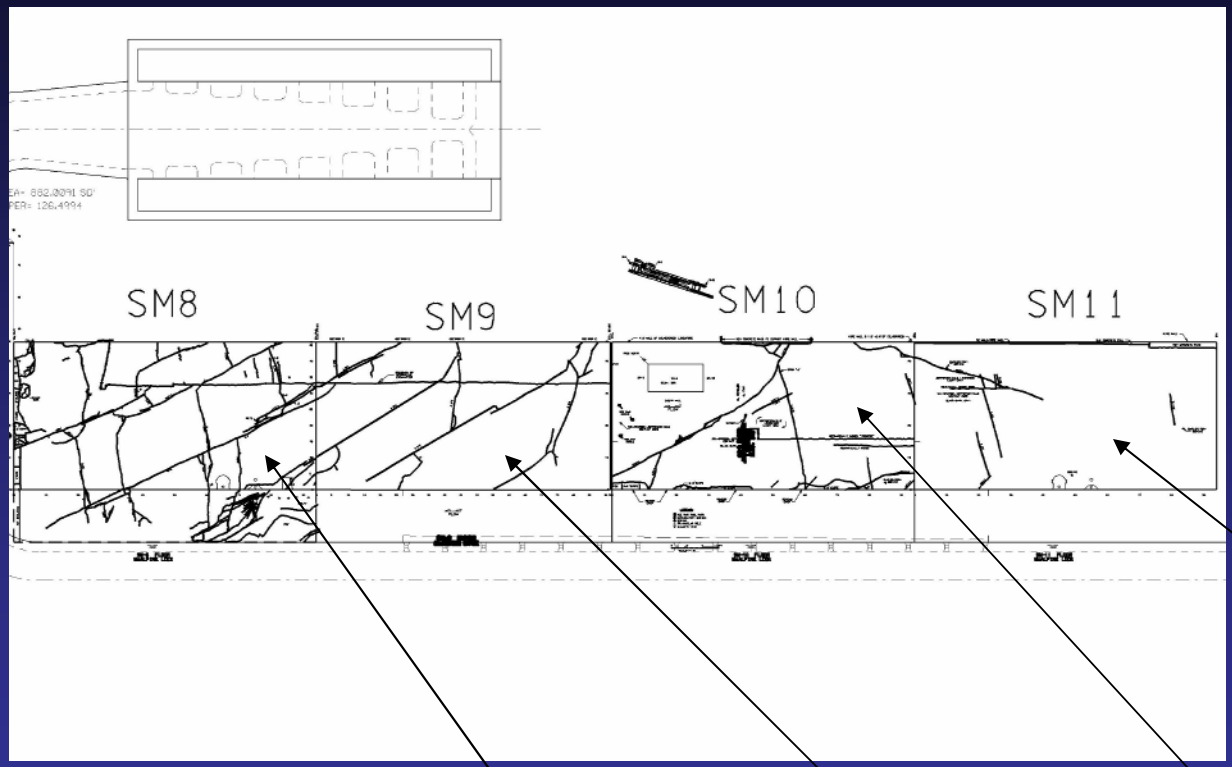
SM-9
phi = 25°
c = 0 psi

SM-10
phi = 27°
c = 0 psi

SM-11
phi = 29°
c = 0 psi



Allowable Bearing Capacity



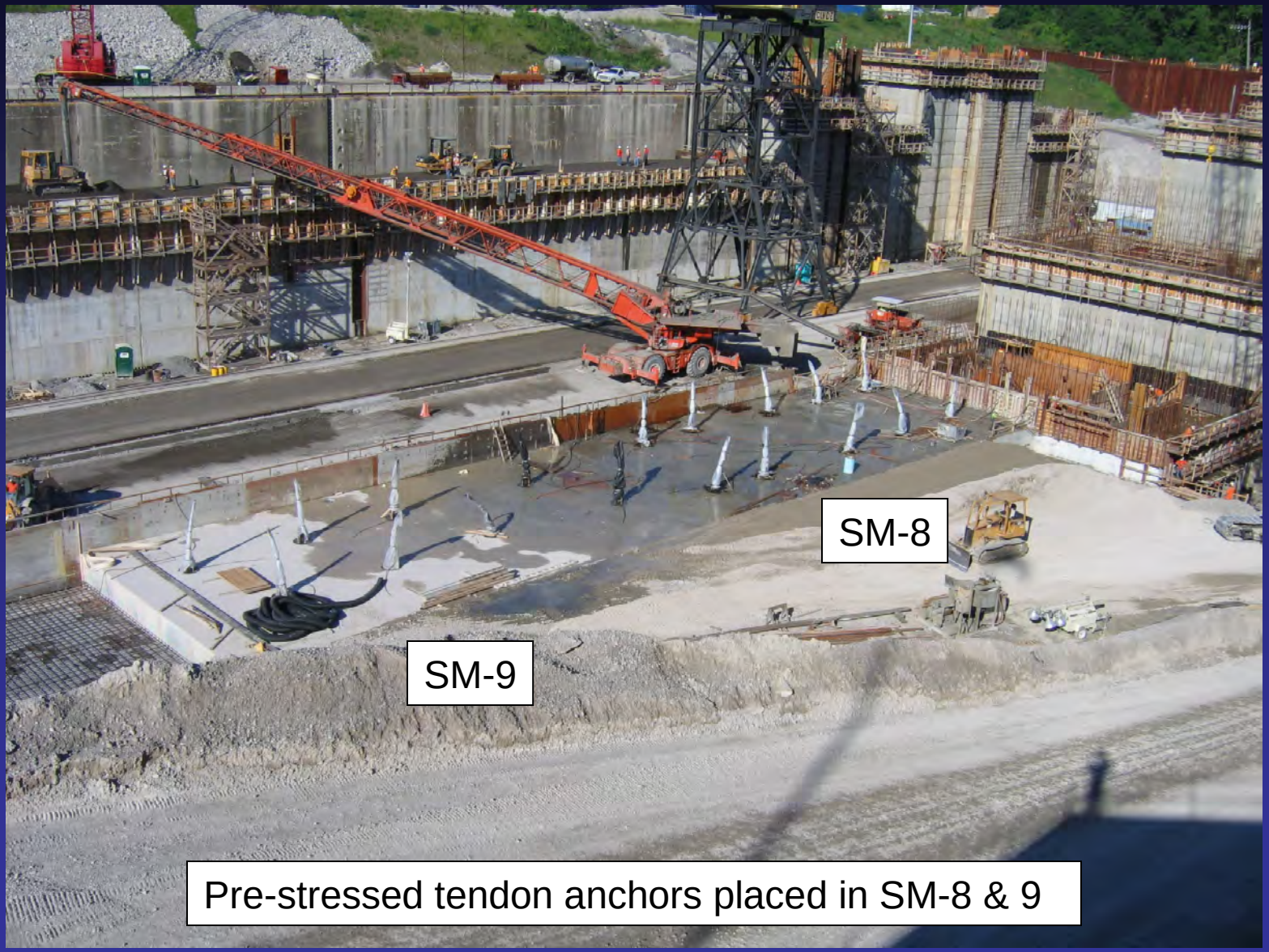
Reduced from 62 ksf

SM-8	SM-9	SM-10	SM-11
29 ksf	46 ksf	46 ksf	62 ksf




SM-11
SM-10
SM-9



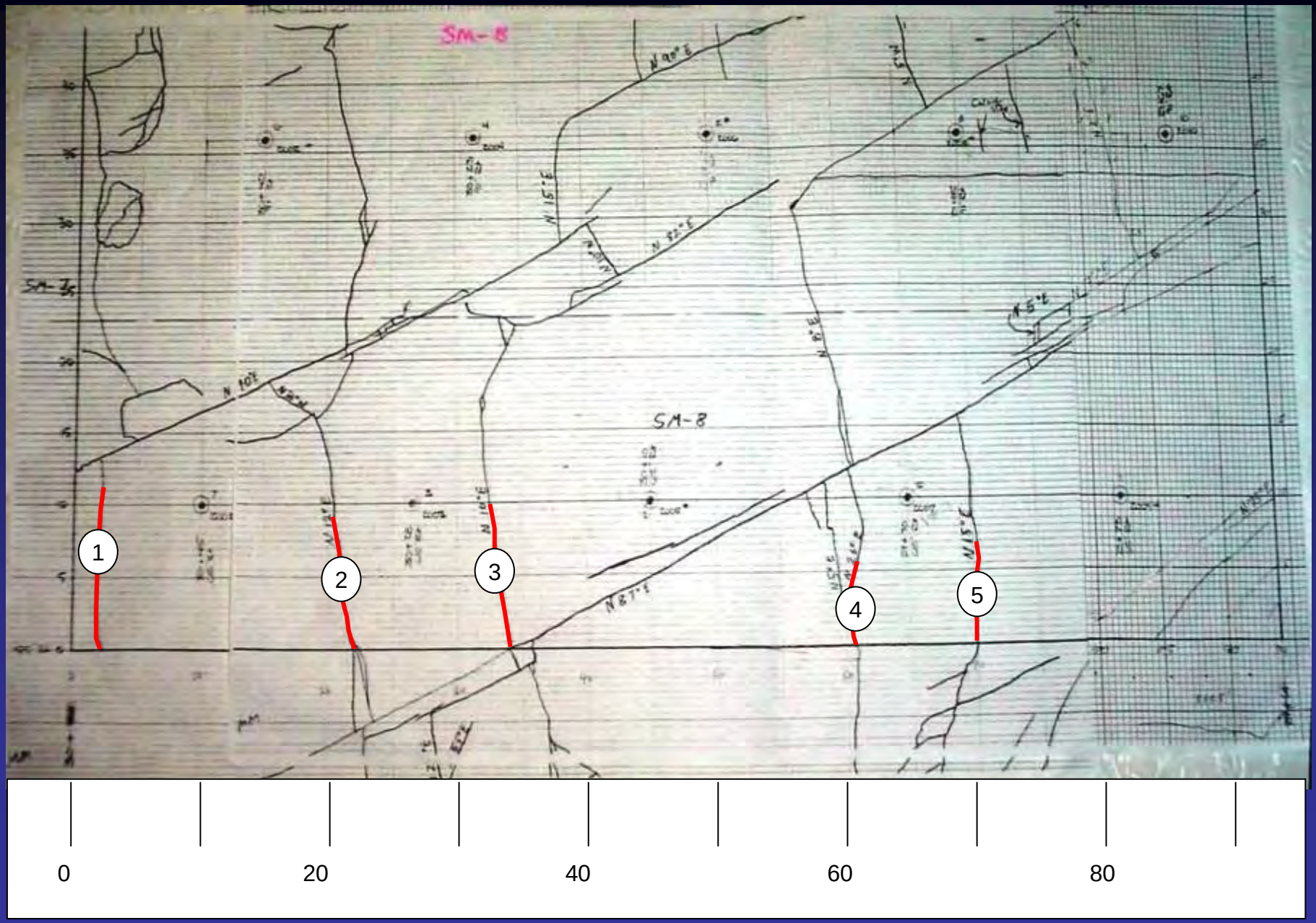


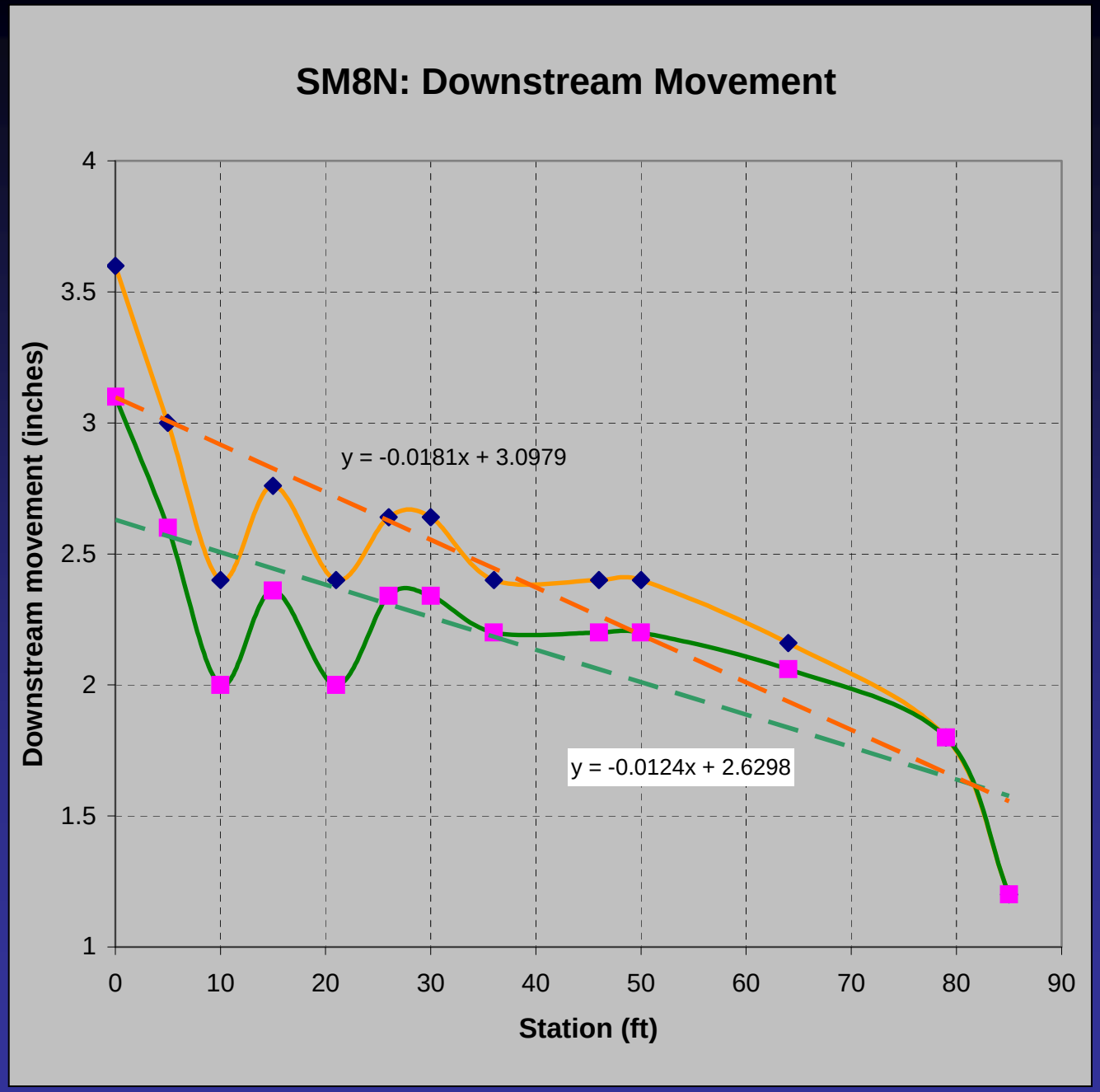
Pre-stressed tendon anchors placed in SM-8 & 9

Interpretation of what caused the damage

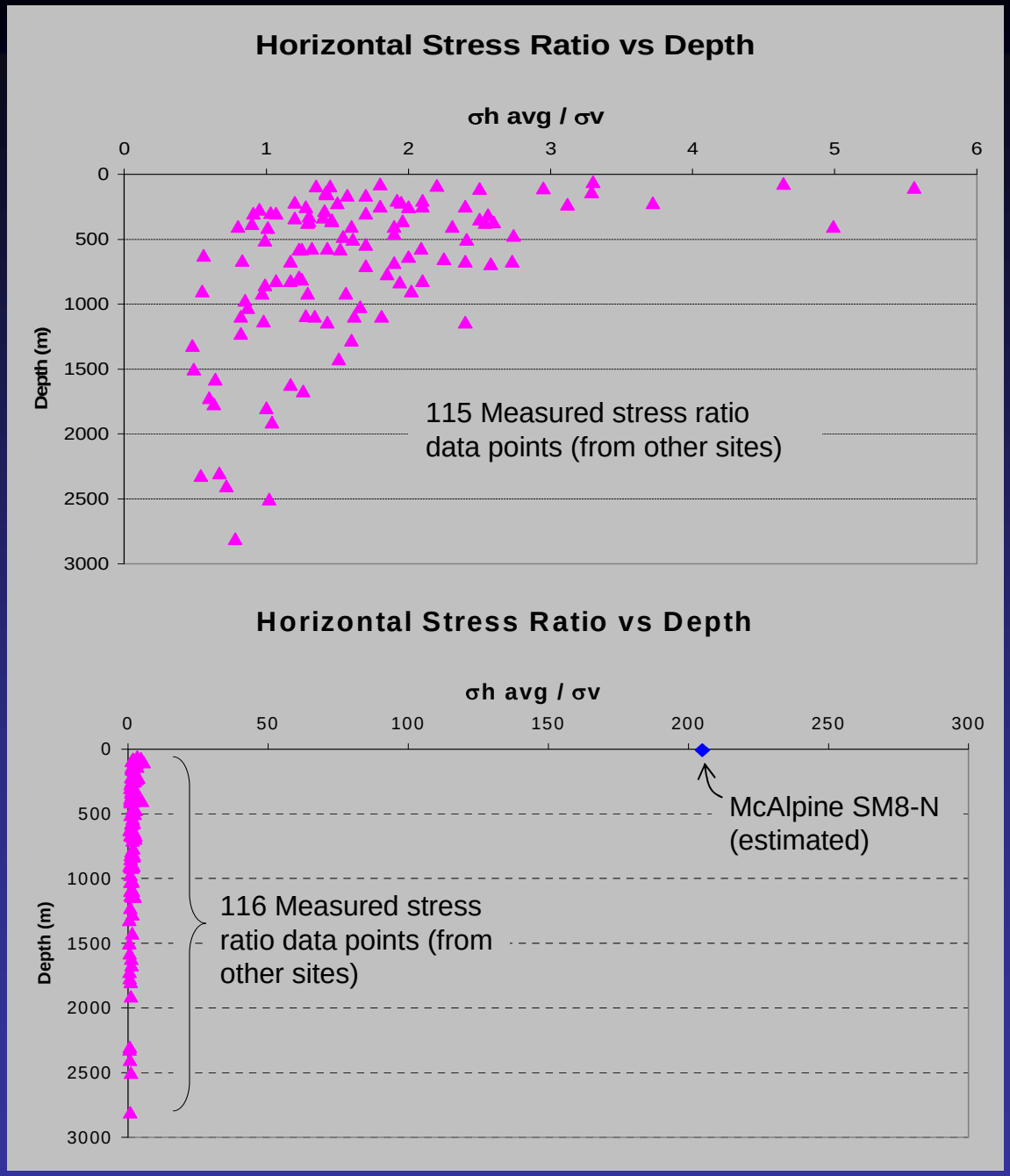
In-Situ Stress

"Prove that it is there" … vs … "Prove that it is *not* there"

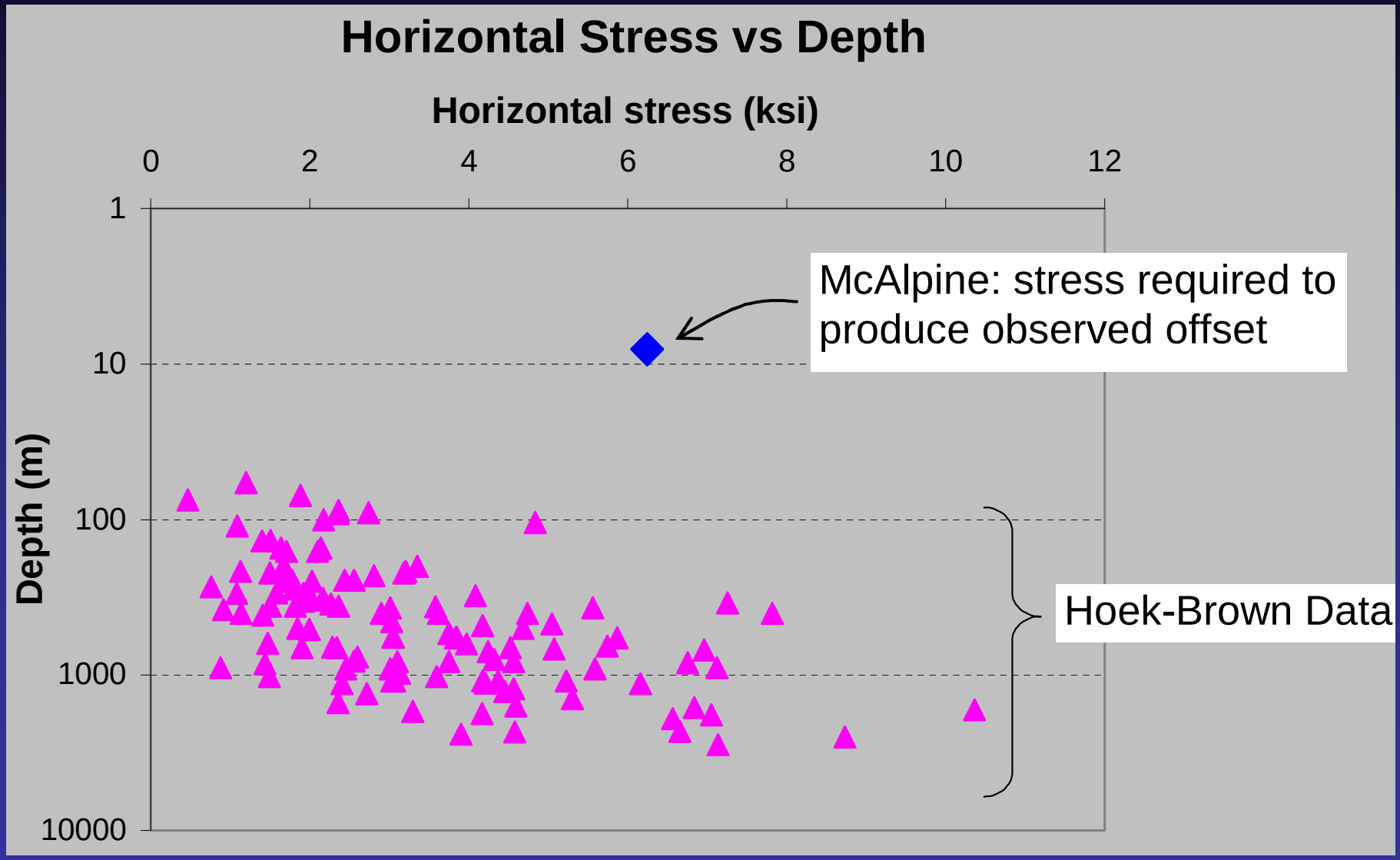

SM-8
SM-8
1
2
3
4
5
0
20
40
60
80



As presented by Dr. Matthew Mauldon

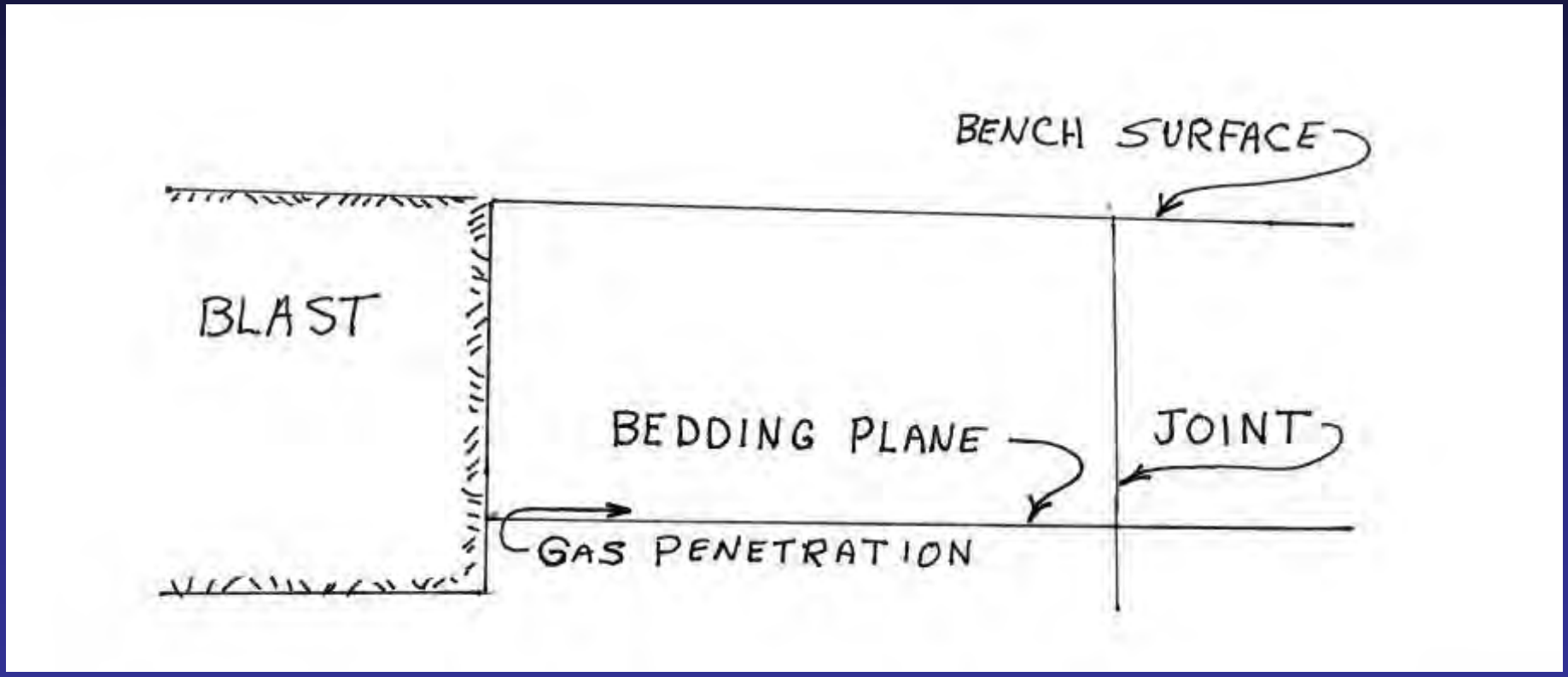


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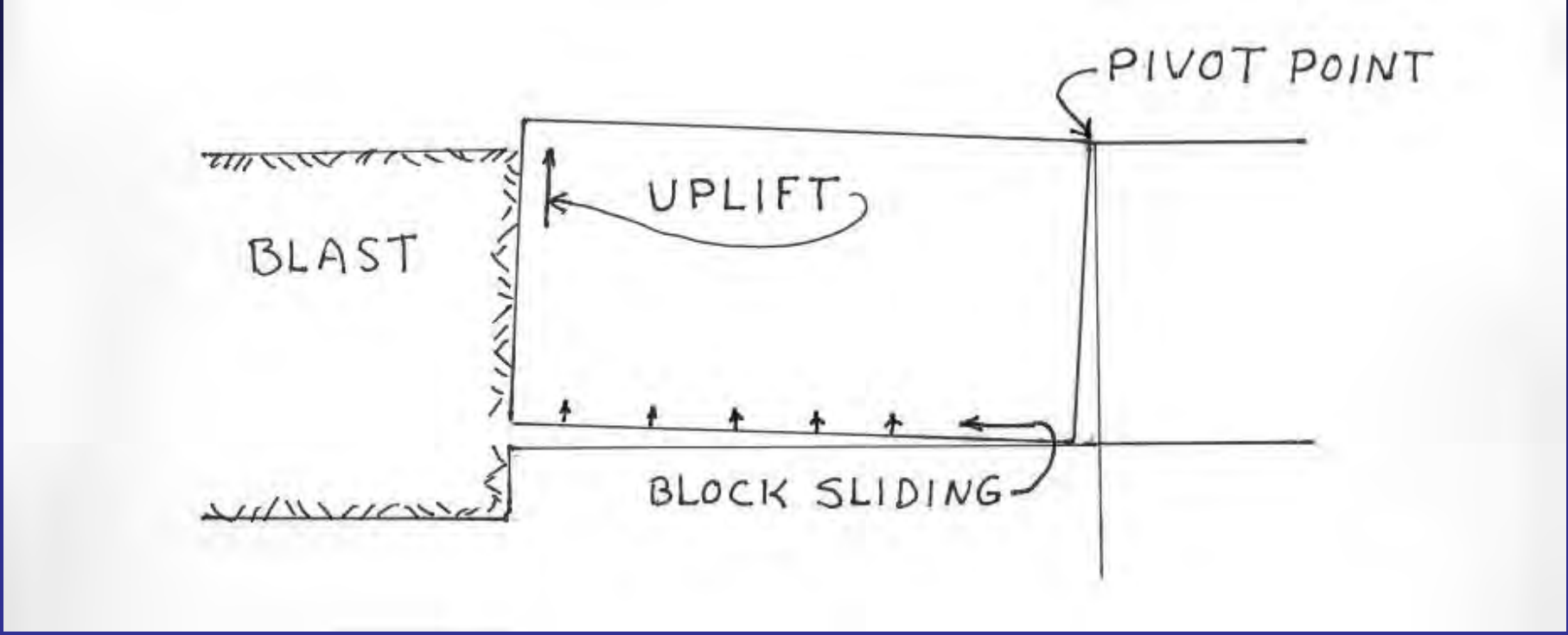


As presented by Dr. Matthew Mauldon

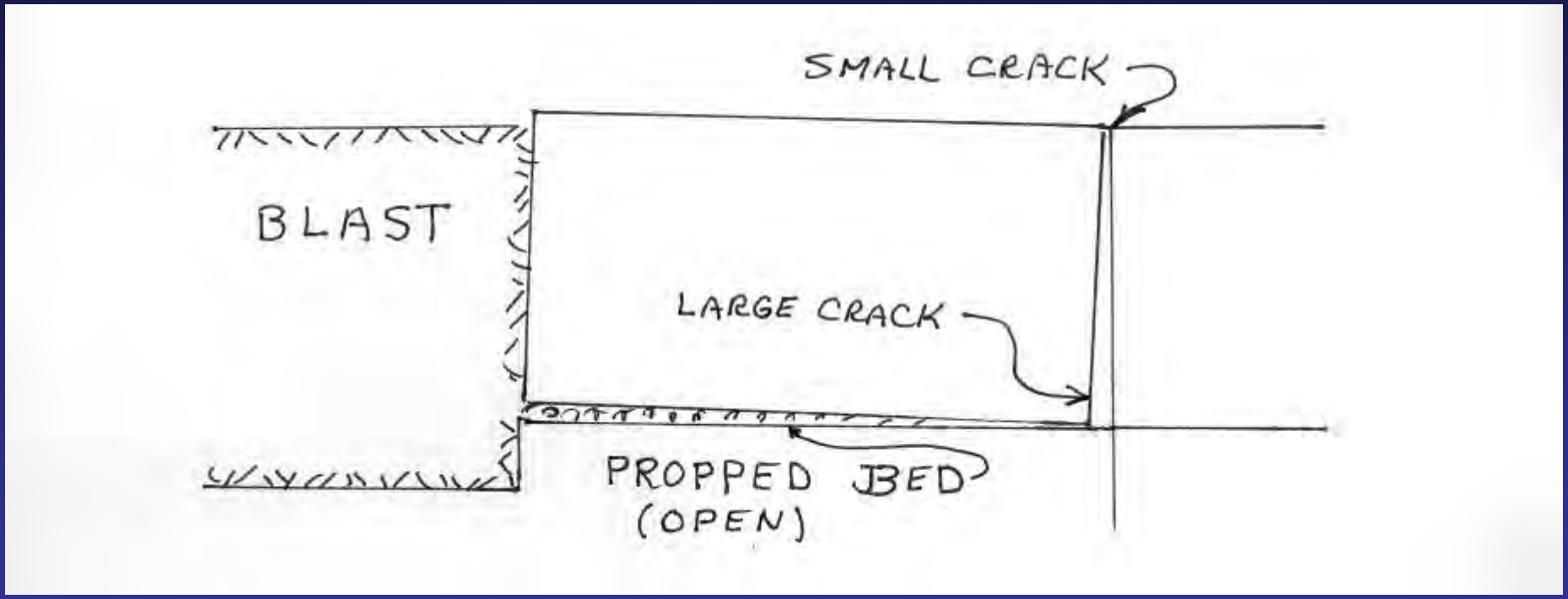
The right interpretation…



As depicted by Dr. Calvin Konya



As depicted by Dr. Calvin Konya



As depicted by Dr. Calvin Konya

Besides….



North Culvert Shots Adjacent to SM-8





North Culvert Shots Adjacent to SM-8



Gas coming out of fracture in adjacent SM-8 foundation

North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



North Culvert Shots Adjacent to SM-8



Lessons Learned

When blasting, always use a proven method which promotes perimeter control, helping to protect the final rock surfaces.



Document every possible observation in detail, no matter how insignificant it appears to be at the time !



In order to make said observations, specify what is expected of the Contractor to maintain as clean a work site as possible.



QC procedures must be implemented and adhered to. Post-blast conditions must be observed so future blast designs are modified to prevent perpetuating problems.



Questions?



The Future of the Discrete Element Method in Infrastructure Analysis

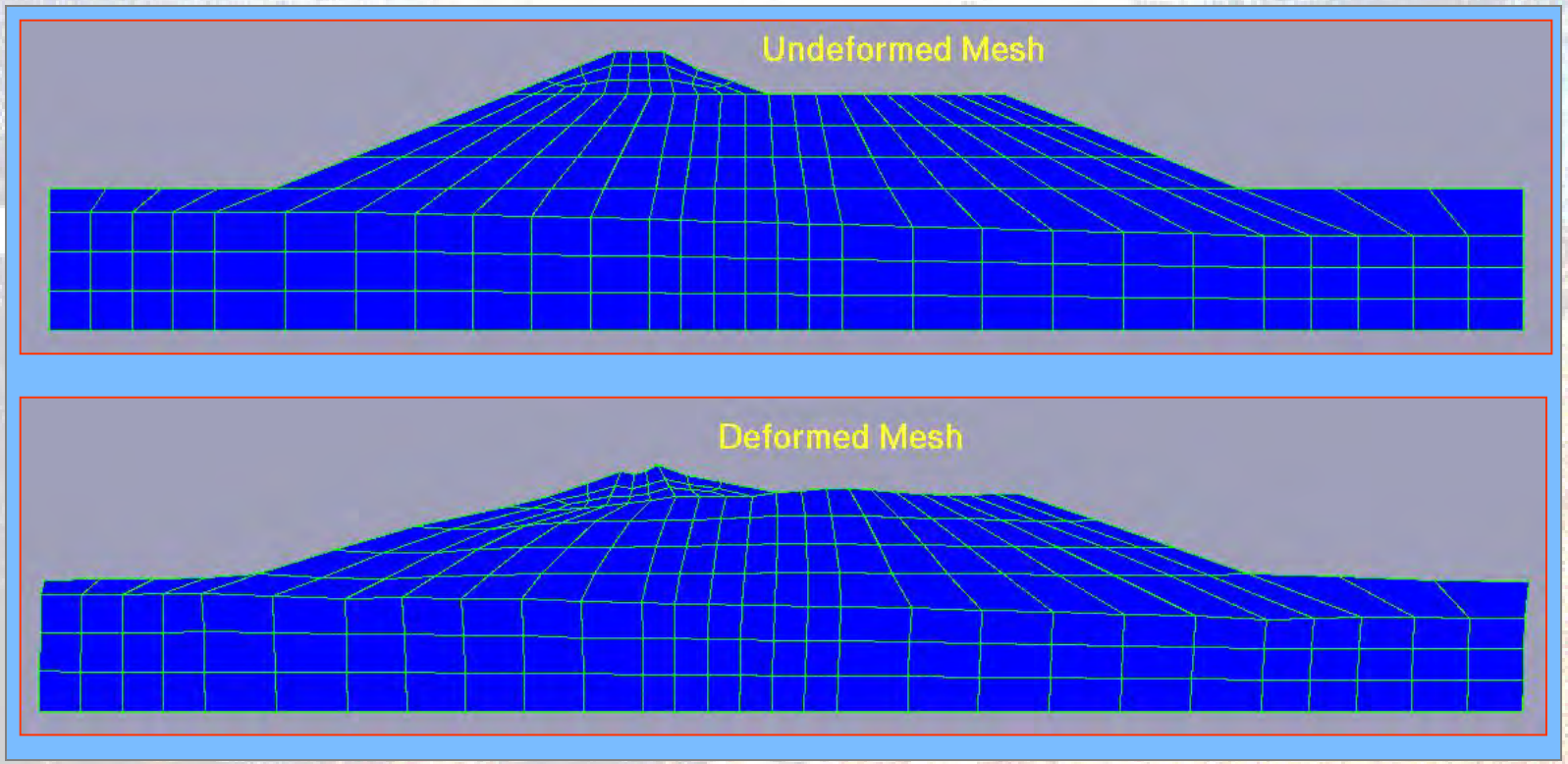
Raju Kala

Johannes L. Wibowo

John F. Peters

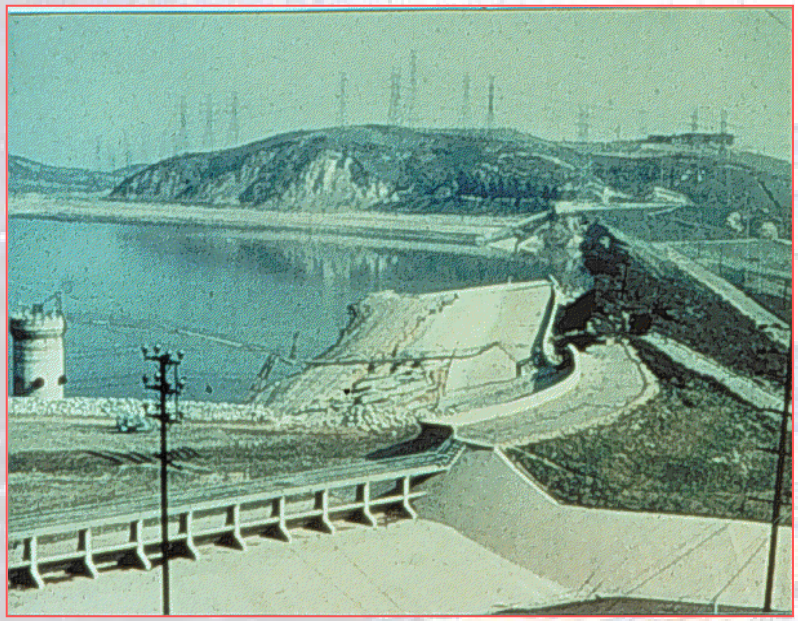
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Finite Elements Imply Continuity

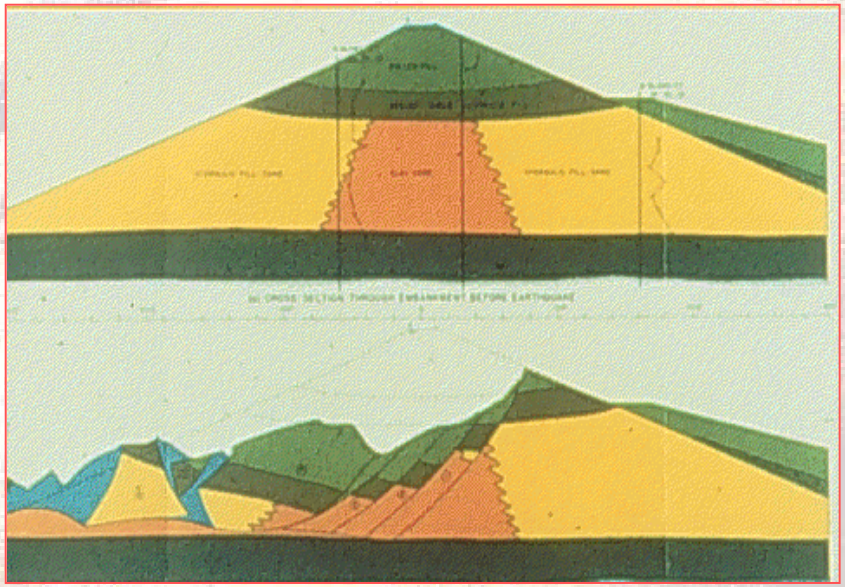


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Challenges in Failure Mechanics



Large deformations with discontinuities are difficult to model by conventional finite elements.

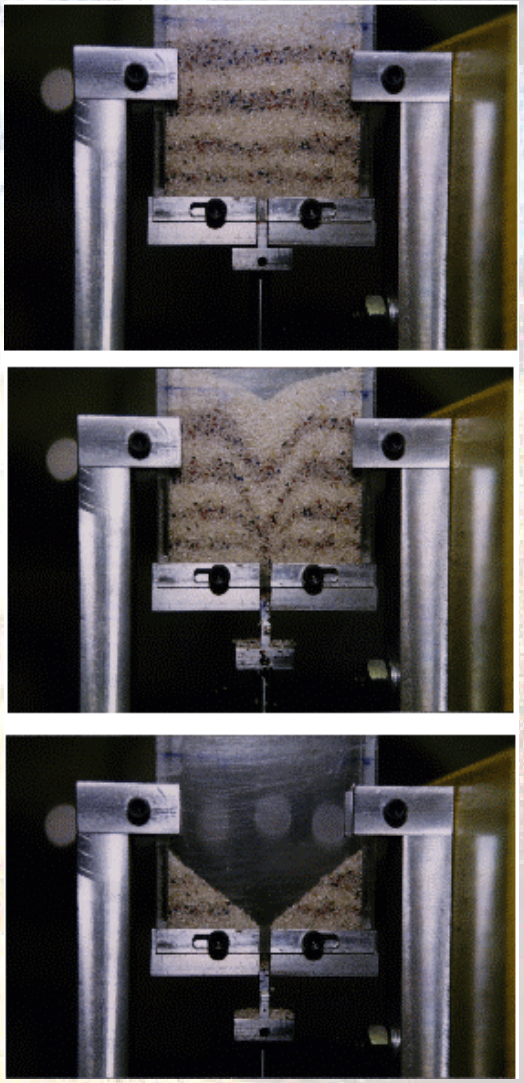


Simply having a factor of safety not enough.

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Particle Methods for Large Deformation Problems

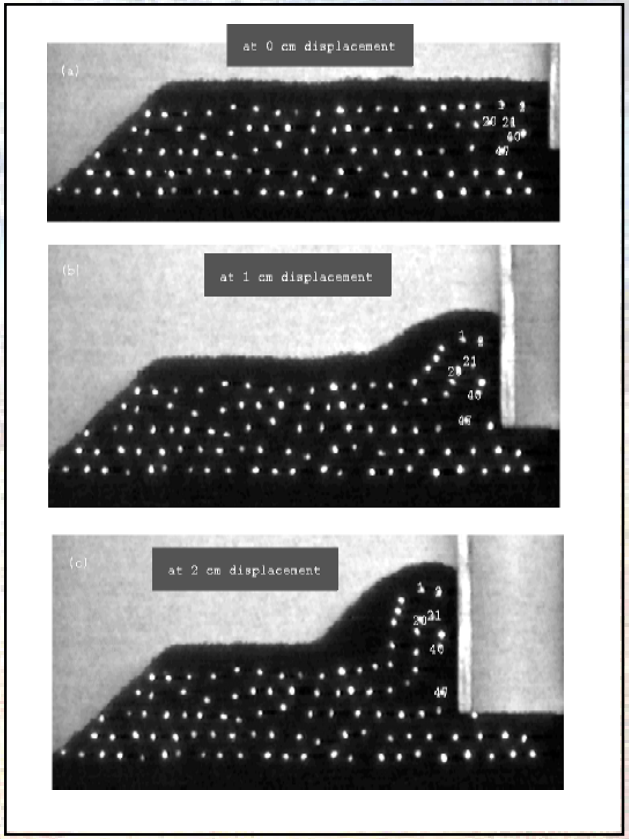
- The trap door experiment is a classical geotechnical problem from earth pressure theory
- Soil behavior ranges from solid to flowing fluid.
- Particle methods are a natural way to address such problems



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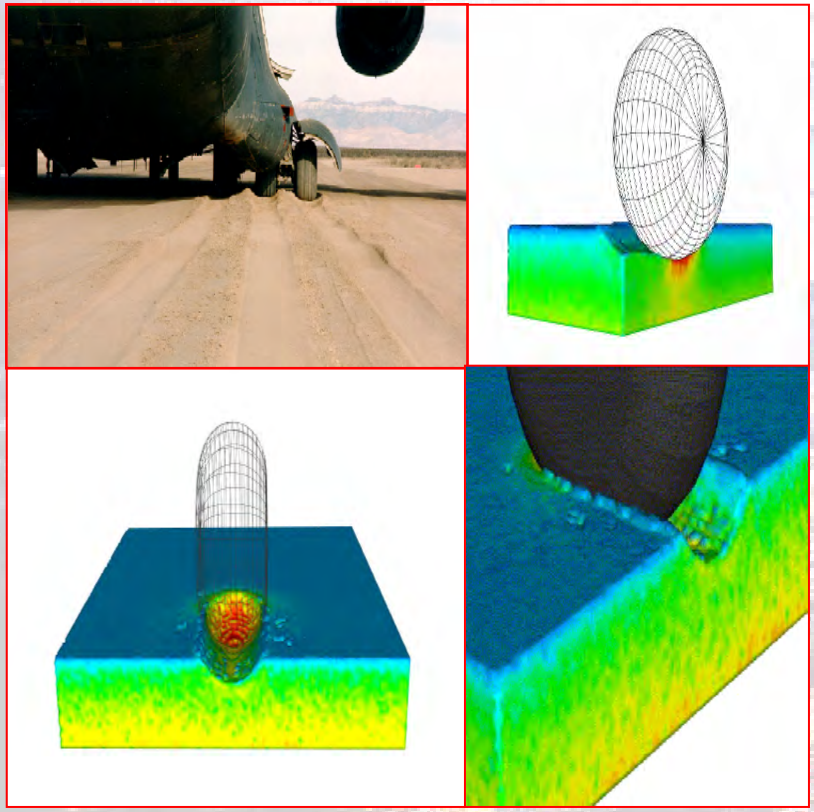
Discontinuous Shear

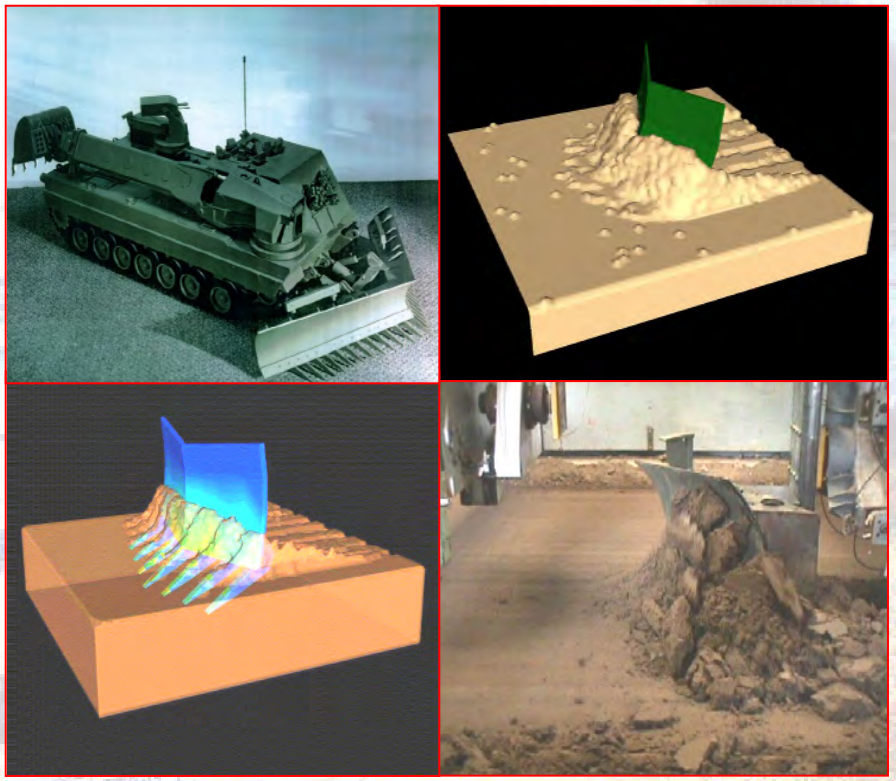
- The passive resistance to motion a rigid wall into sand is an example of very large deformation
- The discontinuous nature of the motion at the base of the wall is especially challenging for traditional numerical methods.



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Numerical Methods for Mobility Modeling

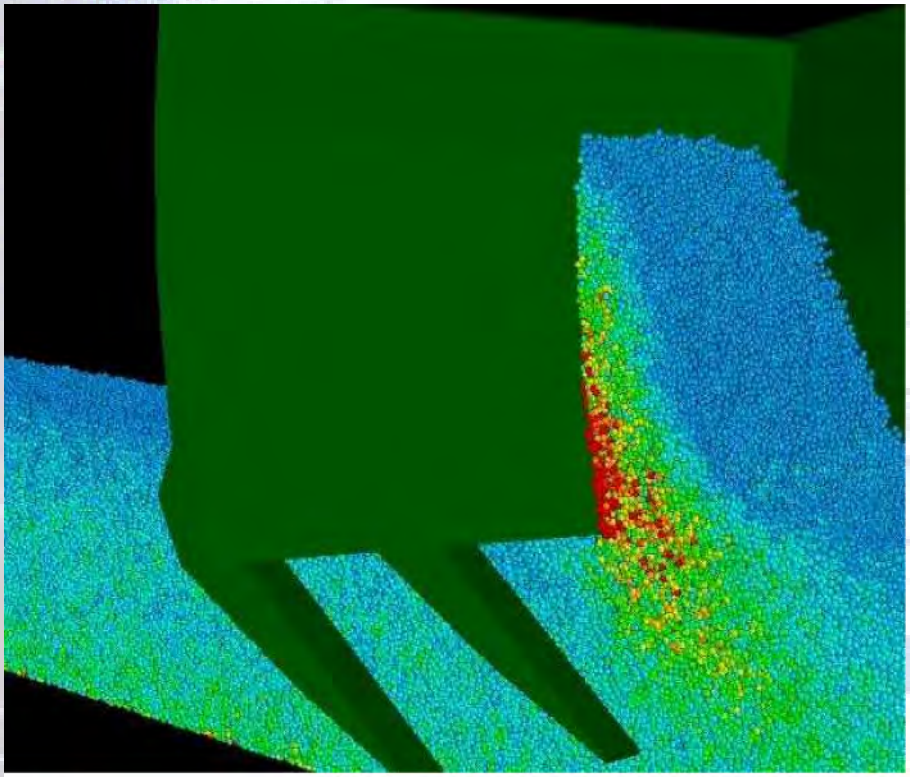


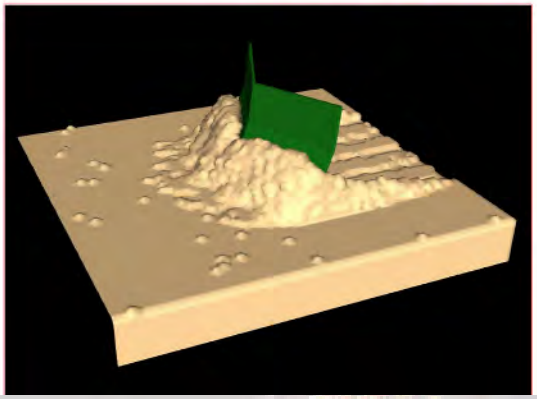


- Vehicle mobility mechanics has much in common with failure mechanics in geotechnical engineering.

- Recent advances in particle methods for mobility modeling hold promise for failure mechanics in geotechnical applications.

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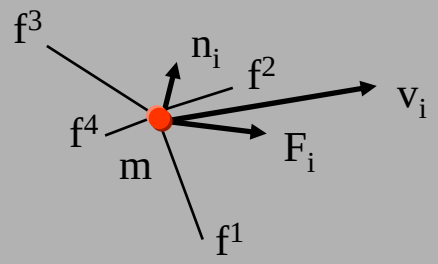
Particle Modeling with the Discrete Element Method

- DEM depicts the soil as individual particles rather than connected elements.
- The particles move in accordance to simple interaction laws rather that complicated constitutive models.

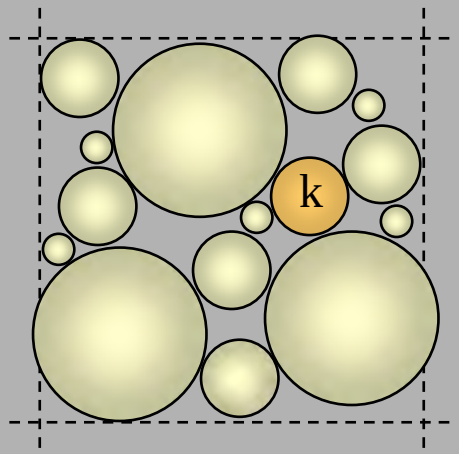
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DEM Mechanics

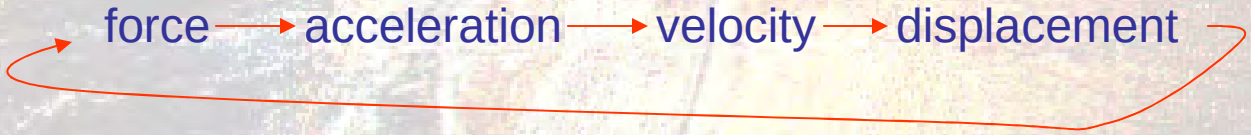
- **Physics based**
- **Replicates particulate nature of soil**
- **Slip planes and separations form between groups of particles thus capturing evolving failure mechanisms more realistically**



Forces Acting on Particle k



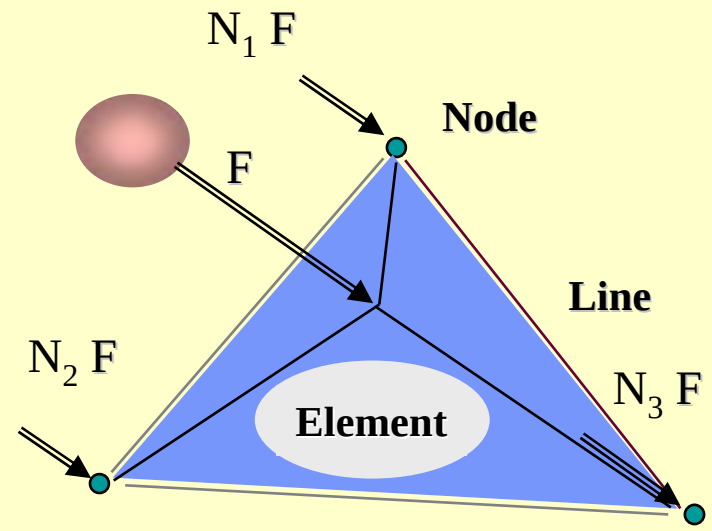
Discrete Particle System

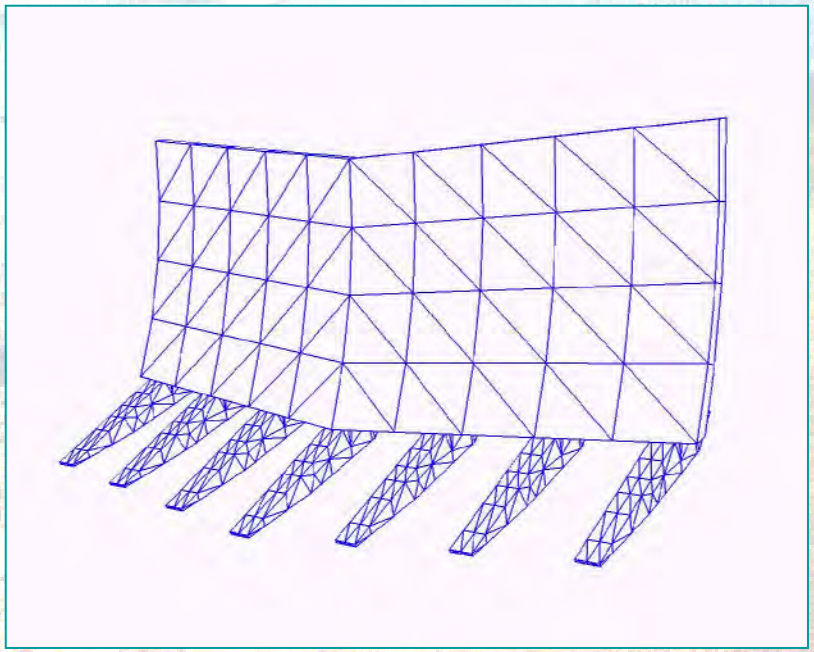


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Interaction with Finite Element Structures

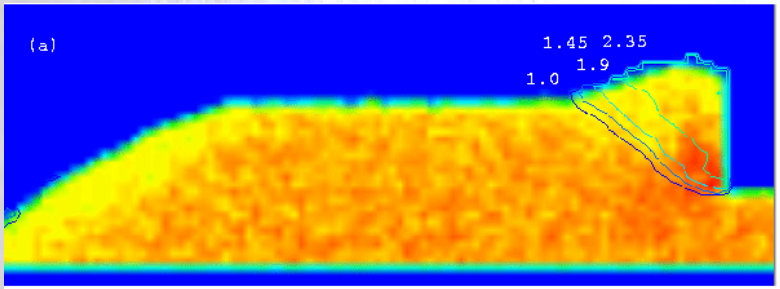
$N_1 + N_2 + N_3 = 1$

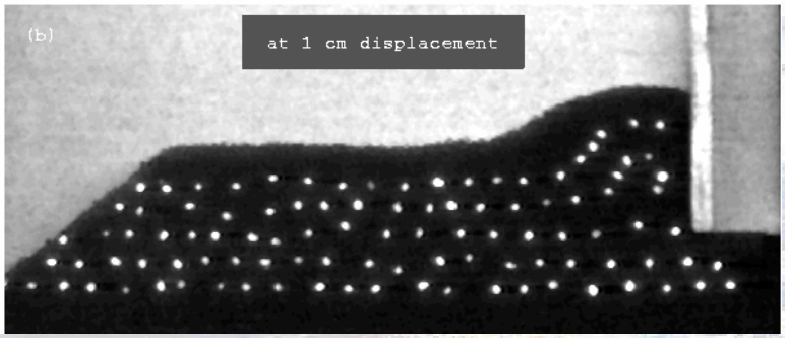




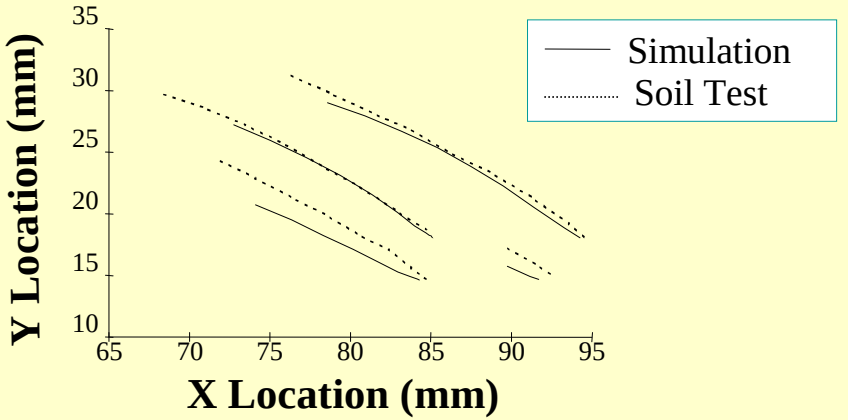
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Simulation of Wall Experiment

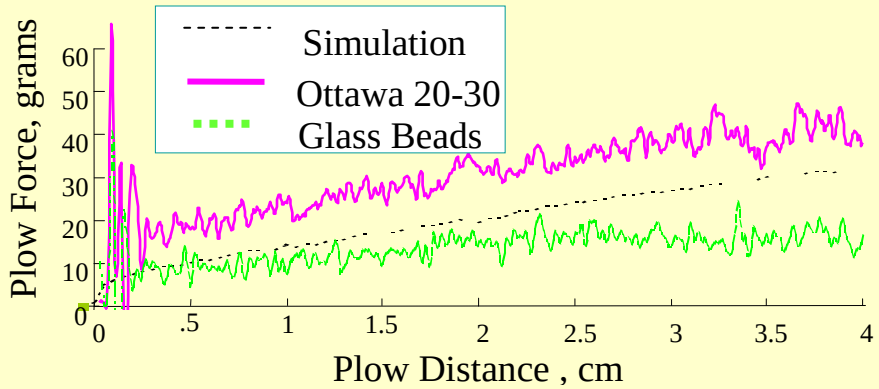




General character of deformation was reproduced well.

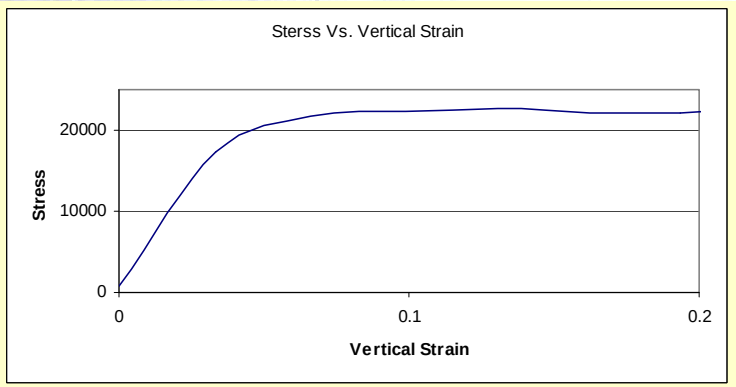


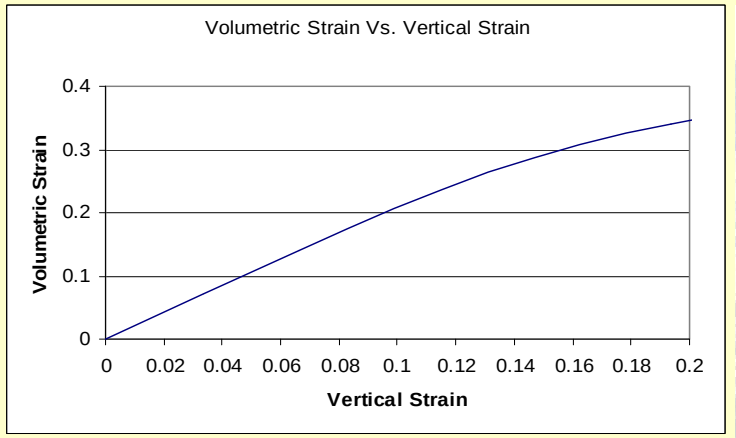
Quantitative agreement was achieved for displacement and force.



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Simulated Laboratory Experiment





Simulated stress-strain and volume change curves

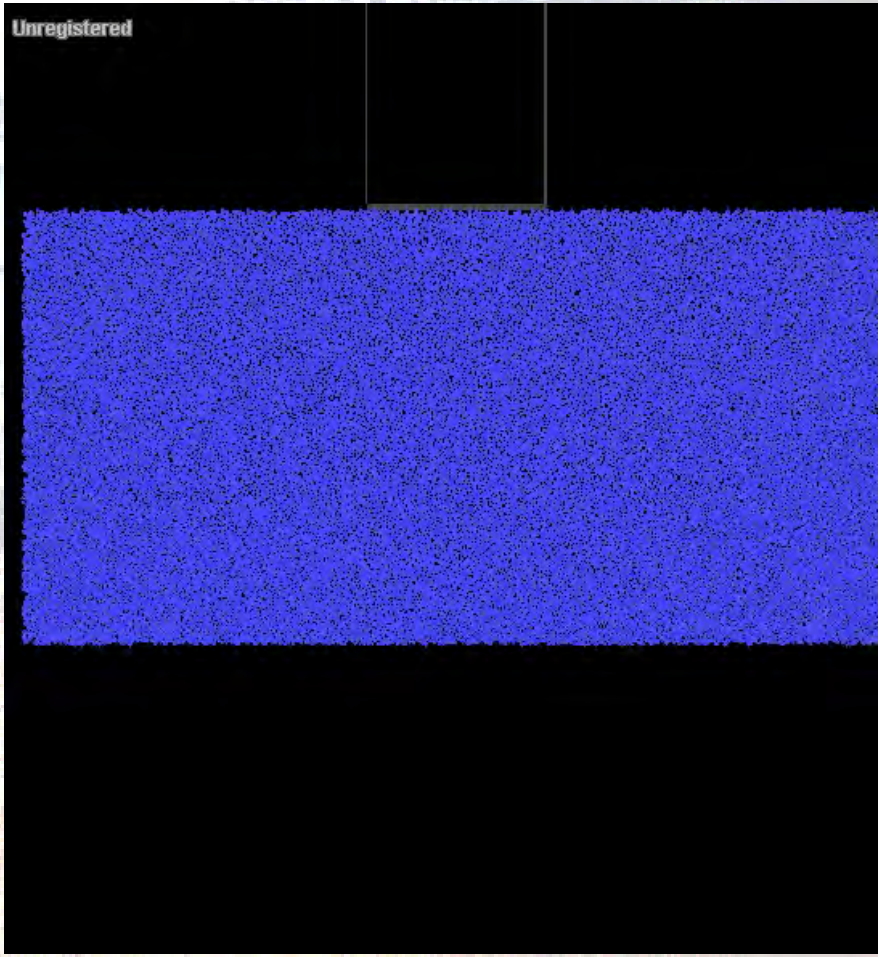


Simulate specimen after formation

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Modeling Large Discontinuous Deformation with Particles

- Bearing Capacity Problems
- Penetrometers
- Slope Stability



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Where is DEM Research Going

- Cohesive particles for slope stability problems
- Asphalt property test simulation
- Vehicle-soil interaction
- Water-soil interaction
- Non-spherical particles

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Future of DEM

- Earth pressure and slope stability problems with soil-structure interaction
- Consequences of failure
- Piping and fines migration
- Spillway erosion

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Raju.V.Kala@ERDC.USACE.ARMY.MIL
Phone : 601 634 2219
John.F.Peters@ERDC.USACE.ARMY.MIL
Phone : 601 634 2590


Thank You

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Huntington District

Engineering Geology Challenges During Design and Construction of the Marmet Lock Project

2005 Tri-Service Infrastructure Systems Conference August 2-5, 5005

Ron Adams & Mike Nield

US Army Corps
of Engineers
Huntington District

Main Topics of Discussion

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Huntington District

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1. PROJECT OVERVIEW

a. Site Plan
b. Site Geology

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1. **PROJECT OVERVIEW**
   a. Site Plan
   b. Site Geology
2. **DEEP SEATED SLIDING**
   a. Design Concerns
   b. Cofferdam Foundation Movement
   c. New Chamber Lockwall Monoliths

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c. New Chamber Lockwall Monoliths

3. GEOLOGIC ASPECTS OF CONSTRUCTION

a. Anchor Installation
b. Rock Excavation
c. Foundation Preparation & Treatment
d. Drilled Shaft Foundations
e. Foundation Drilling and Grouting

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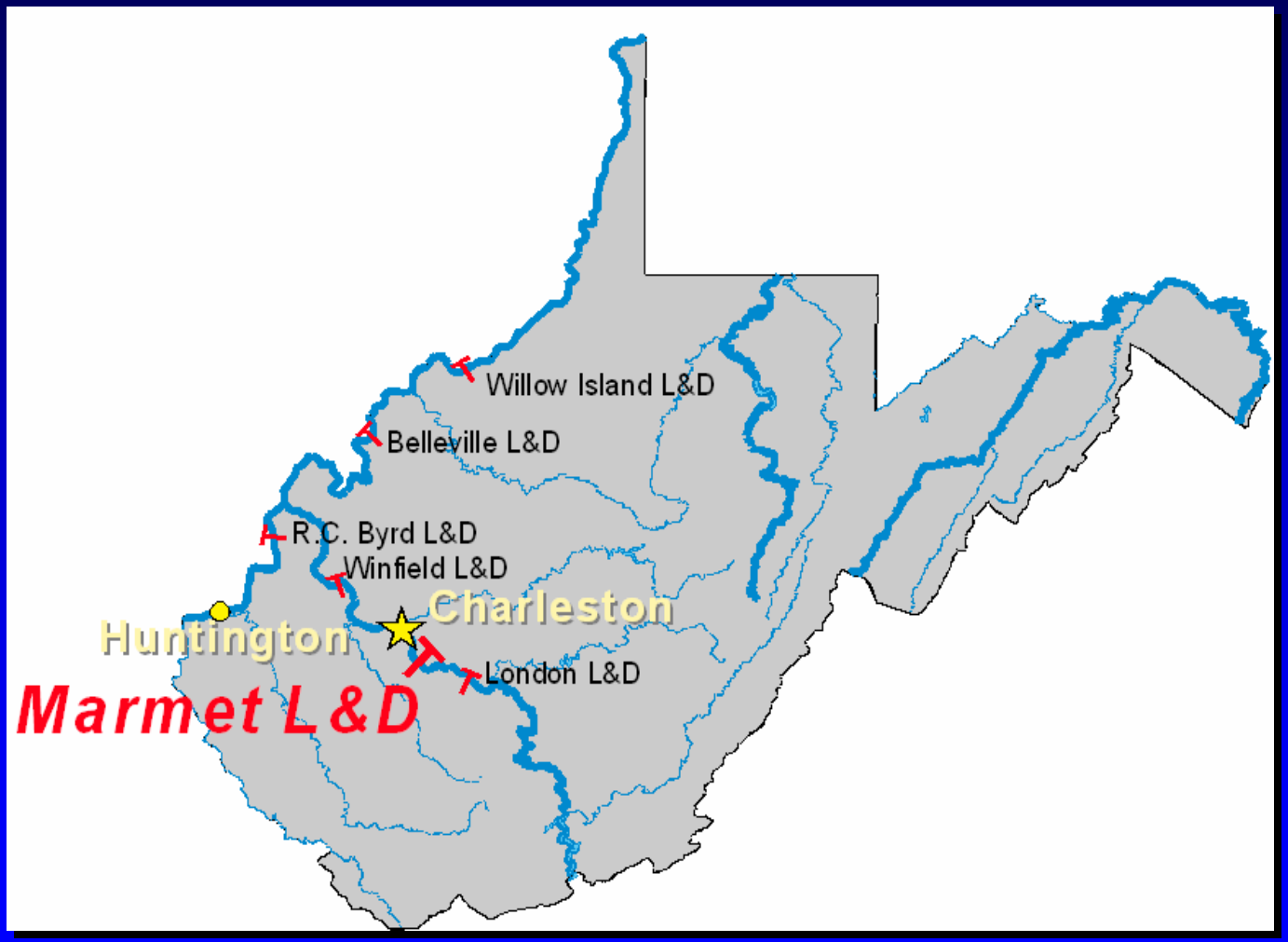
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Marmet Lock Replacement – Project Overview



Site Plan

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Marmet Lock Replacement Project

- **Purpose is to alleviate traffic on the Kanawha River**

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Marmet Lock Replacement Project

- **Purpose is to alleviate traffic on the Kanawha River**
- **Existing and smaller 56’ X 360’ lock chambers inhibit river traffic**

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Marmet Lock Replacement Project

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- **Existing and smaller 56’ X 360’ lock chambers inhibit river traffic**
- **Project adds one larger 110’ X 800’ lock chamber and approach walls, located landward of old locks**

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Marmet Lock Replacement Project

- **Purpose is to alleviate traffic on the Kanawha River**
- **Existing and smaller 56’ X 360’ lock chambers inhibit river traffic**
- **Project adds one larger 110’ X 800’ lock chamber and approach walls, located landward of old locks**
- **Construction started in summer 2002 with a current contract cost of $232 Million**

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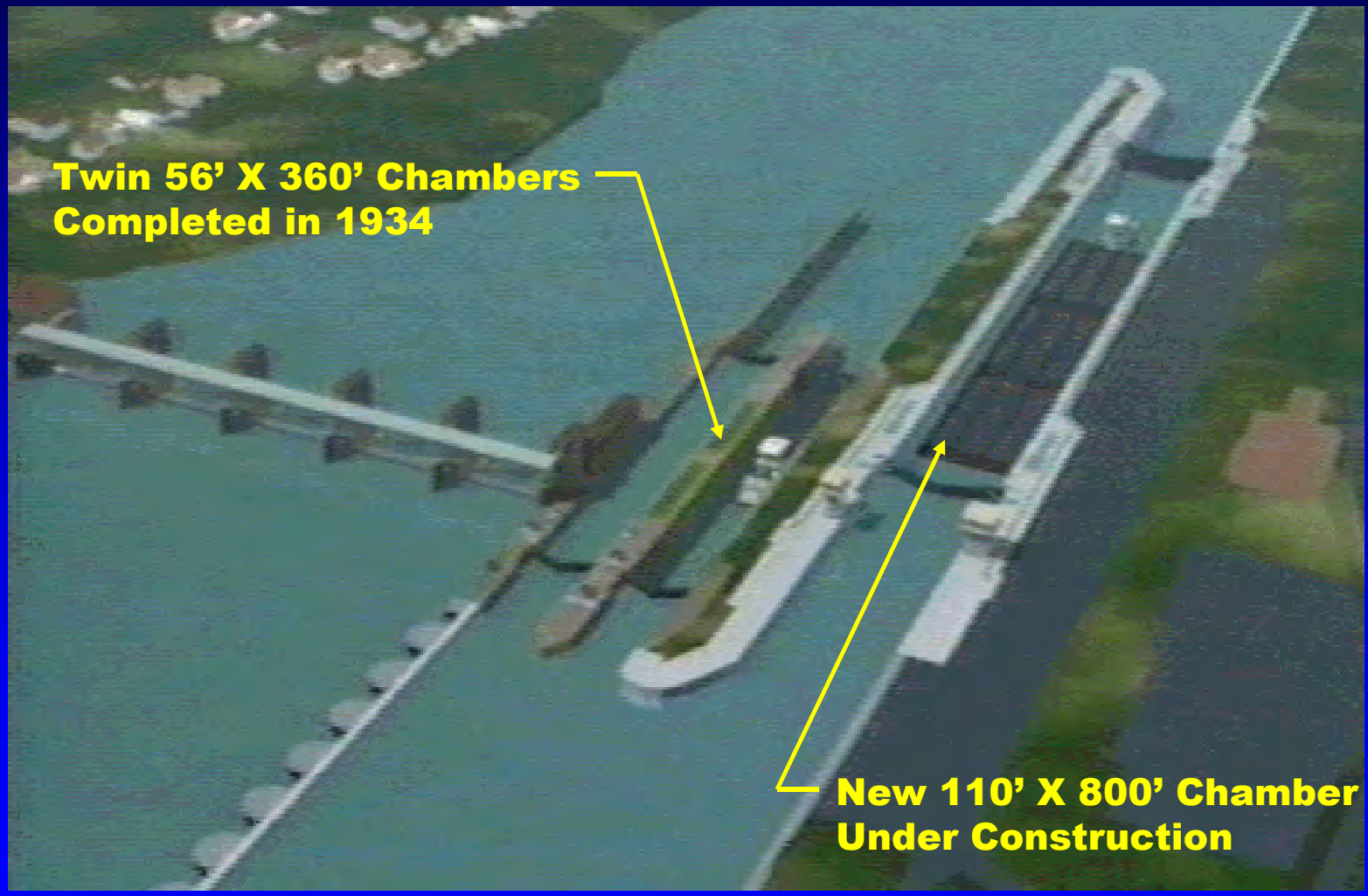
Marmet Lock Replacement – Project Overview



Existing Lock – Prior to Construction

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Marmet Lock Replacement – Project Overview



New Lock – Conceptual Drawing

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Marmet Lock Replacement – Project Overview



New Lock Construction - Ariel View - May 2005

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Marmet Lock Replacement – Project Overview



New Lock Construction - Ariel View - May 2005

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One Corps, One Regiment, One Team

Marmet Lock Replacement – Project Overview

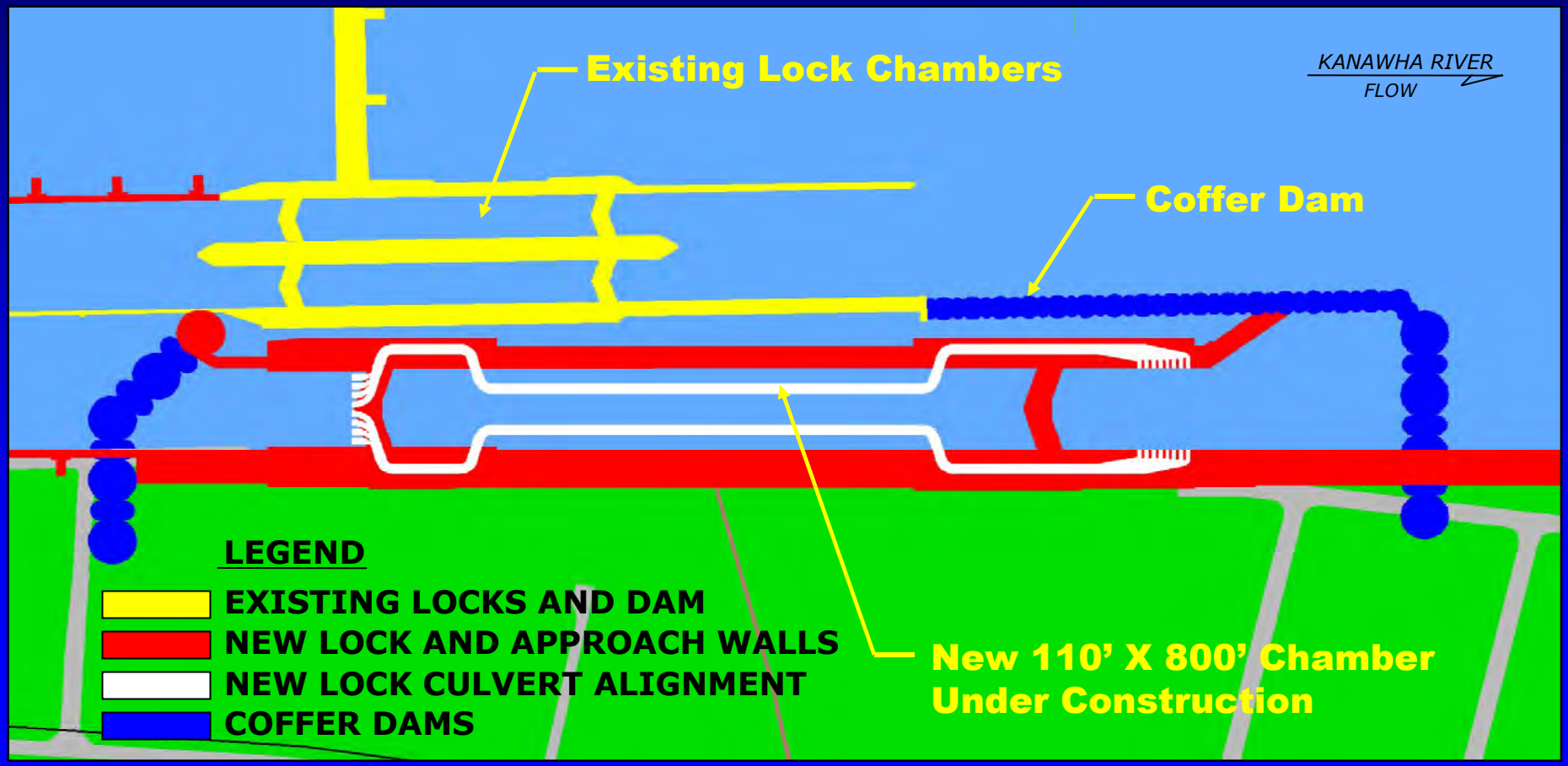


New Lock Construction - Ariel View - May 2005

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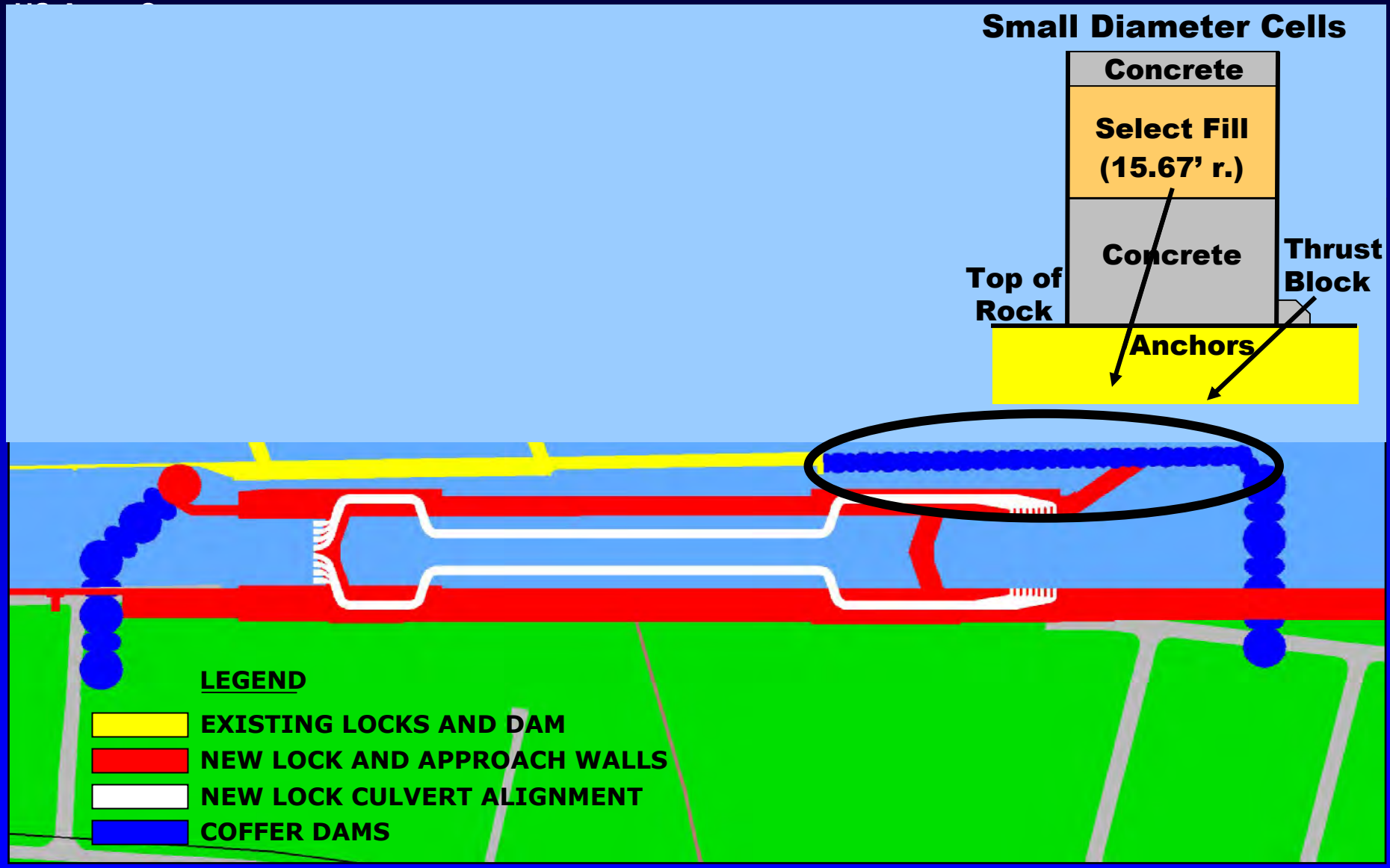
One Corps, One Regiment, One Team

Marmet Lock Replacement – Project Overview



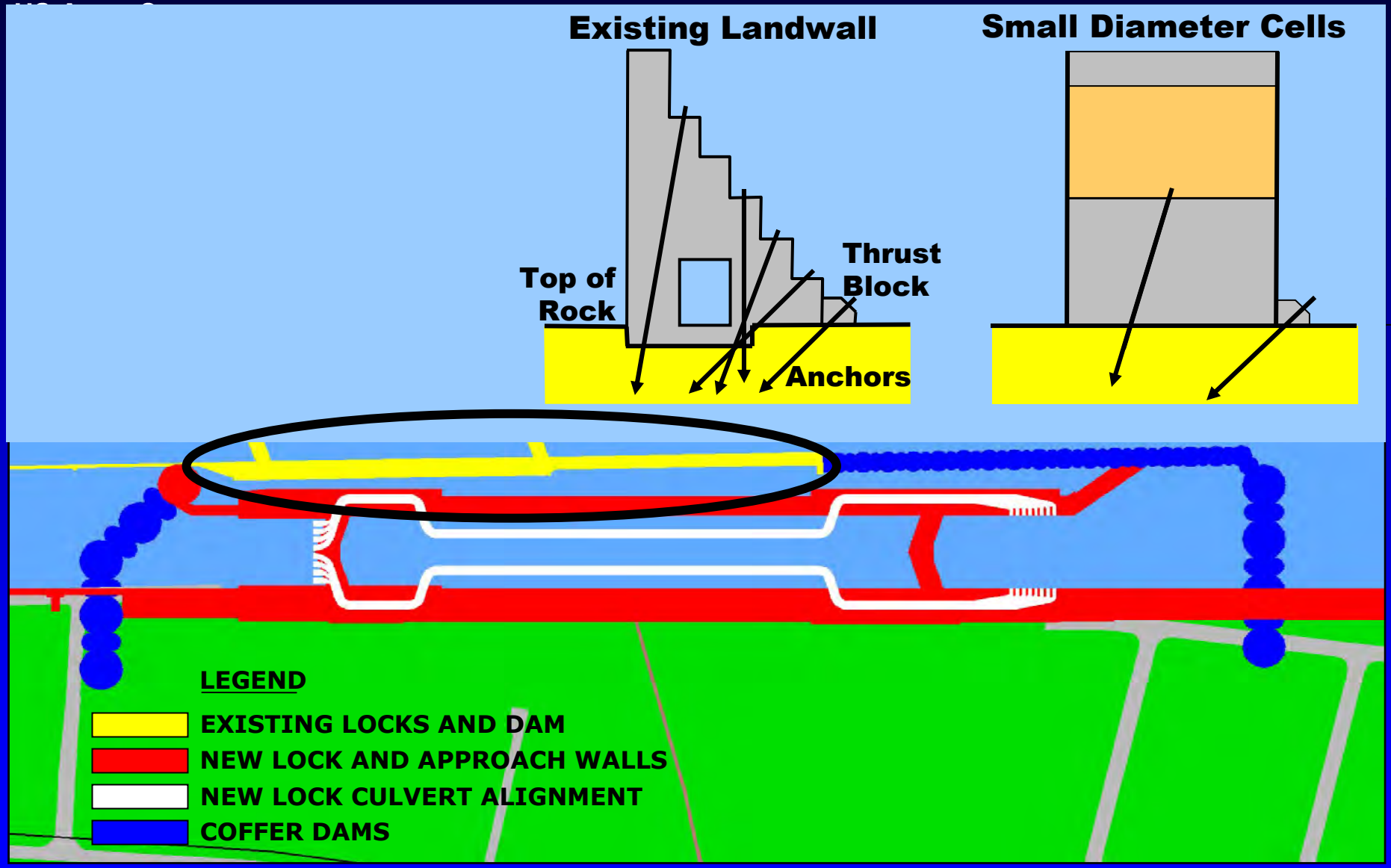
Site Plan

Marmet Lock Replacement – Project Overview



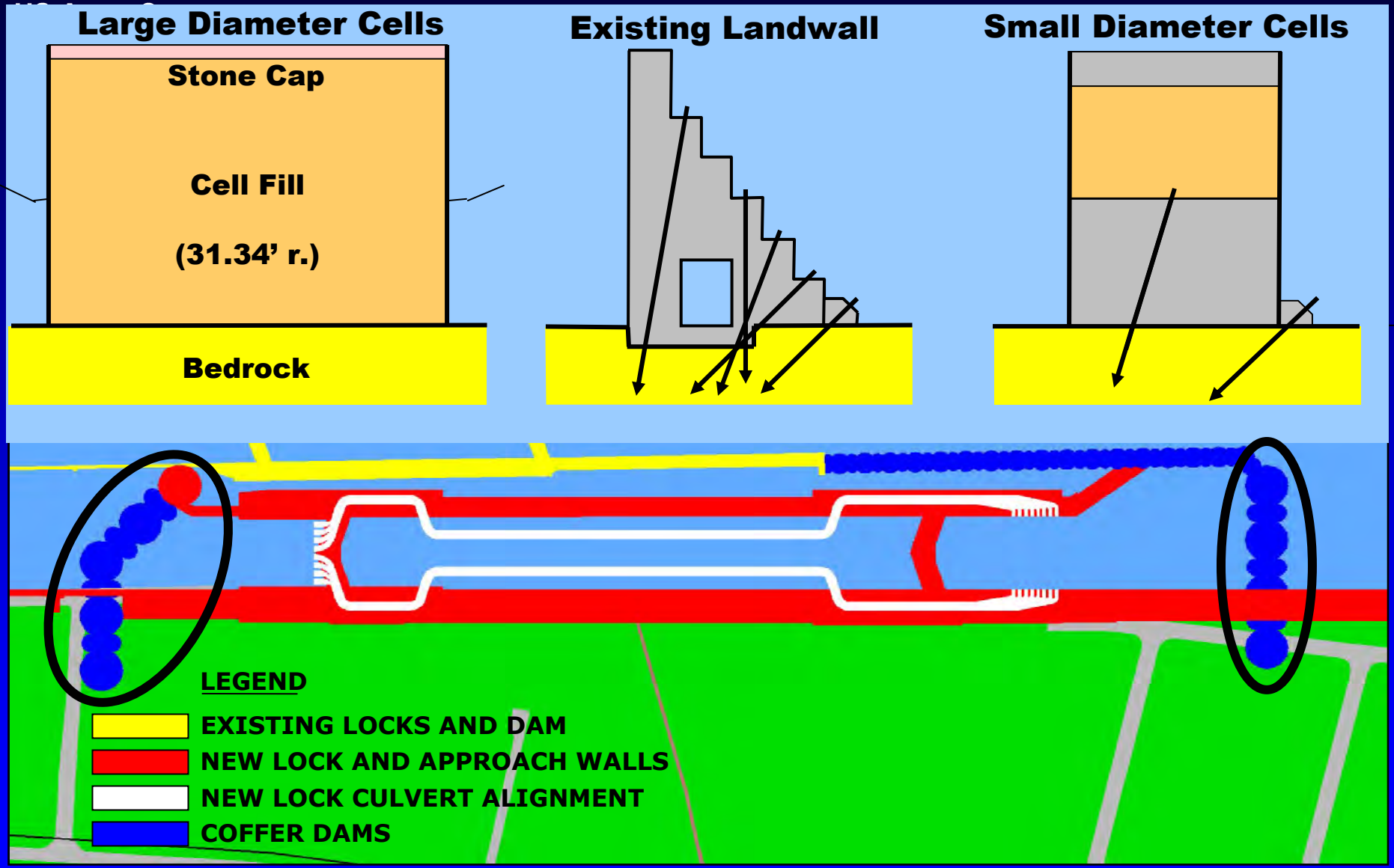
Cofferdam Components – Typical Sections

Marmet Lock Replacement – Project Overview



Cofferdam Components – Typical Sections

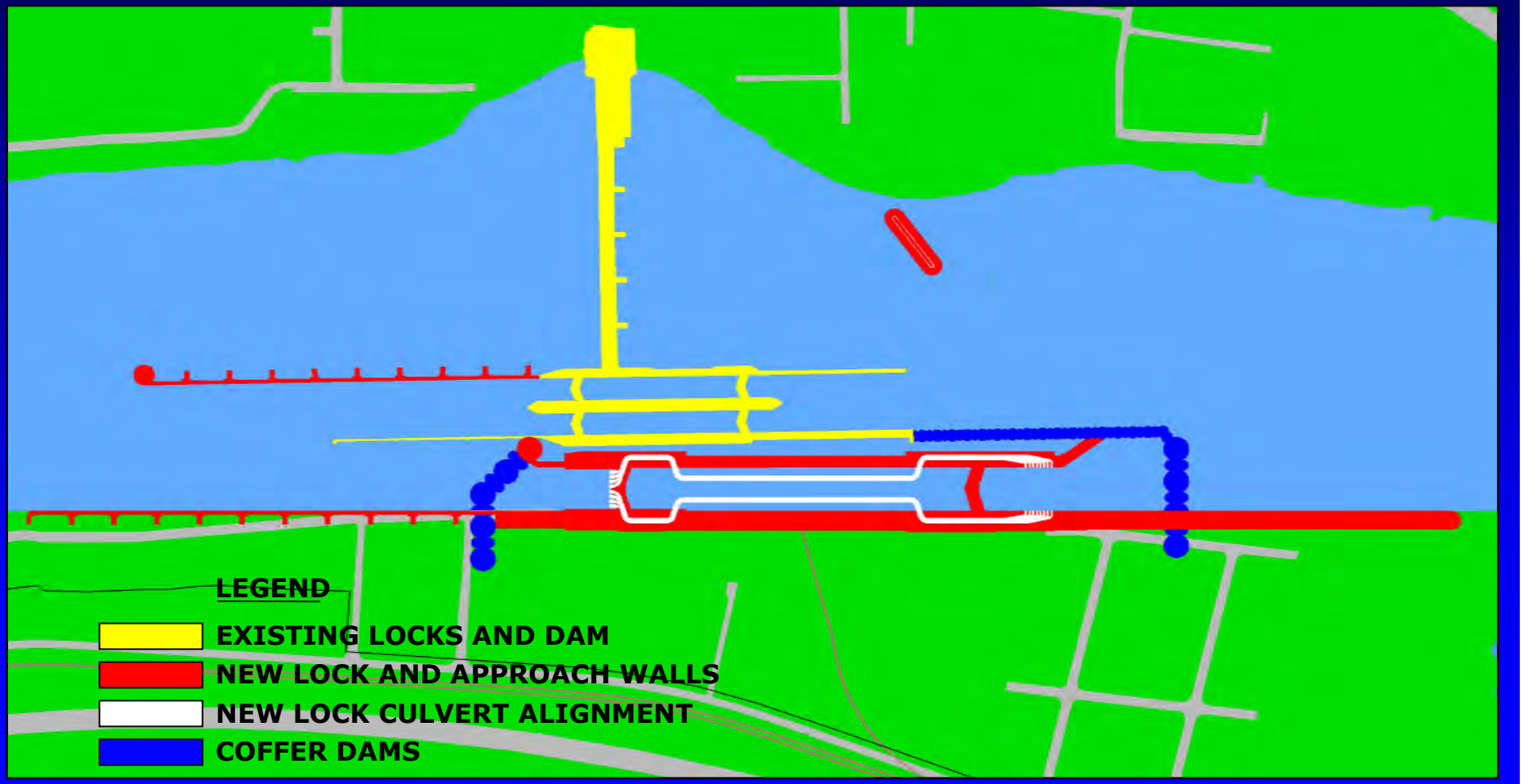
Marmet Lock Replacement – Project Overview



Cofferdam Components – Typical Sections

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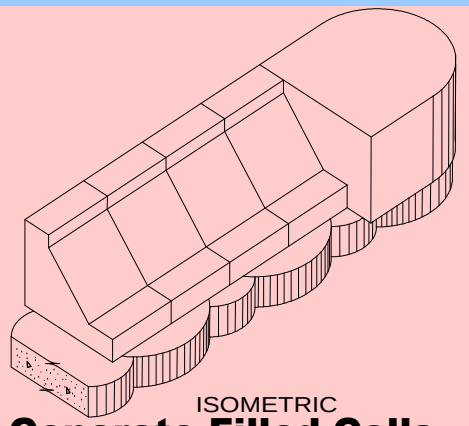
Marmet Lock Replacement – Project Overview



New Lock Features – Plan View

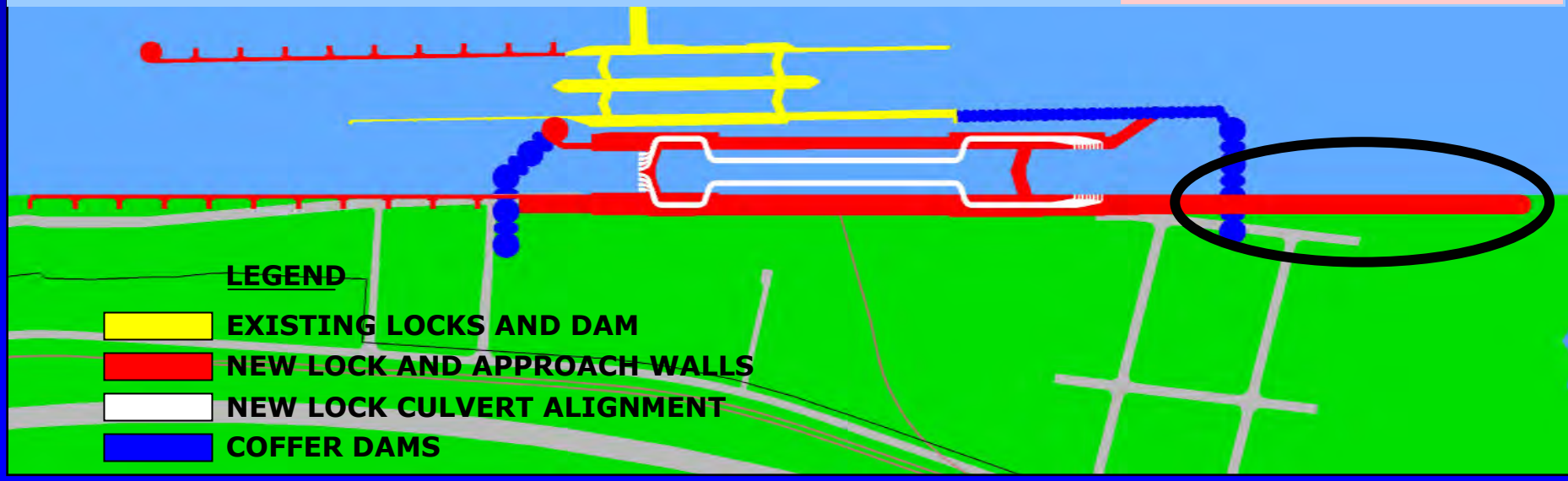
Marmet Lock Replacement – Project Overview

Lower Approach Wall



ISOMETRIC

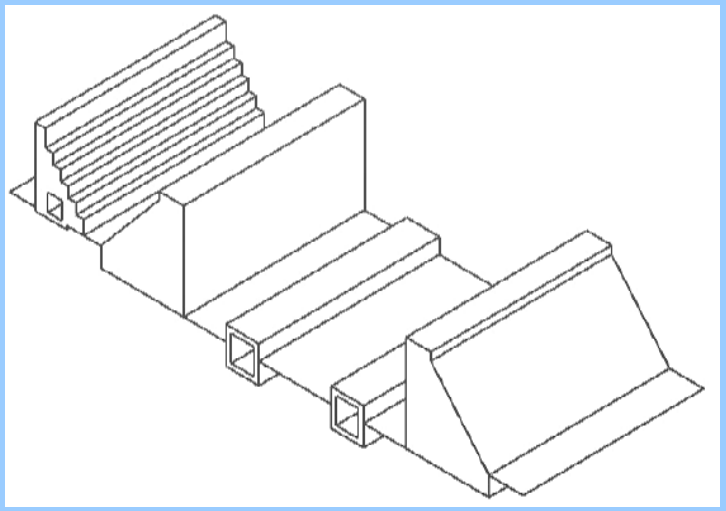
Concrete Filled Cells
Founded ~1’ below TOR



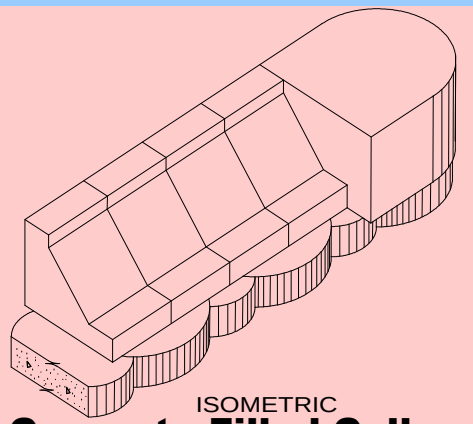
New Lock Features

Marmet Lock Replacement – Project Overview

Lock Chamber

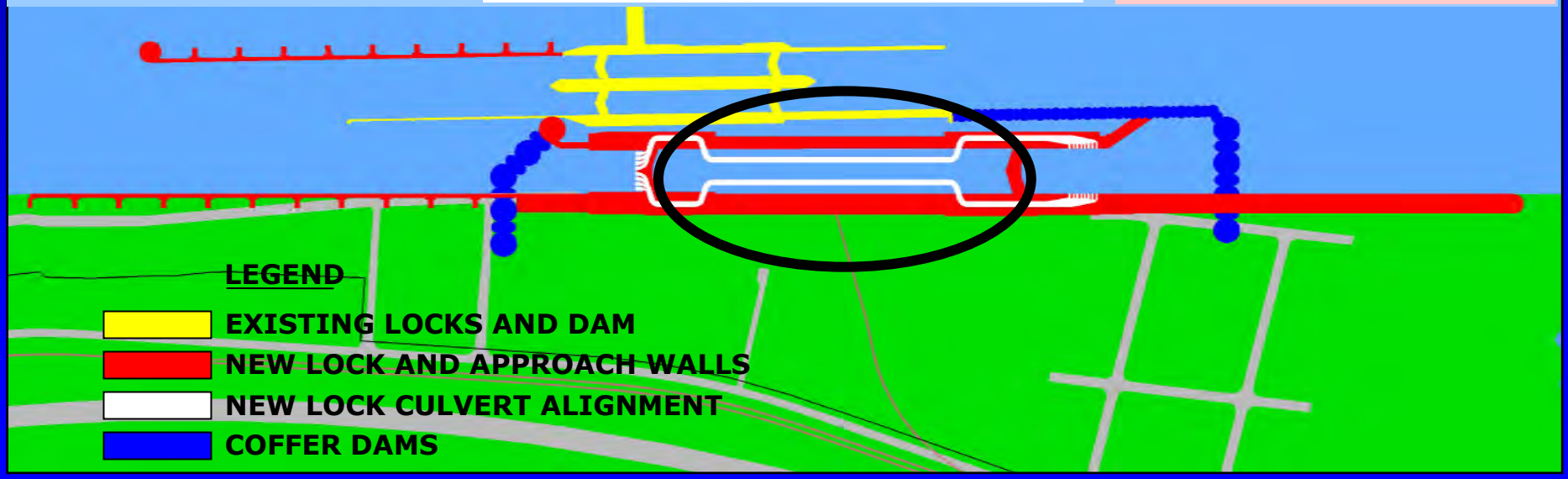


Lower Approach Wall



ISOMETRIC

Concrete Filled Cells
Founded ~1' below TOR



New Lock Features

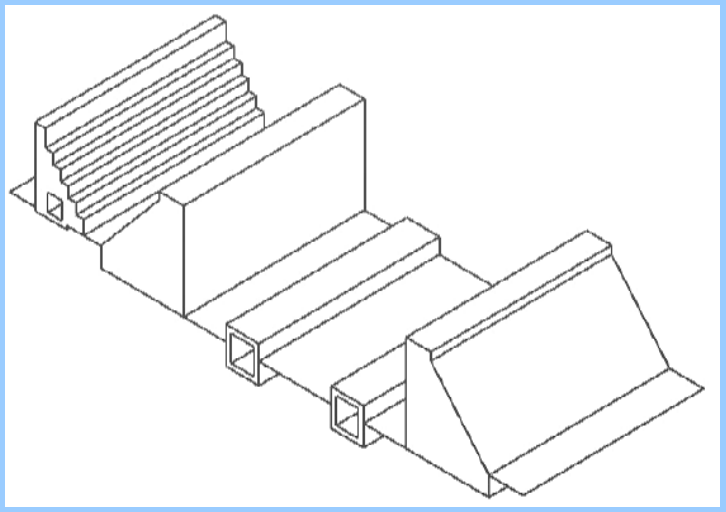
Marmet Lock Replacement – Project Overview

Upper Approach Walls

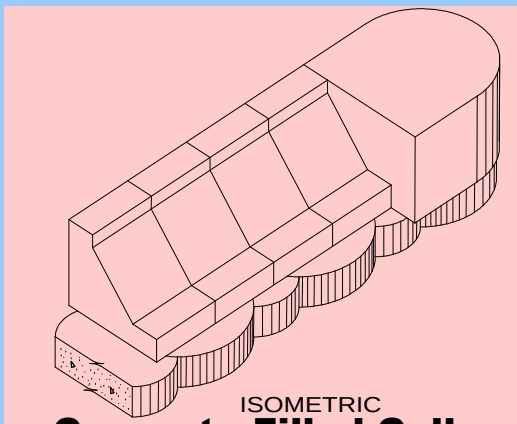


Drilled Shafts Socketed 15' into Bedrock

Lock Chamber

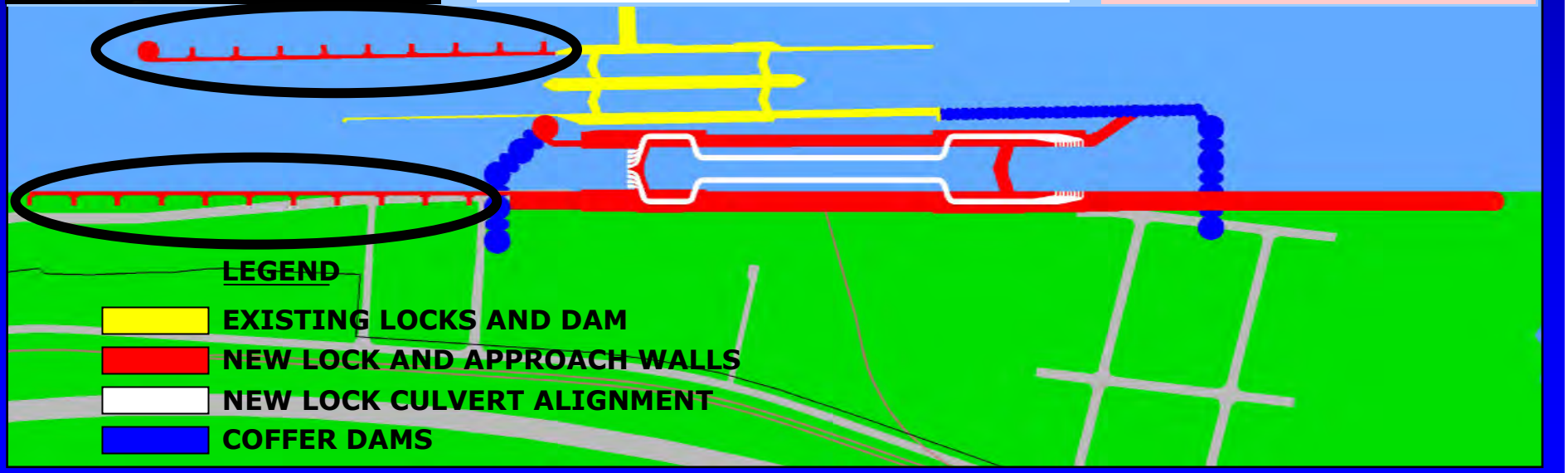


Lower Approach Wall



ISOMETRIC

Concrete Filled Cells Founded ~1' below TOR



New Lock Features

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Huntington District

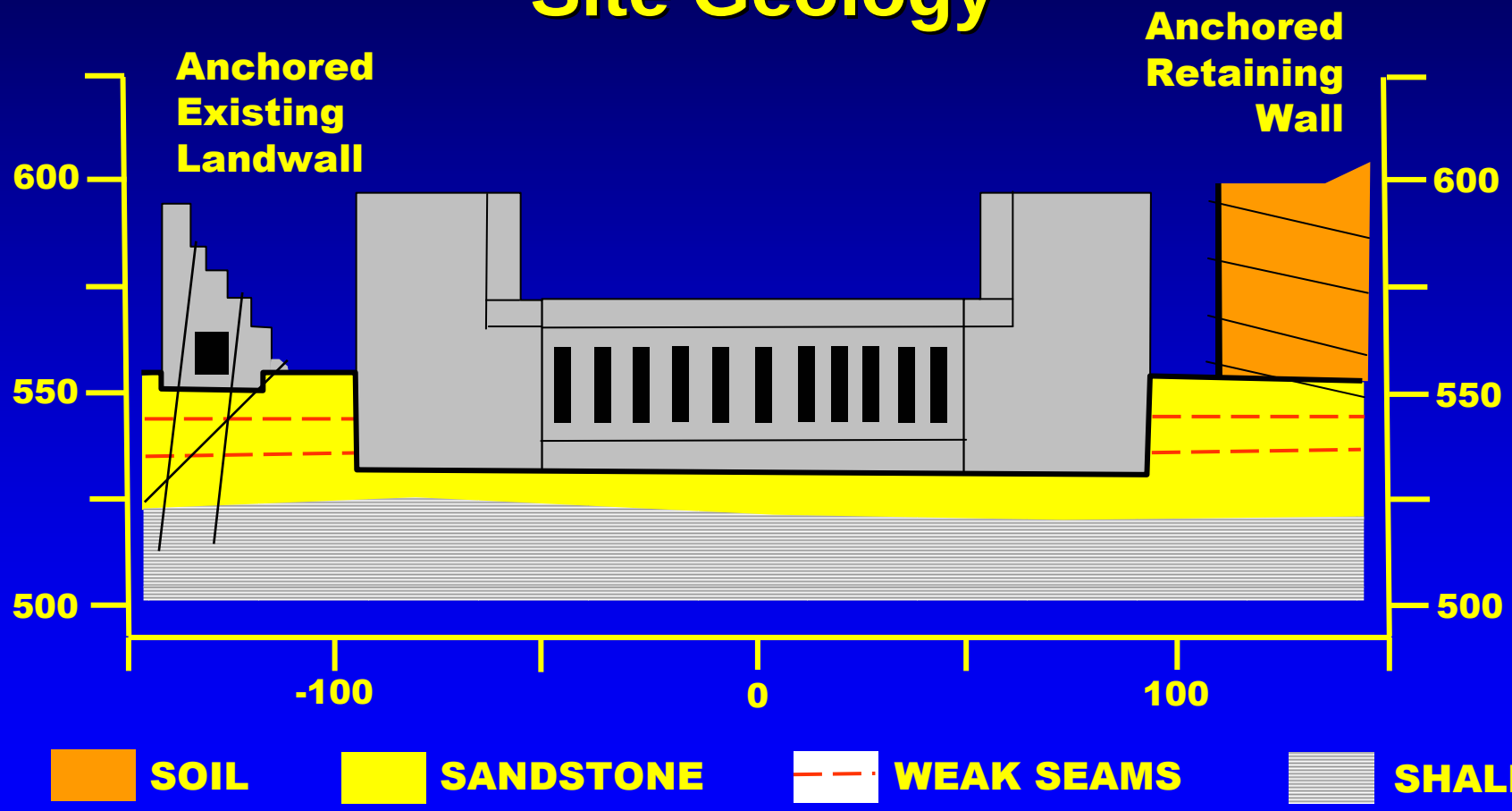
Site Geology

- Relatively flat top of rock surface
- Sedimentary rock of the Pennsylvanian-aged Kanawha Formation
- Nearly horizontal bedding. **Discovered low angled (5 - 10°) dip to the Northwest during construction with localized stratigraphic dip**
- Rock Units:
  - Sandstone member (23 to 43 feet thick)
  - Shale member (19 to 33 feet thick)
- Sandstone member is competent but interbedded with many thin seams and stringers of coal and shale. **Discovered to be continuous in excavated sidewalls during construction.**

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Marmet Lock Replacement – Project Overview

Site Geology

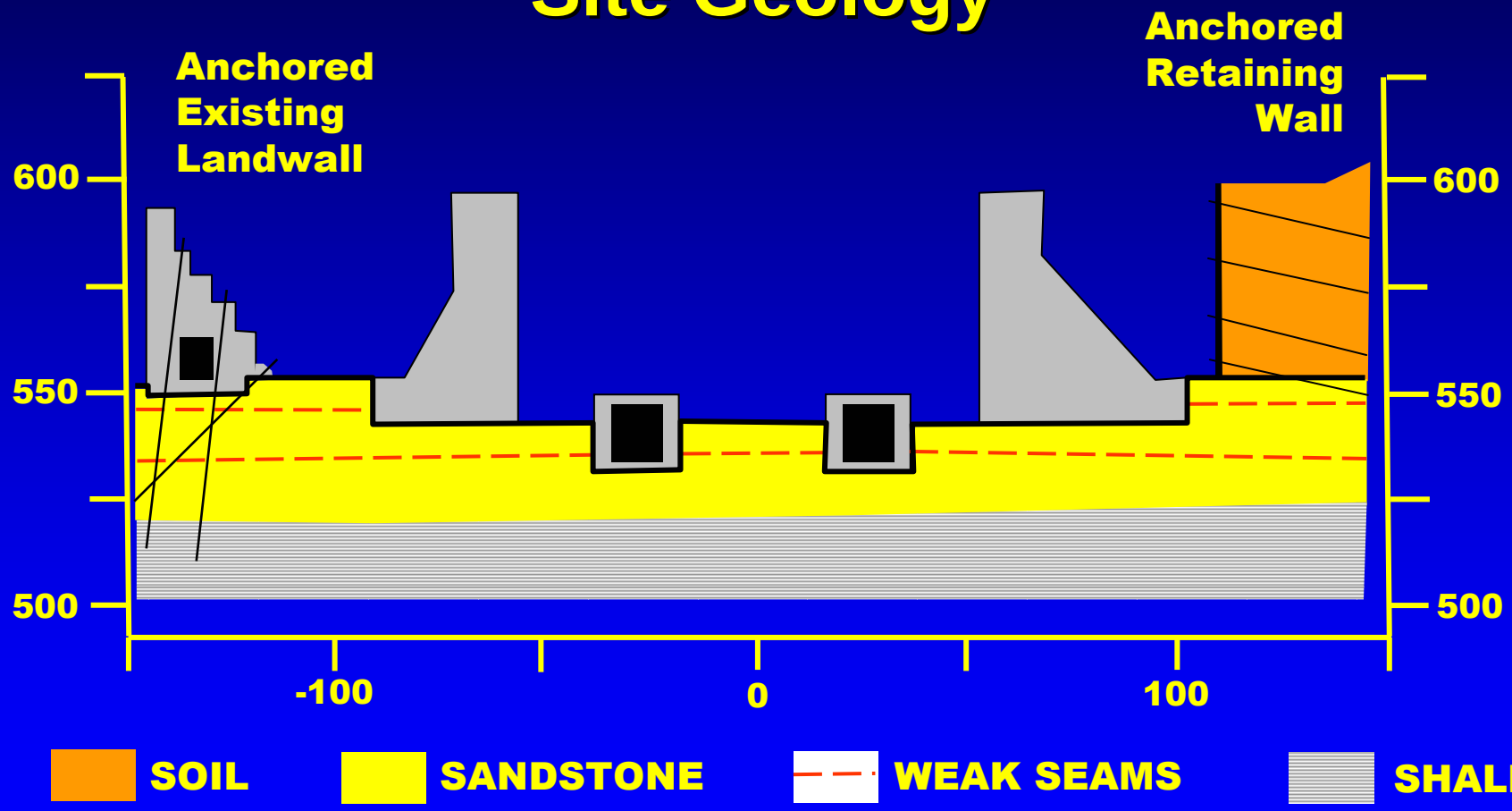


Geologic Cross Section – Upper Miter Gate

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Project Overview

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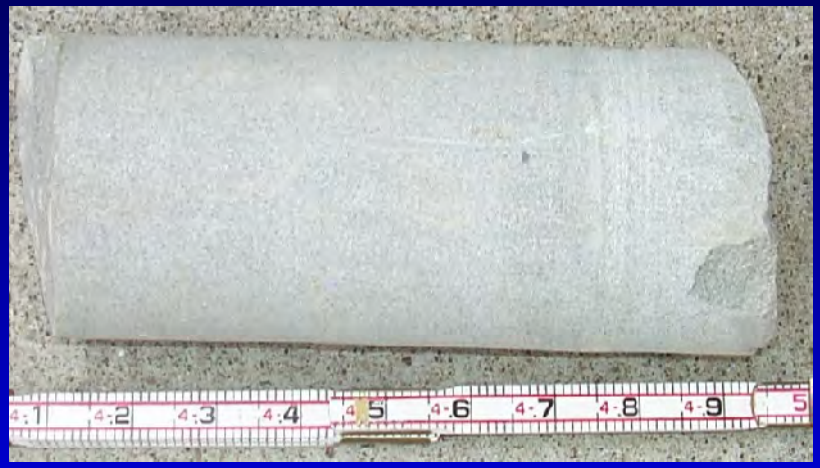


Geologic Cross Section – Chamber Monoliths

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Project Overview

Site Geology





- Light gray
- Moderately hard to hard
- Medium to fine grained
- Average unconfined compressive strength 8,442 psi

Sandstone Member

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Project Overview

Site Geology





- Gray to dark gray
- Moderately hard to soft
- Silty
- Average unconfined compressive strength 6,678 psi

Shale Member

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Project Overview

Rock Mechanics Testing

- **Design Sliding Friction Strength: phi angle = 30°, cohesion = 4psi**
- **Cross Bed Shear Strength: phi angle = 45°, cohesion = 73psi**





Typical Sandstone Member Bedding Plane

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Project Overview

Rock Mechanics Testing



Design Sliding Friction Strength:
phi angle = 23°, cohesion = 0psi



Thin Shale and Coal Seams within Sandstone

US Army Corps
of Engineers
Huntington District

Main Topics of Discussion

1. PROJECT OVERVIEW

a. Site Plan
b. Site Geology

2. DEEP SEATED SLIDING

a. Design Concerns
b. Cofferdam Foundation Movement
c. New Chamber Lockwall Monoliths

3. GEOLOGIC ASPECTS OF CONSTRUCTION

a. Anchor Installation
b. Rock Excavation
c. Foundation Preparation & Treatment
d. Drilled Shaft Foundations
e. Foundation Drilling and Grouting

US Army Corps
of Engineers
Huntington District

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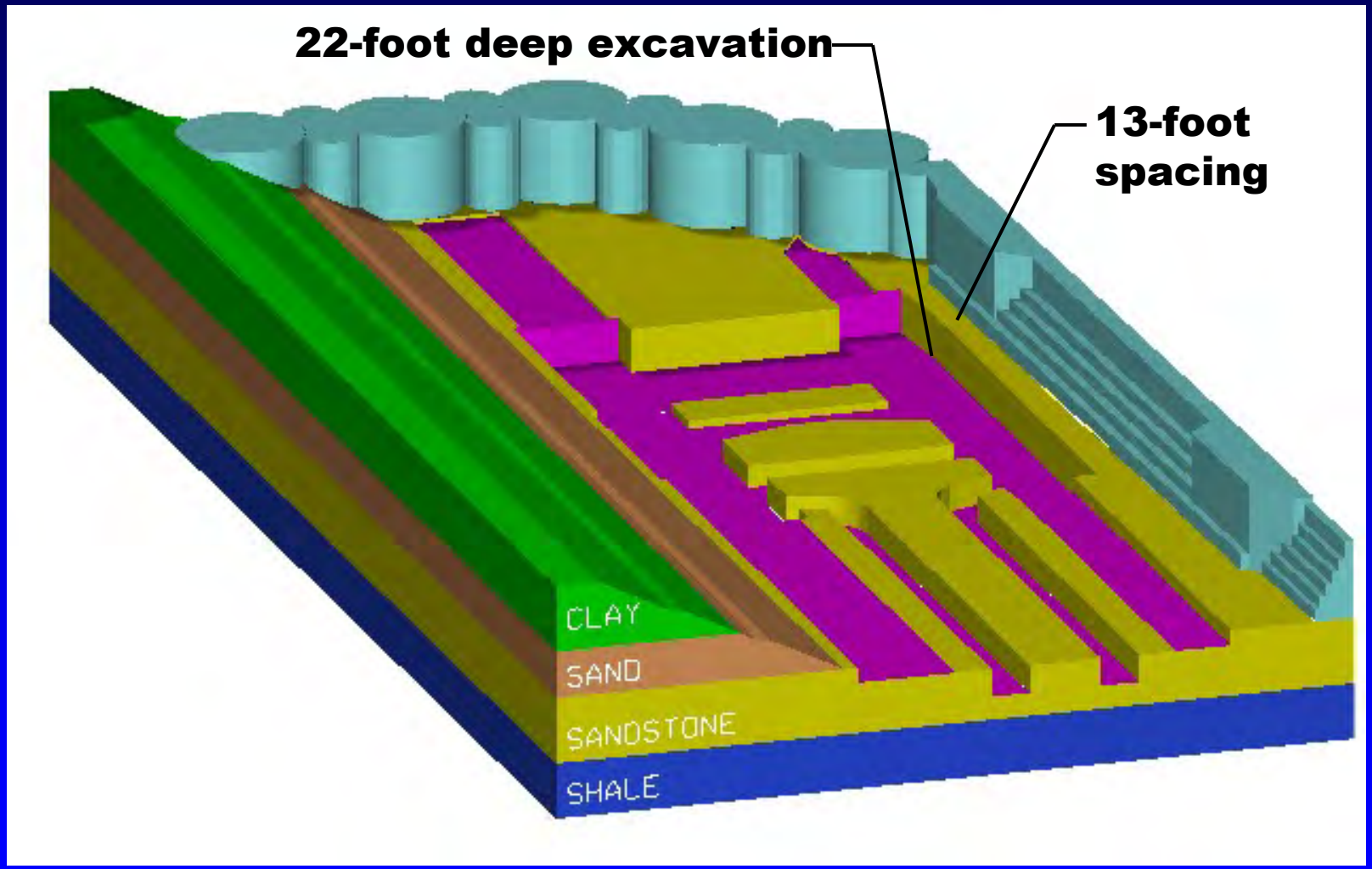
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a. Design Concerns
b. Cofferdam Foundation Movement
c. New Chamber Lockwall Monoliths

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

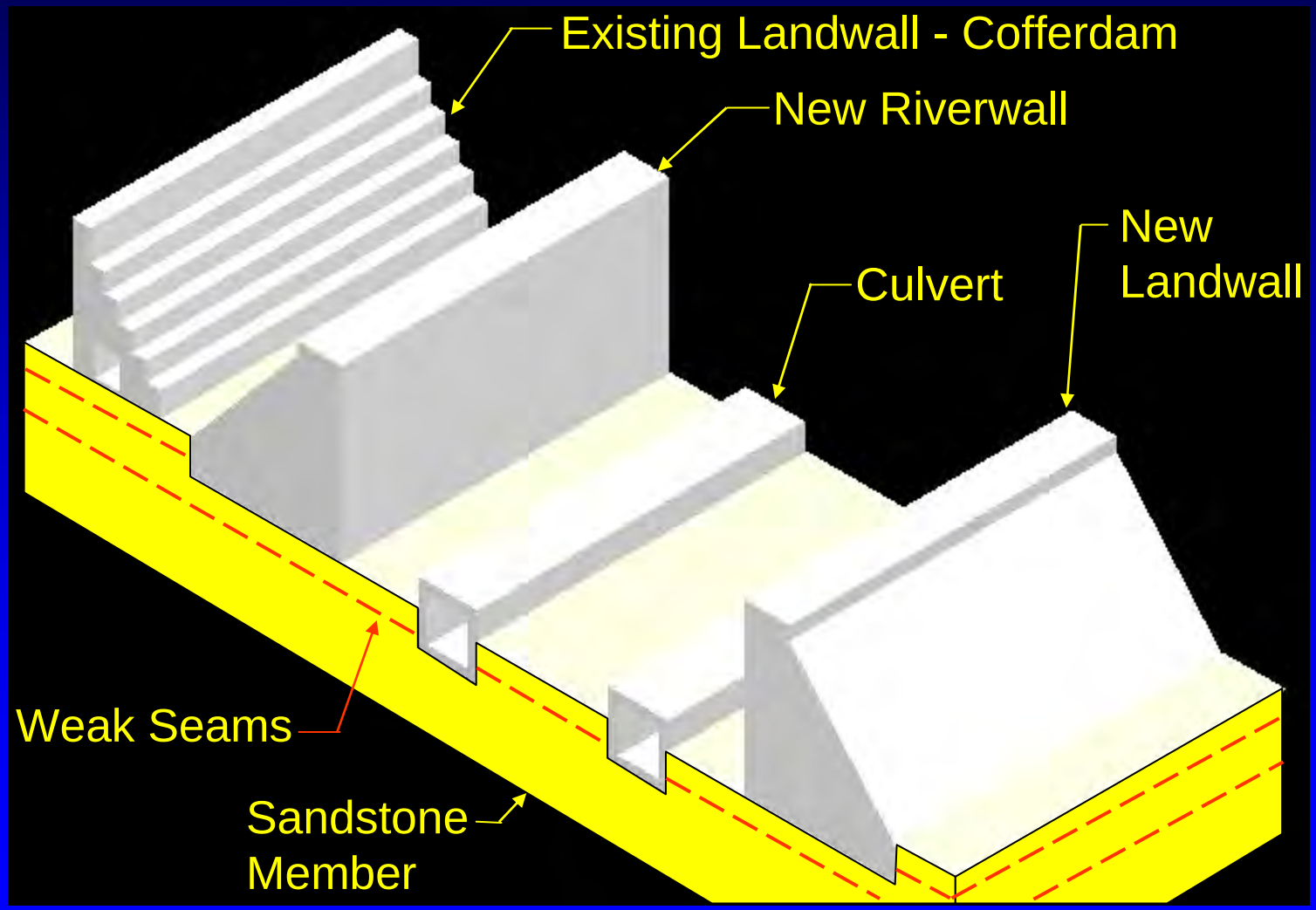


Excavation Adjacent to Structures – 3D view

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Huntington District

Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

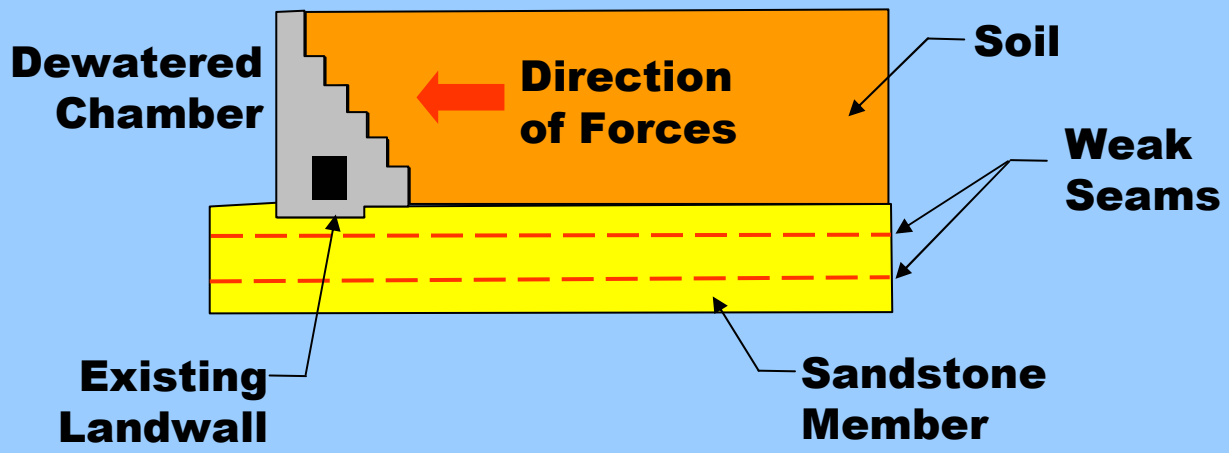


Deep Seated Sliding – Daylighted Weak Seams

Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

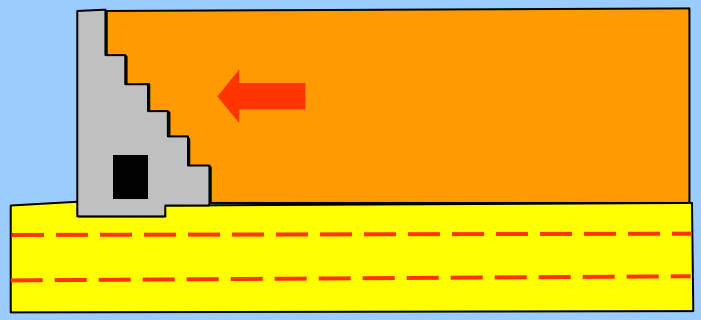
Pre-Construction Condition



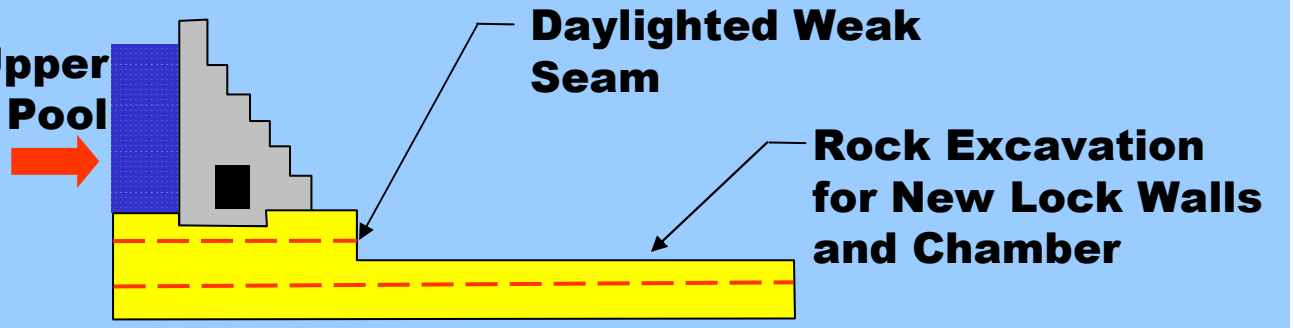
Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

Pre-Construction Condition



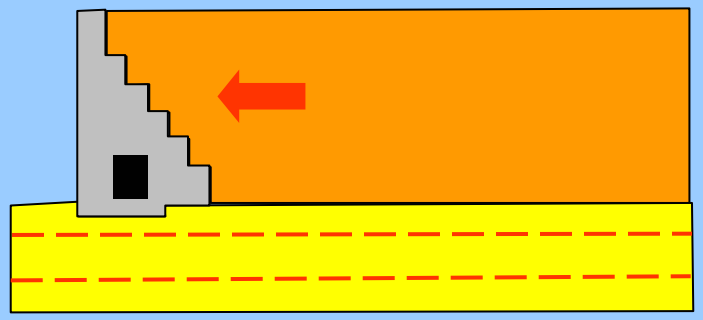
Construction Condition



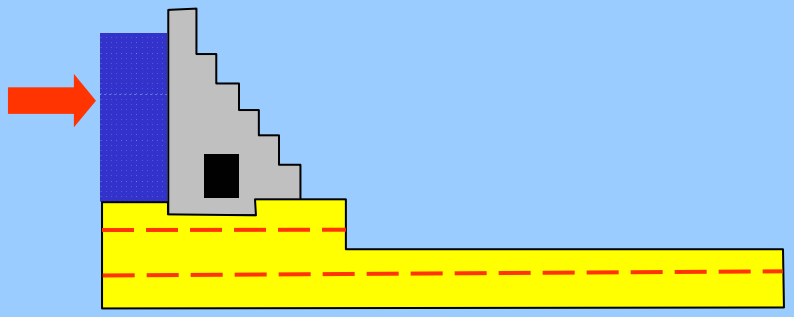
Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

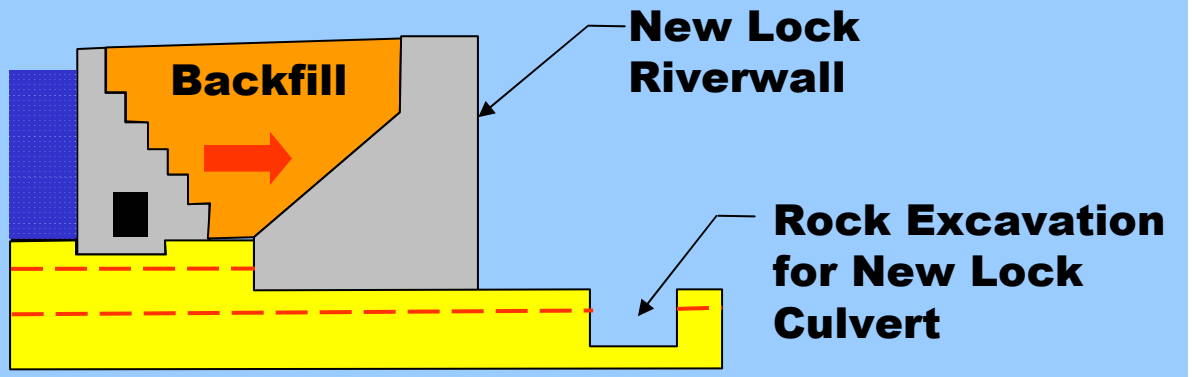
Pre-Construction Condition



Construction Condition

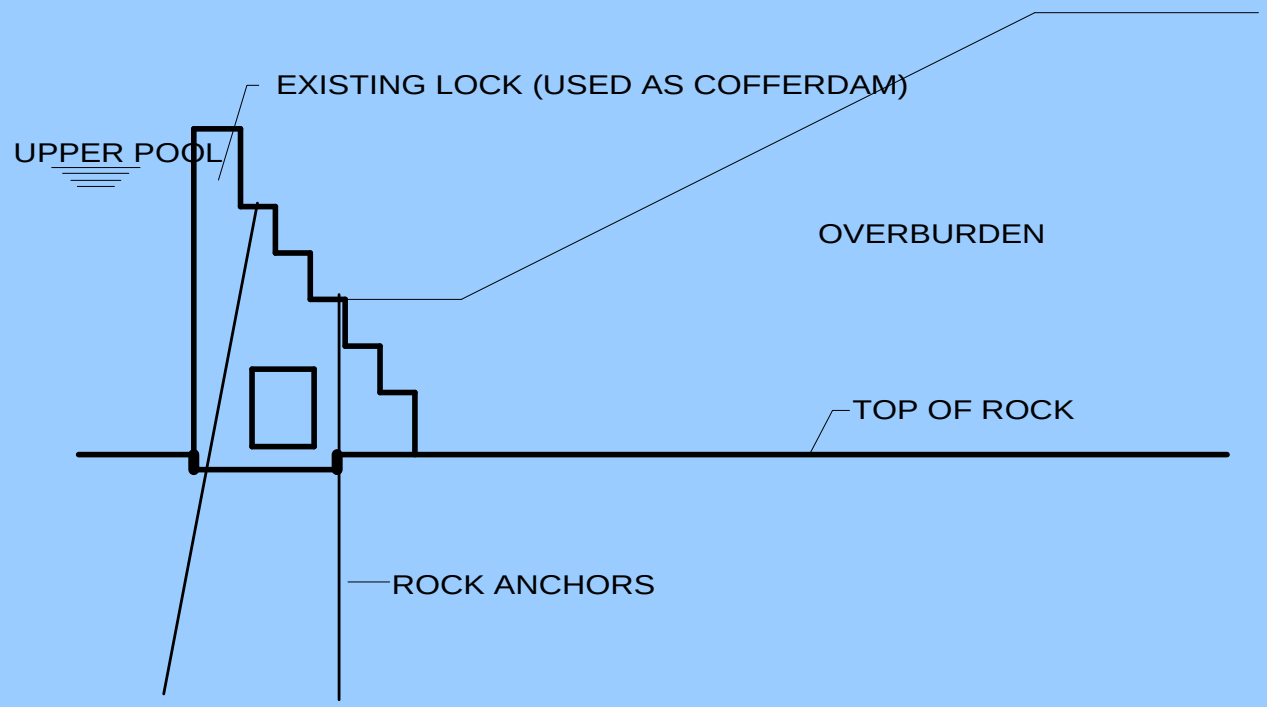


Permanent Condition



Marmet Lock Replacement – Deep Seated Sliding

Design Concerns

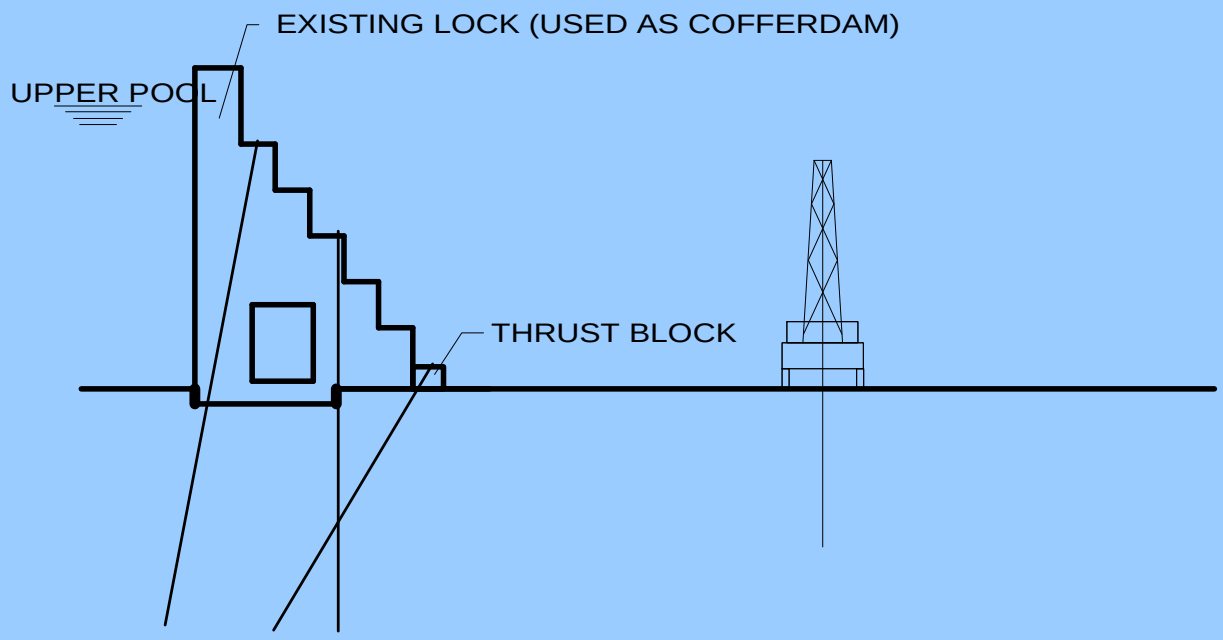


STAGED ANCHORING DURING OVERBURDEN EXCAVATION
Analyzed for coal/shale seam at foundation (phi=23°, c=0psi)

INSTALL INSTRUMENTATION

Marmet Lock Replacement – Deep Seated Sliding

Design Concerns



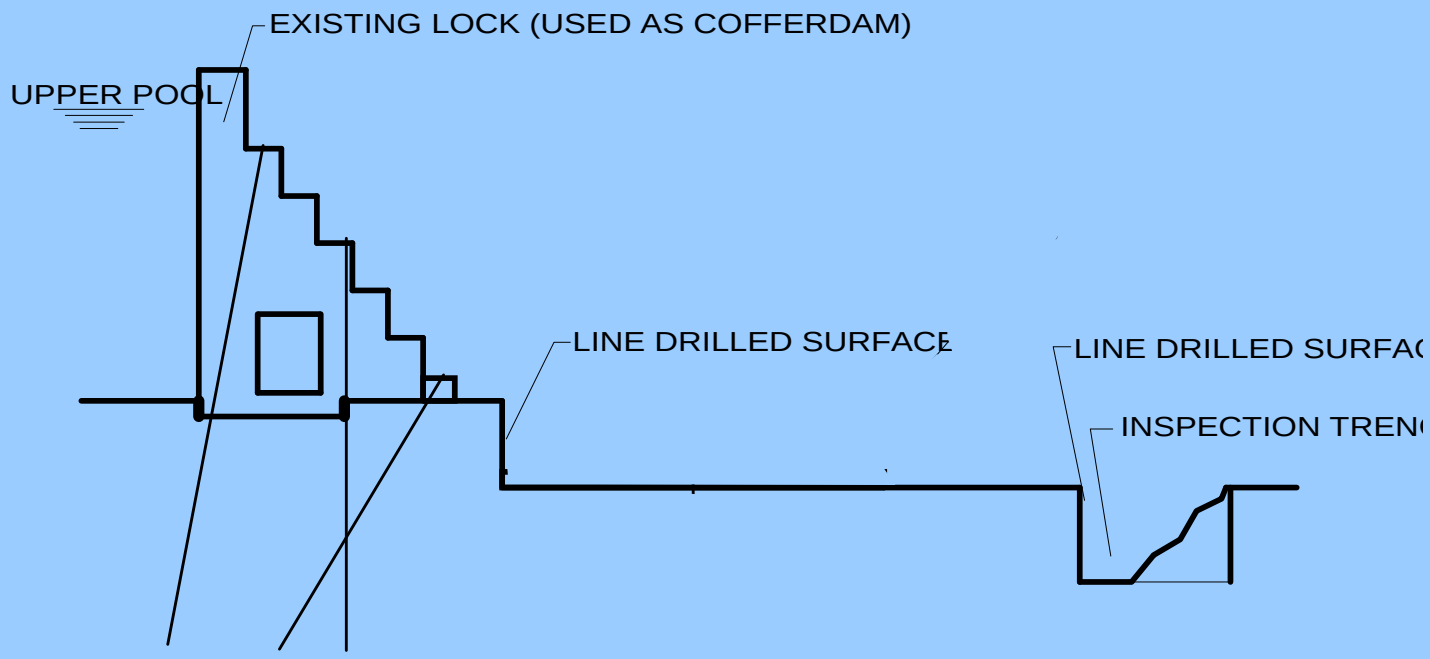
THRUST BLOCK ANCHORED PRIOR TO ROCK EXCAVATION
Analyzed for daylighted horizontal fault gouge (phi=13°, c=0psi)

SUBSURFACE EXPLORATION PERFORMED

US Army Corps of Engineers
Huntington District

Marmet Lock Replacement – Deep Seated Sliding

Design Concerns



COMPLETE EXCAVATION FOR CULVER/INSPECTION TRENCH

ESTABLISH PRESENCE AND EXTENT OF WEAK SEAMS – NEW LOCK

DETERMINE CORRECIVE FOUNDATION TREATMENT – NEW LOCK

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of Engineers
Huntington District

Manual Instruments

Manually Read Instruments

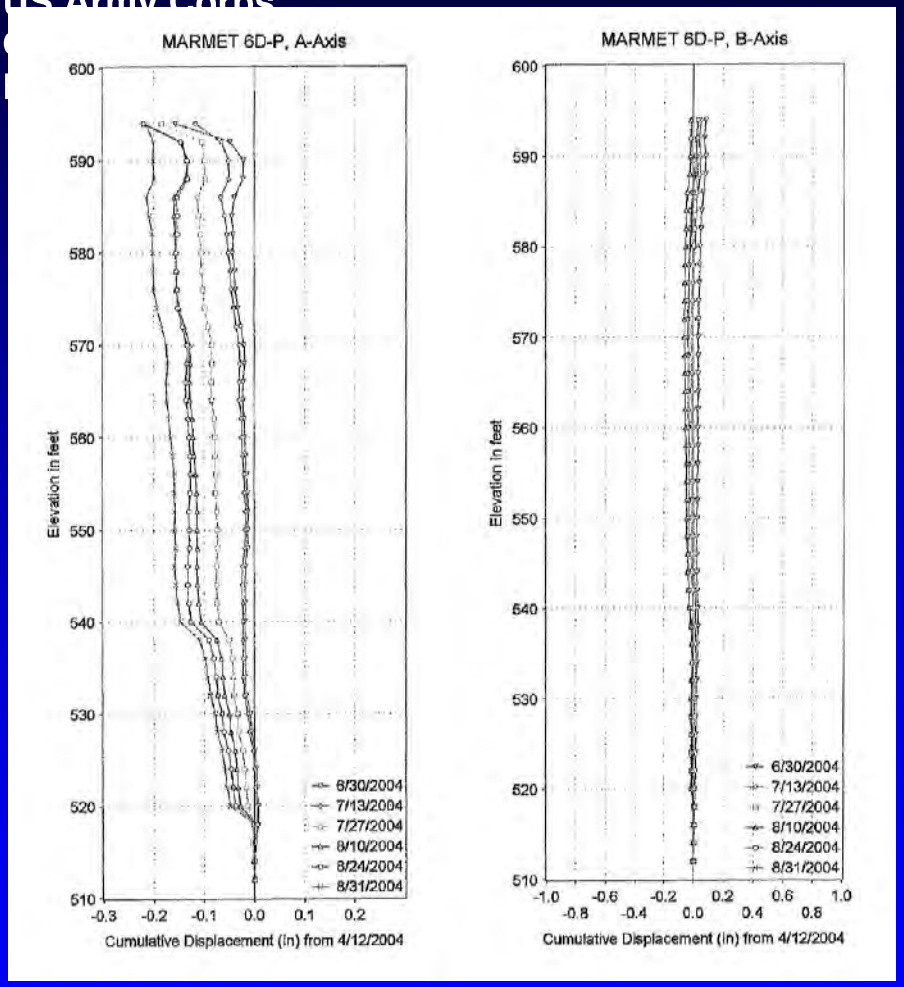
- Portable Inclinometers
- Settlement And Alignment Pins
- Joint Monitoring Pins
- Saw Cuts

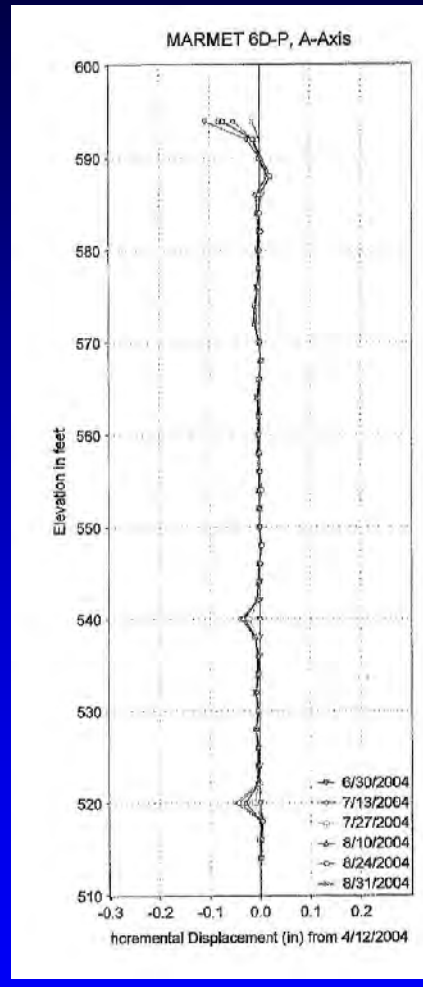
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Huntington District

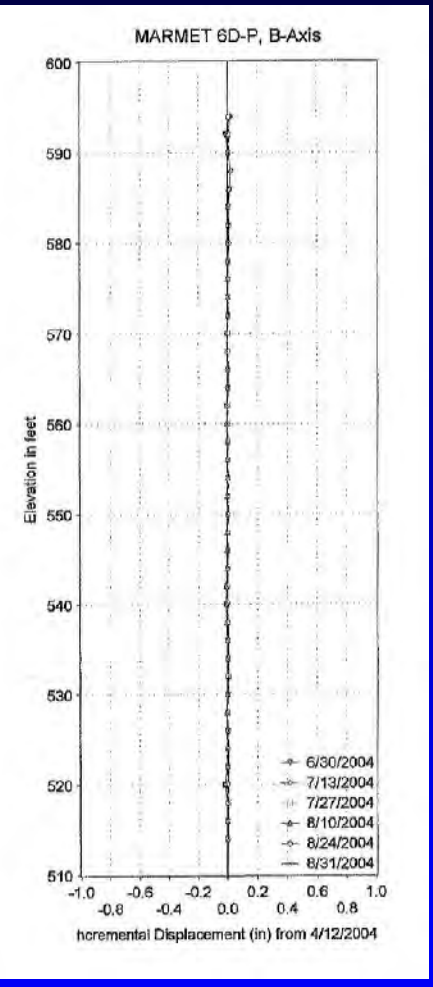
Deep Seated Sliding Occurs

- **Initial Downstream Movement**
  - **August 2004 Movement Occurred Along Two Weak Planes**
    - **El 540 +/- Where There Is A Series Of Thin Seams Of Carbonaceous Shale And Coal Within An Otherwise Generally Competent Sandstone Formation**
    - **El 520 +/- Where There Is A Discontinuous Thin Seam Of Clayey Material Near The Bottom Of The Sandstone Unit And An Underlying Shale Formation. This Seam Is Slightly Lower Than Any Required Excavation**

US Army Corps

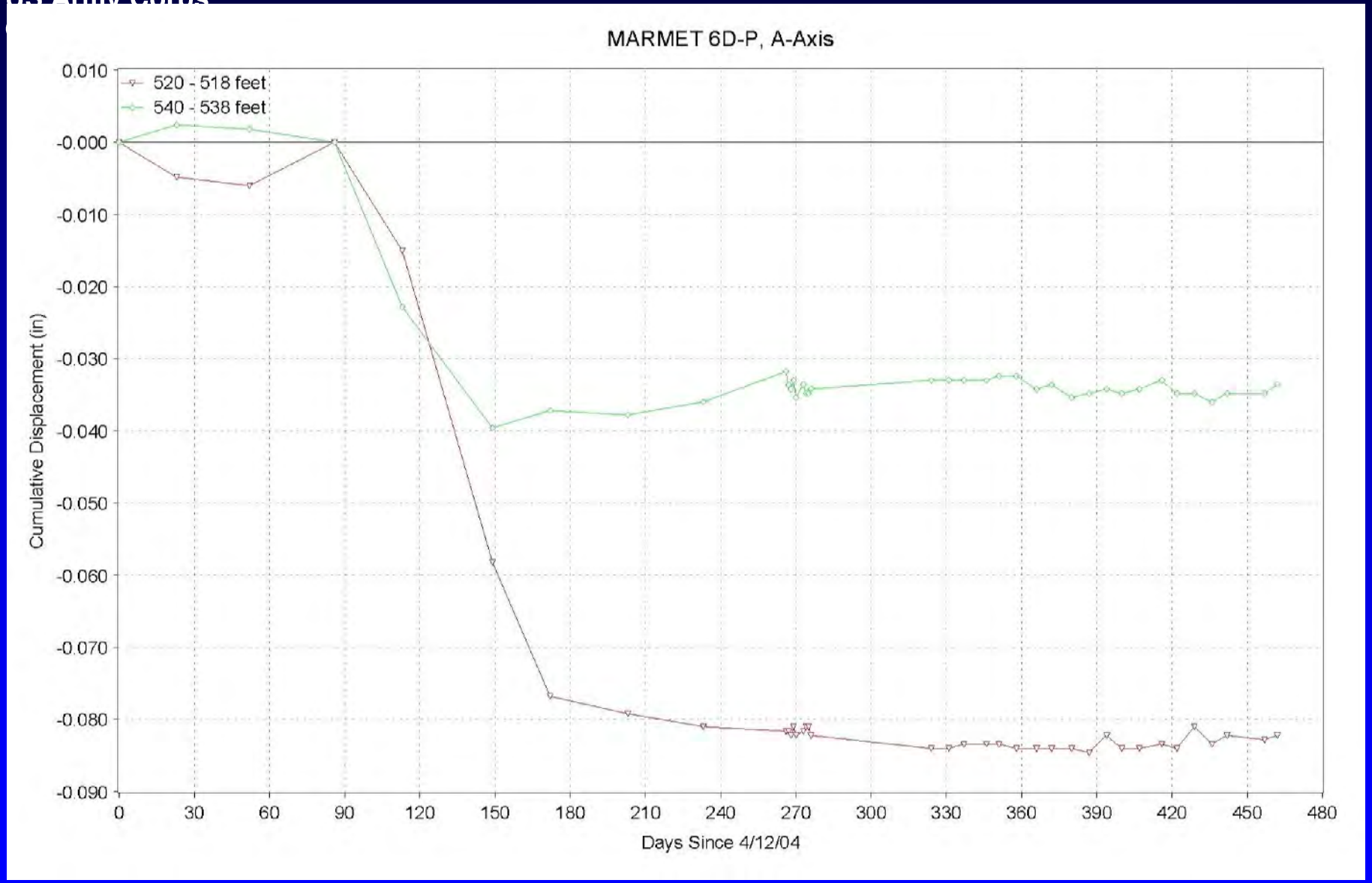






Initial Movement – Cell 6D

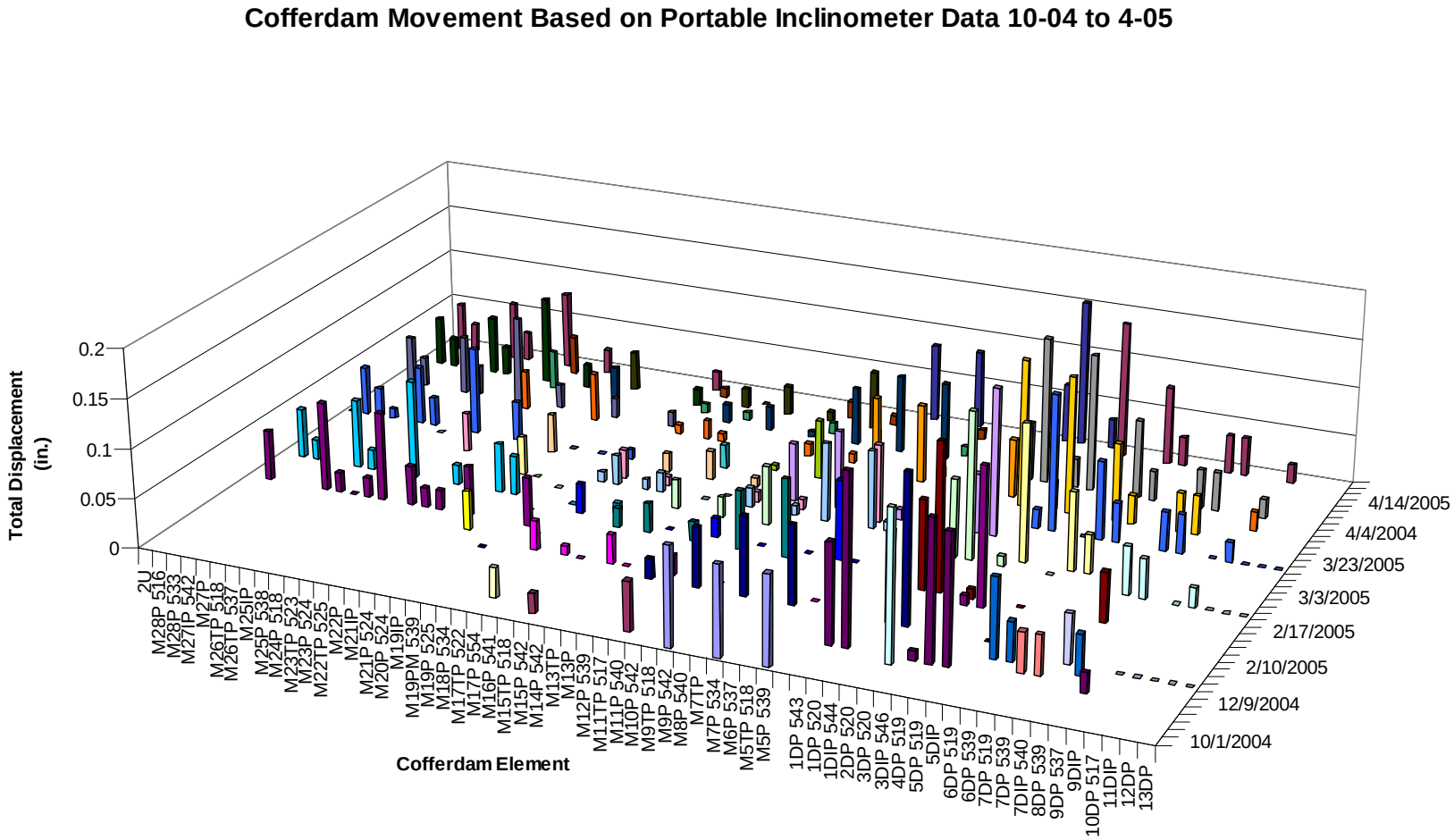
August 2004


MARMET 6D-P, A-Axis
520 - 518 feet
540 - 538 feet
Cumulative Displacement (in)
0.010
-0.000
-0.010
-0.020
-0.030
-0.040
-0.050
-0.060
-0.070
-0.080
-0.090
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
Days Since 4/12/04

US Army Corps of Engineers
Huntington District

One Corps, One Regiment, One Team

Portable Inclinometer Displacement



US Army Corps of Engineers
Huntington District

E.A.P. Response

- **Recommended Actions Of The PDT**
  - Increase Frequency Of Instrumentation Readings And Evaluation Of Data
  - Reanalyze Additional Failure Planes Within The Rock Foundation
  - Add Additional Upstream Anchors
  - Add Additional Inclinometers Of Greater Depth And At Additional Locations

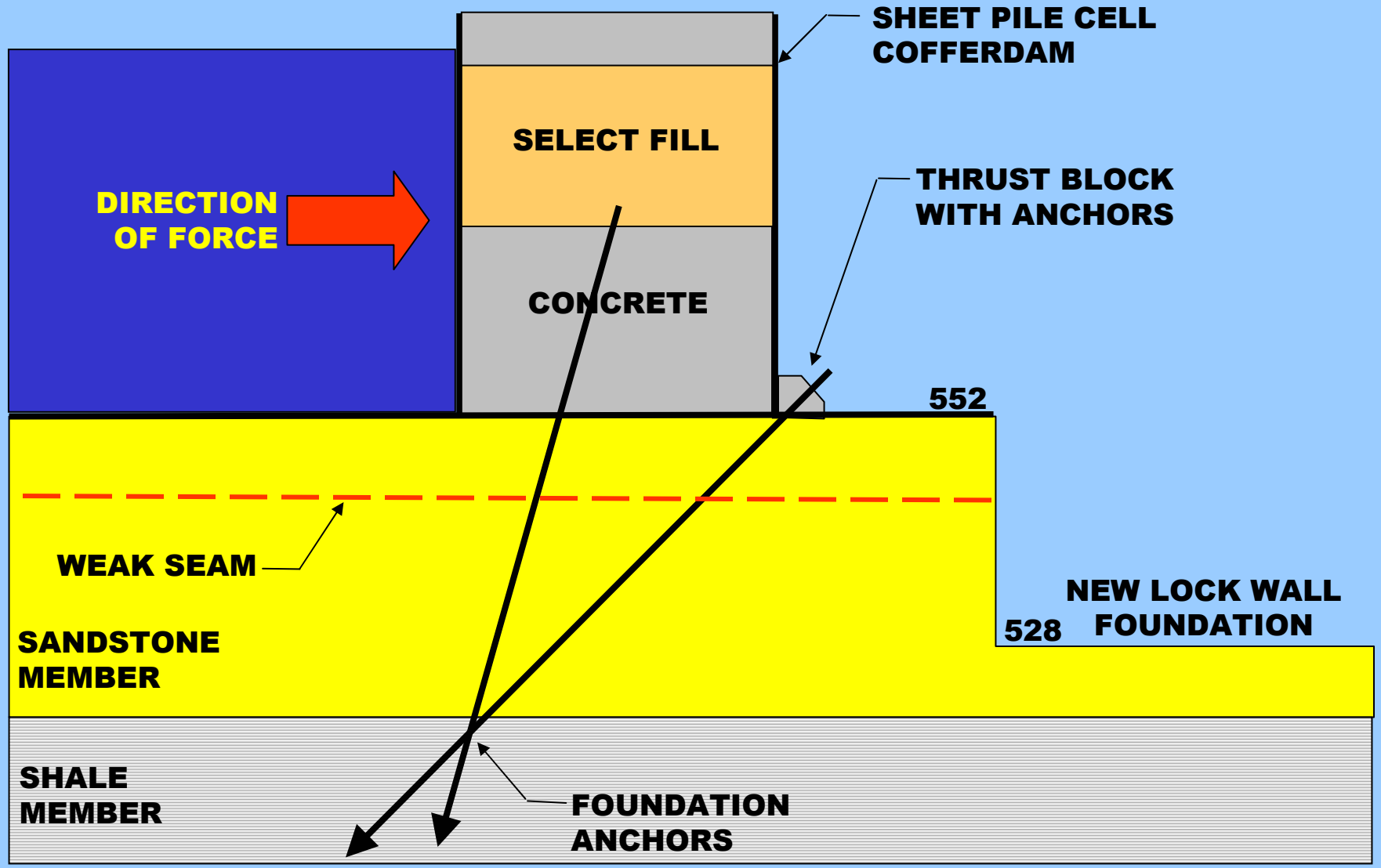
  Obtained Contingency Anchors

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Huntington District

EAP Movement Action Levels

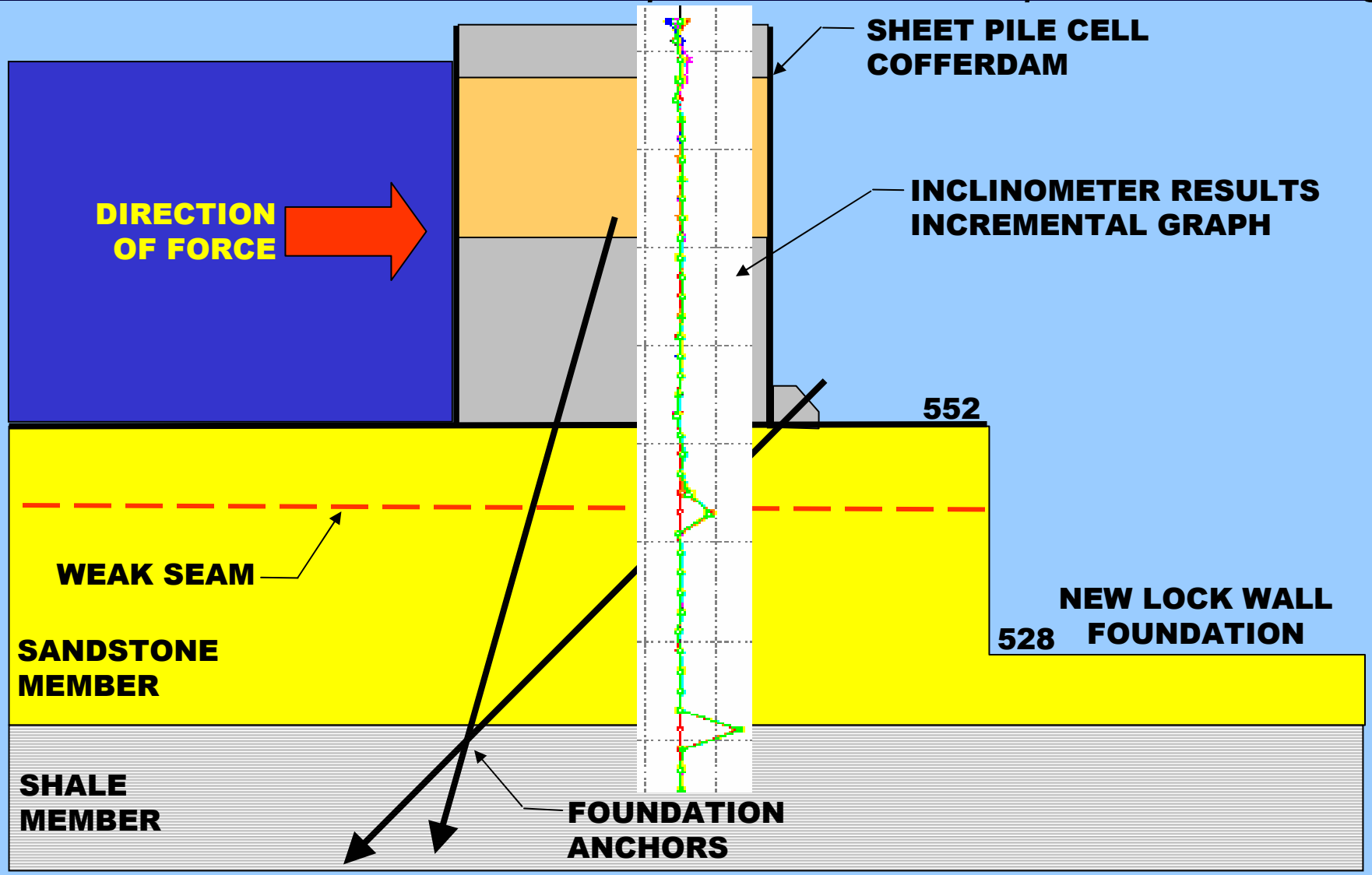
- 0.20 in. Displacement
  - Mobilize Contractor to Install “Contingency” Anchors
  - Accelerate Placement of Concrete on Deep Excavation Monoliths
  - Partial Flood and/or Backfill Chamber Work Area
  - Limit Rock Excavation
- 0.25 in. Displacement
  - All Non-remediation Work Stopped and Evacuated
  - Work Area Partially or Completely Flooded and/or Backfill
- 0.35 in. Displacement
  - Failure Immenent
  - Evacuate Excavation

Marmet Lock Replacement – Deep Seated Sliding



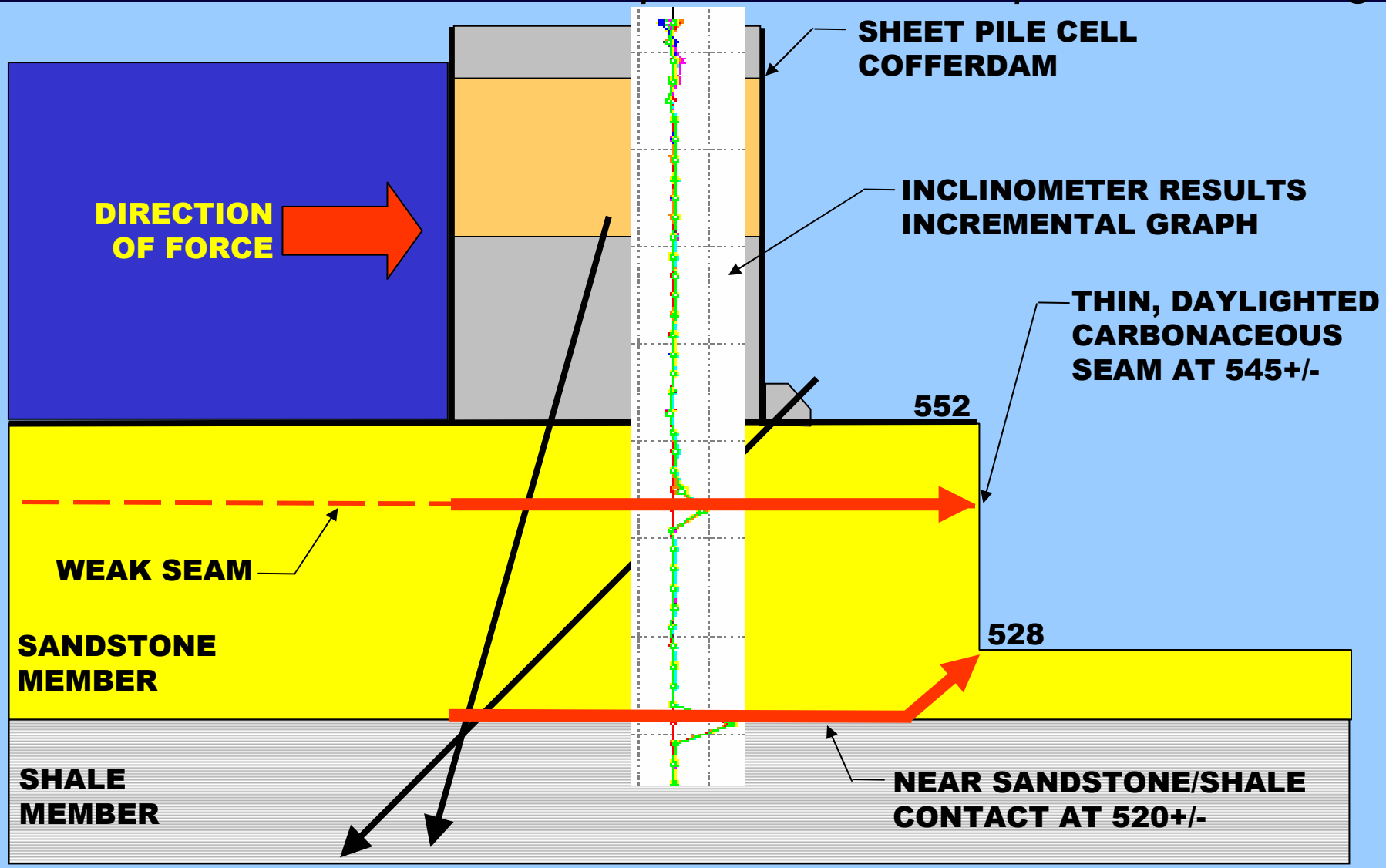
Cofferdam Foundation Movement - Section

Marmet Lock Replacement – Deep Seated Sliding



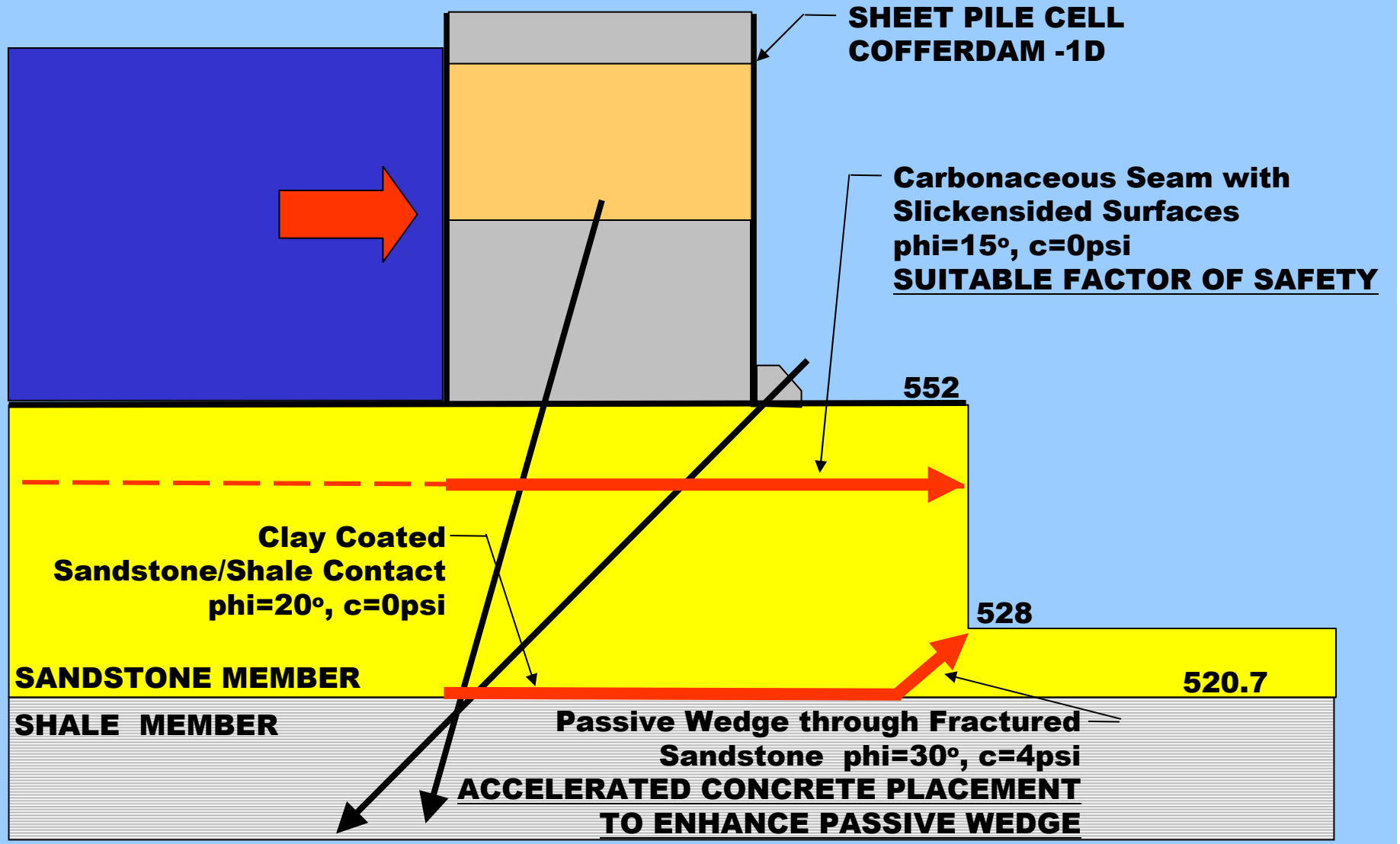
Cofferdam Foundation Movement - Section

Marmet Lock Replacement – Deep Seated Sliding



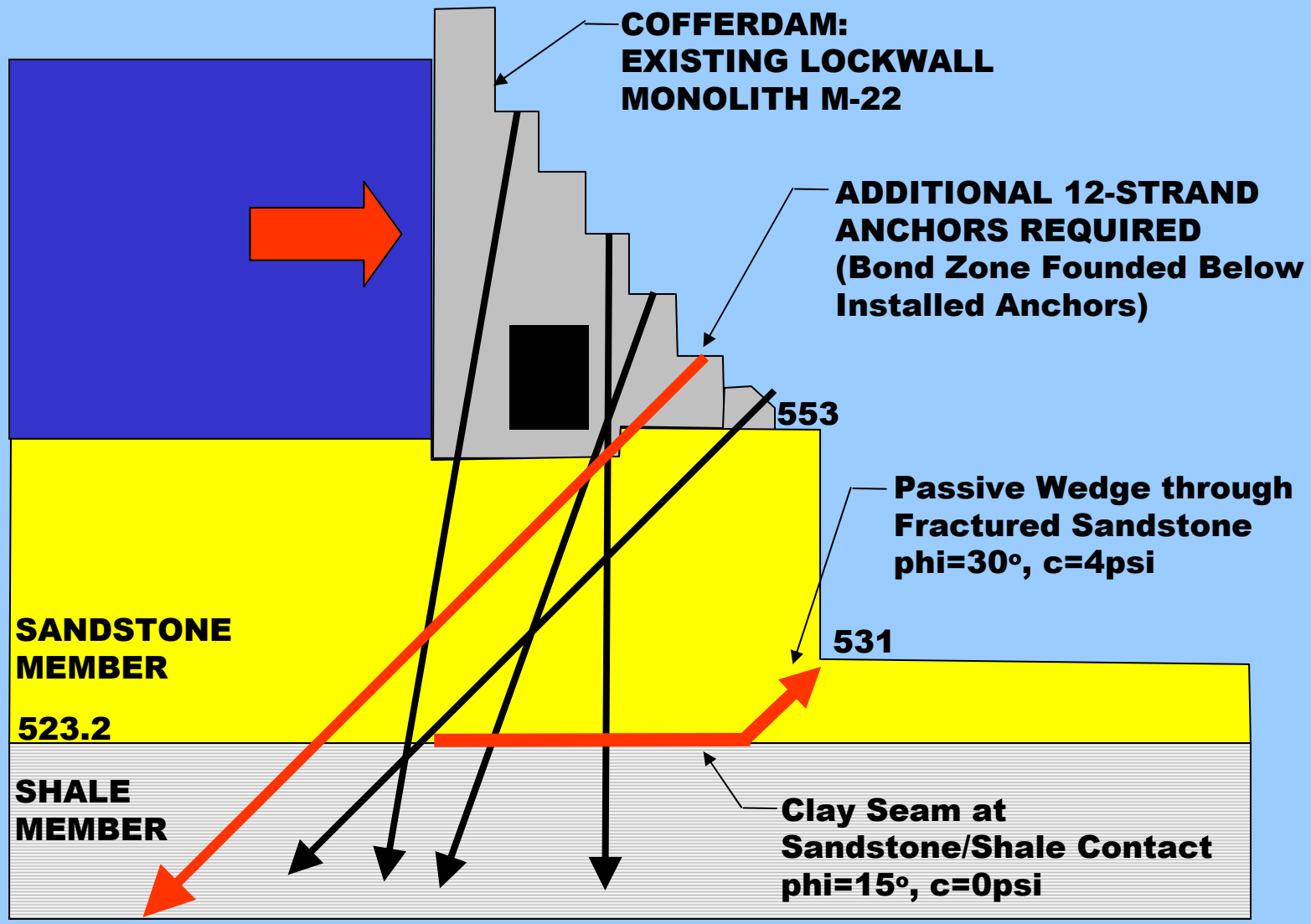
Cofferdam Foundation Movement - Section

Marmet Lock Replacement – Deep Seated Sliding



Cofferdam Foundation Movement – Cell 1D

Marmet Lock Replacement – Deep Seated Sliding

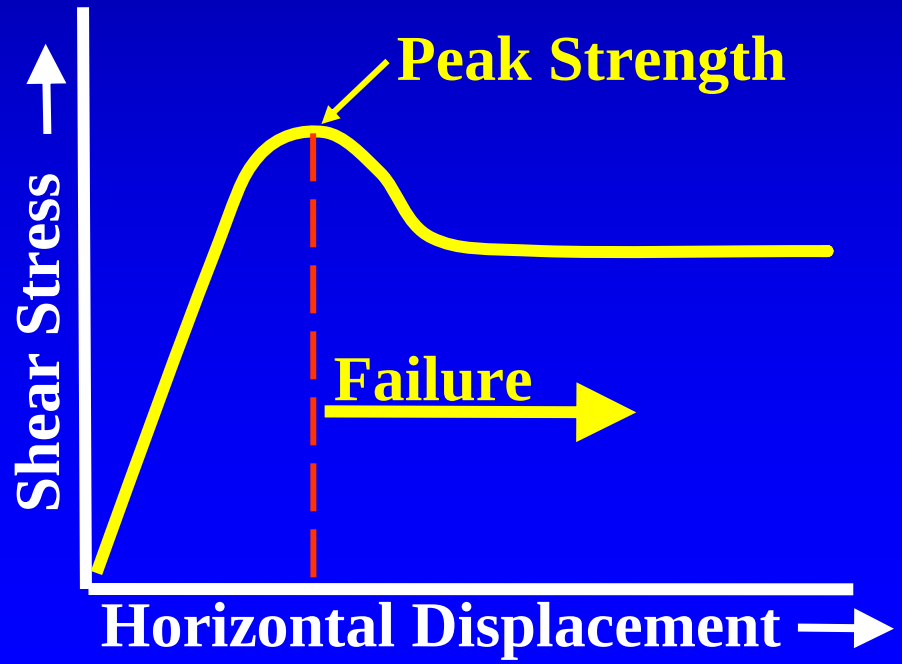


Cofferdam Foundation Movement – M-22

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Huntington District

Cofferdam Foundation Movement

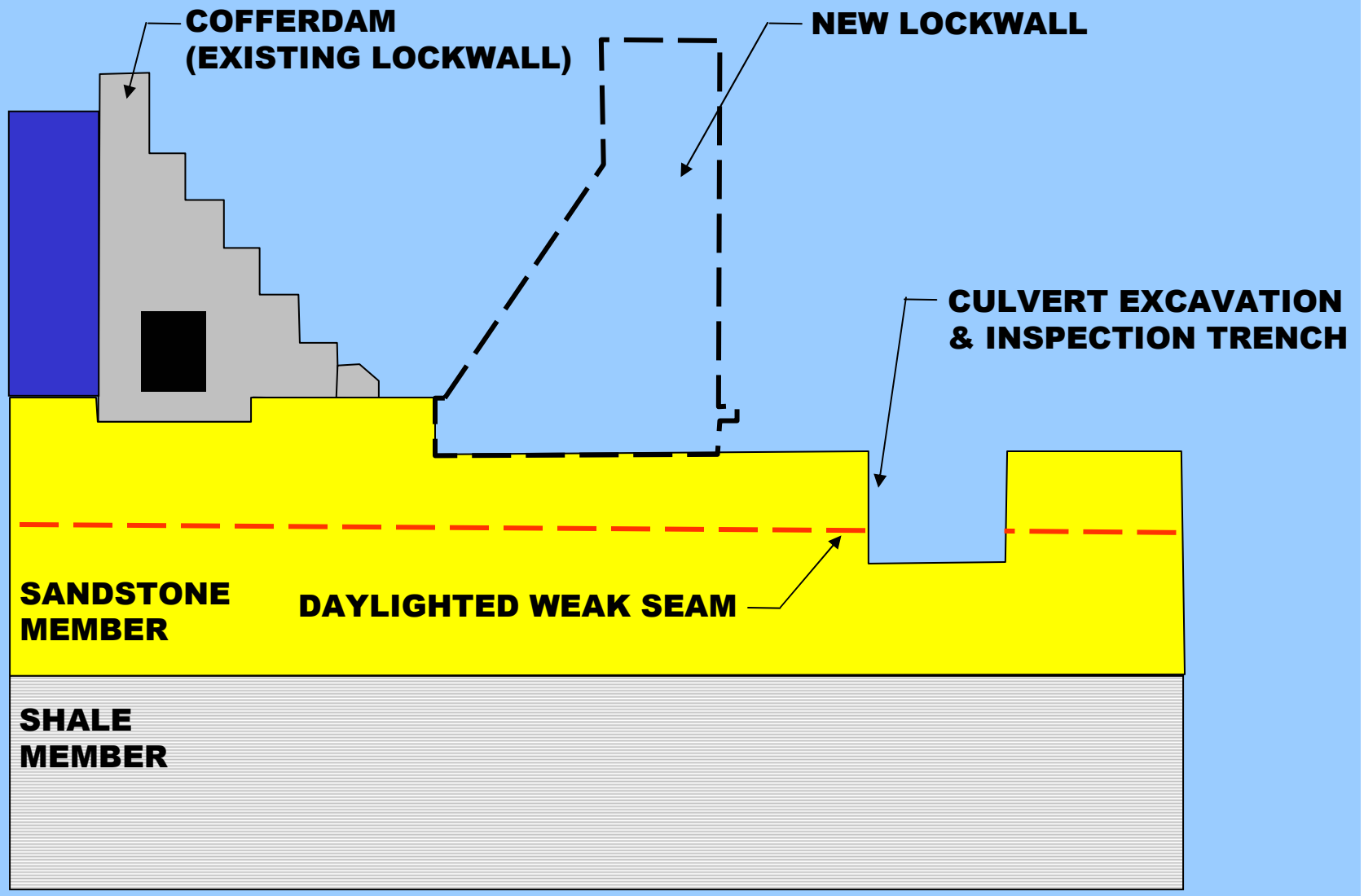
- **Some displacement is required to engage rock mass shear strength**
- **Establish how much movement is acceptable**



SCALE EFFECT OR LENGTH OF SHEARED BLOCK WAS TAKEN INTO CONSIDERATION

0.35 INCHES ESTABLISHED AS APPROACHING FAILURE

Marmet Lock Replacement – Deep Seated Sliding



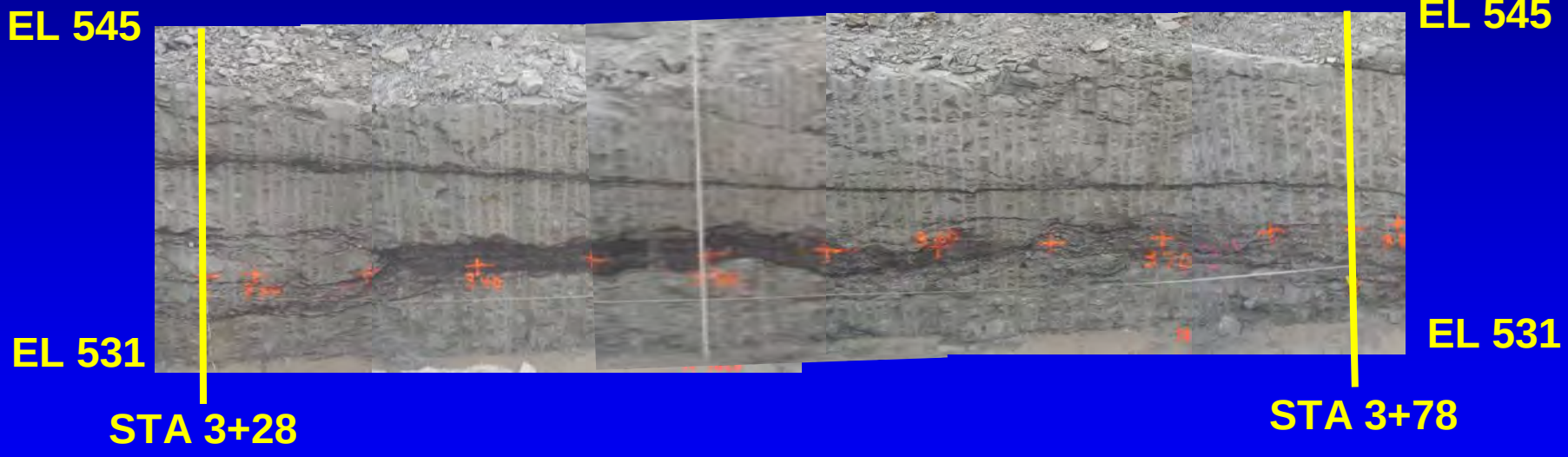
New Chamber Lockwall Monoliths

Marmet Lock Replacement – Deep Seated Sliding

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Huntington District

Inspection Trench Sidewall - Photo

MONOLITH R-15A



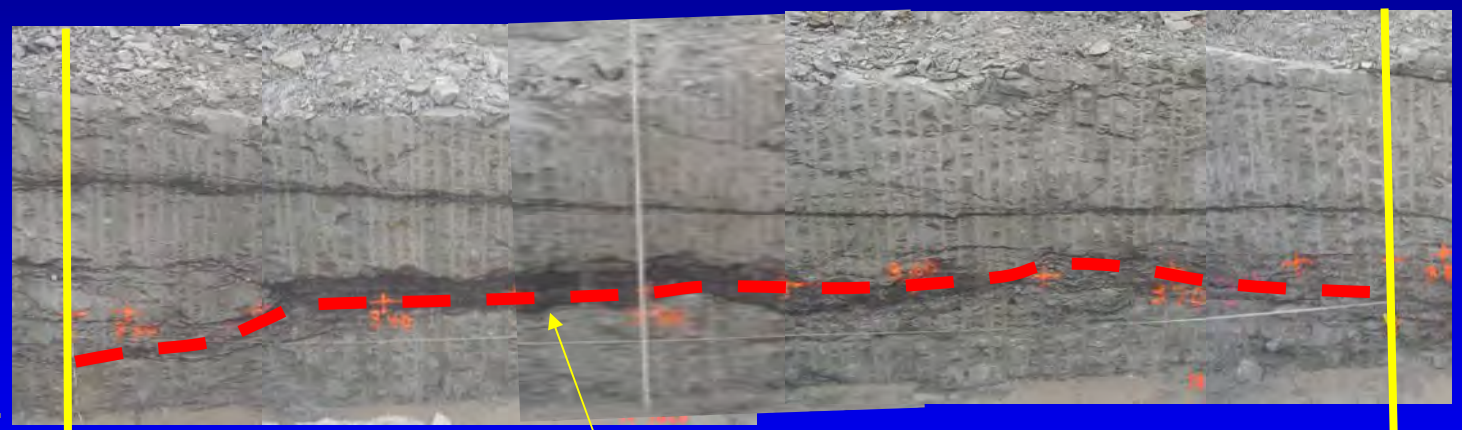
New Chamber Lockwall Monoliths

Marmet Lock Replacement – Deep Seated Sliding

US Army Corps of Engineers
Huntington District

Inspection Trench Sidewall - Photo

MONOLITH R-15A

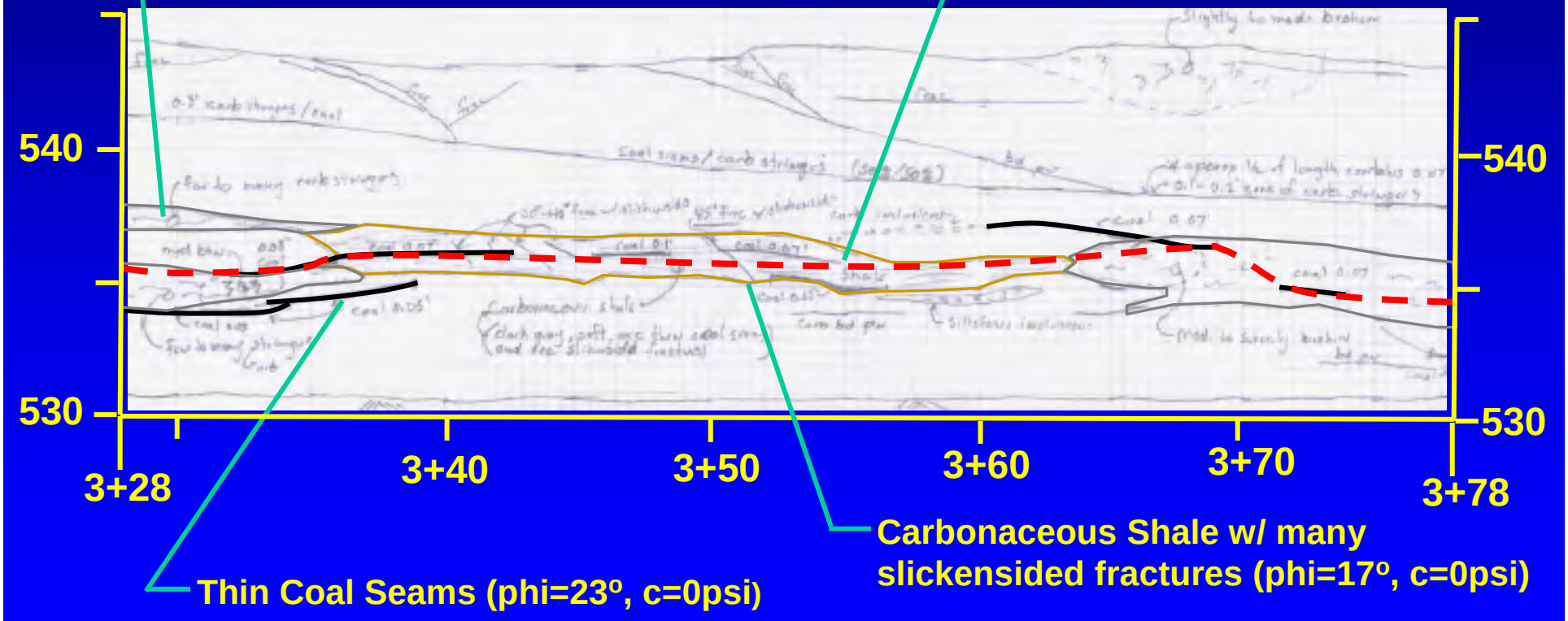


New Chamber Lockwall Monoliths

US Army Corps of Engineers
Huntington District

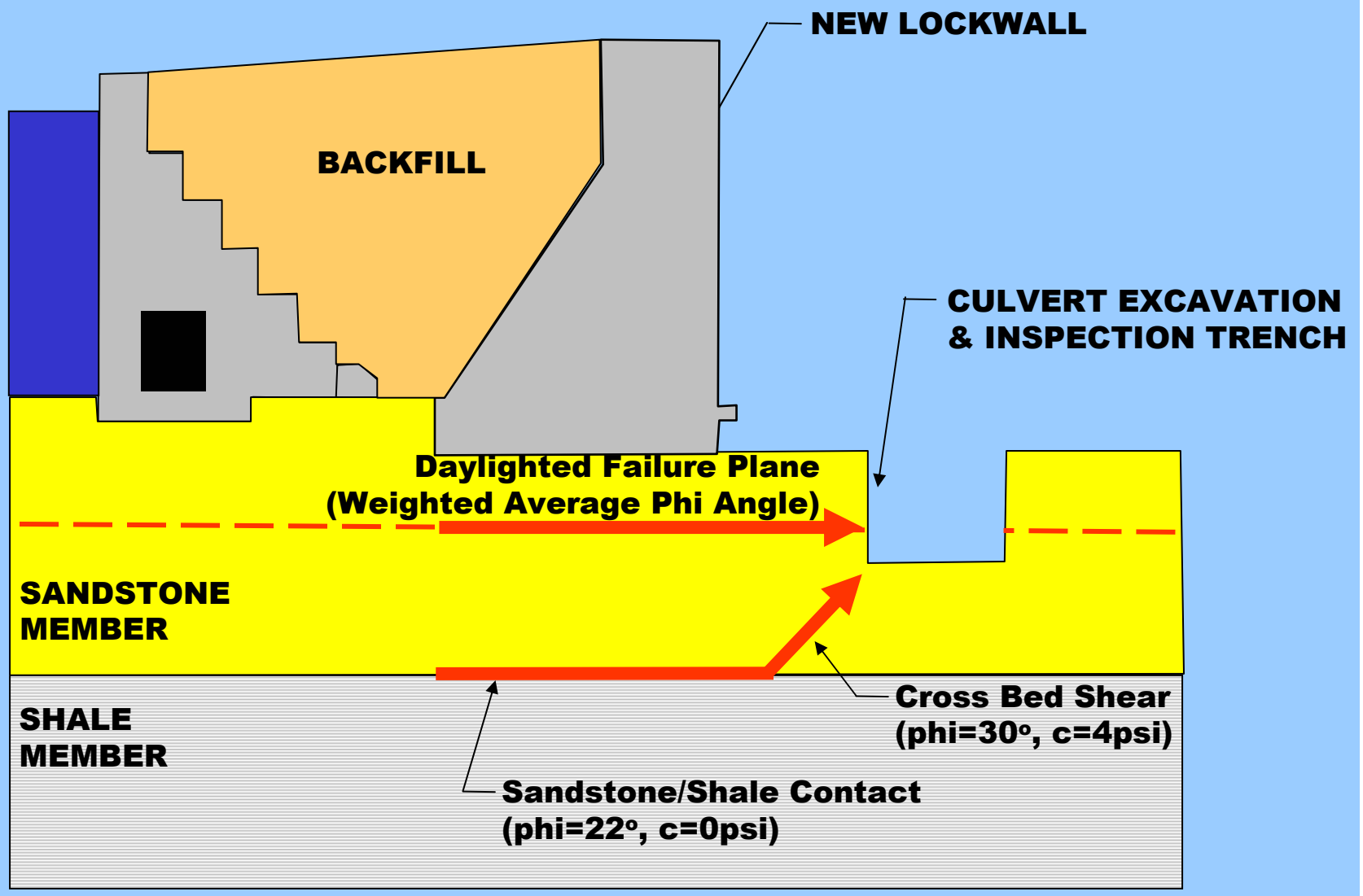
Marmet Lock Replacement – Deep Seated Sliding

Inspection Trench Sidewall - Map



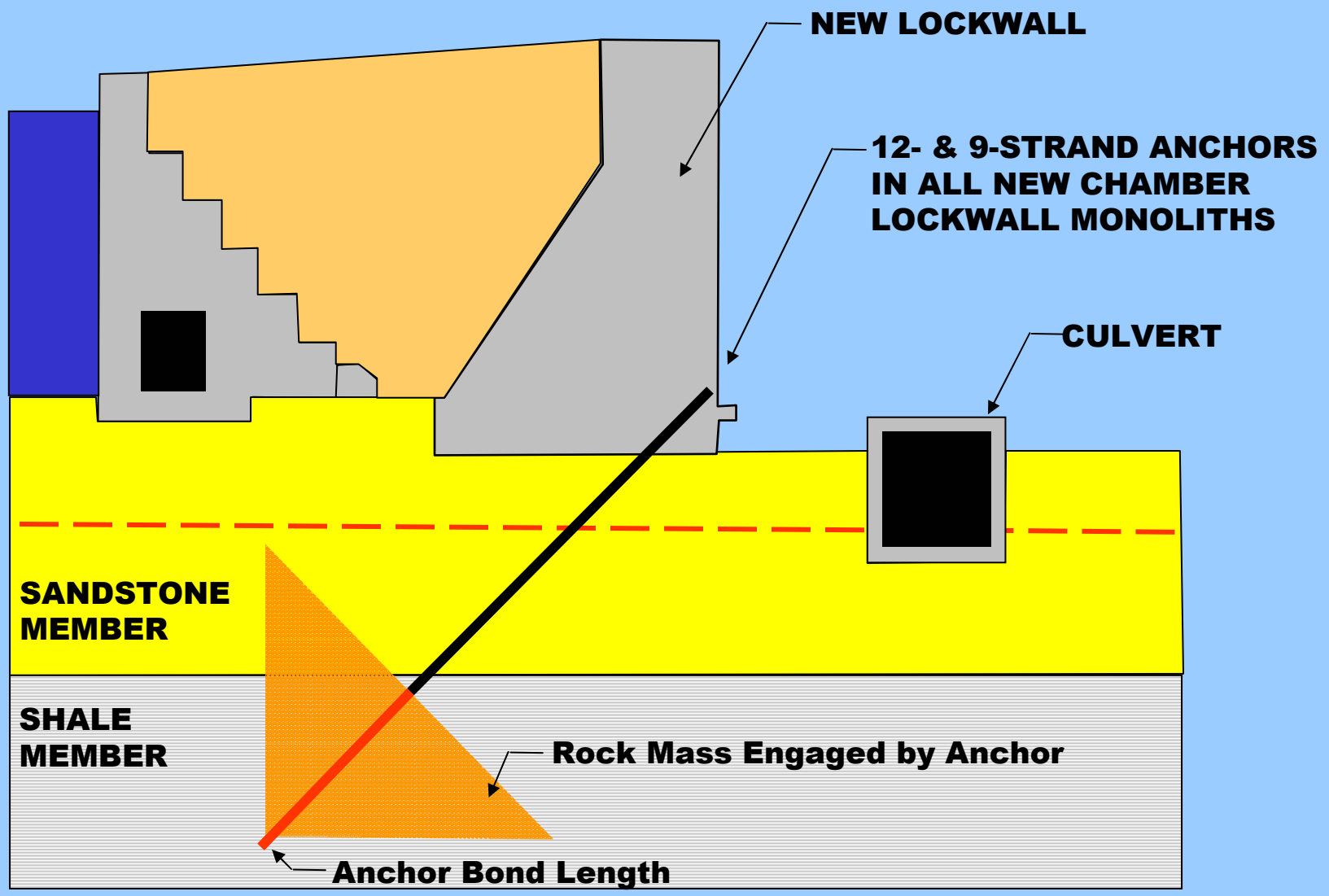
New Chamber Lockwall Monoliths

Marmet Lock Replacement – Deep Seated Sliding



New Chamber Lockwall Monoliths

Marmet Lock Replacement – Deep Seated Sliding



New Chamber Lockwall Monoliths

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of Engineers
Huntington District

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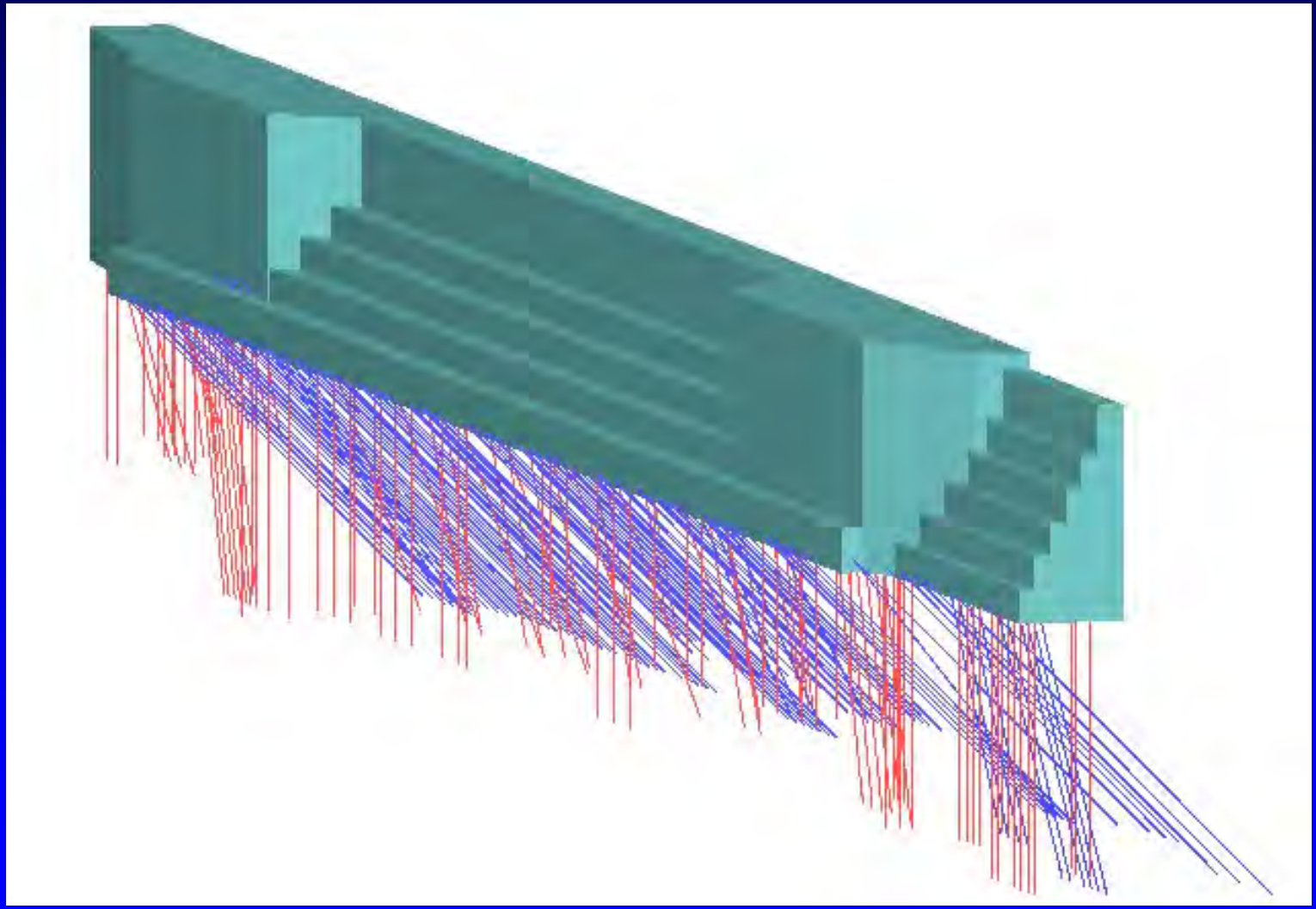
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Over 560 anchors required



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Anchor Drilling





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Anchor Alignment Specifications

- **Initial Alignment**
  - Within 0.5° of Specified Azimuth
  - Within 0.5° of Specified Inclination
- **Drilling Alignment**
  - Within 0.5° Starting Azimuth
  - Within 0.5° Specified Inclination
  - Less than 1 in. Deviation per 10 ft. of Drilling

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Anchor Alignment Testing



Tropari



Maxibor

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of Engineers
Huntington District

Anchor Tensioning



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Anchor Tensioning Loads

	GUTS	Design Load	Lock Off Load (70% GUTS)
9 Strand	527 kips	316 kips	369 kips
12 Strand	703 kips	422 kips	492 kips
15 Strand	879 kips	527 kips	615 kips

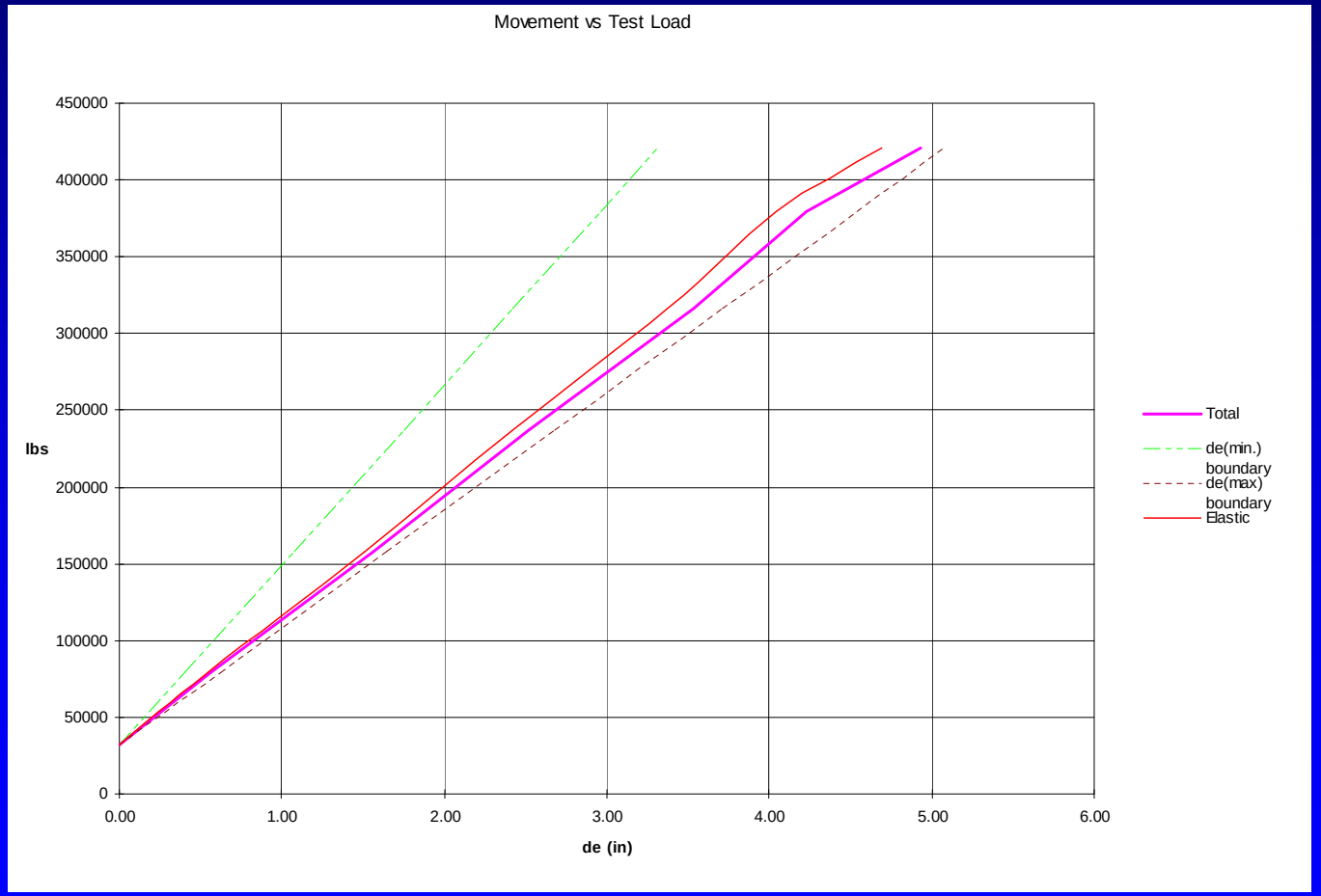
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Huntington District

Specified Anchor Testing

- Followed PTI
- Performance Tests
  - One Anchor per Cofferdam Element
- Proof Tests
  - All Remaining Anchors in each Cofferdam Element
- Extended Creep Tests
  - Due to Shale in Bond Zone
  - Conducted on All Performance Tested Anchors

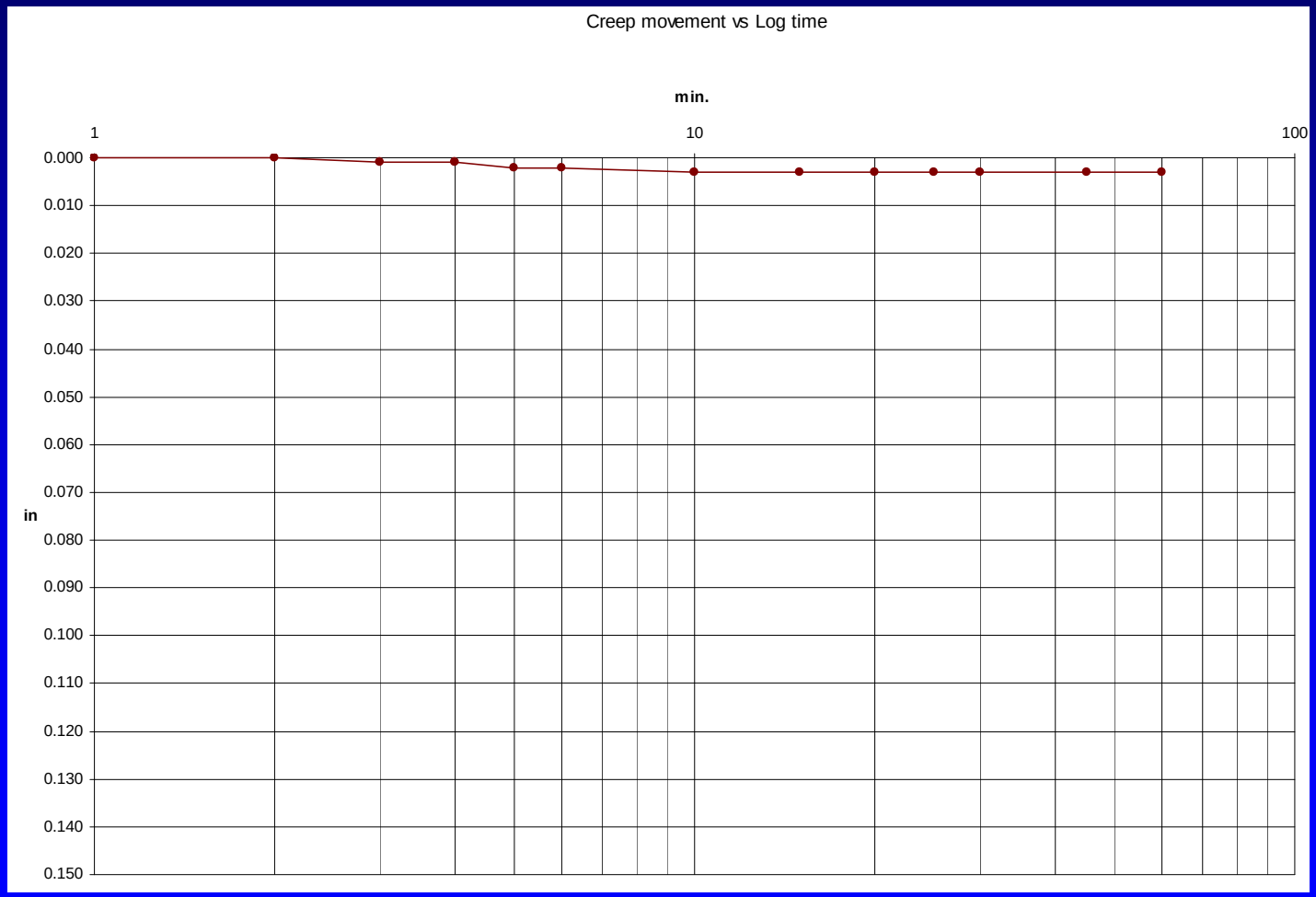
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Performance Test Results



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Creep Test Results

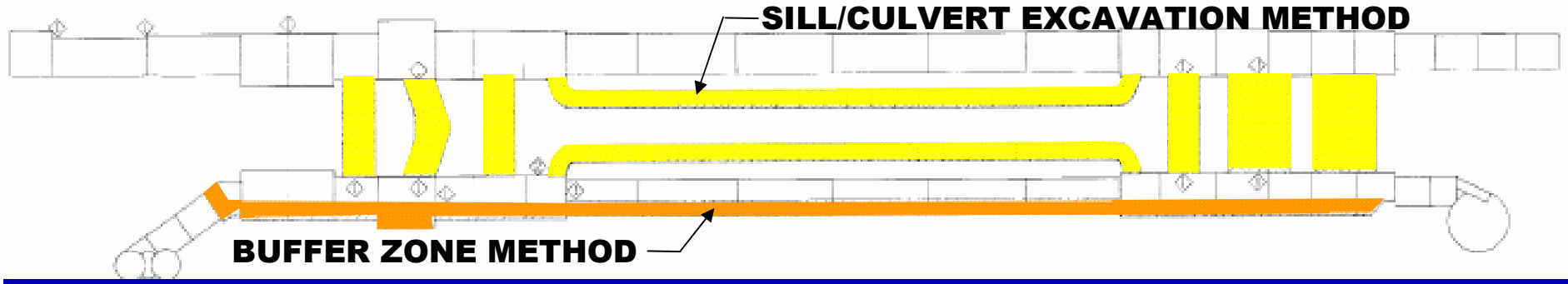


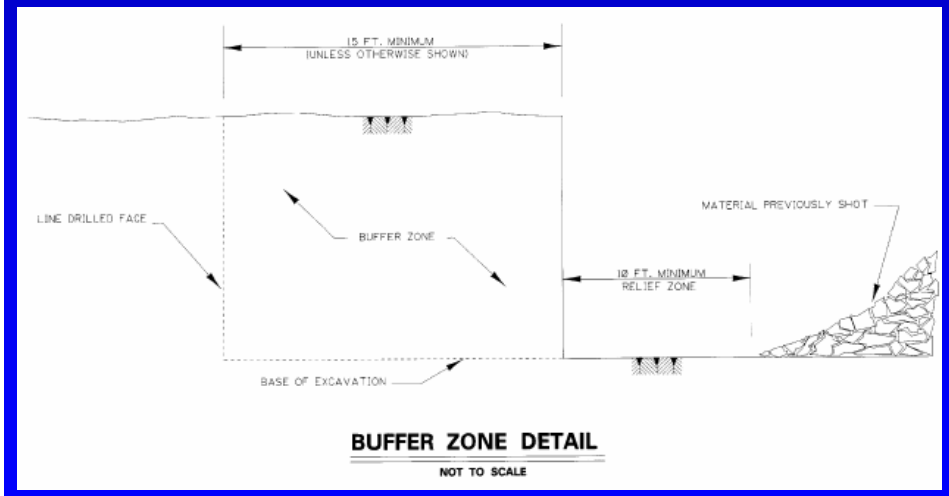
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Huntington District

One Corps, One Regiment, One Team

Marmet Lock Replacement – Rock Excavation

Excavation Restrictions

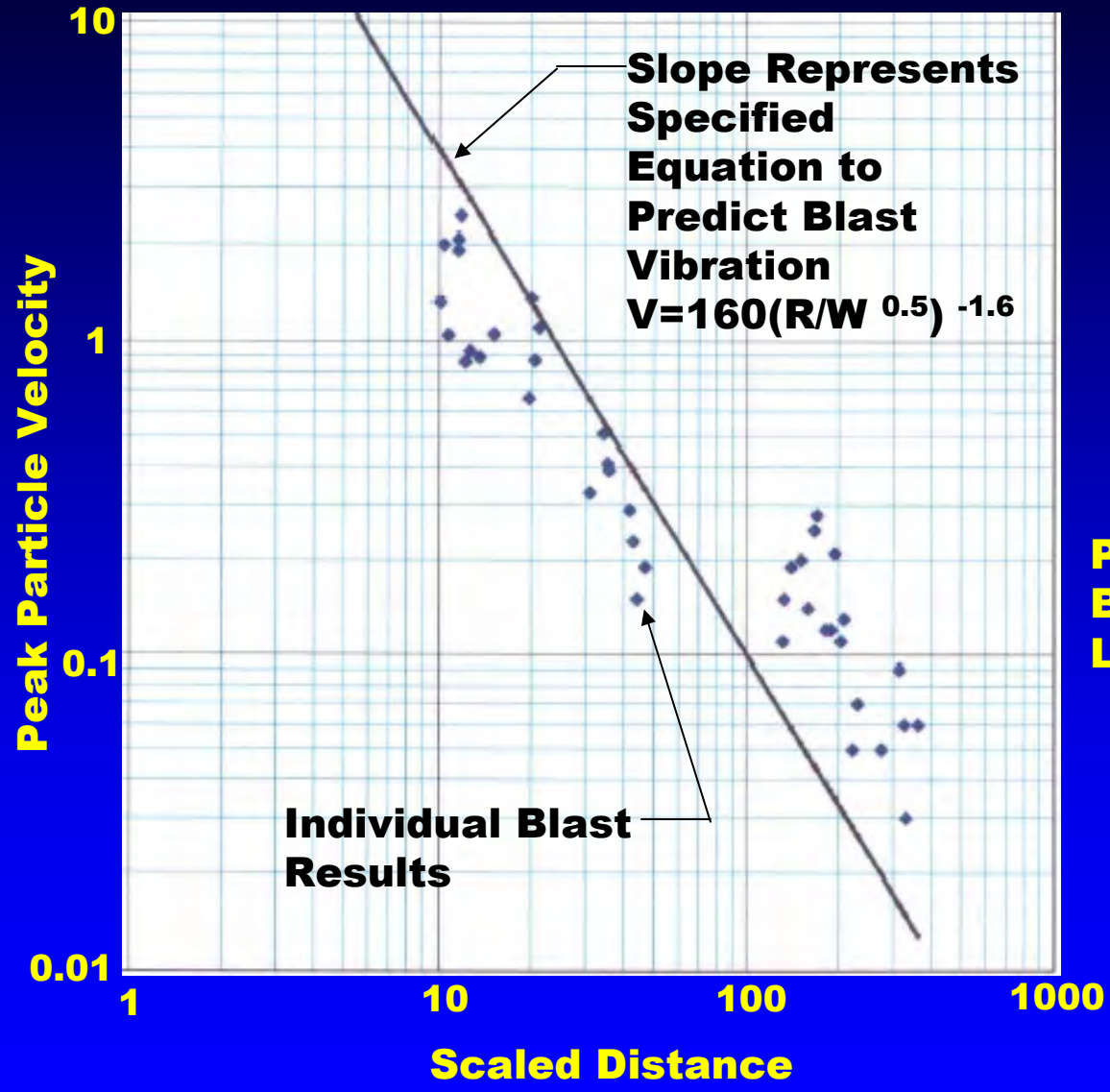




- **Pre-blast Survey of Community**
- **50’ Maximum Blasting Dimension Along Axis**
- **Buffer Zone and Sill Excavation Methods**
- **3 in/sec Peak Particle Velocity at Nearest Structure**
- **Line Drilled Perimeters**

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Marmet Lock Replacement – Rock Excavation

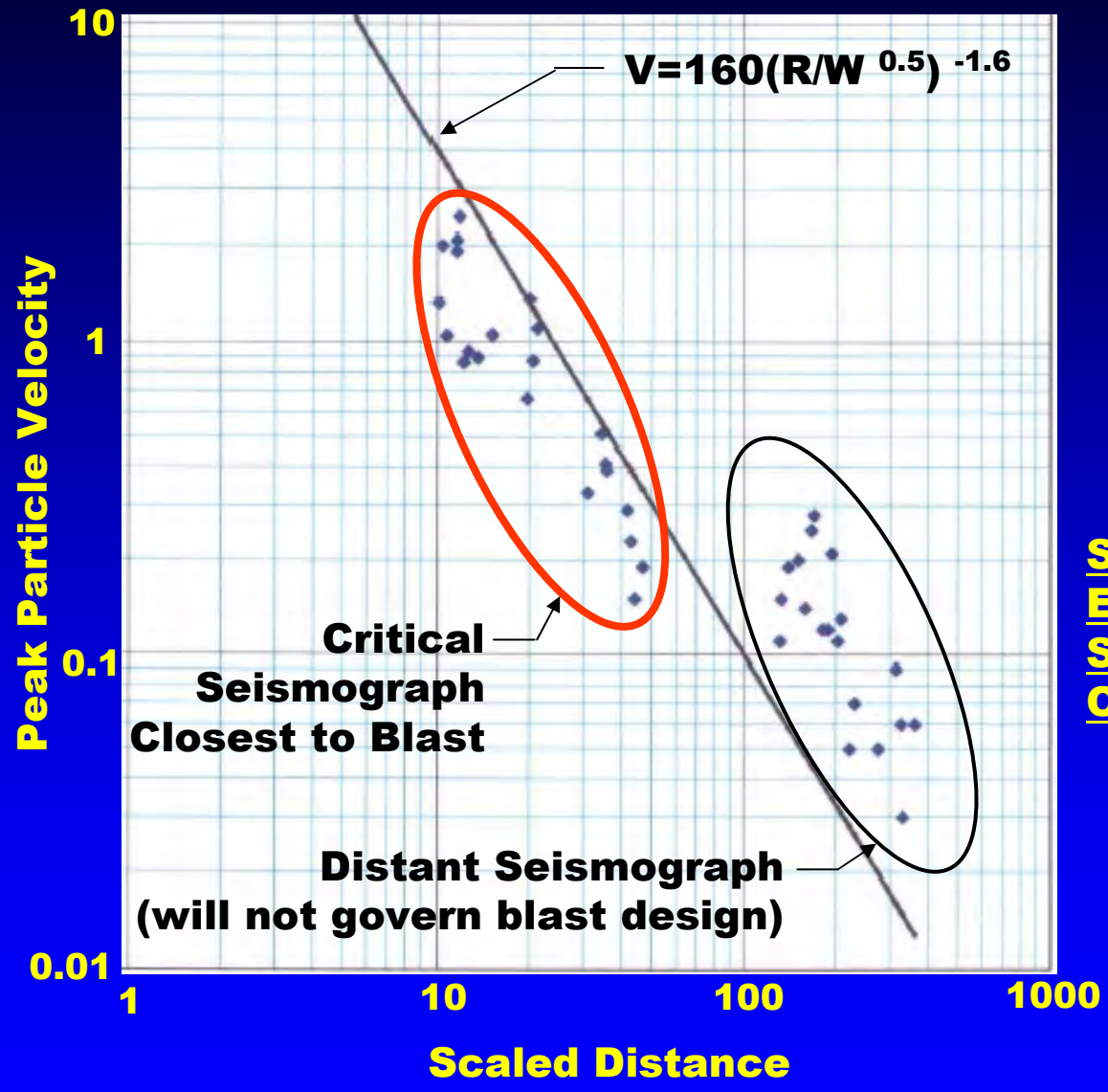


Plot Individual Blast Results on Log/Log Graph

Evaluating Specified Vibration Equation

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Huntington District

Marmet Lock Replacement – Rock Excavation



Specified Equation is Suitable for Critical Blasts

Evaluating Specified Vibration Equation

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Marmet Lock Replacement – Rock Excavation

Line Drilled Perimeter



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Marmet Lock Replacement – Rock Excavation

Production Shot



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Foundation Preparation Challenges

- Lenticular Shale Bedding
- Blast Damage
- Thin Bedded Carbonaceous Laminations and Tree Fossils
- Artesian Joints

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Lenticluar Beds



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Lenticular Shale Bed Plan View



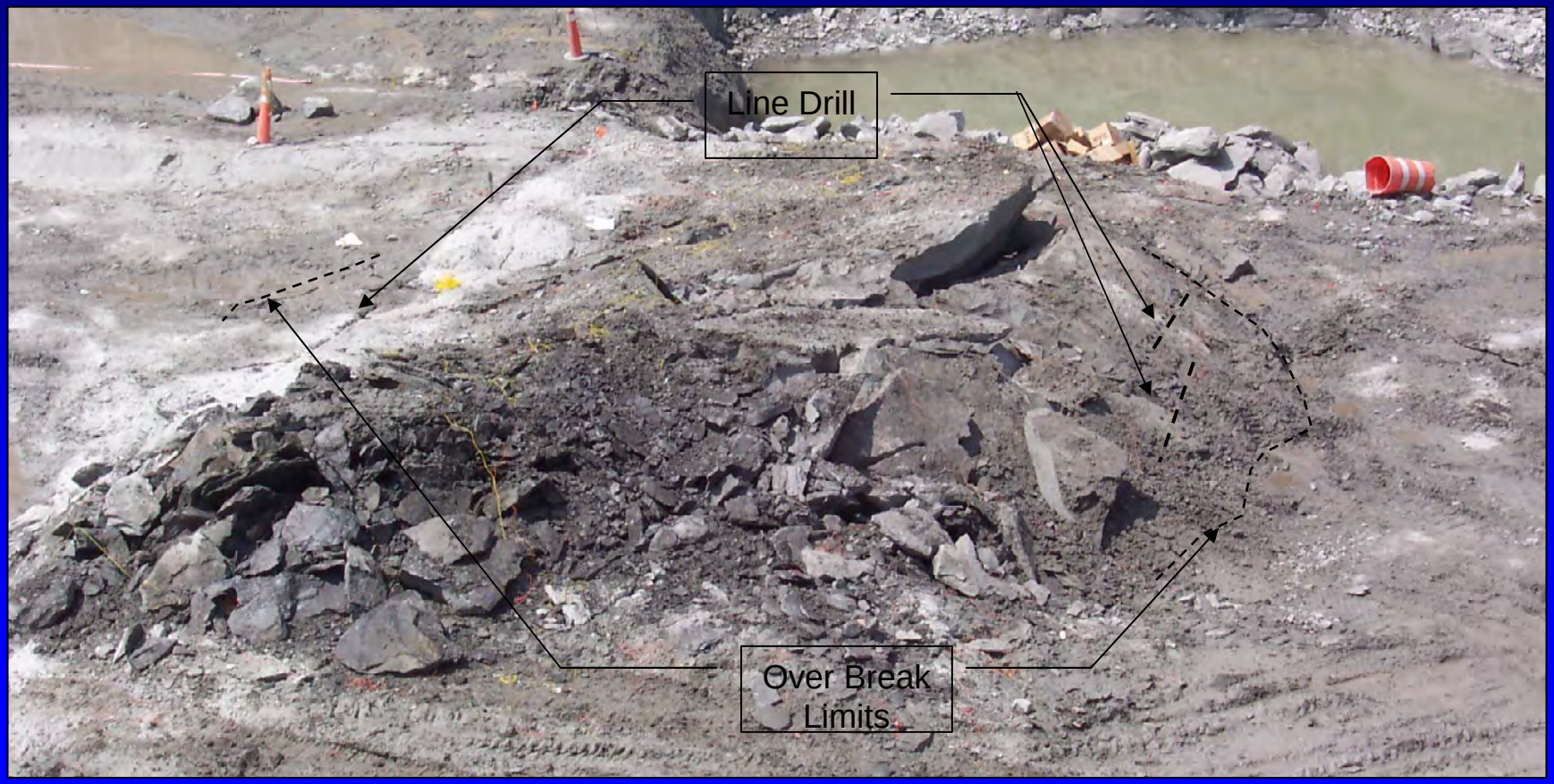


Blasting Damage Types

- **Over Break Behind Line Drilled Faces**
- **Sub Drilling**

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Over Break Behind Line Drilled Face



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Over Break Behind Line Drilled Face



Sub Drilled Shot Hole Damage



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Shot Hole Damage



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Huntington District

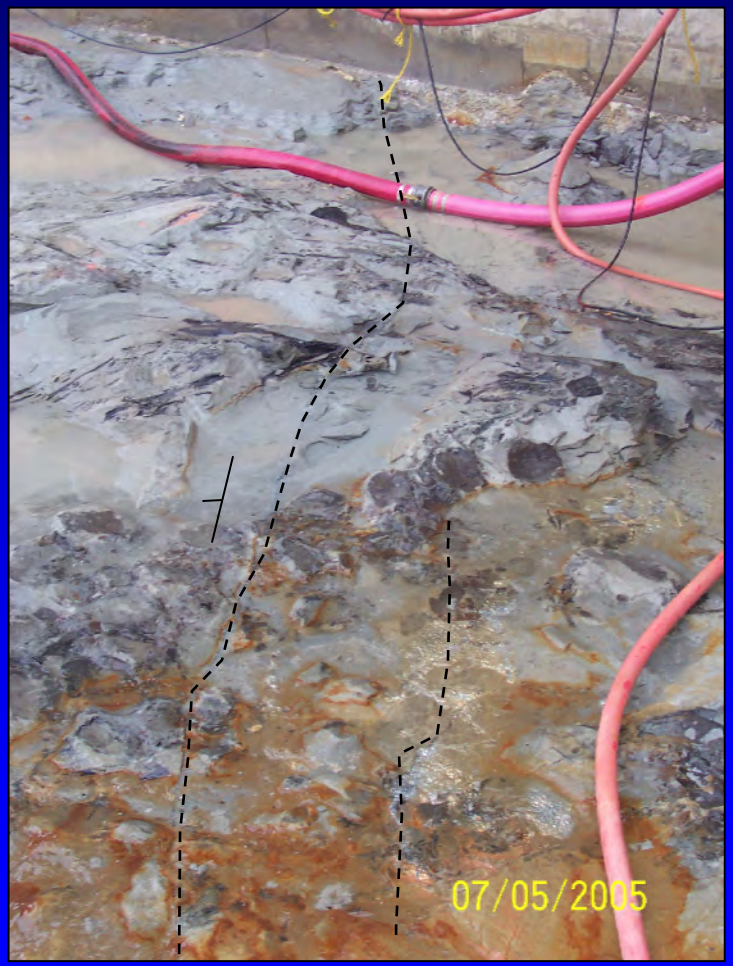
Shot Damage Post Foundation Prep.



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Artesian Joints





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Joints Excavated





Pipes Placed



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Concrete Placed



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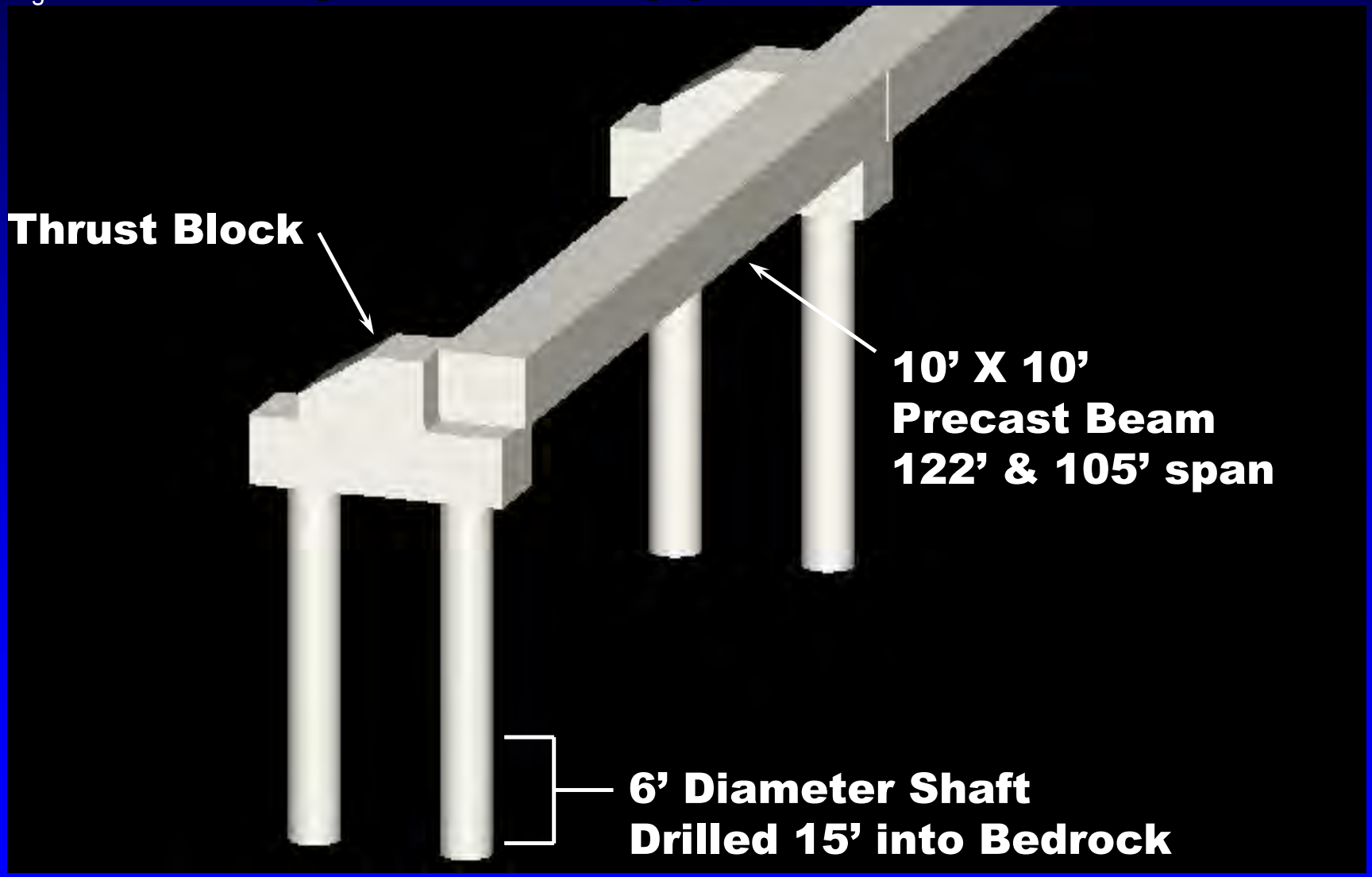
Carbonaceous Laminations and Tree Fossils



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Marmet Lock Replacement – Drilled Shafts

Upstream Approach Walls



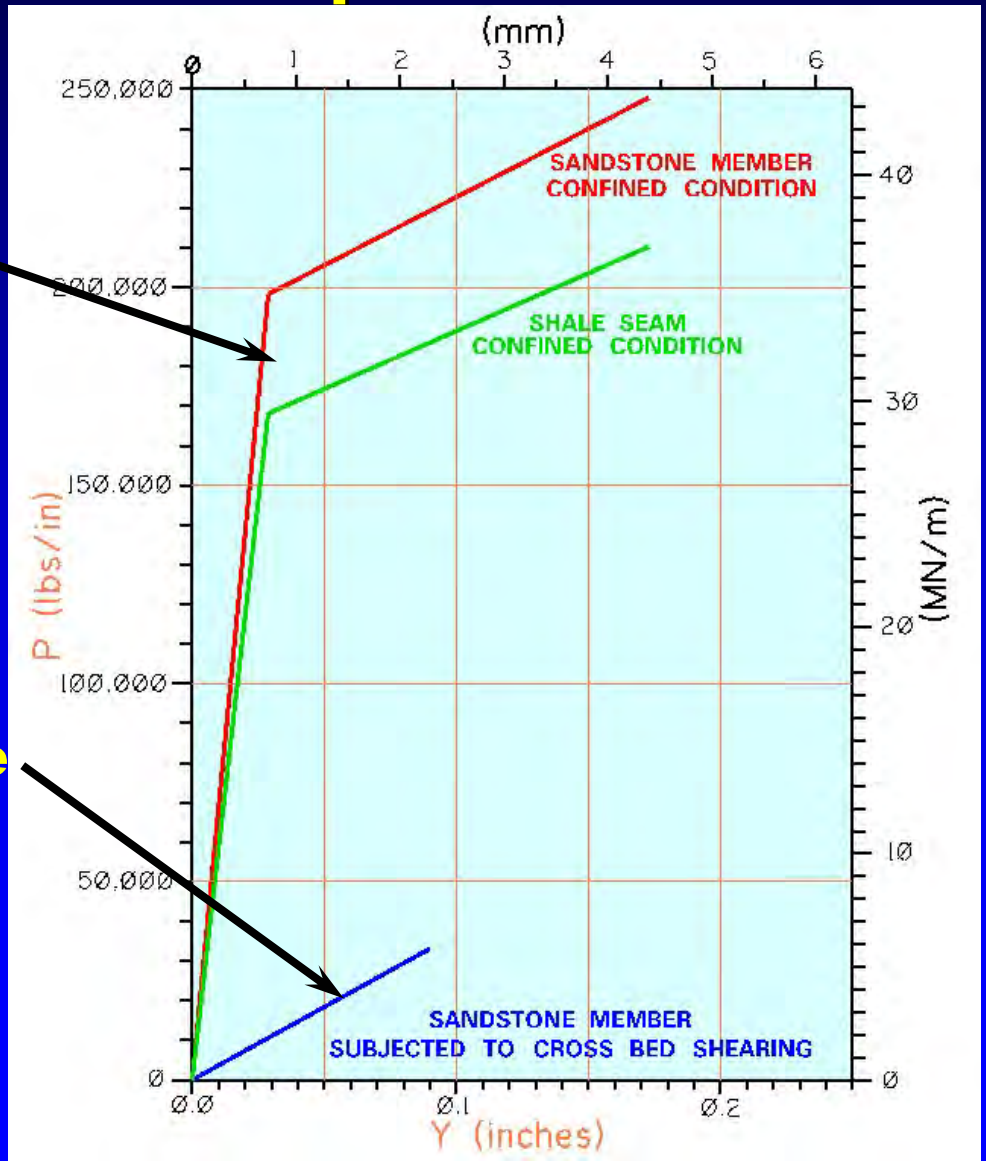
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Marmet Lock Replacement – Drilled Shafts

Developed PY Curves

Utilized Borehole Jack Results

Utilized Passive Wedge Results



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Drilled Shaft Drill Rig





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Auger Drill Bits





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Drilled Shaft Core Bit





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One Corps, One Regiment, One Team

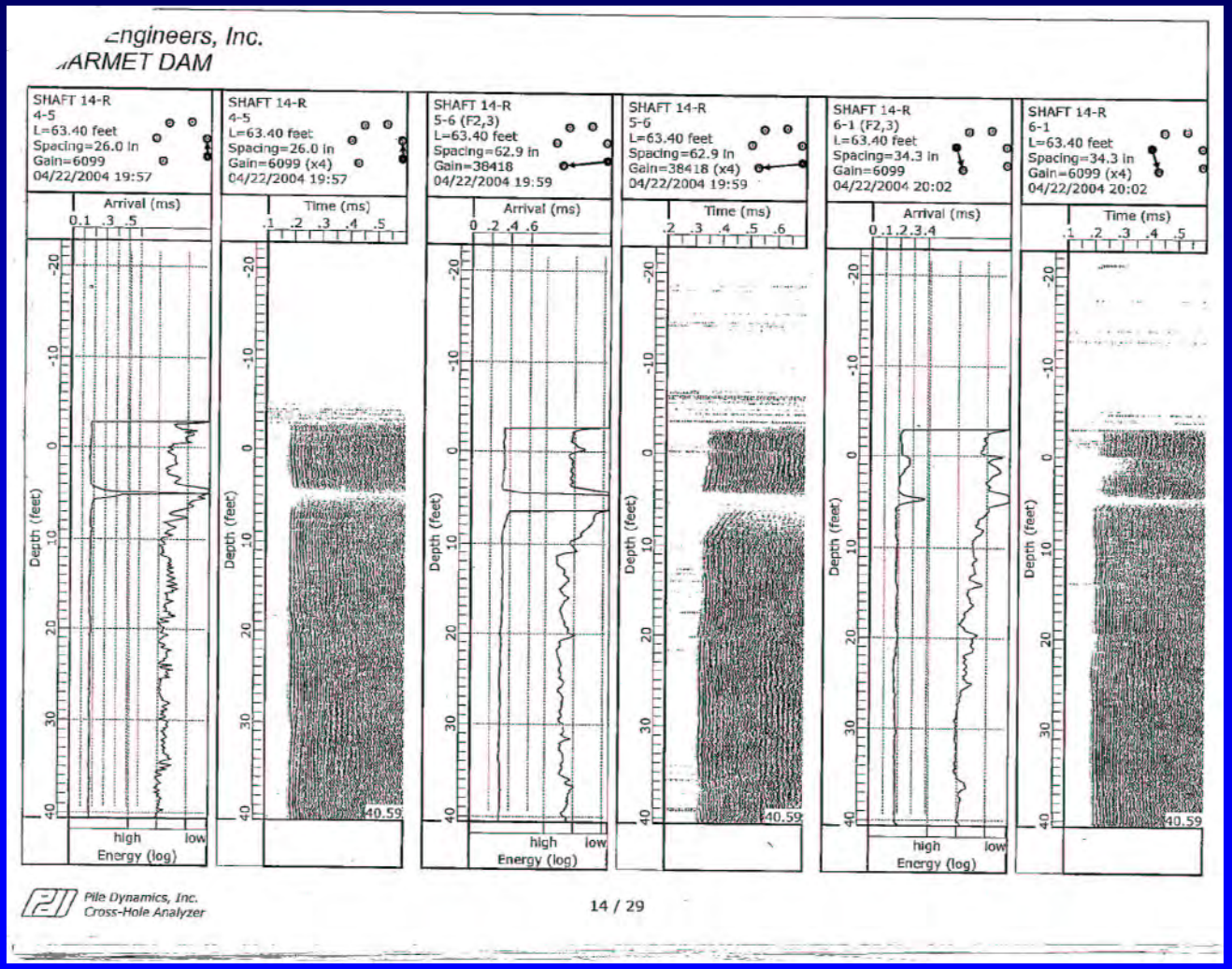
Rebar and Concrete Placement





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Drilled Shaft CSL Test Results



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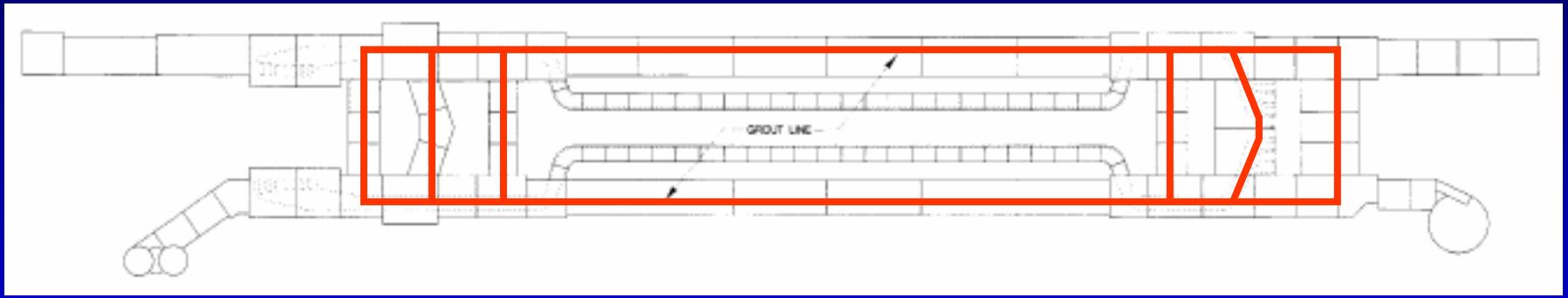
Drilled Shaft Low Density Concrete

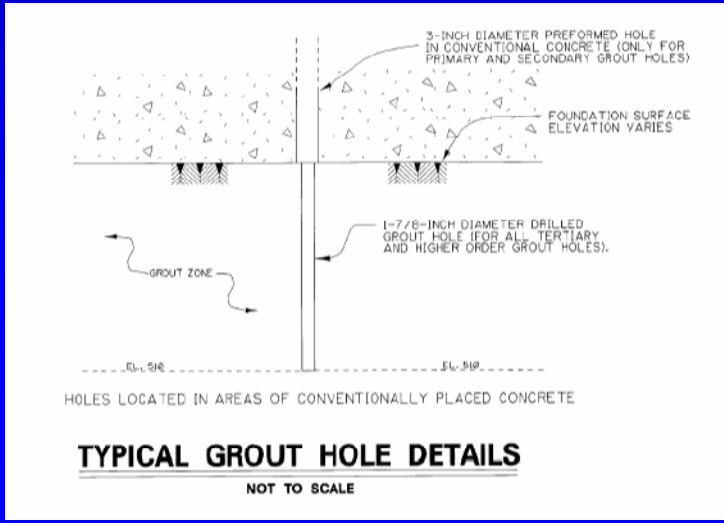


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Marmet Lock Replacement – Drilling & Grouting

Foundation Drilling and Grouting





- **Grout Curtain Extends to Elevation 510**
- **10’ Spacing Between Primary and Secondary Holes**
- **Optional Tertiary and Higher Order Holes**
- **All Holes Pressure Testing**
- **Neat Cement Grout**

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Marmet Lock Replacement – Conclusion

QUESTIONS AND ANSWERS

Contact Information

Mike Nield
304-399-5056
michael.c.nield@lrh01.usace.army.mil

Ron Adams
304-529-5279
ronnie.l.adams@lrh01.usace.army.mil

McAlpine Lock Replacement Instrumentation

Design, Construction, Monitoring, and Interpretation

Troy S. O'Neal, P.E.

US Army Corps
of Engineers
Louisville District

McAlpine Lock Replacement Instrumentation



INSTRUMENTATION DESIGN

Instrumentation Design Philosophy

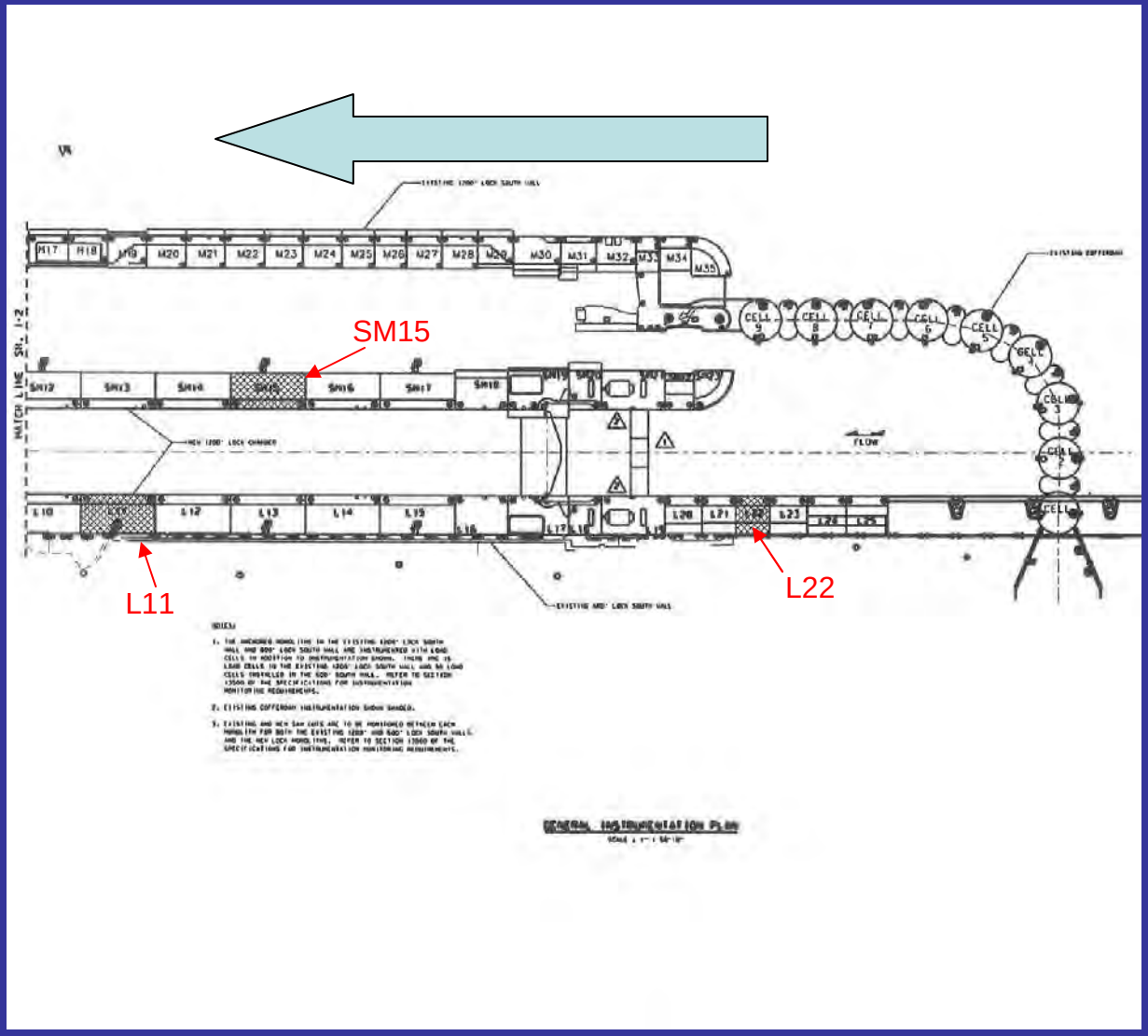
1. Every instrument has a purpose.
2. Envision placement and constructability.
3. Have adequate redundancy of instruments.
4. Use to verify critical or variable design parameters.

Parameters Monitored

1. Concrete temperature
2. Concrete (monolith) strain
3. Monolith base pressures and distribution
4. Earth pressures and backfill sequence
5. Ambient temperature

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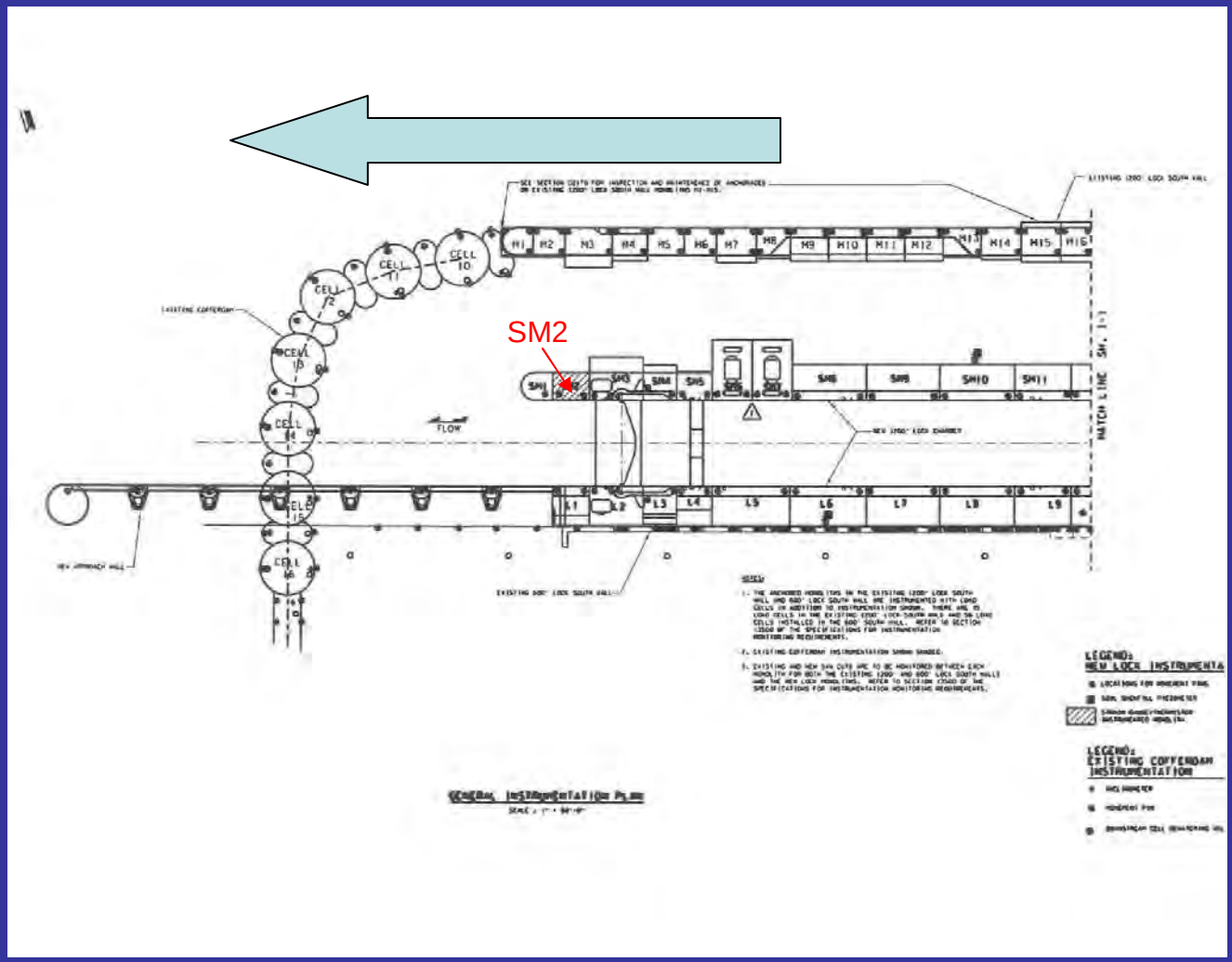
McAlpine Lock Replacement Instrumentation



Shaded Monoliths L11, L22 and SM15 have instrumentation

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McAlpine Lock Replacement Instrumentation

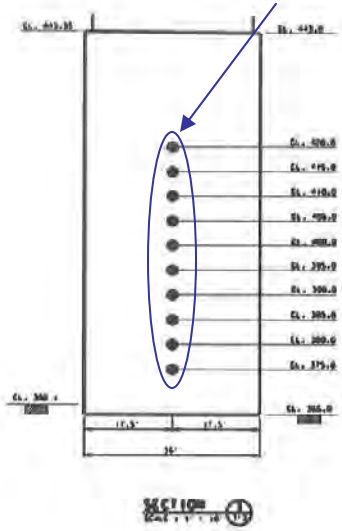


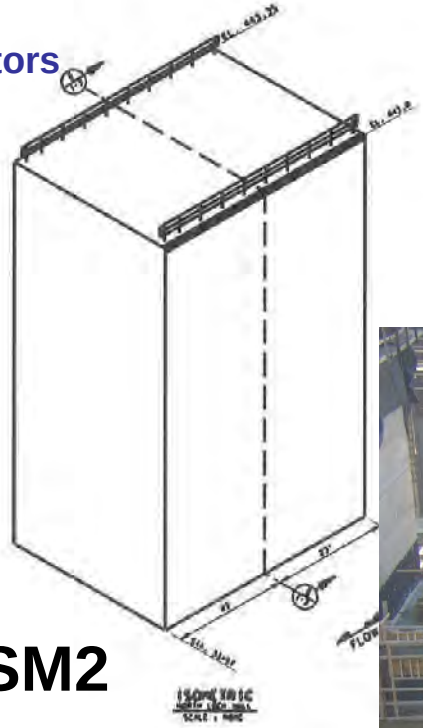
Shaded Monolith SM2 has instrumentation

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McAlpine Lock Replacement Instrumentation

Strain Gauges/Thermistors





Monolith SM2

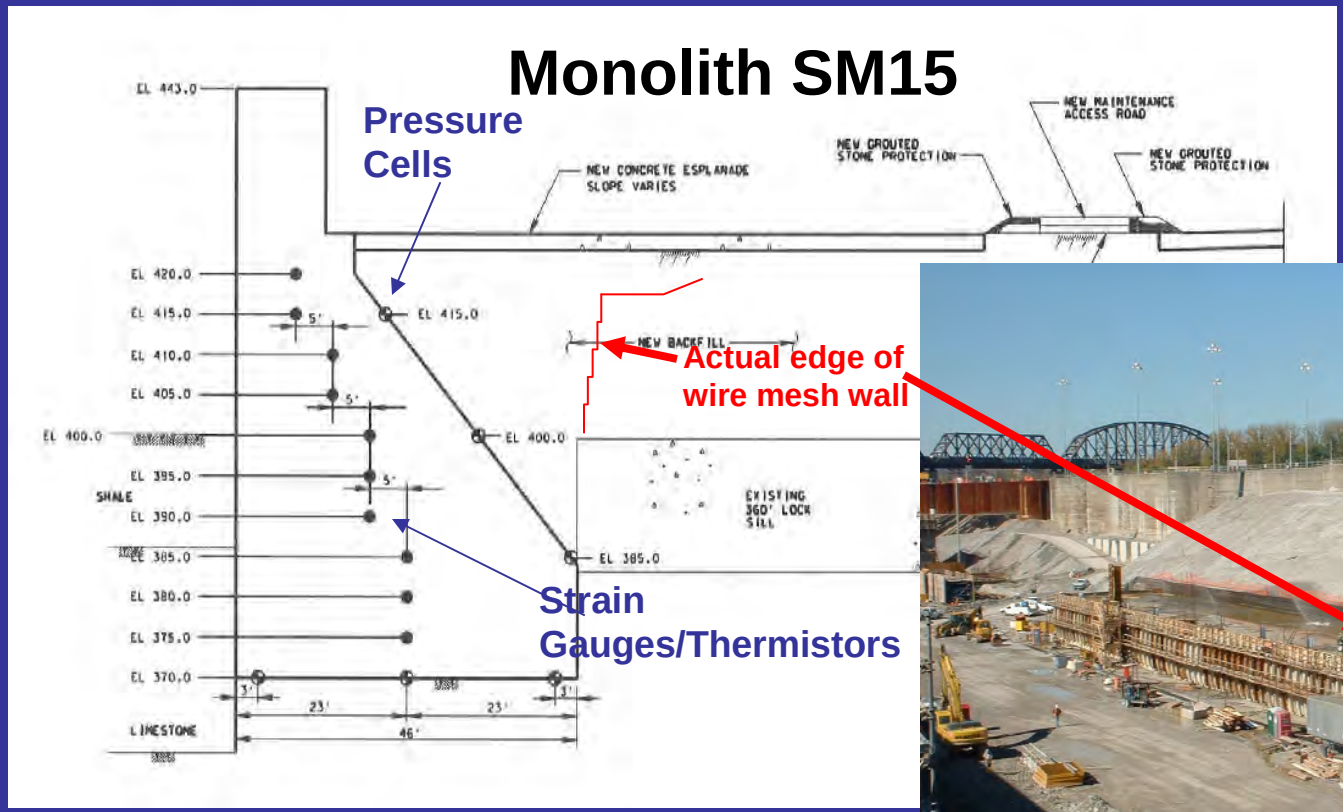


Monolith SM2 with location of Strain Gauges

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McAlpine Lock Replacement Instrumentation

Monolith SM15



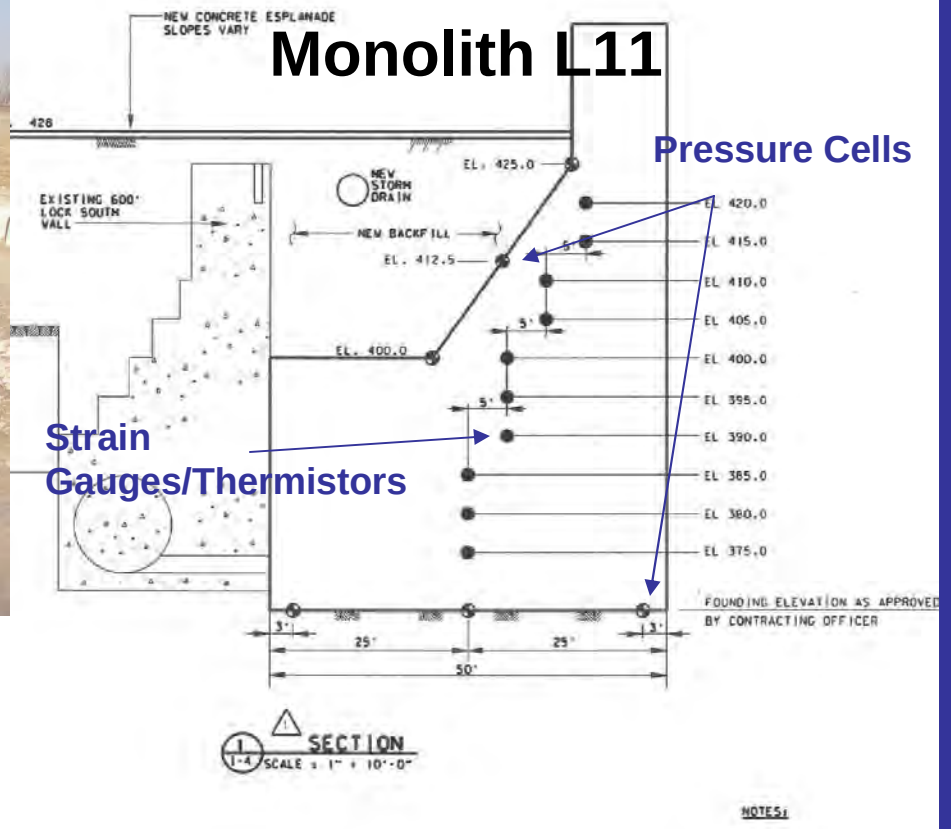


SM15 showing locations of strain gauges (solid circles) and pressure cells (shaded circles).

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McAlpine Lock Replacement Instrumentation





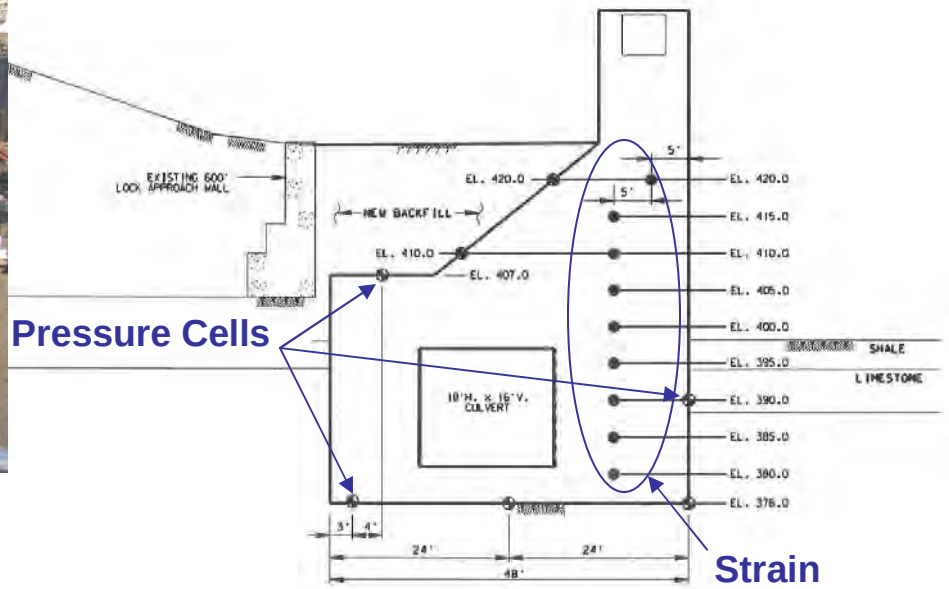
L11 with locations of strain gauges (solid circles) and pressure cells (shaded circles).

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Monolith L22



L22 with locations of strain gauges (solid circles) and pressure cells (shaded circles).

INSTALLATION METHODS

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Placement of Pressure Cell



Leveling Pressure Cell

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Placing Pressure Cell in L22



Completed Pressure Cell

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Solar Powered Data Reading Station

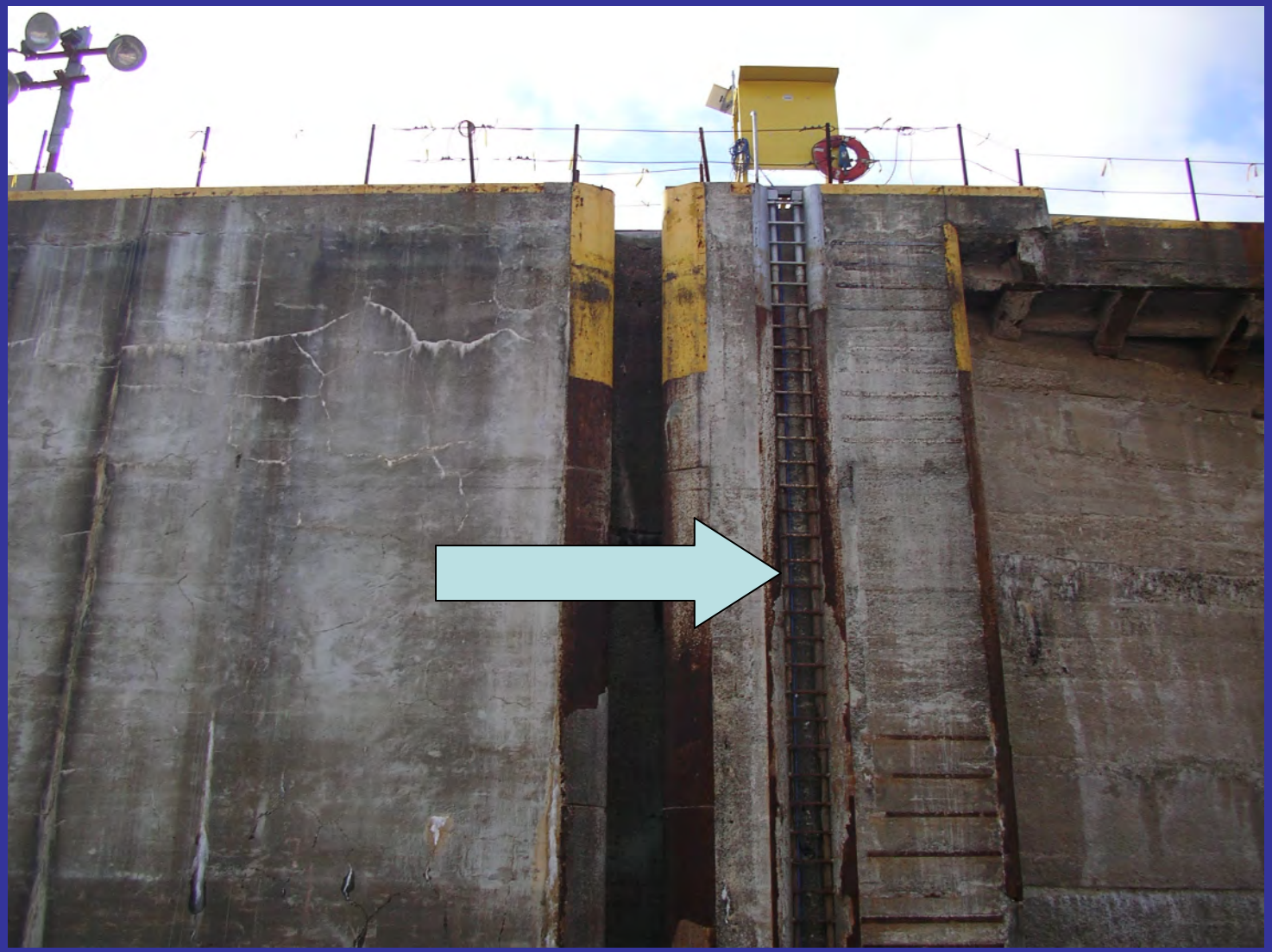


Strain gauge mounted in L22

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McAlpine Lock Replacement Instrumentation

Location of Wires for Instrumentation

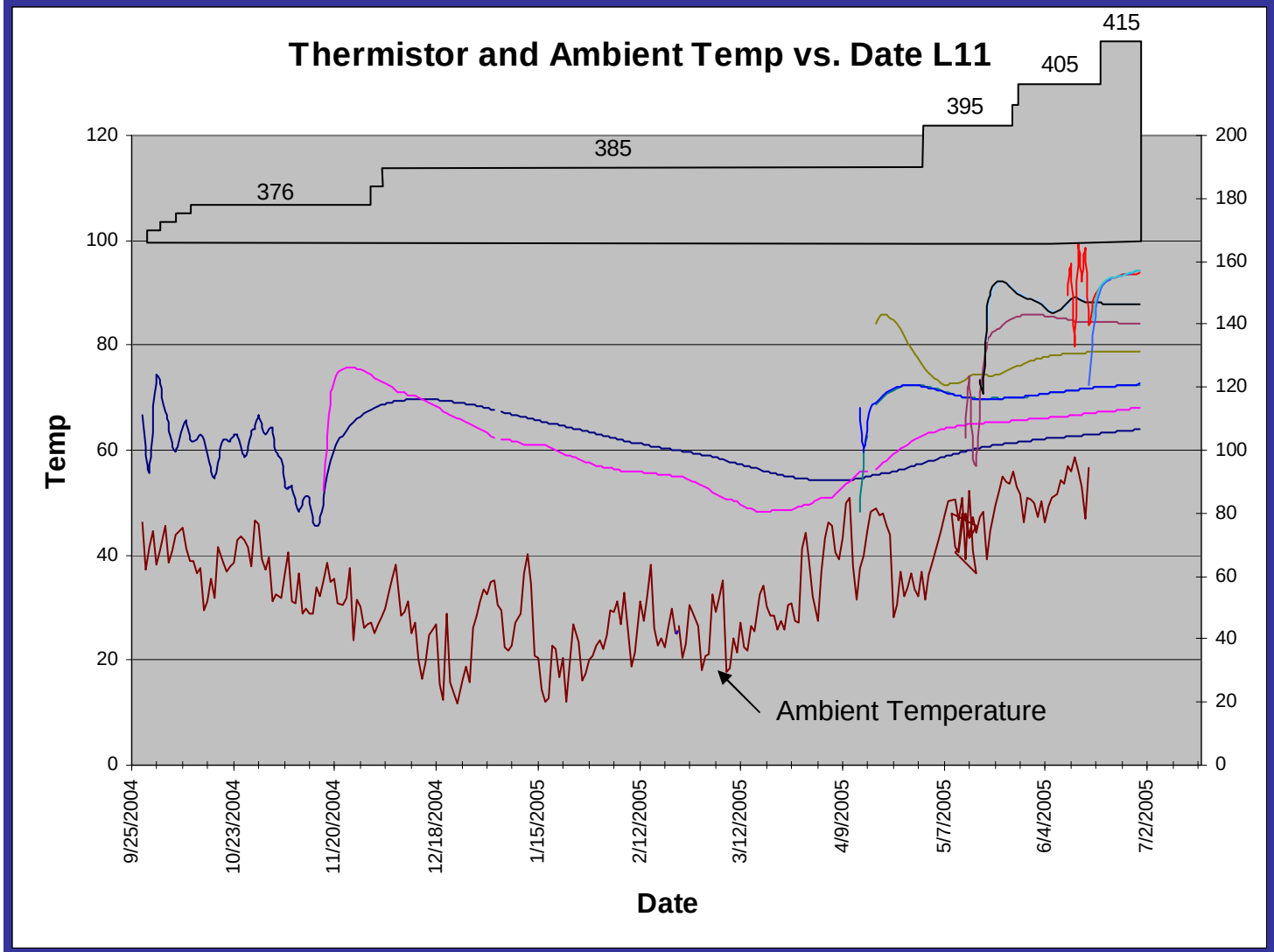


DATA INTERPRETATION

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McAlpine Lock Replacement Instrumentation

Data Interpretation



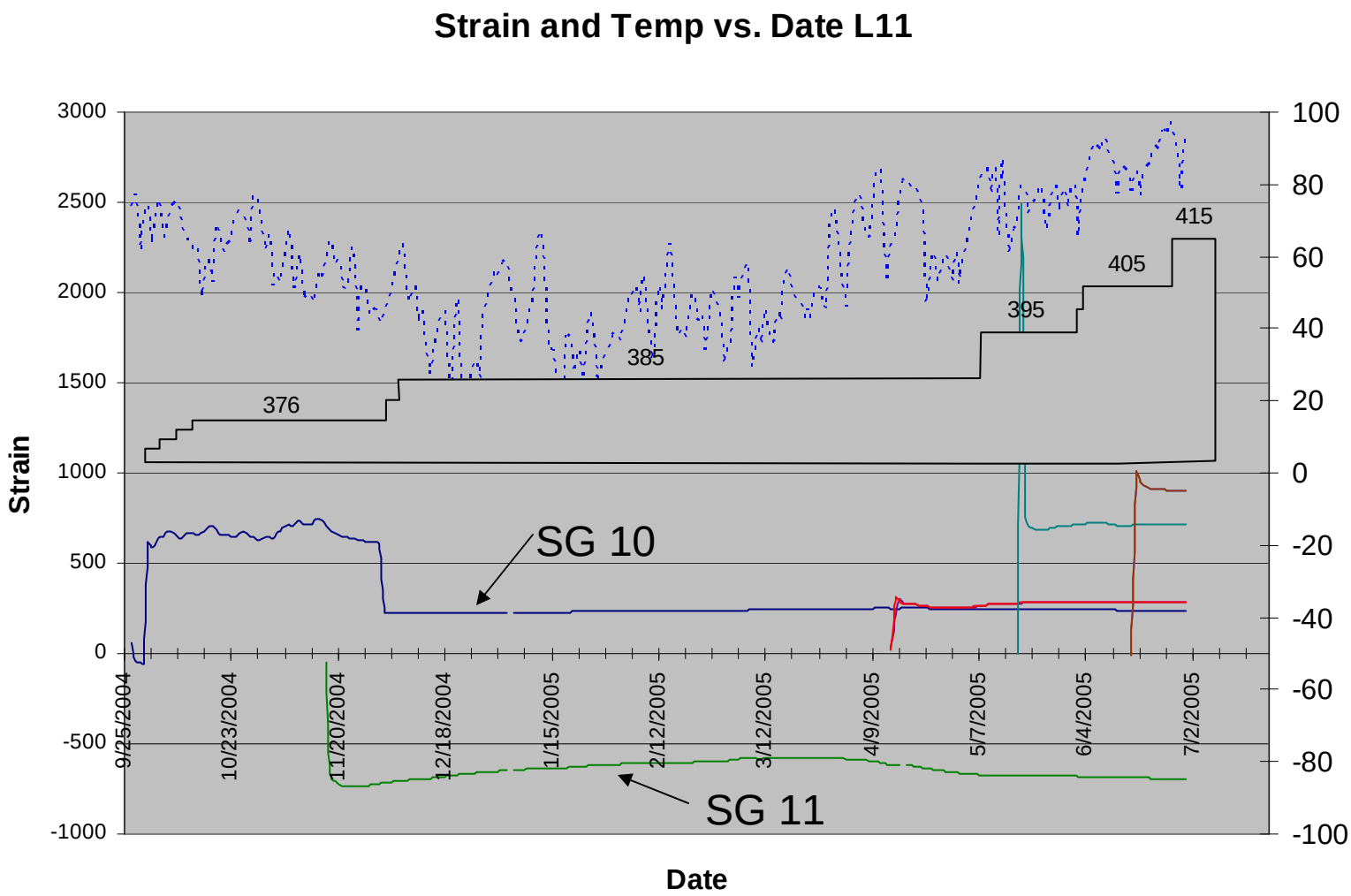
L11 Thermistor

-Note: temperature increases during initial cure then decreases gradually

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McAlpine Lock Replacement Instrumentation

Data Interpretation



L11 Strain

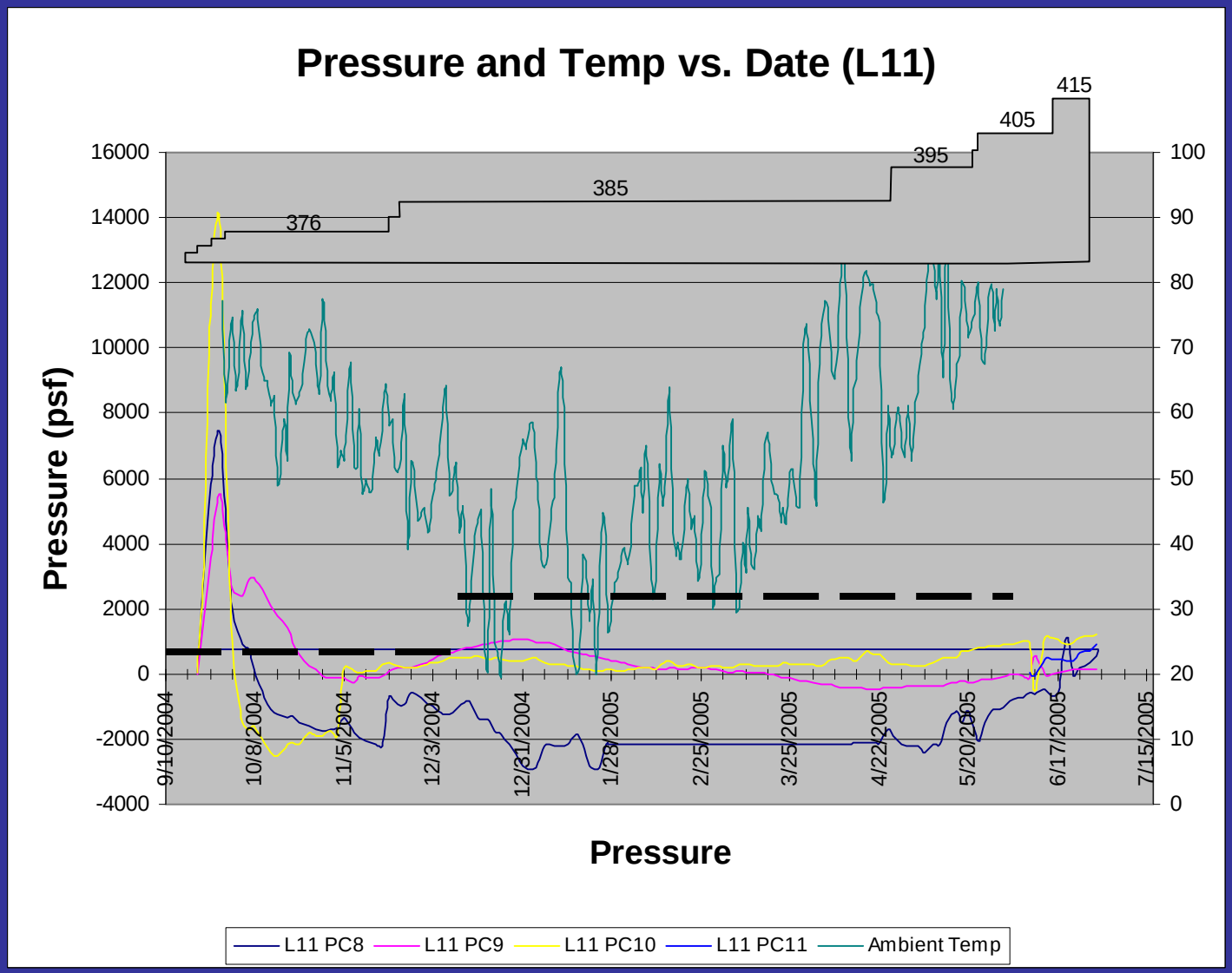
-SG 10 is placed perpendicular to the lock centerline and is reading positive.

-SG 11 is placed parallel to the lock centerline and is reading negative.

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McAlpine Lock Replacement Instrumentation

Data Interpretation



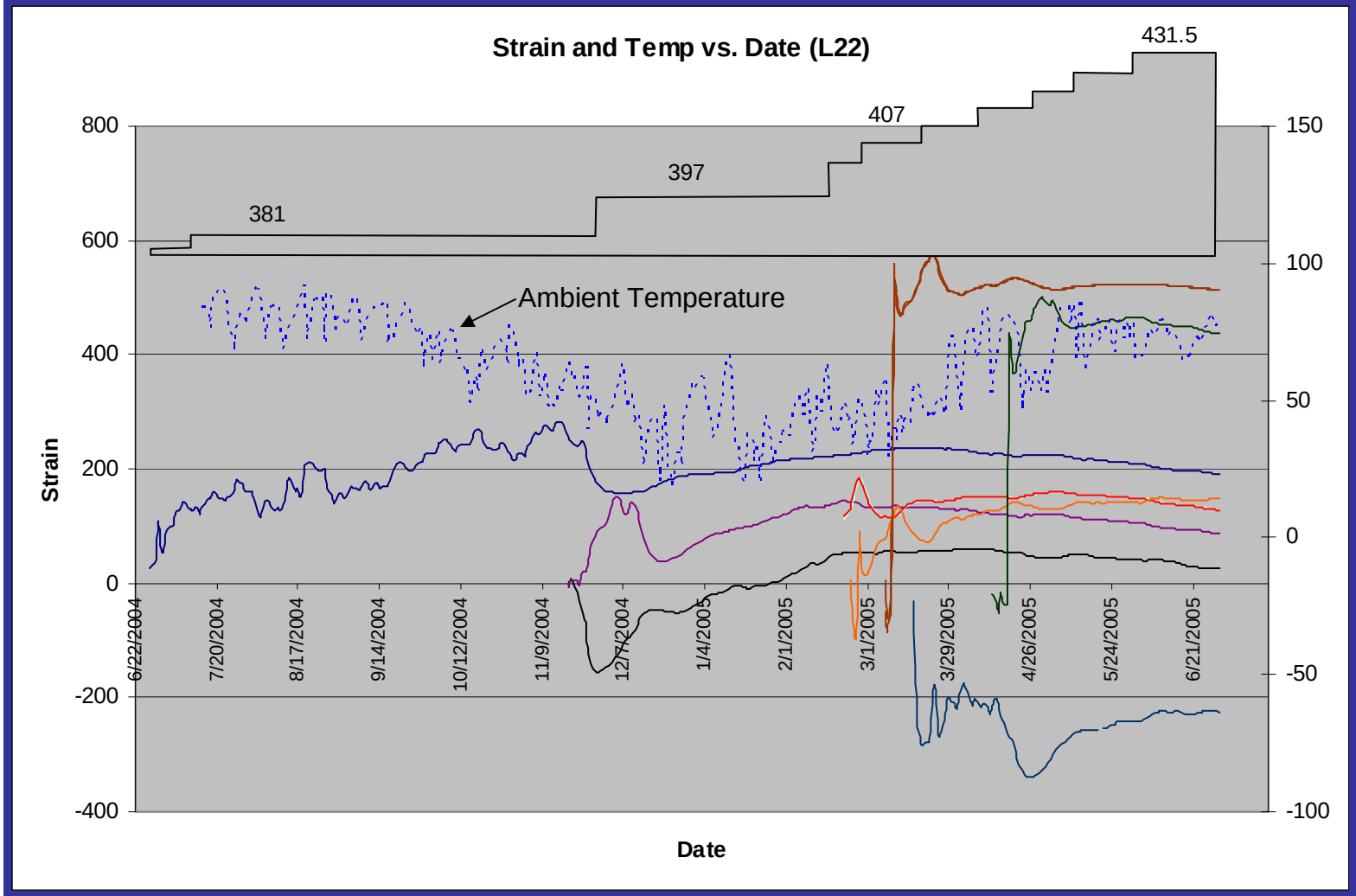
L11 Pressure Cells

-Note: Extreme spike as concrete is placed.

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McAlpine Lock Replacement Instrumentation

Data Interpretation



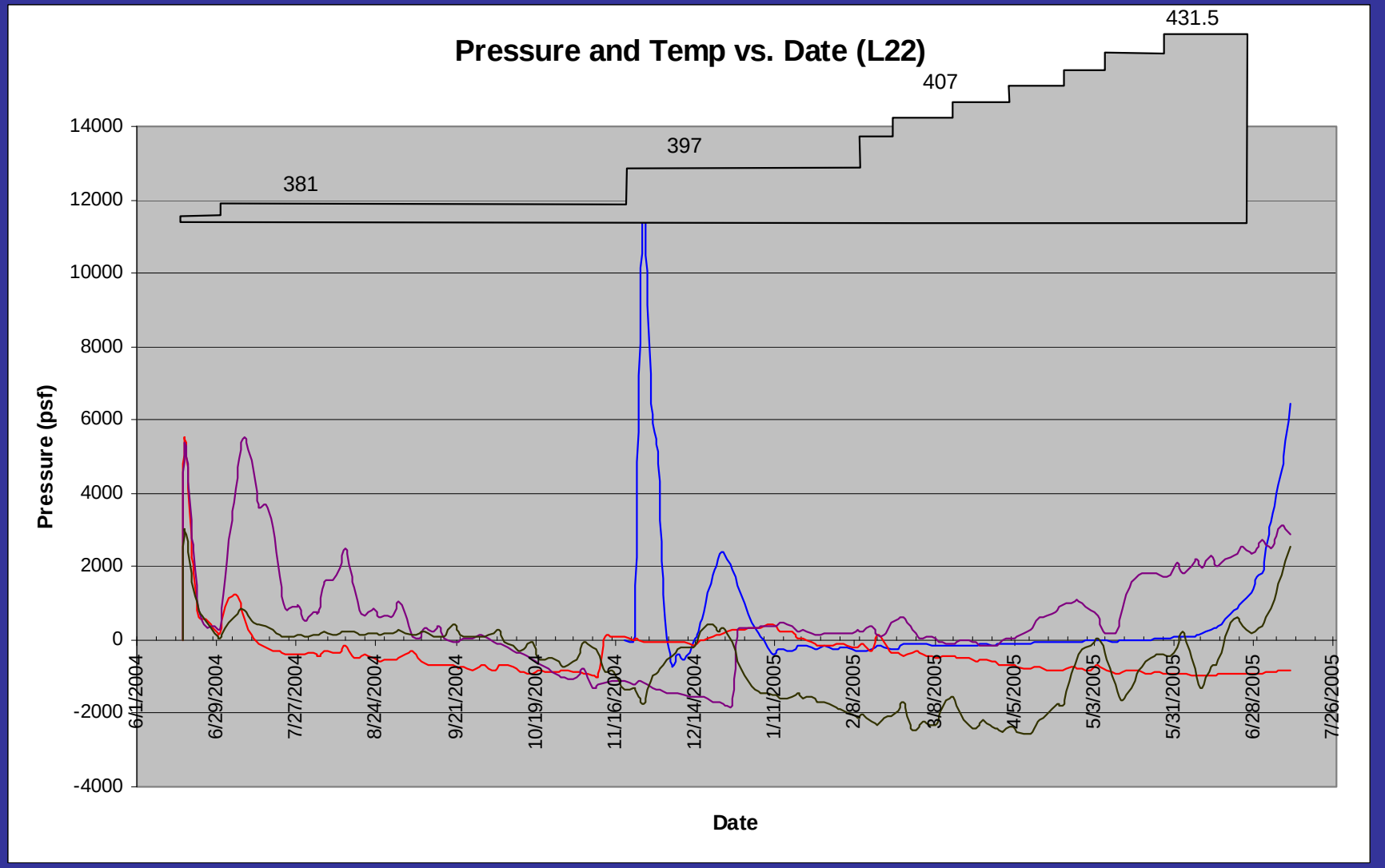
L22 Strain

Note: Gages placed parallel to lock centerline, reading is negative.

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McAlpine Lock Replacement Instrumentation

Data Interpretation



L22 Base Pressures

Earth Pressures

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Instrumentation

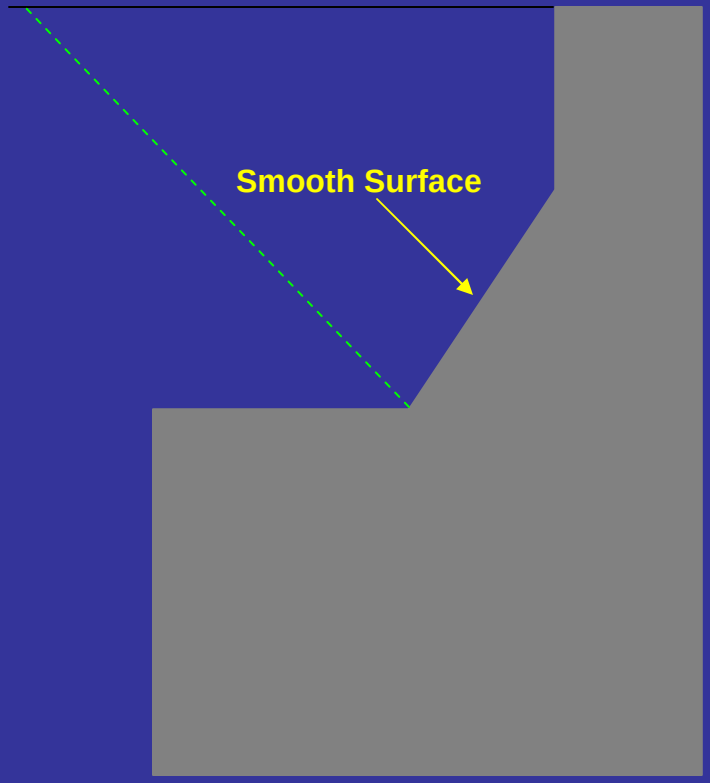


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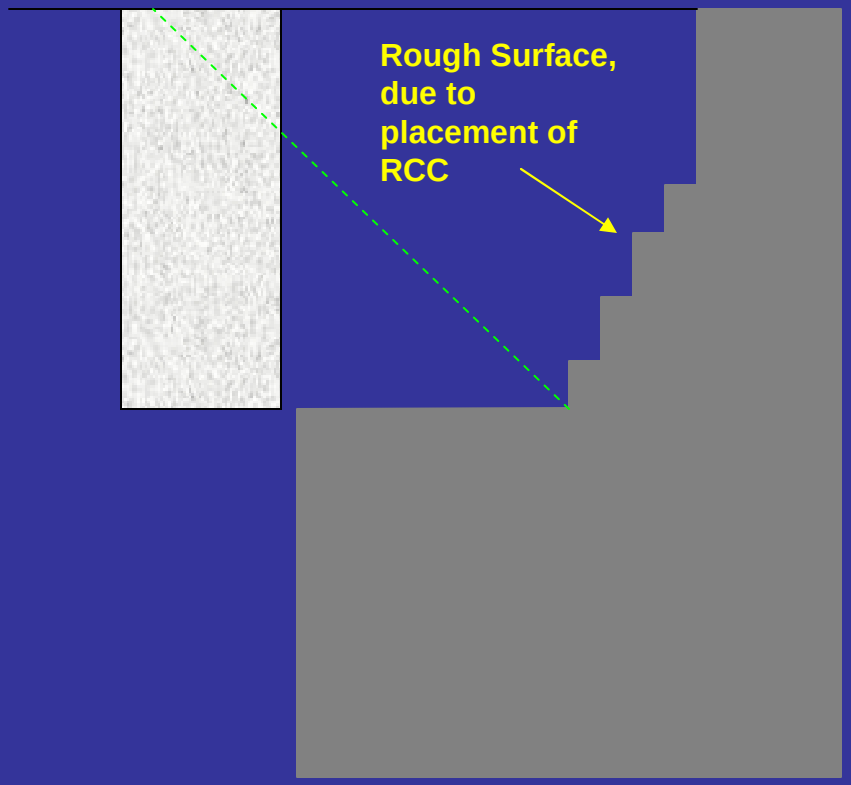
McAlpine Lock Replacement Instrumentation

Monolith Construction

Design Shape



Actual Shape

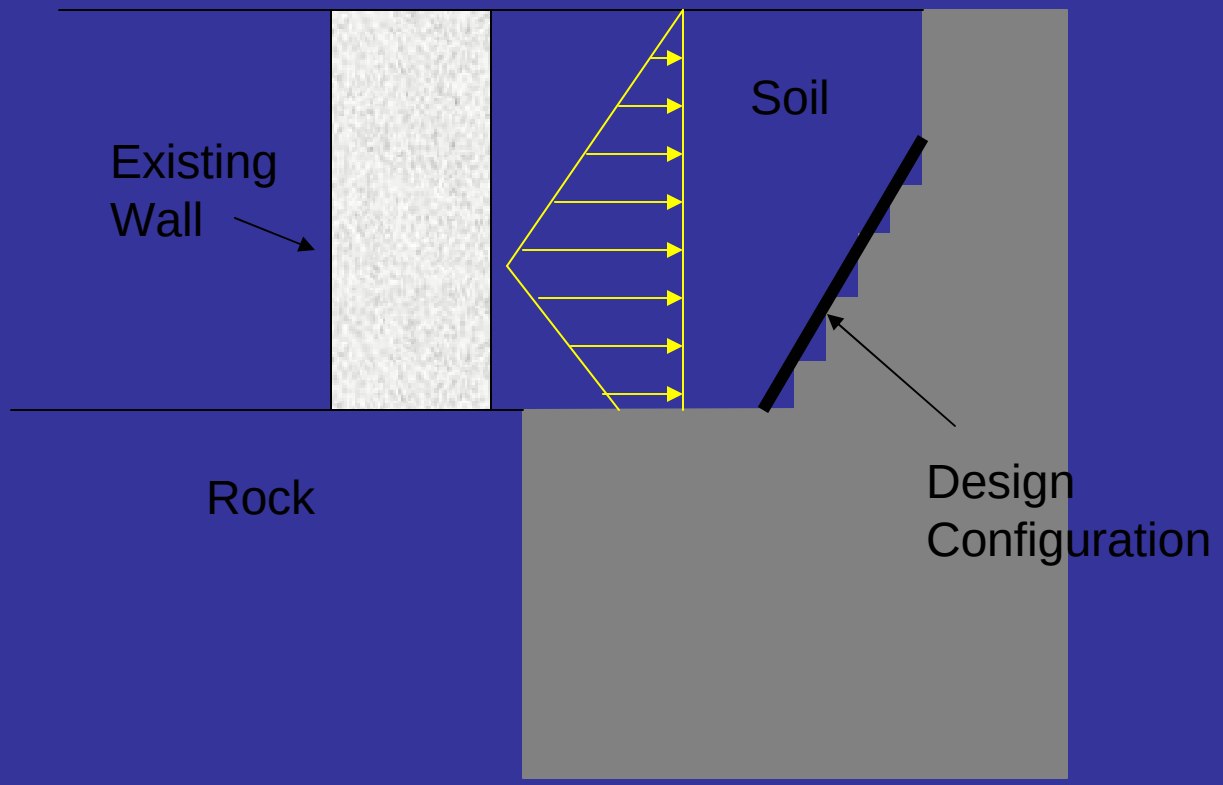


General Design Methodology

K_o Value used for lateral soil pressure calculations with reduction in lower area of monolith based on anticipated soil arching.

$K_o = 1 - \sin\Phi$

(Jaky's Equation)



Design vs. Actual Construction Conditions

DESIGN

- Design attempted to account for arching on smooth sloping wall with $\Phi = 32$.
- Actual design now calls for 3"minus gravel and a stair stepped wall. ($\Phi > 32$).
- Instantaneous loading assumed.
- Arching action invokes increased vertical shear effects that were not included at time of analysis.

CONSTRUCTION CONDITIONS

- **Material change**
- **Stair-stepped back of monolith**
- **Confined backfill areas with unique configurations**
- **Staged Fill Placement**

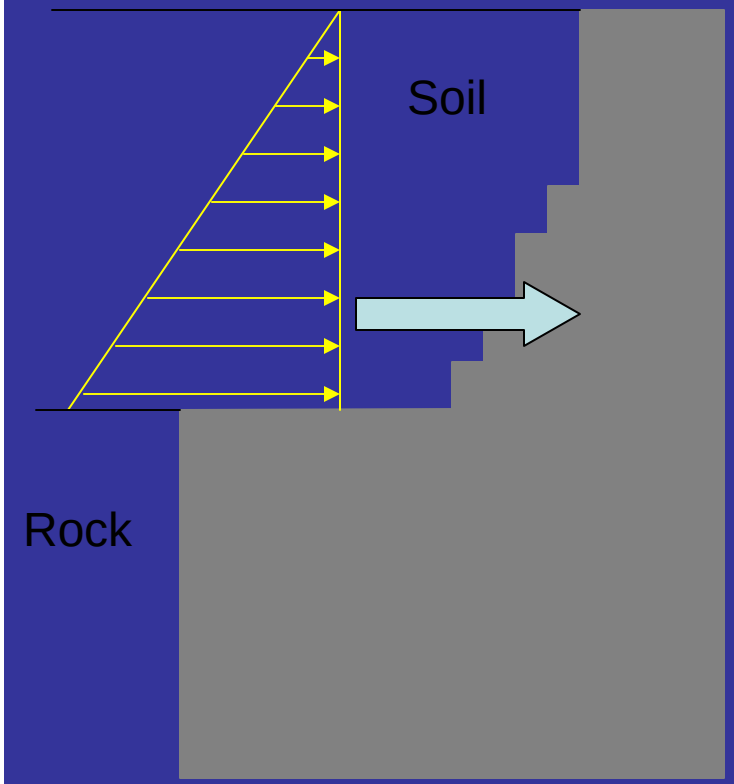
CONCLUSION

- **Changes from original design will likely increase arching effects, vertical shear, and nonlinearity of load distribution along the back of the monolith.**

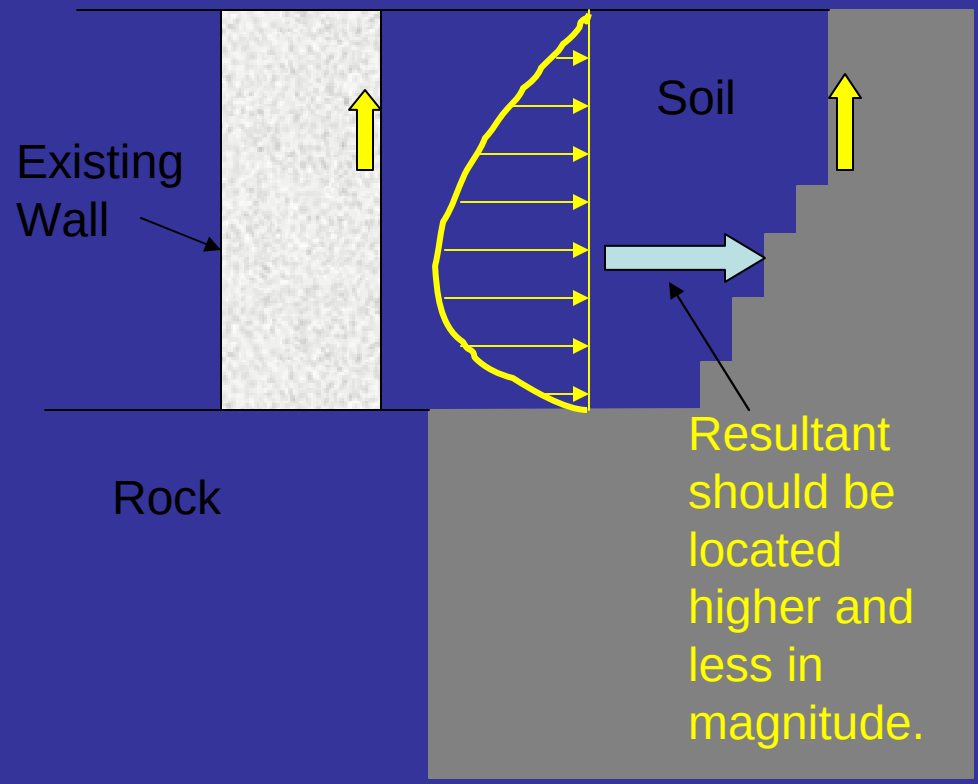
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How Does Arching Effect Lateral earth Pressures on the Monolith?



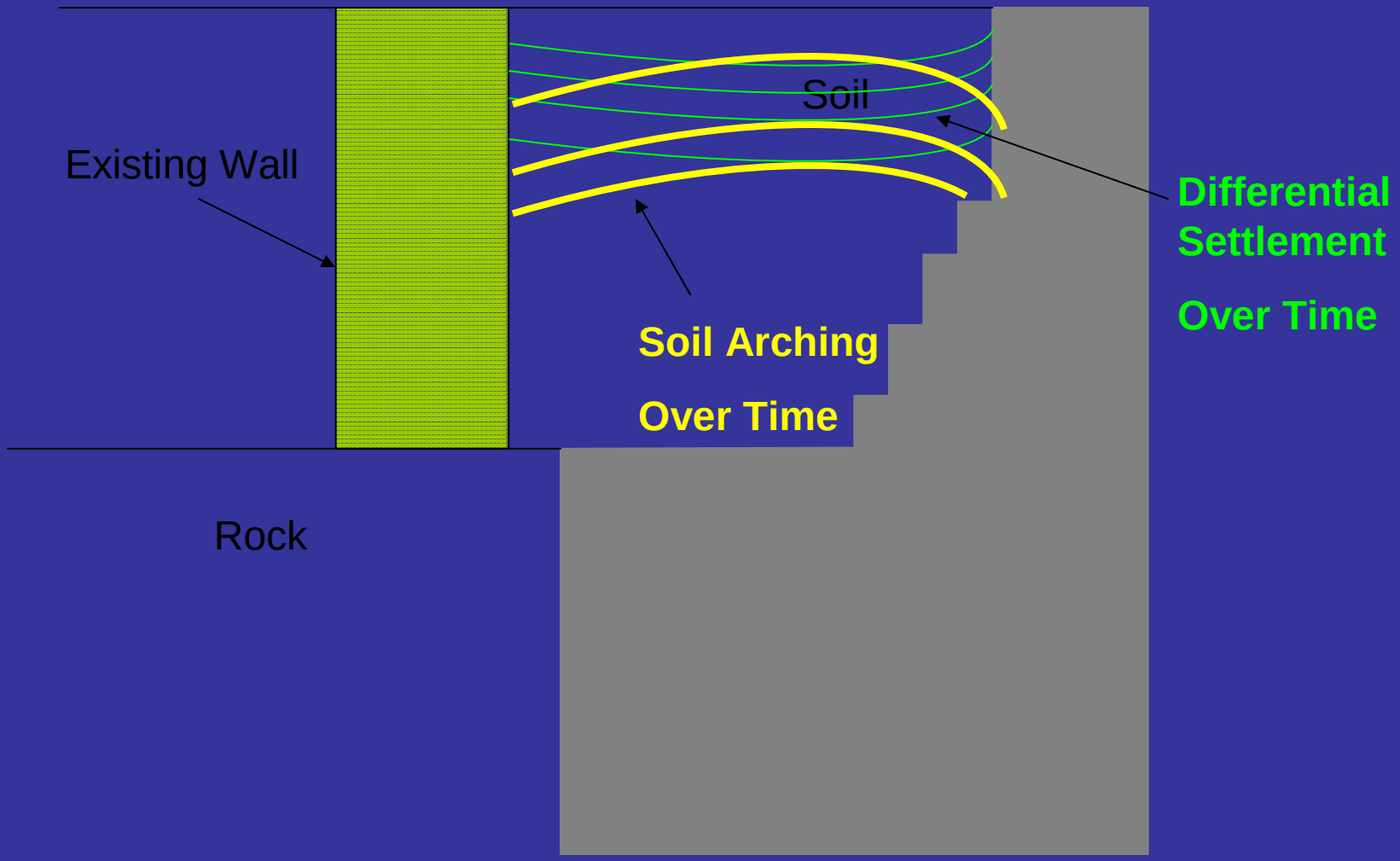
Free Field Condition



Confined Field Condition

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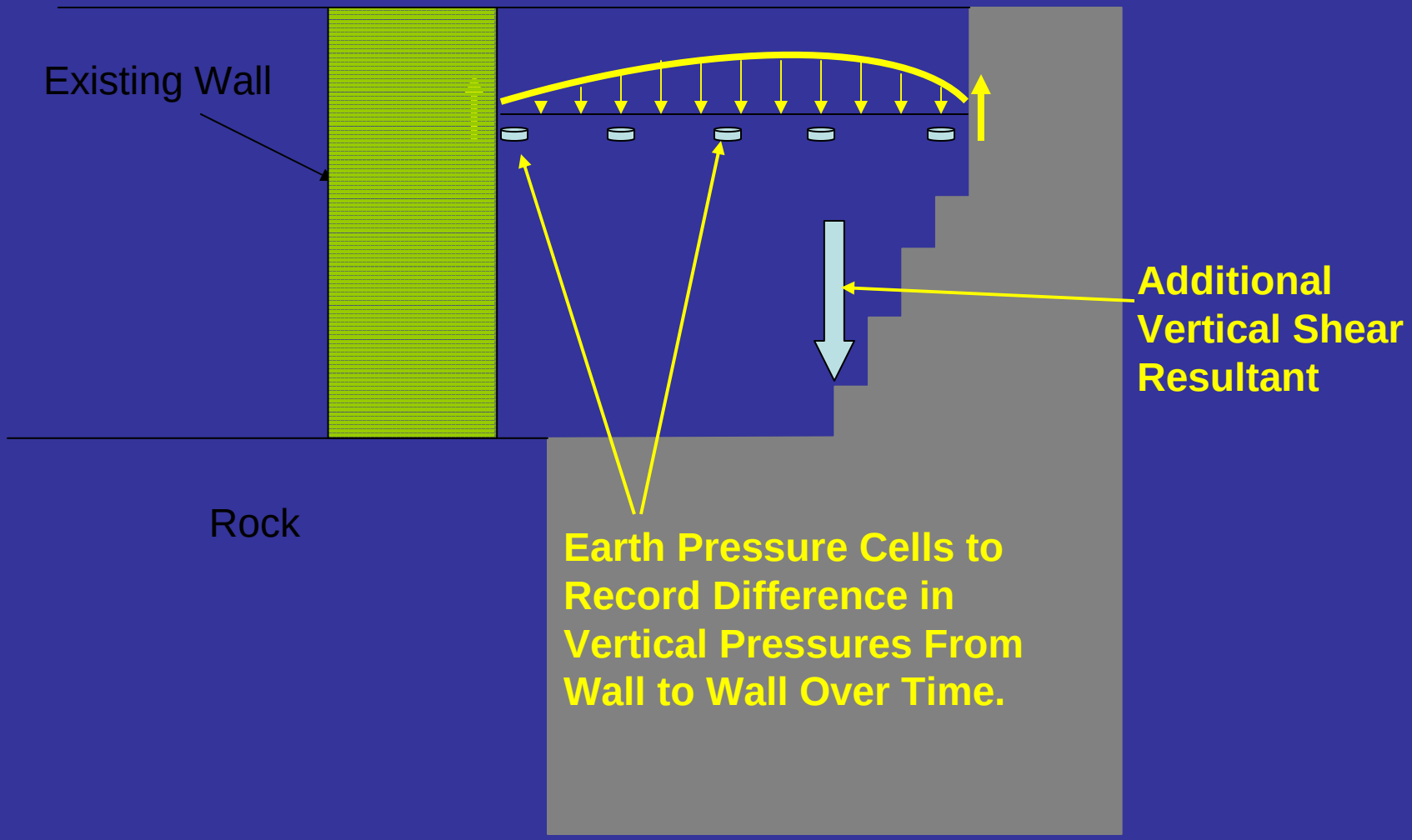
Soil Arching Mechanism



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McAlpine Lock Replacement Instrumentation

Vertical Shear



Why is Vertical Shear Important?

Publication Number: **EC 1110-2-6058**
Title: **Engineering and Design - Stability Analysis of Concrete Structures**
Proponent: **CECW-E**
Publication Date: **30 November 2003**

APPENDIX F

F-2

d. “Filz, Duncan, and Ebeling (1997) present an example calculation using vertical shear for a 30-ft high, step-tapered, rock founded, gravity wall retaining dense sand with surcharge. This example compares the result with a conventional design and **shows a 14 percent reduction in base width by including vertical shear, without compromising the design safety requirements.”**

If applied to the McAlpine Lock Project (say at only 7 percent) it could yield:

- (3.5 ft reduction in each monolith wide)X(2400 ft) = 23,000 CY
- (23,000 CY)X($150/CY) = $3.5M Savings

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SUPPLEMENTAL EARTH PRESSURE CELL WERE ADDED TO CONTRACT.

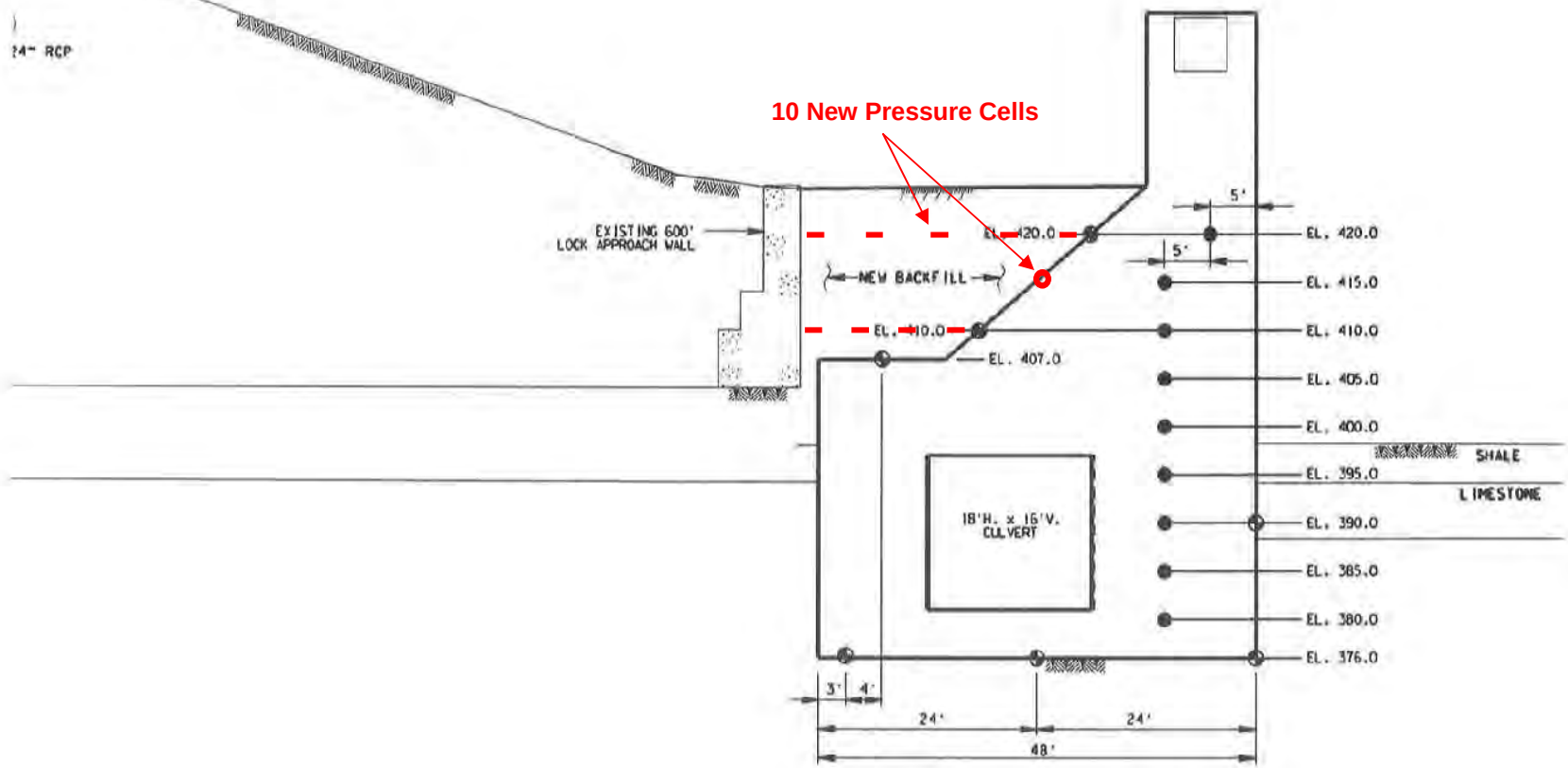
Why?

- **Verify design assumptions.**
- **Define earth pressure nonlinearity.**
- **Capture vertical shear loading over time.**

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McAlpine Lock Replacement Instrumentation

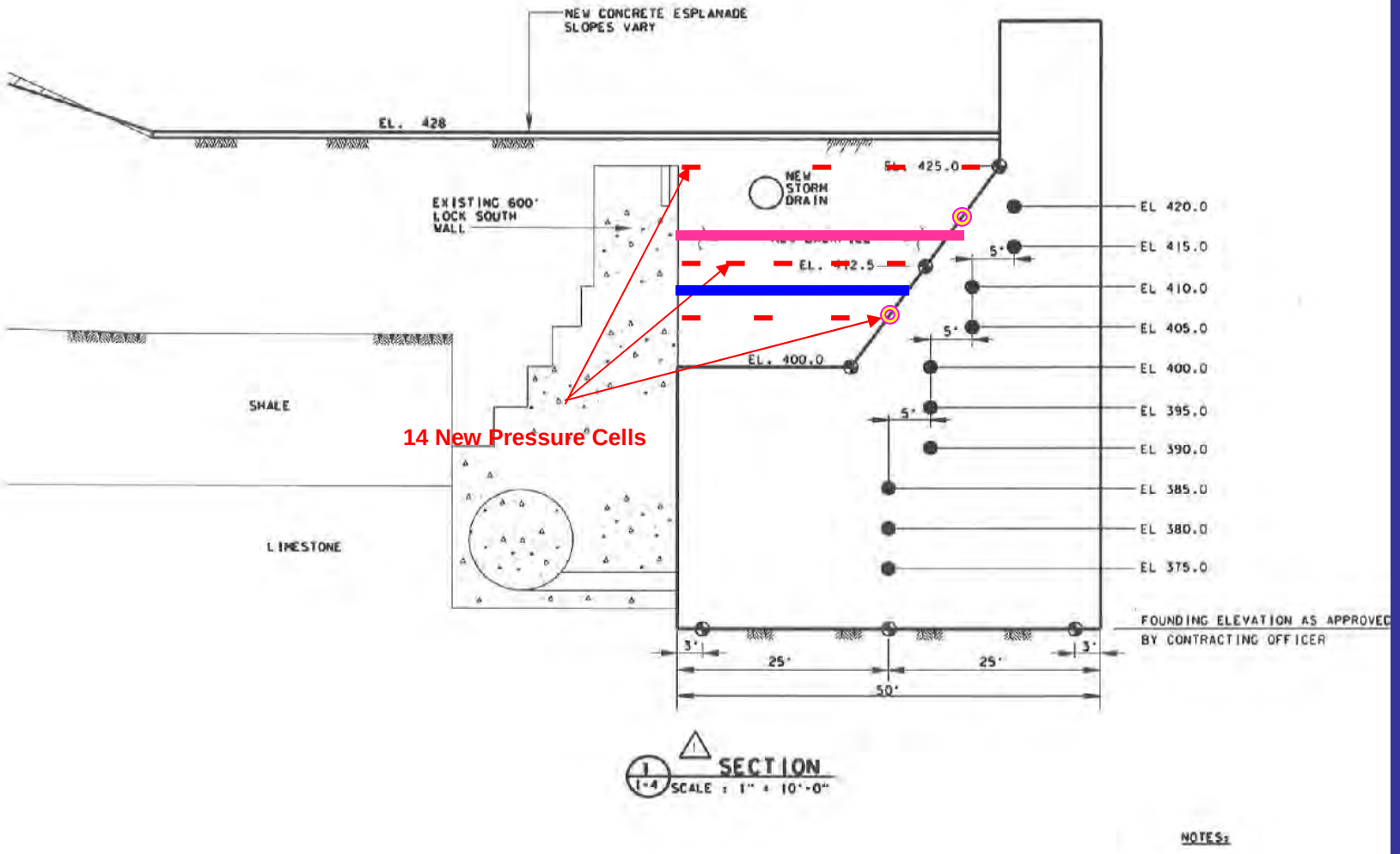
Monolith L22



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McAlpine Lock Replacement Instrumentation

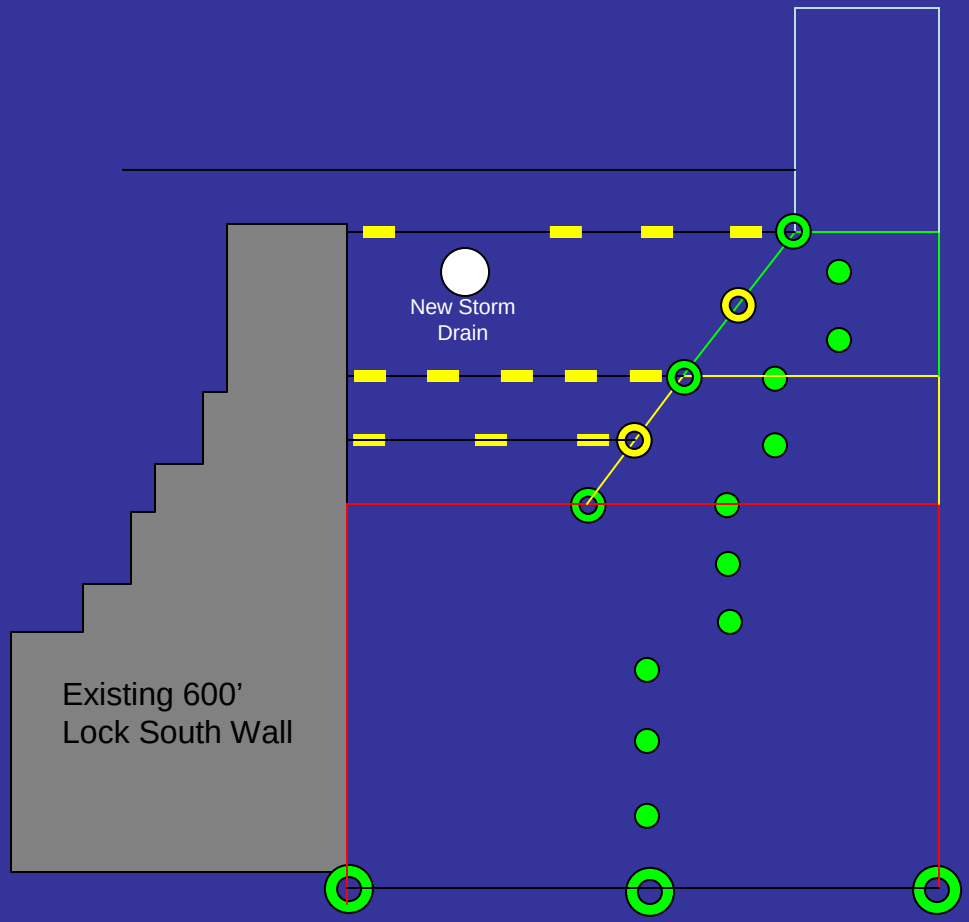
Monolith L11



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McAlpine Lock Replacement Instrumentation

Proposed Construction Sequence L11



= Proposed Pressure Cell

= Proposed Horizontal Pressure Cell

= Current Pressure Cell

= Current Strain Gauge

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McAlpine Lock Replacement Instrumentation

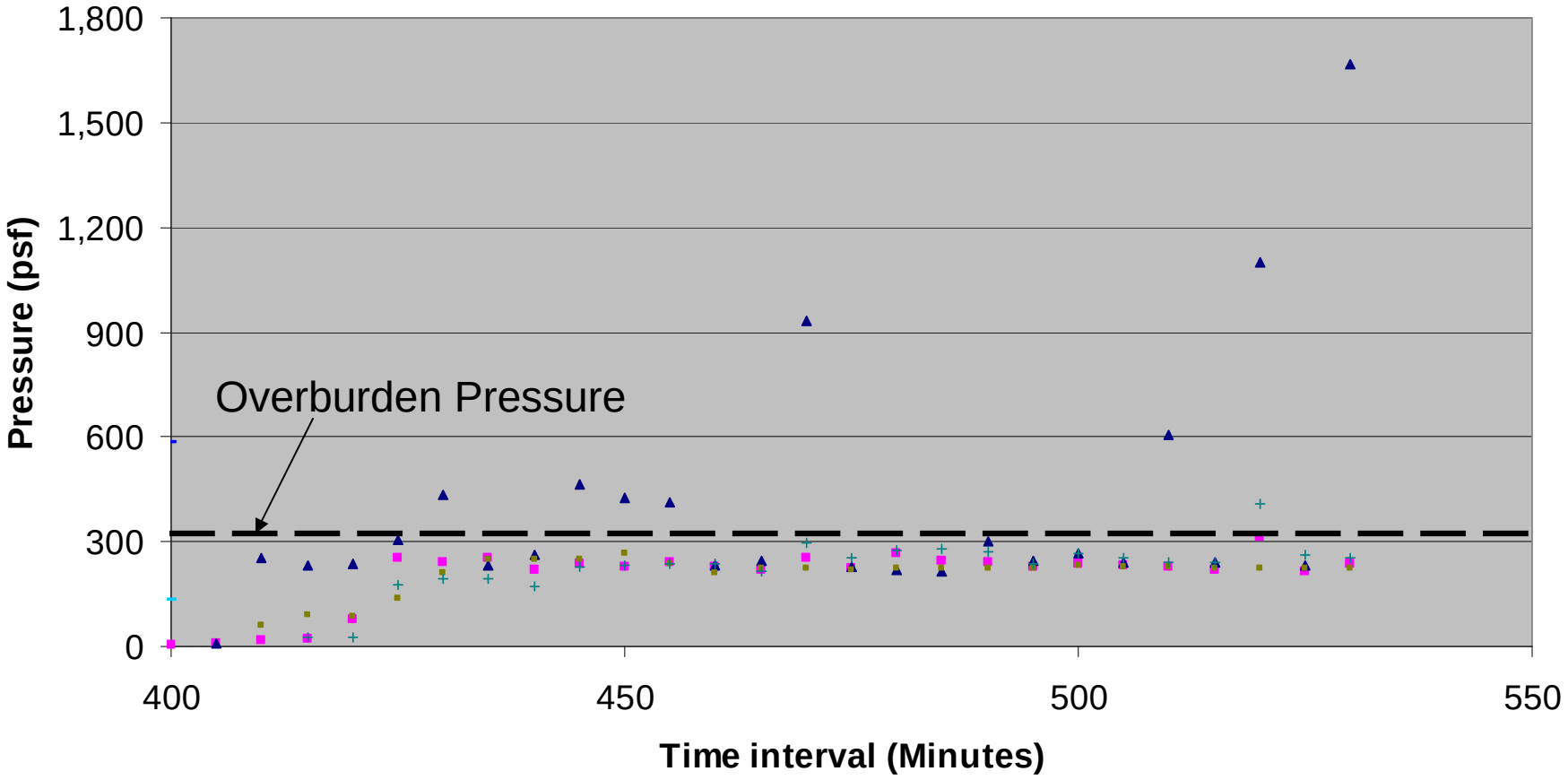


EARTH PRESSURES DURING COMPACTION

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McAlpine Lock Replacement Instrumentation

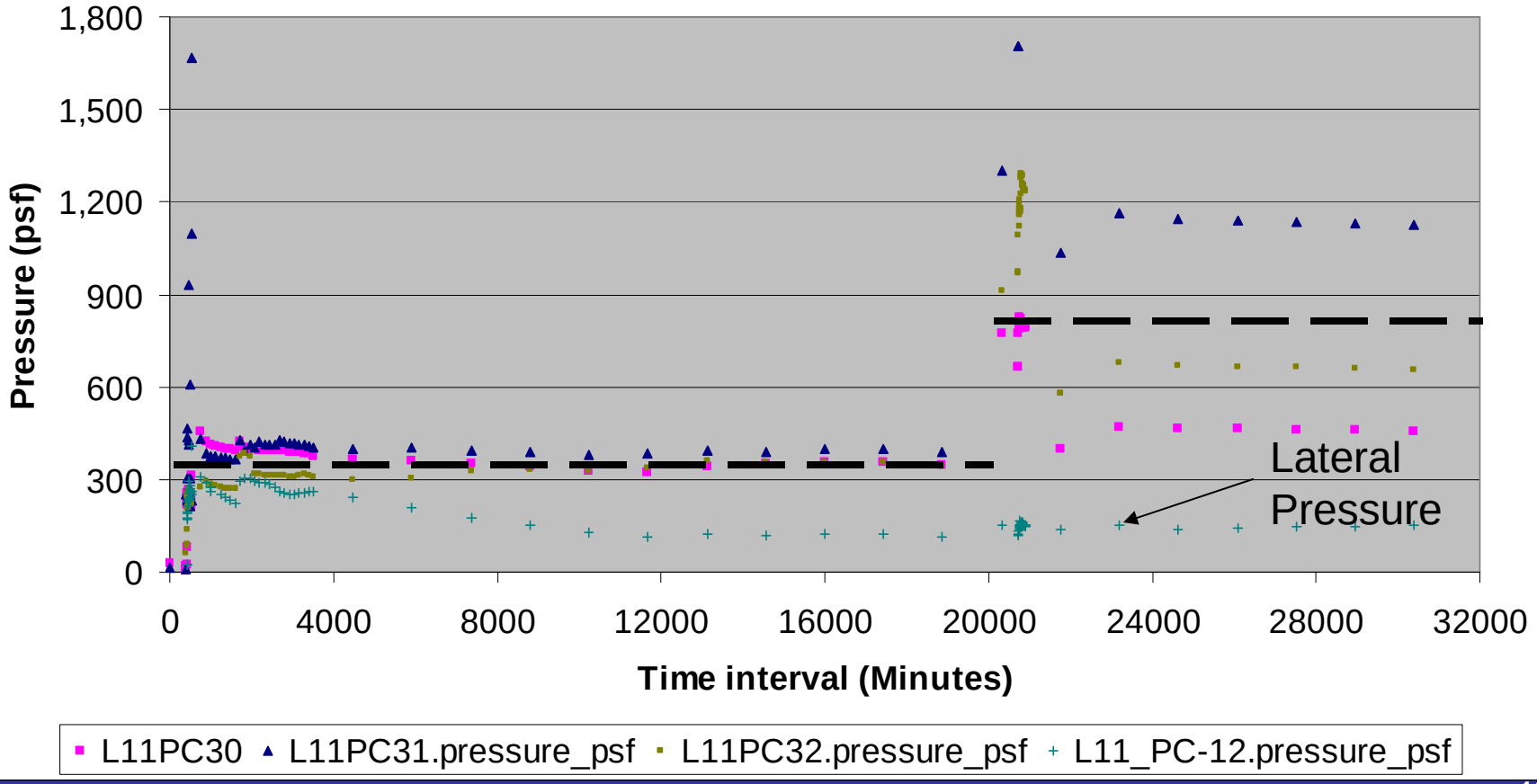
L11 Pressure Cell Readings (psf)
3FT OF Backfill at El. 408.5 With Compaction Effort



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McAlpine Lock Replacement Instrumentation

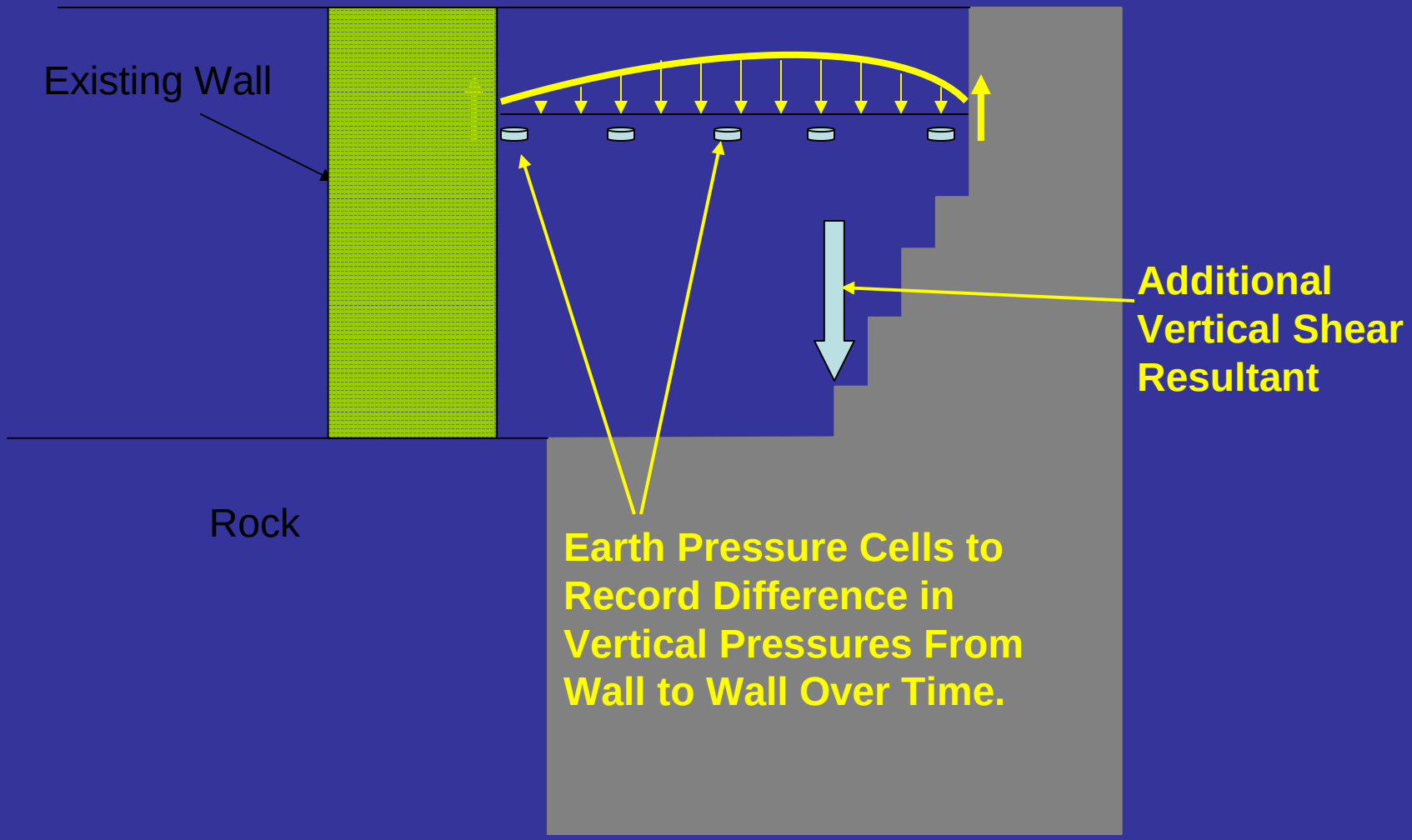
L11 Pressure Cell Readings (psf)
Lower EP Cells with 3 ft and 7ft OF Backfill



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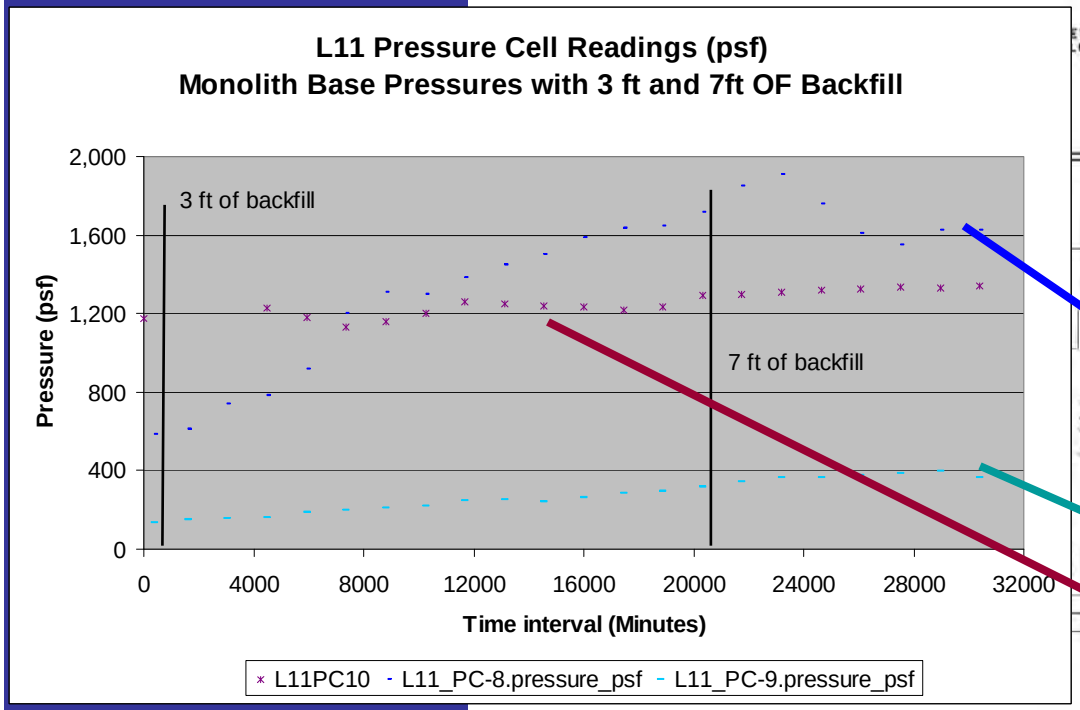
McAlpine Lock Replacement Instrumentation

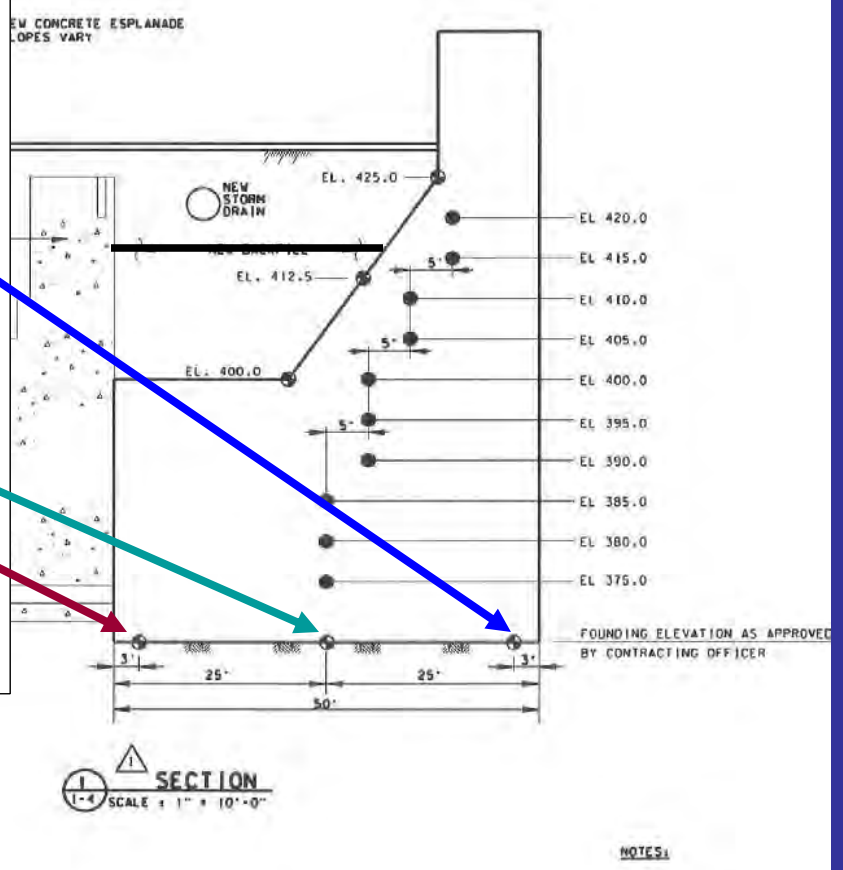
Vertical Shear



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McAlpine Lock Replacement Instrumentation

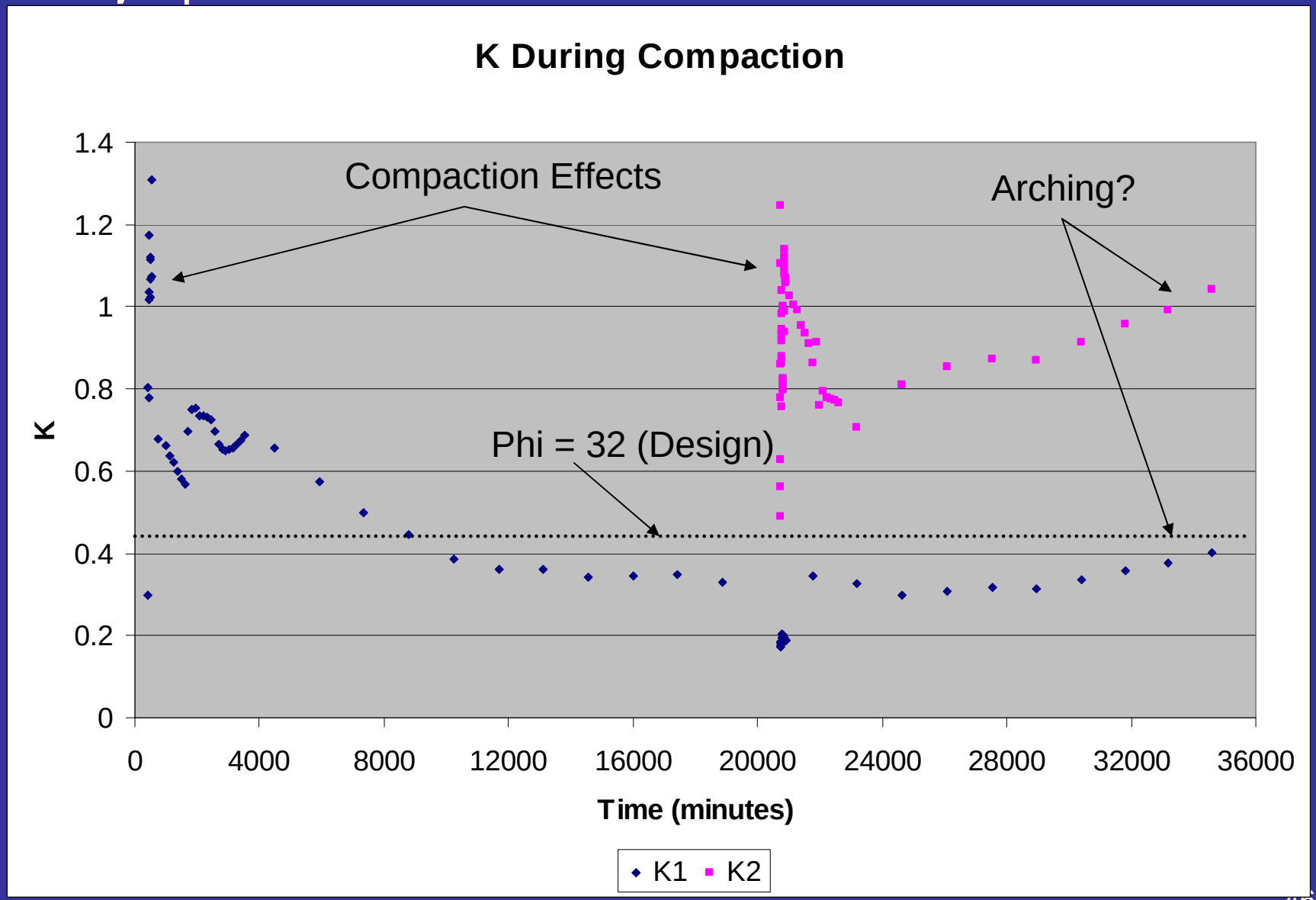




BASE PRESSURES

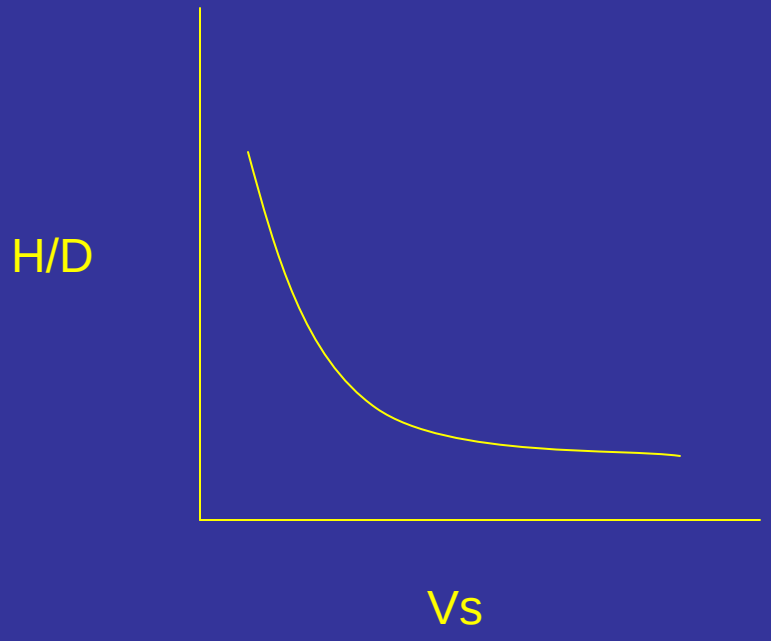
US Army Corps

McAlpine Lock Replacement Instrumentation



Analysis Goals

1. **Develop design charts and a simplified procedure for design future walls with similar conditions could be developed.**



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Questions?



Time-Dependent Reliability Modeling for Use in Major Rehabilitation of Embankment Dams and Foundation

Robert C. Patev

NAD Regional Technical Specialist

Navigation/Risk and Reliability

Outline

- Time-Dependent Reliability
- Hazard Functions
- Wolf Creek Major Rehabilitation Report (MRR)
  - Time-Dependent Reliability Modeling
  - Expert-Opinion Elicitation

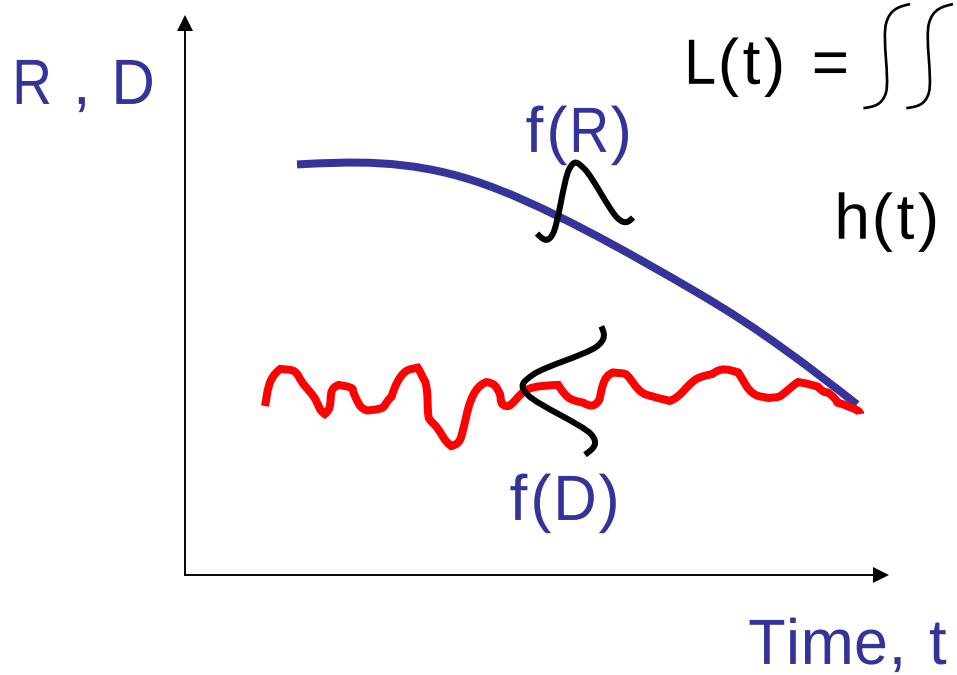
Reliability

- Probability of unsatisfactory performance (PUP)
  - Limit state defined before failure occurs
  - Problem – snapshot in time
  - Not cumulative (does not account for previous loadings)
  - Must account for degradation of structures
    - Mechanisms
      - Corrosion
      - Fatigue
      - Freeze-Thaw
      - Wear
      - Abrasion/Erosion

Time-Dependent Reliability

- Geotechnical Aspects
  - Difficult task-at-hand
    - Foundations
      - Karst
        - Used Expert-Opinion Elicitation to define PUPs
        - Snapshot
      - Alluvial
        - Used Taylor Series
        - Snapshot
    - Degradation
      - Data/Rates
      - Models

Time-Dependent Reliability



$$L(t) = \iint f(R)*g(t)\ f(D)$$

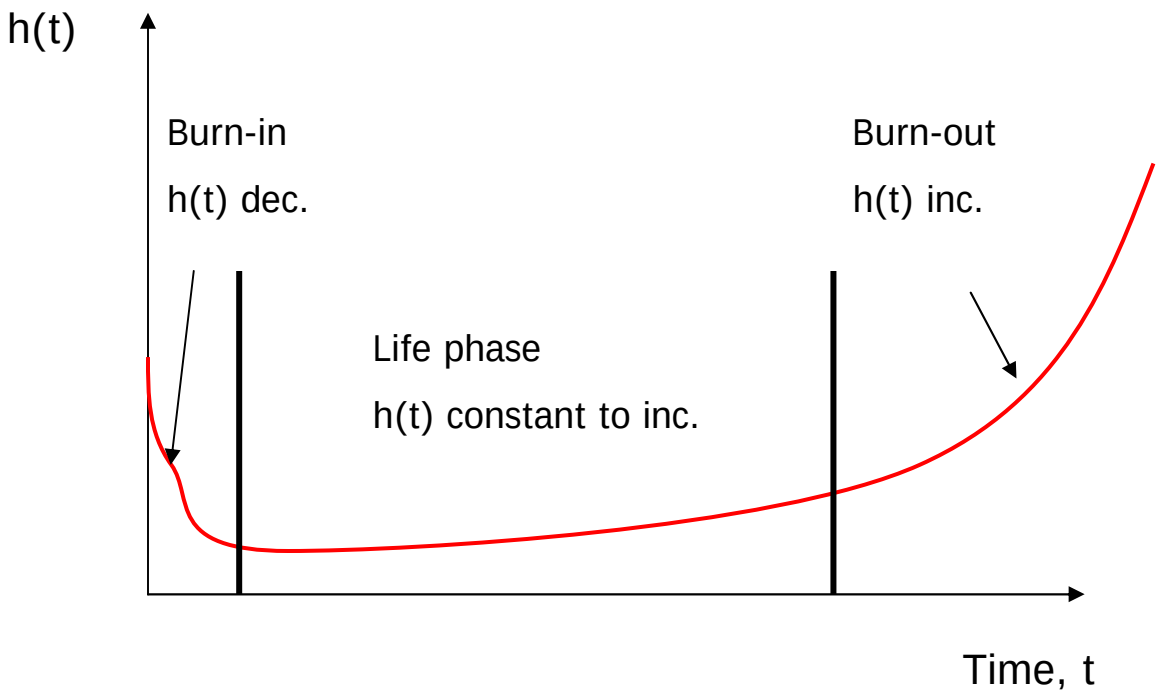
$$h(t) = -\ln d/dt\ (L(t))$$

Time-Dependent Reliability

- Hazard Function
  - Developed by actuaries in 1880's
  - Used by aerospace industry in early 1950's
  - Conditional probability
    - h(t) = PUP [t + dt, t]
      - PUP in time, t+ dt, given you have survived up to time, t
      - Based on efforts on Ohio River Mainstem Study

$$h(t) = \frac{\text{Number of unsatisfactory performances in time, } t+1}{\text{Number of survived up to time, } t}$$

Hazard Function



Wolf Creek Dam Project

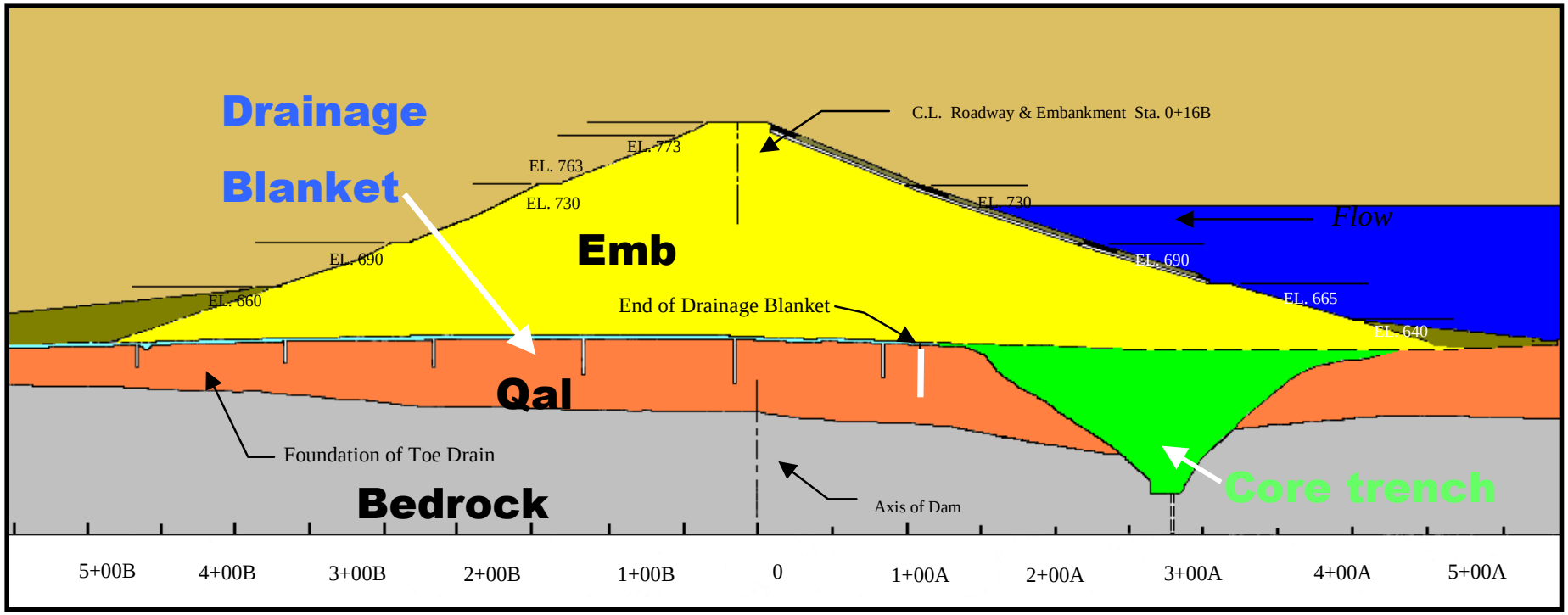


- Concrete 240’ ht 1836’ length
- Earth Emb 200’ ht 3900’ length

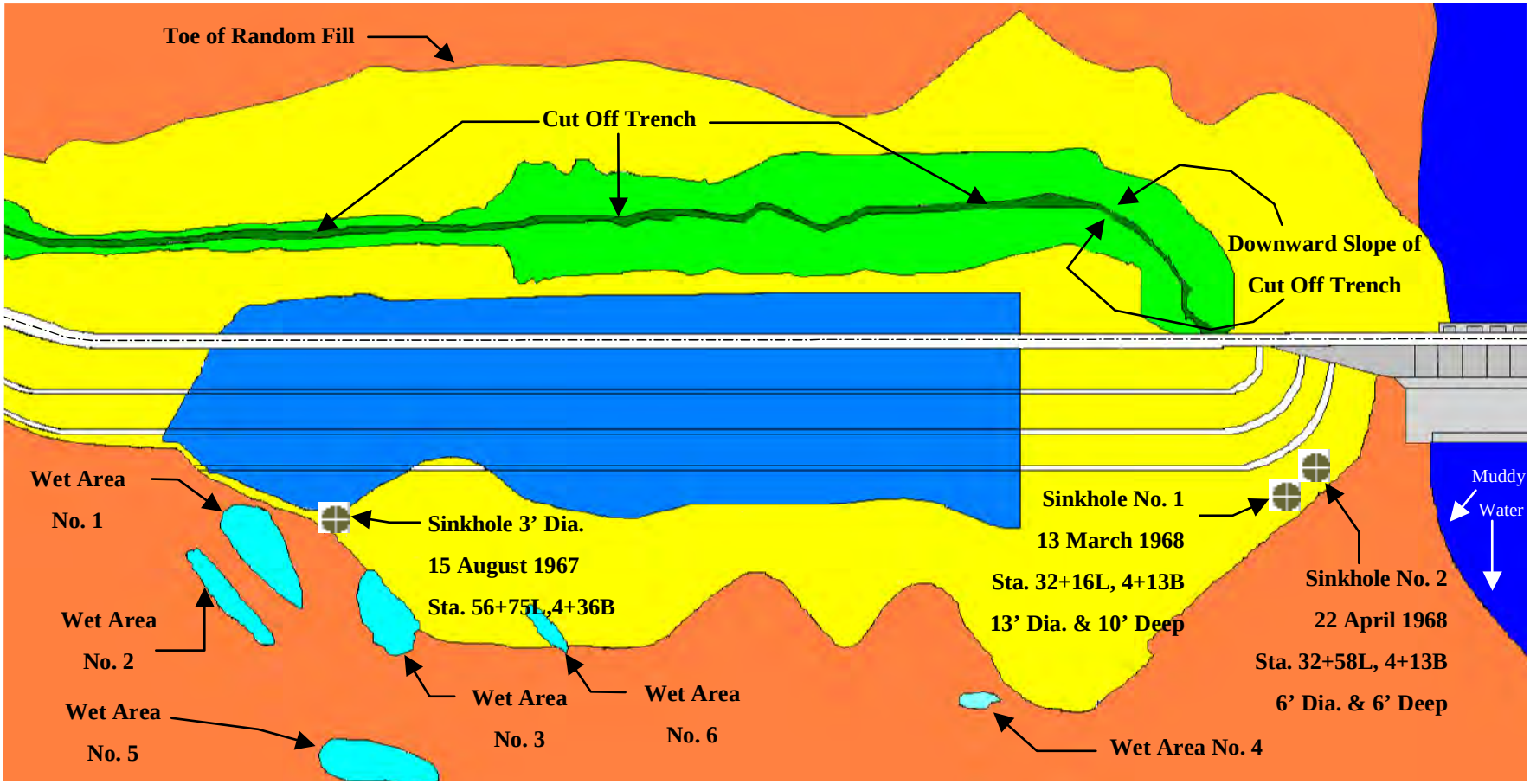
Wolf Creek Dam - History

- Designed in late 1930's
- Construction began 1941
- Completion delayed until 1951 due to WWII
- 1967-68 Sinkholes near Switchyard + right d/s abutment wet areas D/S of embankment, muddy flows
- 1968-72 Emergency exploration / grouting
- 1975-79 Diaphragm walls construction (ICOS)

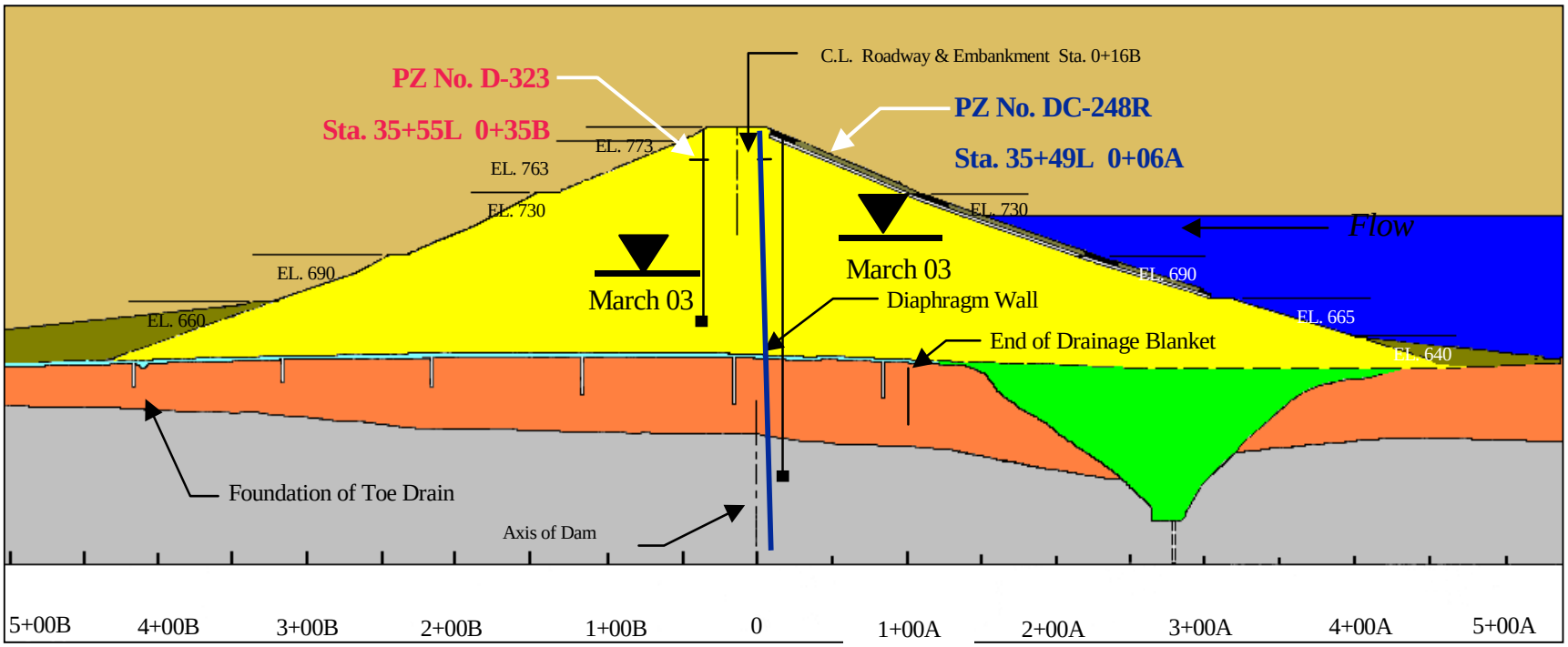
Wolf Creek Dam – Typical Section



Wolf Creek Dam – 1967/1968 Events



Wolf Creek Dam – Piezometers



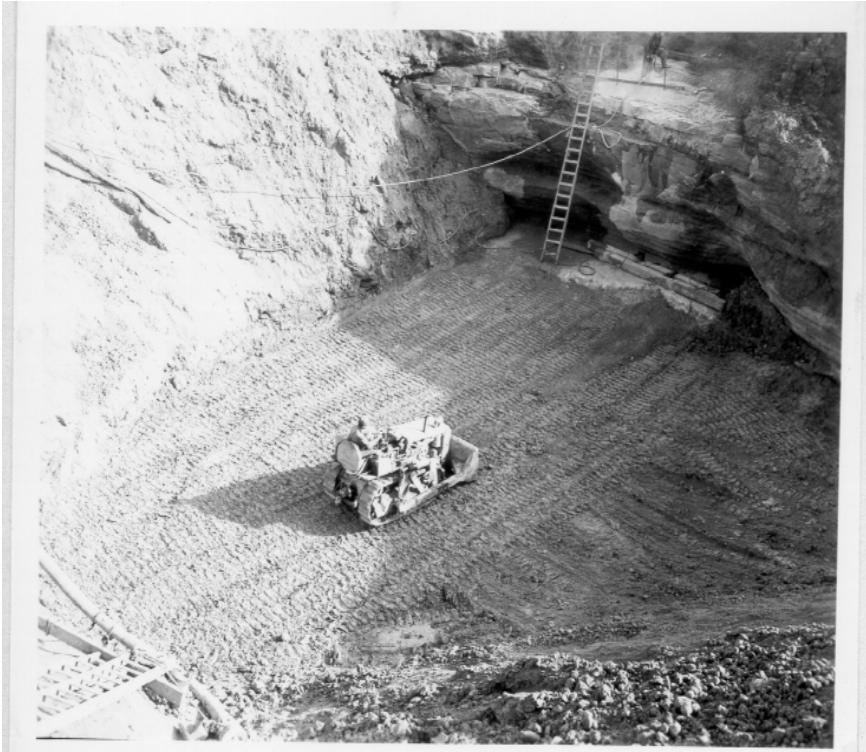
Wolf Creek Dam – Cutoff Trench



Wolf Creek Dam – Cutoff Trench

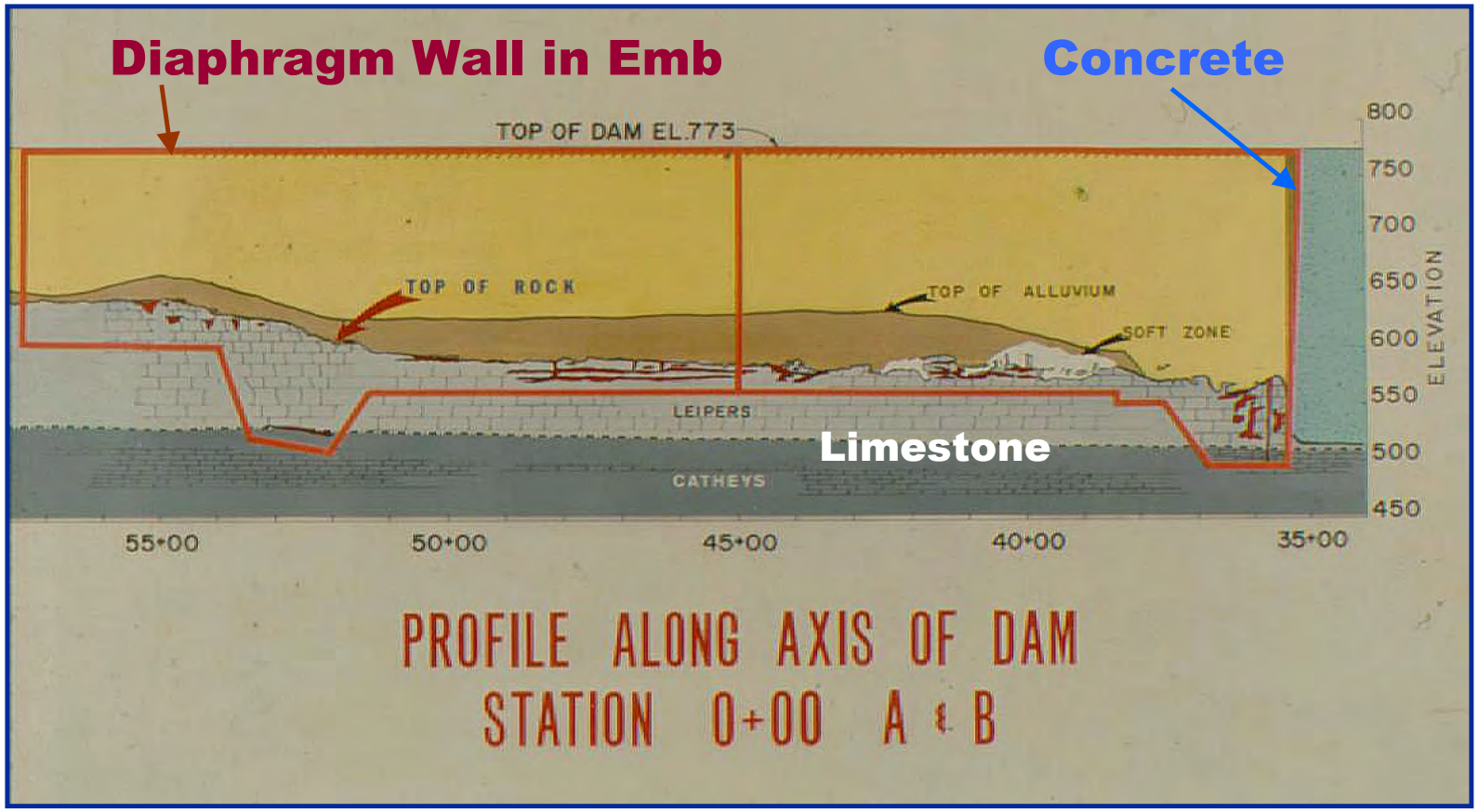


61/421 14 August 1947
Filling core trench, Mon. 37

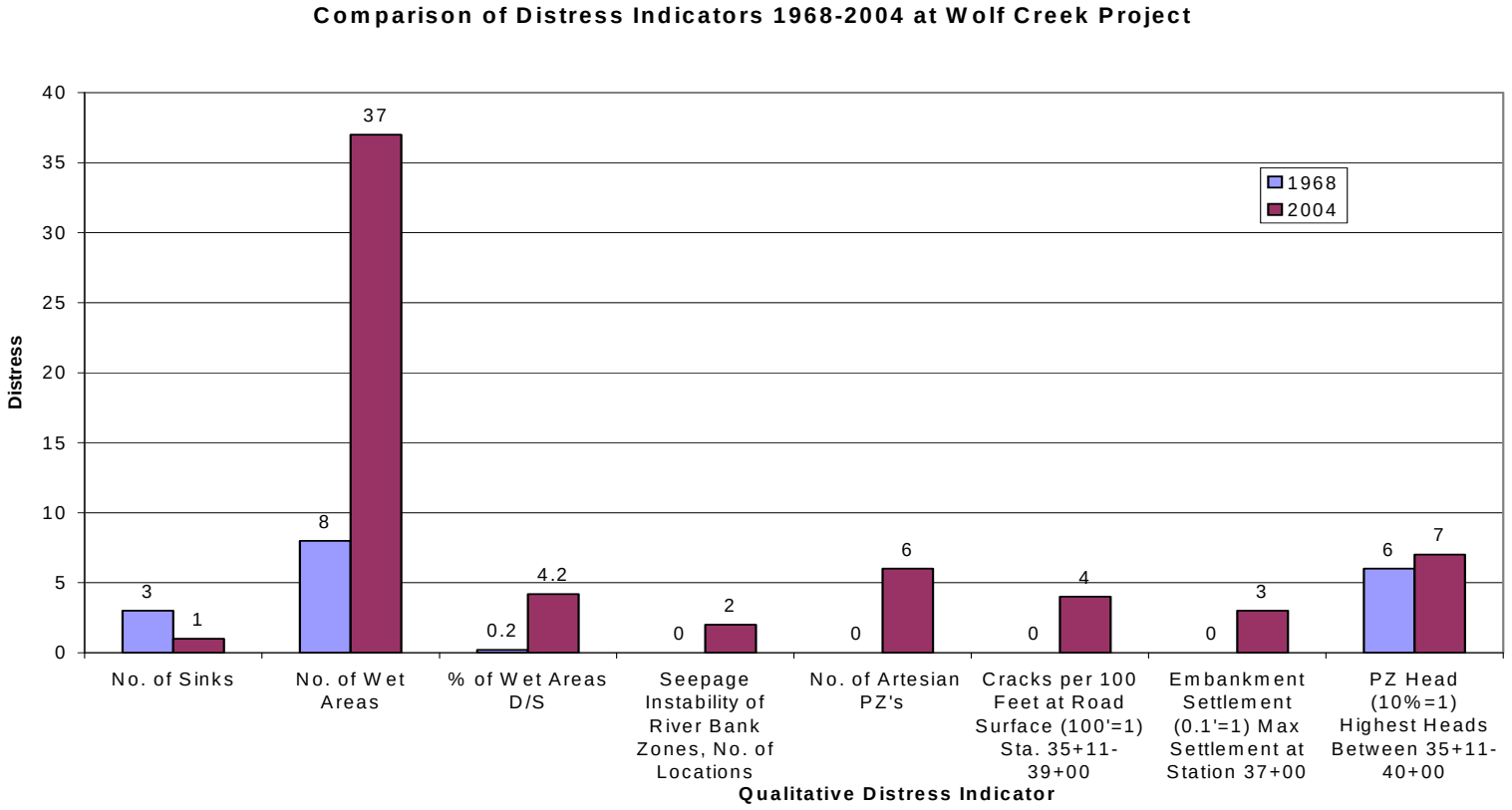


31,822 19 November 1942
View of backfilling operations in cavity at Sta. 50+00 on cutoff trench

Wolf Creek Dam – Diaphragm Wall, 1975-1979

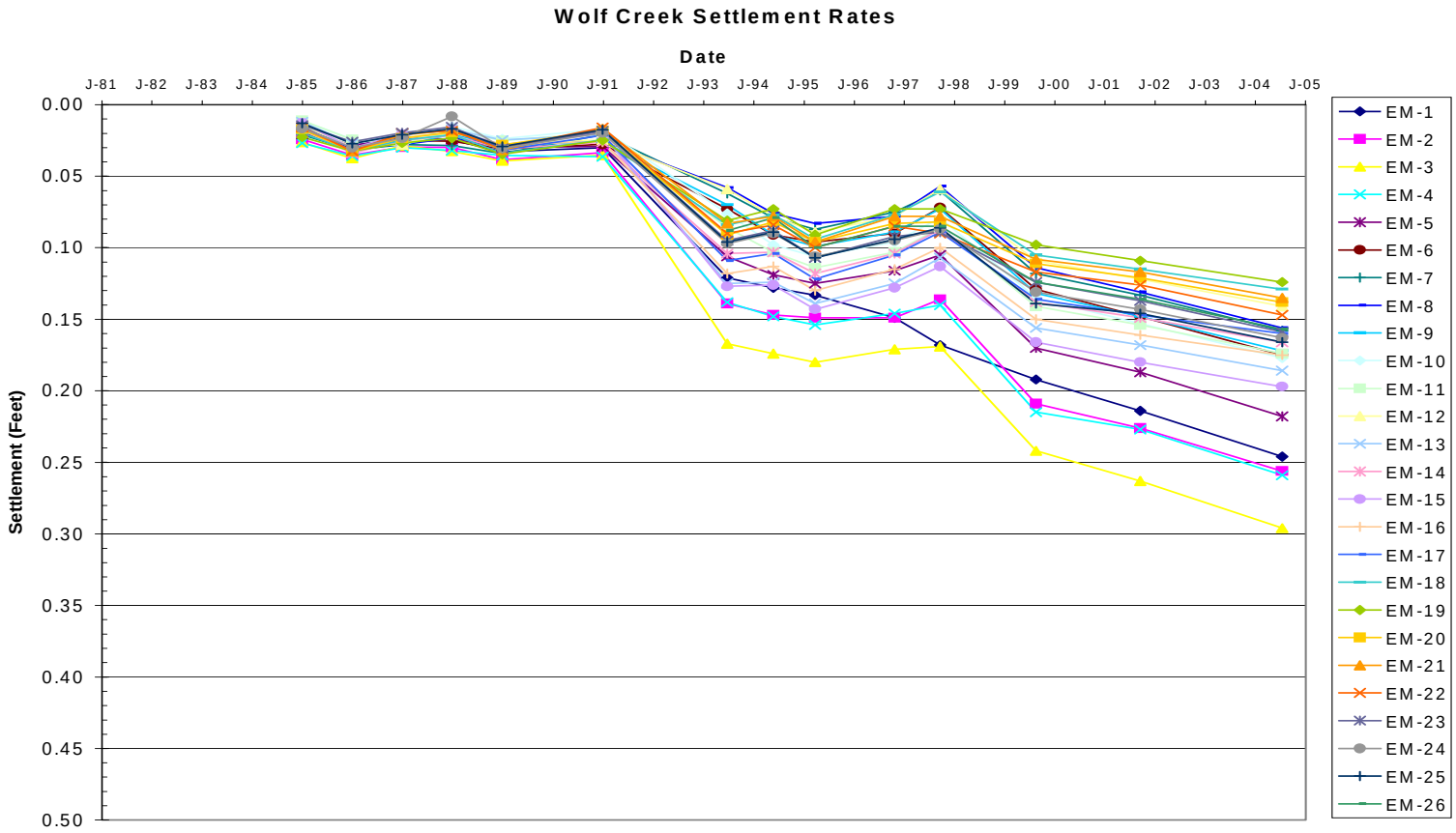


Wolf Creek Dam – Distress Indicators

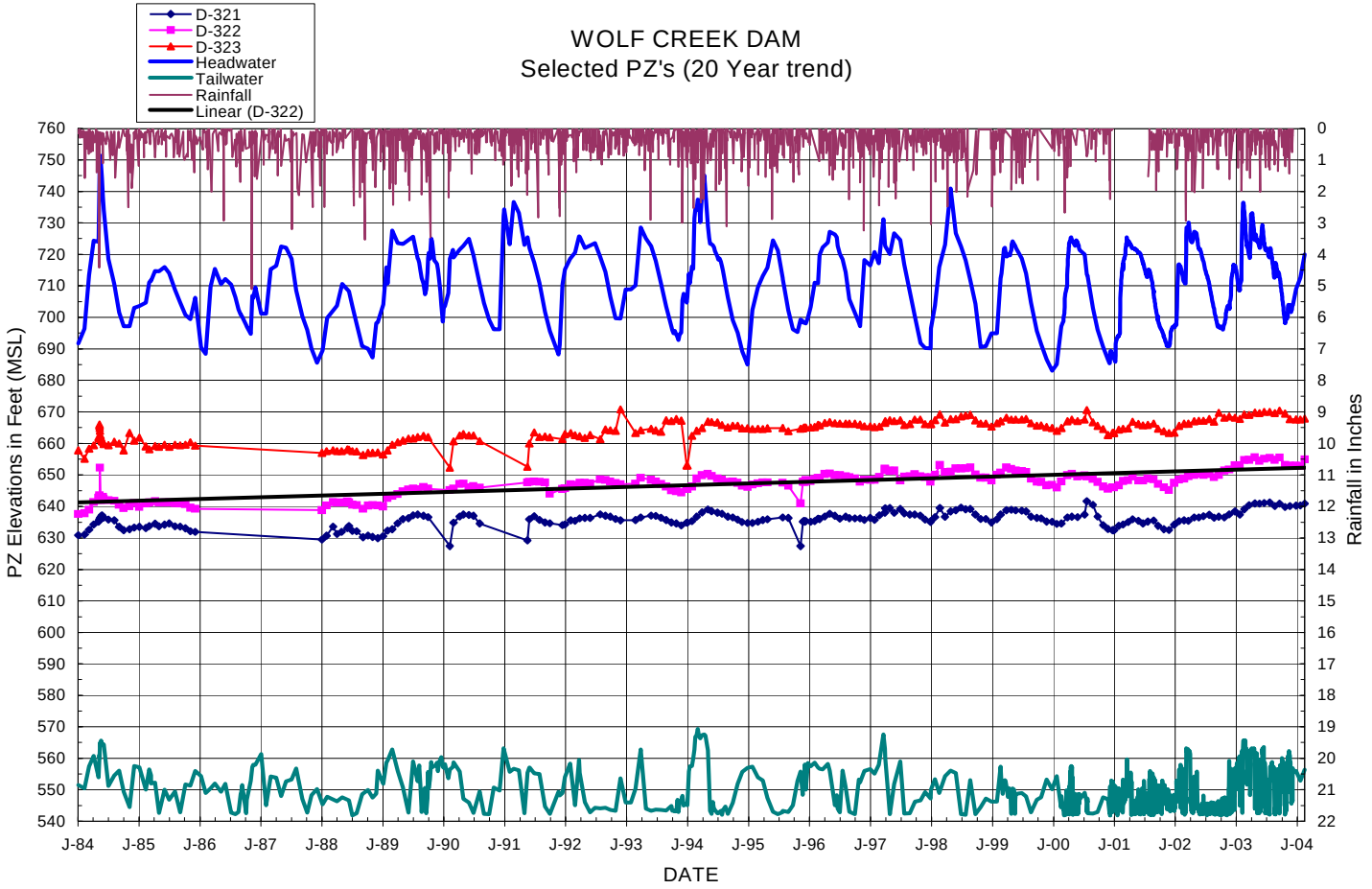


* Temperature measurements from PZs in 1968 and 2004 show anomalistic cold areas downstream of dam axis.

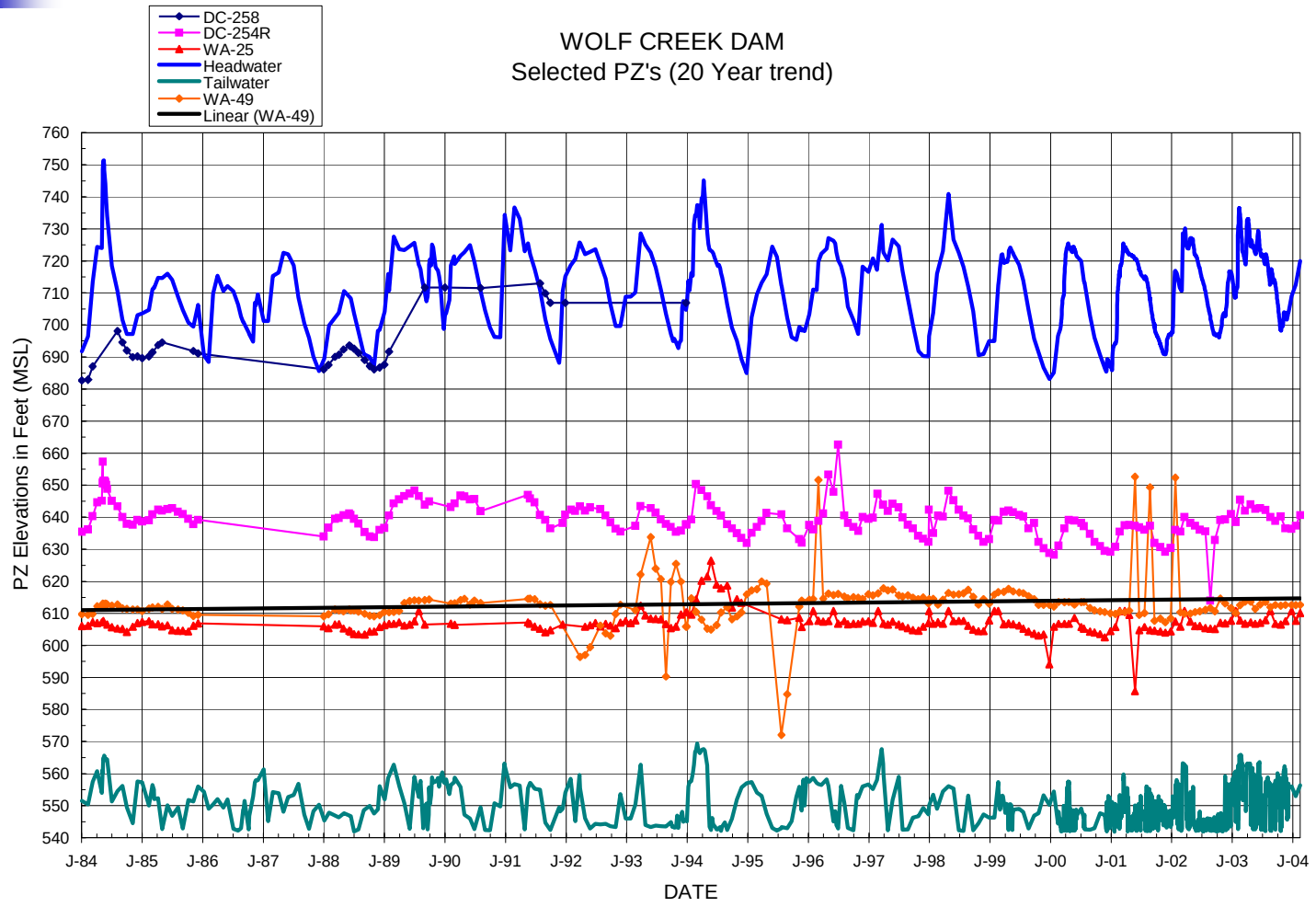
Wolf Creek Dam – Crest Settlement



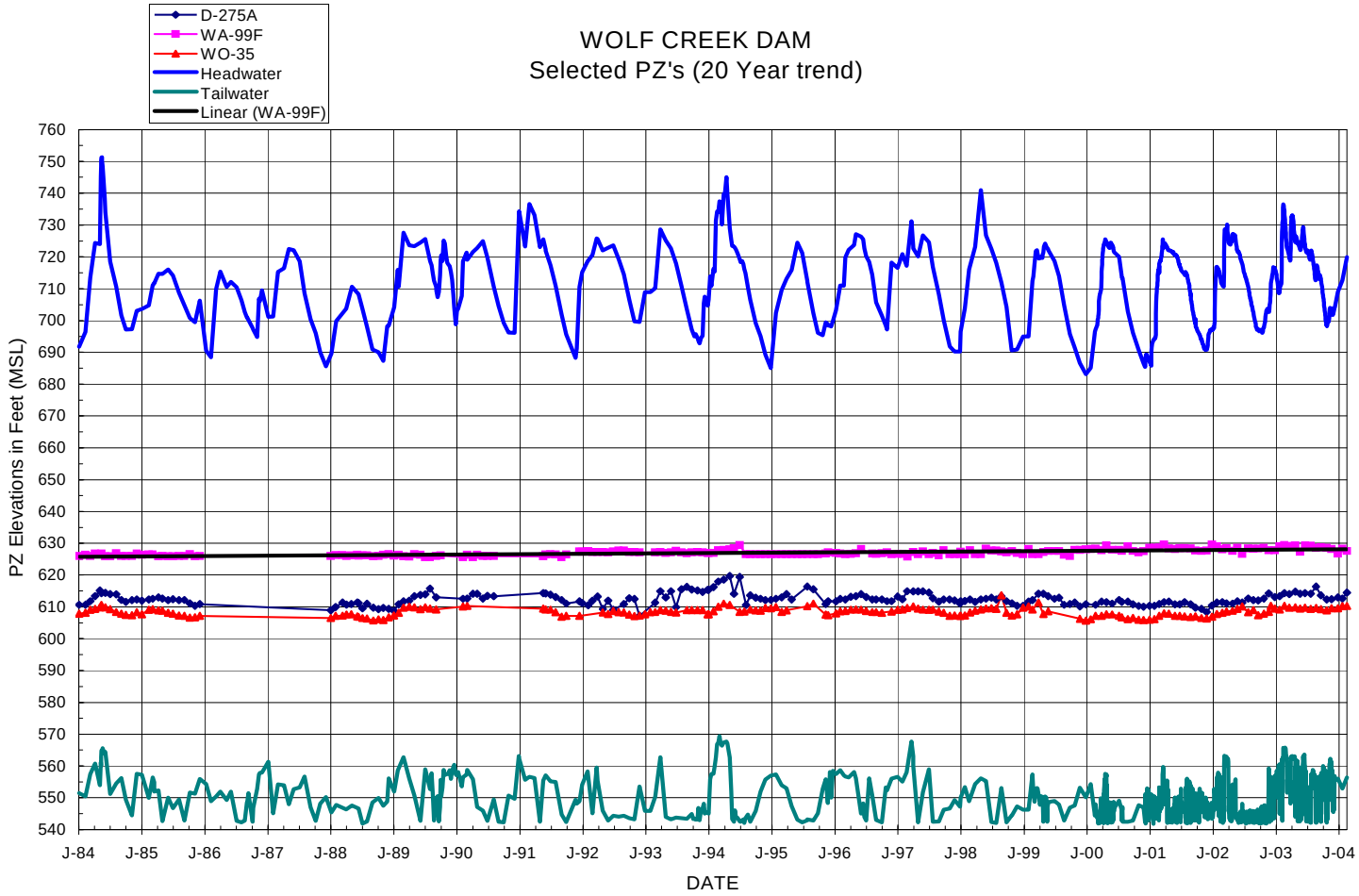
Wolf Creek Dam – Piezometric Data - Section 1



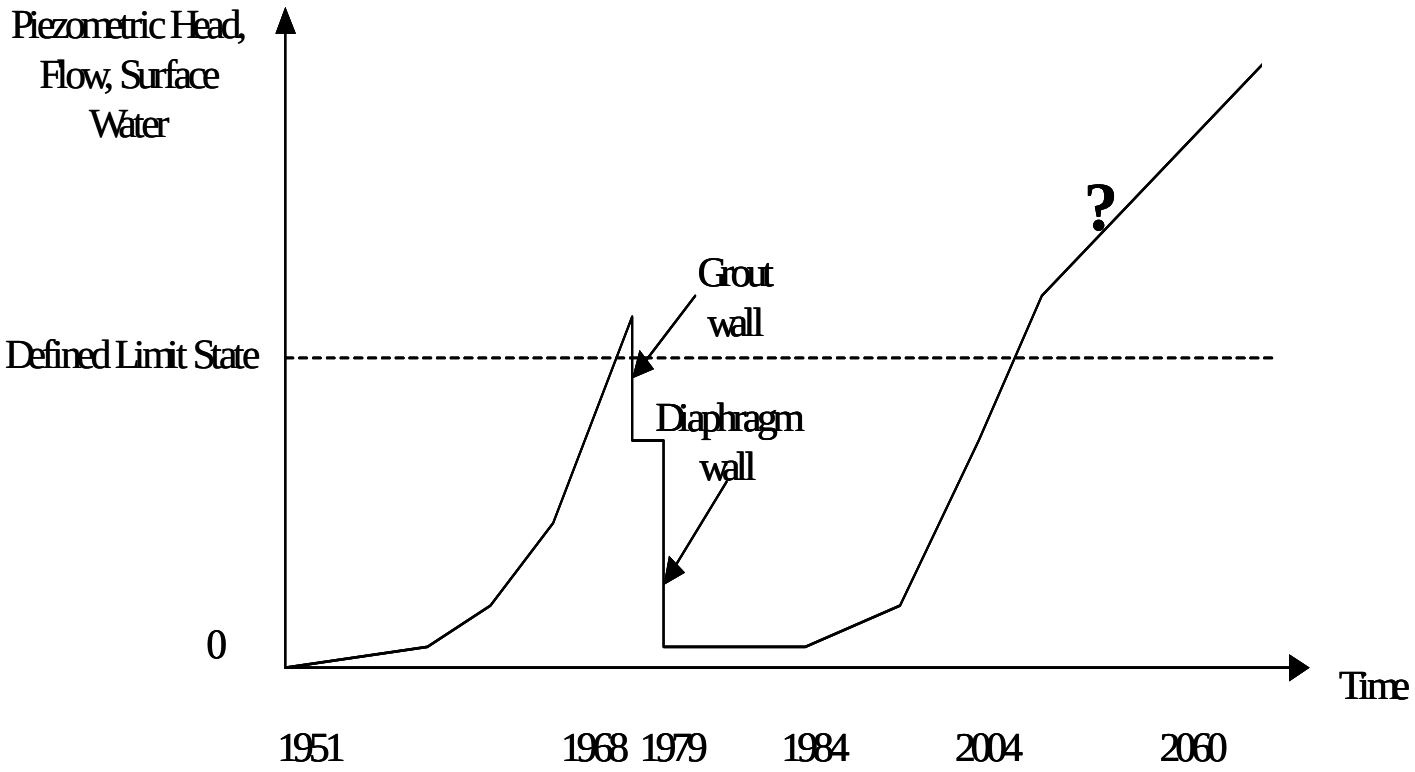
Wolf Creek Dam – Piezometric Data -Section 2



Wolf Creek Dam – Piezometric Data - Section 3



Wolf Creek Dam – Time-Dependent Reliability Concepts

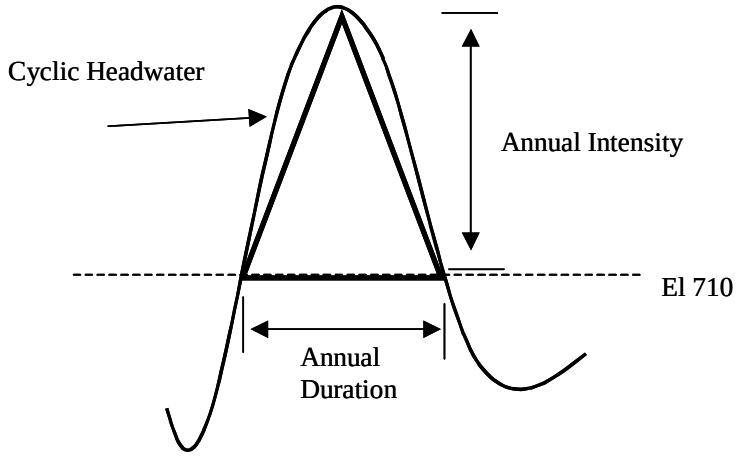


Wolf Creek Dam MRR

- Time-Dependent Reliability Model
  - Utilize permanent rise in piezometric pressures in the foundations
    - Reliable and most consistent data
    - Model three different embankment sections
    - Assume that selected limit state occurs before any decrease or fall in piezometric pressure which would indicate a more critical situation

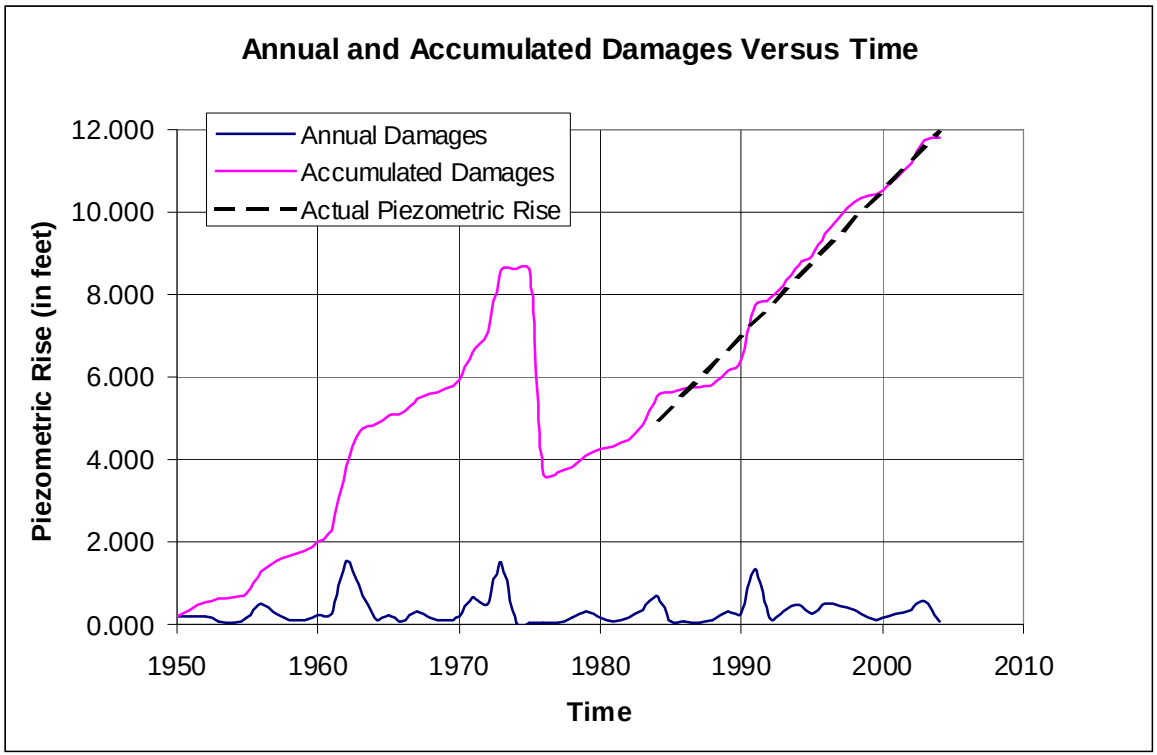
Wolf Creek Dam MRR

- Time-Dependent Reliability Model
  - Damage Accumulation Model (DAM)
    - Used in fatigue and wear rate analyses
    - Model cyclic variations of headwater above EL 710



Wolf Creek Dam MRR

- Time-Dependent Reliability Model
  - DAM Calibration



Wolf Creek Dam MRR

- Time-Dependent Reliability Model
  - Developed Monte Carlo Simulation Model
    - Accounted for entire life cycle including past remedial repairs
    - Performed 50,000 iterations for reliability calculations
  - Random Variables
    - Annual Intensity –
      - Based on historical records from 1950 to 2004
      - Truncated lognormal distribution
    - Annual Duration –
      - Based on historical records from 1950 to 2004
      - Truncated lognormal distribution

Wolf Creek Dam MRR

- Time-Dependent Reliability
  - Random Variables (cont')
    - Spatial Variability Factor-
      - Accounts for variation in piezometric pressures in the foundation
      - Based on a wide range of piezometer data for each section
      - Incorporated as quadratic modifier to annual damage accumulation
      - Uniform distribution
        - More uncertainty in Section 3 than Sections 1 or 2 due to continued wet spots downstream and lack of diaphragm wall

Wolf Creek Dam MRR

- Time-Dependent Reliability Model
  - Limit state
    - Defined limit state for unsatisfactory performance on piezometric rise in 3 sections
    - Used Expert-Opinion Elicitation to quantify those values

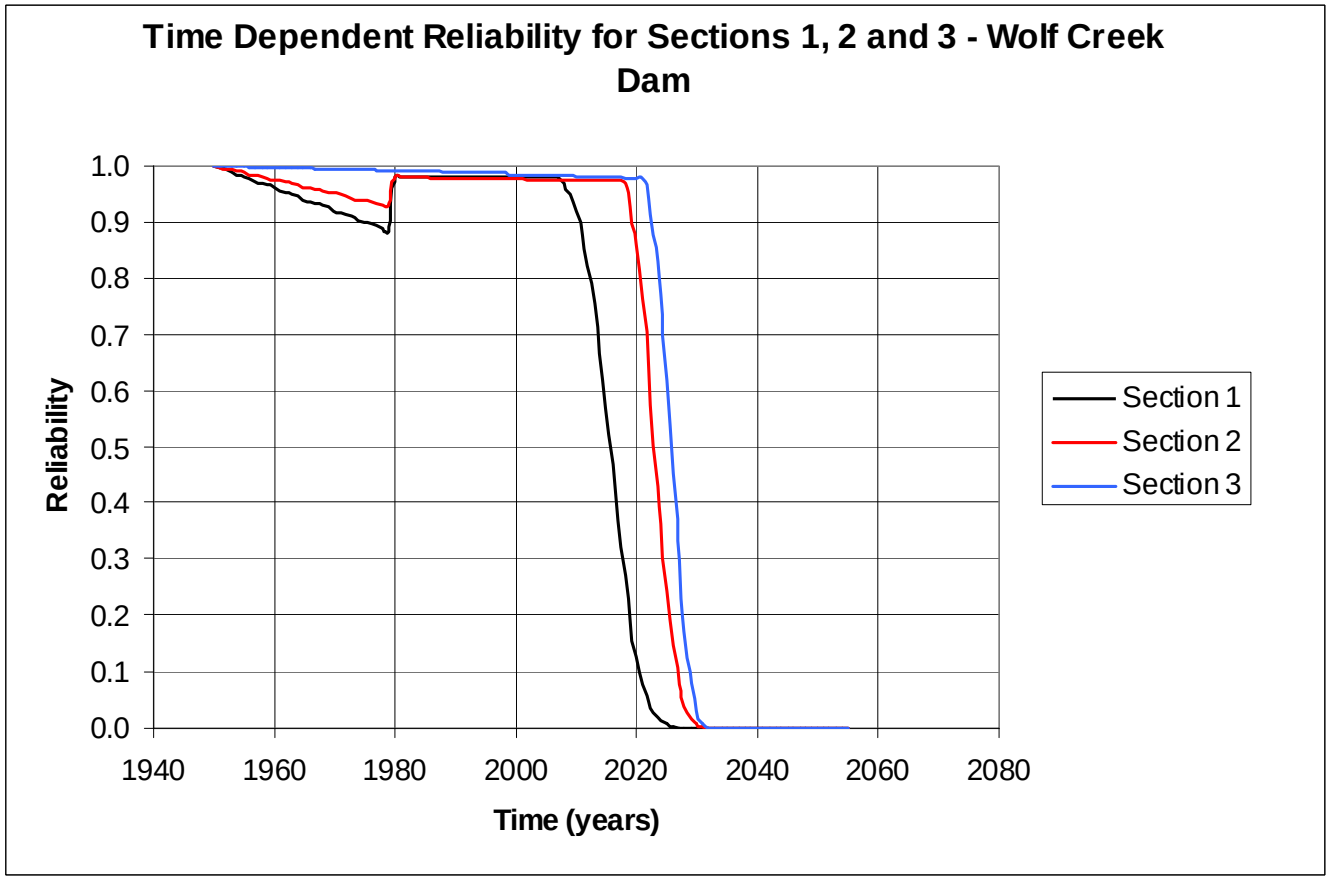
Section	Average PZ Value in 2004 (in feet)	Rise of PZ from EOE (in feet)	Unsatisfactory Performance Limit State (in feet)
1	9.3	5	14.3
2	4.1	5	9.1
3	1.2	3	4.2

Wolf Creek Dam MRR

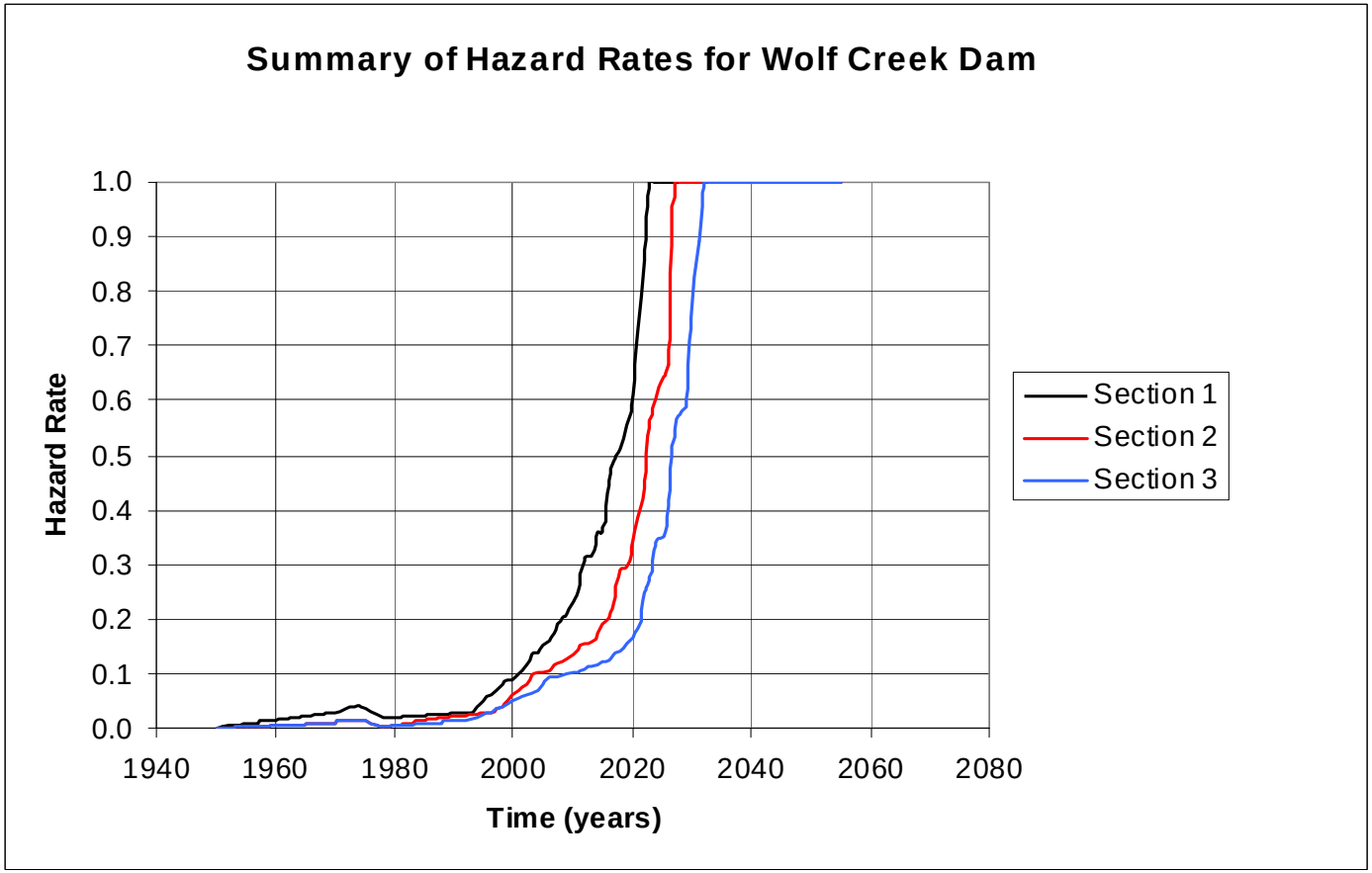
Wolf Creek Expert Elicitation

Event Name	Full Description of Issue	Expert-opinion elicitation			Summary Table	
		First Response	Second Response			
Unsatisfactory performance occurs in Section 1	At what future change in piezometric pressure in the foundation would you expect unsatisifactory performance in Section 1?	**Median =** 5	**Median =** 5			
				Confidence	**Minimum =**	1
	Expert #1	0.5	1	med	**25 Percentile =**	3
	Expert #2	5	5	high		
	Expert #3	10	7	med	**Median =**	5
	Expert #4	3	2	med		
	Expert #5	5	5	med	**75 Percentile =**	5
	Expert #6	5	4	high		
					90 Percentile =	6
					High =	7
	Minimum =	0.5	1			
	Median =	5	5			
	Maximum =	10	7			

Wolf Creek Dam MRR



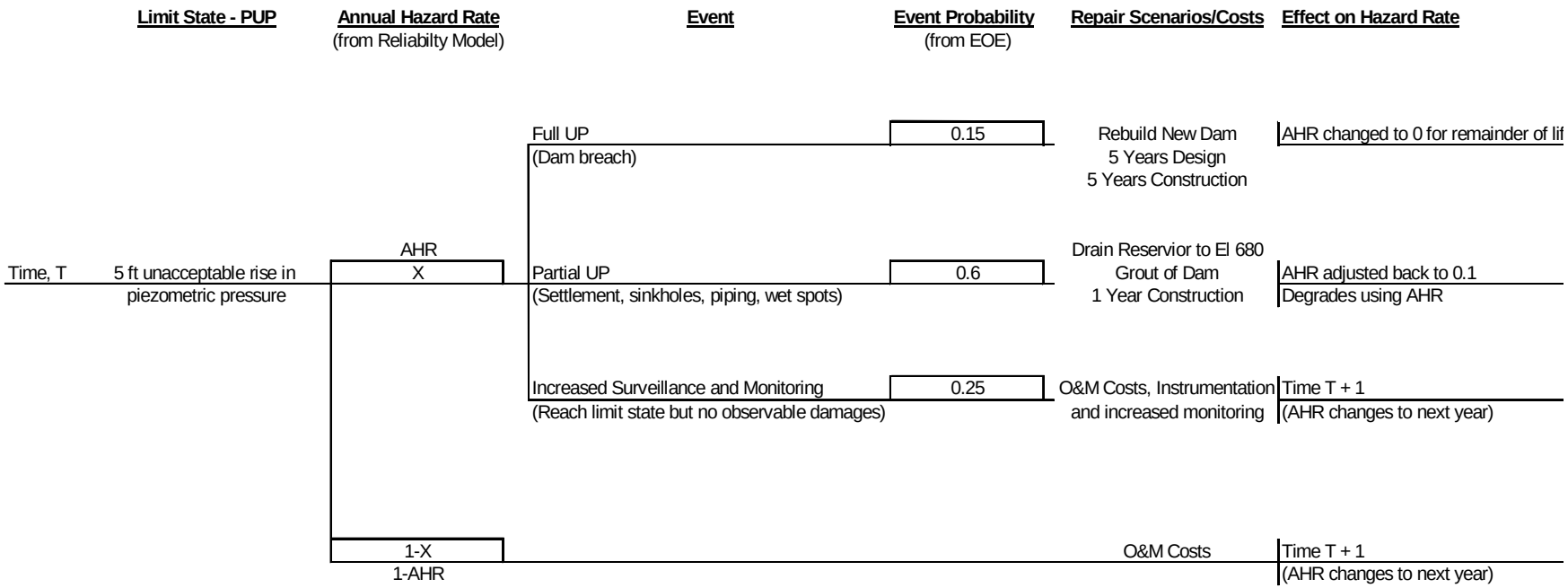
Wolf Creek Dam MRR



Wolf Creek Dam MRR

Wolf Creek Dam Event Tree

Baseline Condition - Section 1



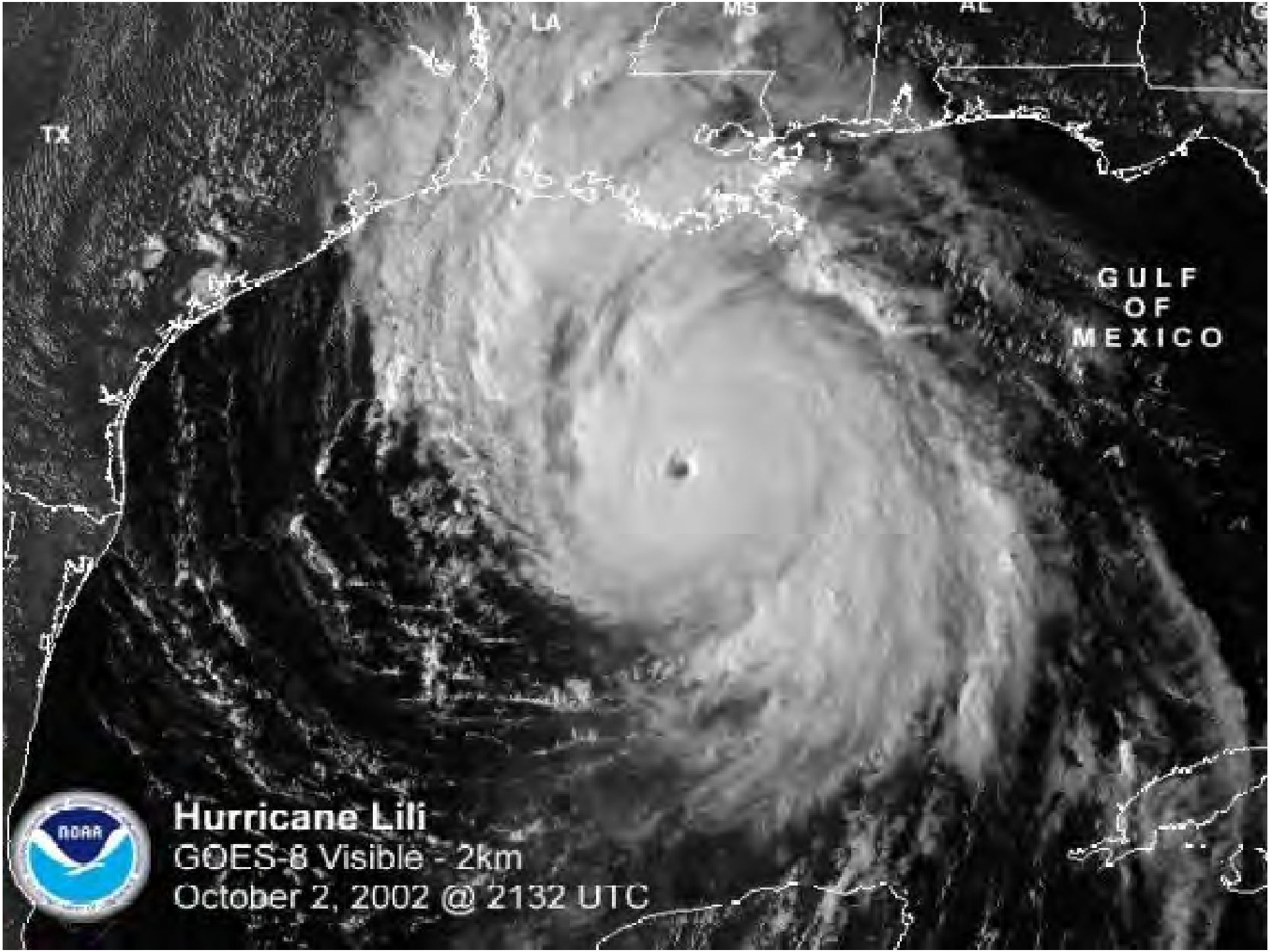
Time-Dependent Reliability

- Conclusions
  - Time-dependent geotechnical models are difficult
    - Need to think well outside the box (deductive versus inductive thinking)
    - Incorporate and define distress indicators
      - My require some data processing
  - Understand - models are for major rehabilitation purpose to gain funding to rehab structure
    - Don’t get lost in the fine details
    - Not the true probability of failure
      - Within an order of magnitude
      - Not for dam safety


U.S. ARMY CORPS OF ENGINEERS
NEW ORLEANS
DISTRICT
SERVING THE ARMY...SERVING THE NATION

LATERAL PILE LOAD TEST RESULTS WITHIN A SOFT COHESIVE FOUNDATION

Richard J. Varuso, P.E.
New Orleans District


LA
MS
AL
TX
GULF
OF
MEXICO
Hurricane Lili
GOES-8 Visible - 2km
October 2, 2002 @ 2132 UTC



TROPICAL STORM FRANCES 1998

BOLLINGER SHIPYARD

HARVEY CANAL

West Bank & Vicinity, New Orleans, LA, Hurricane Protection Project Facts

- WRDA 1986
  - Authorized Westwego to Harvey Canal
- WRDA 1996
  - Modified project to add Lake Cataouatche
  - Also authorized East of Harvey Canal
- WRDA 1999
  - Combined the 3 projects into one
- Cost shared
  - 65% Federal / 35% Non-federal
- Sponsor
  - LADOTD for construction & WJLD for O&M
- Current estimated total project cost: $308M

West Bank & Vicinity, New Orleans, LA, HPP Summary

- Project construction began in 1991
- Will protect approximately 250,000 citizens
- When complete, will cover over 65 miles of levees, floodwalls and floodgates in Orleans, Plaquemines and Jefferson
- Will protect over 65,000 homes and businesses in tri-parish area
- By the end of 2005, federal & local sources will have spent over $100 million
- B/C = 5.1

West Bank & Vicinity, New Orleans, LA, Hurricane Protection Project



New Orleans

MISSISSIPPI RIVER

East of Harvey Canal Area

Lake Cataouatche Area

Westwego to Harvey Canal Area

HARVEY LOCK

HARVEY CANAL

ALGIERS LOCK

ALGIERS CANAL

HERO CANAL

B. SEGNETTE

LAKE CATAOUATCHE

LAKE SALVADOR

SEGNETTE P.S.

OLD WESTWEGO P.S.

NEW WESTWEGO P.S.

AMES P.S.

MT. KENNEDY P.S.

OAK COVE P.S.

HARVEY P.S.

COUSINS P.S.

NEW ESTELLE P.S.

ESTELLE P.S.

HERO P.S.

PLAQUEMINES P.S.

PLANTERS P.S.

N.O. S&WB P.S. #11

N.O. S&WB P.S. #13

BELLE CHASSE #2 P.S.

90

45

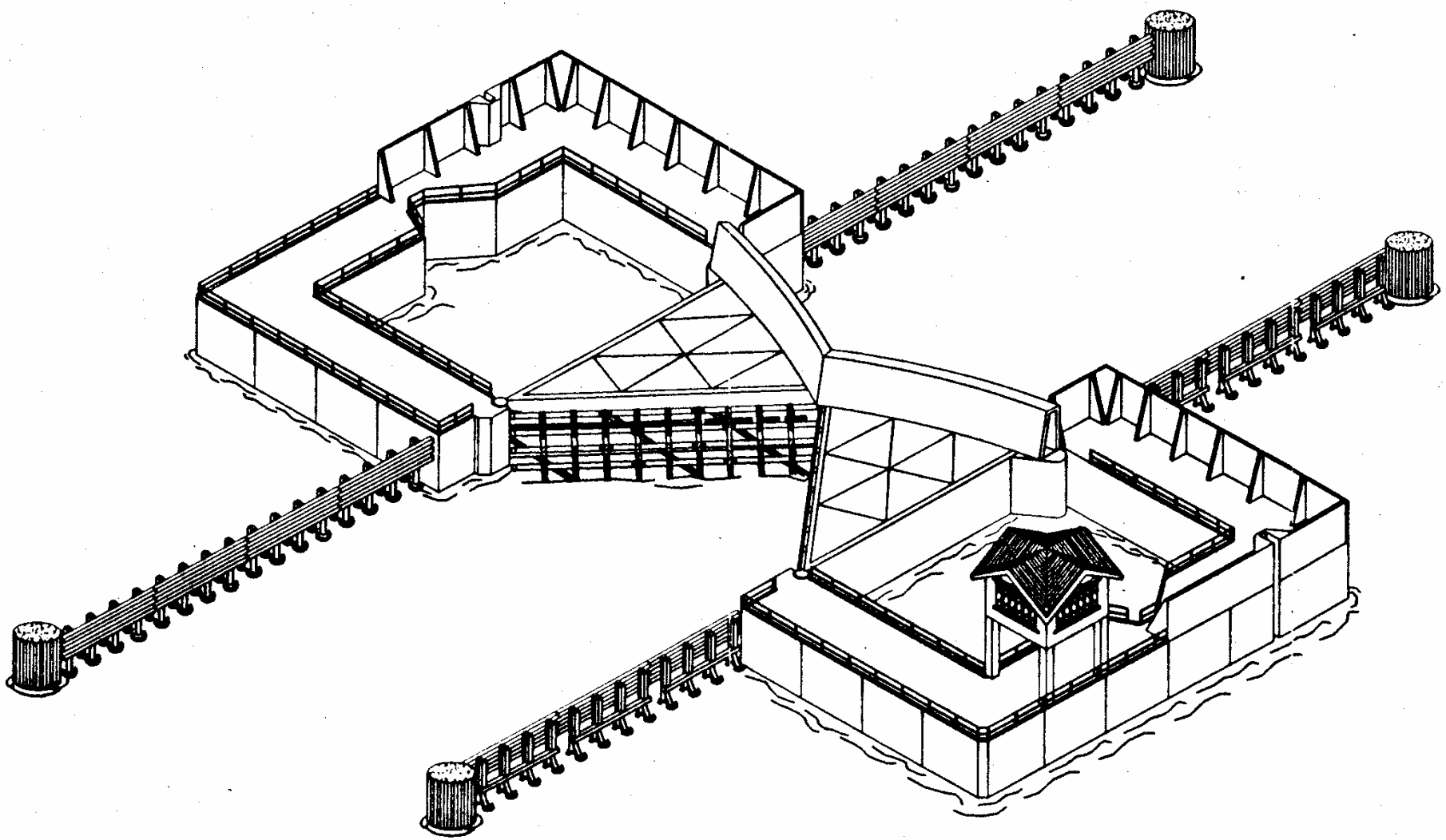
23

Existing Pumping Stations

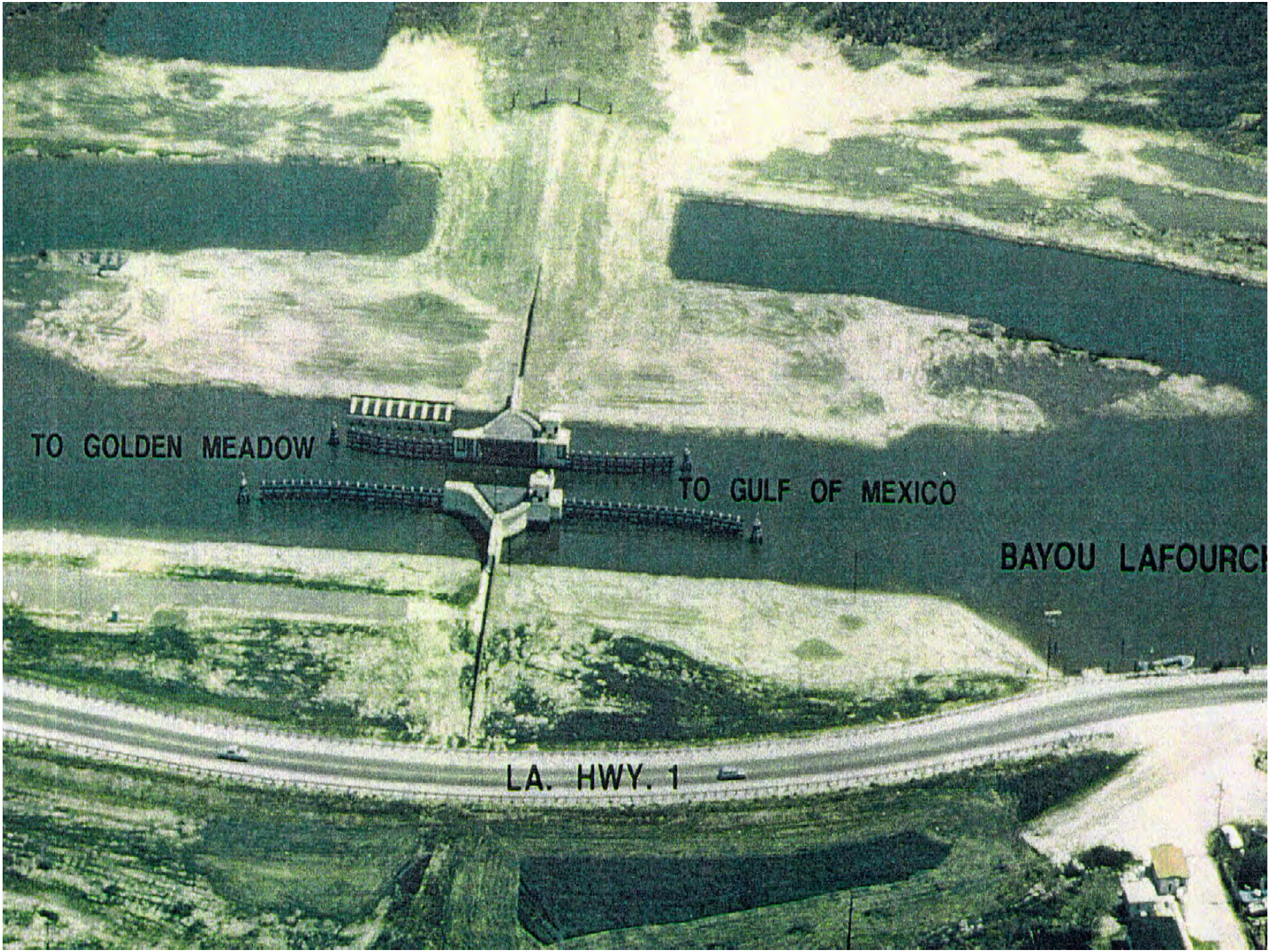
Project Levees/Floodwalls

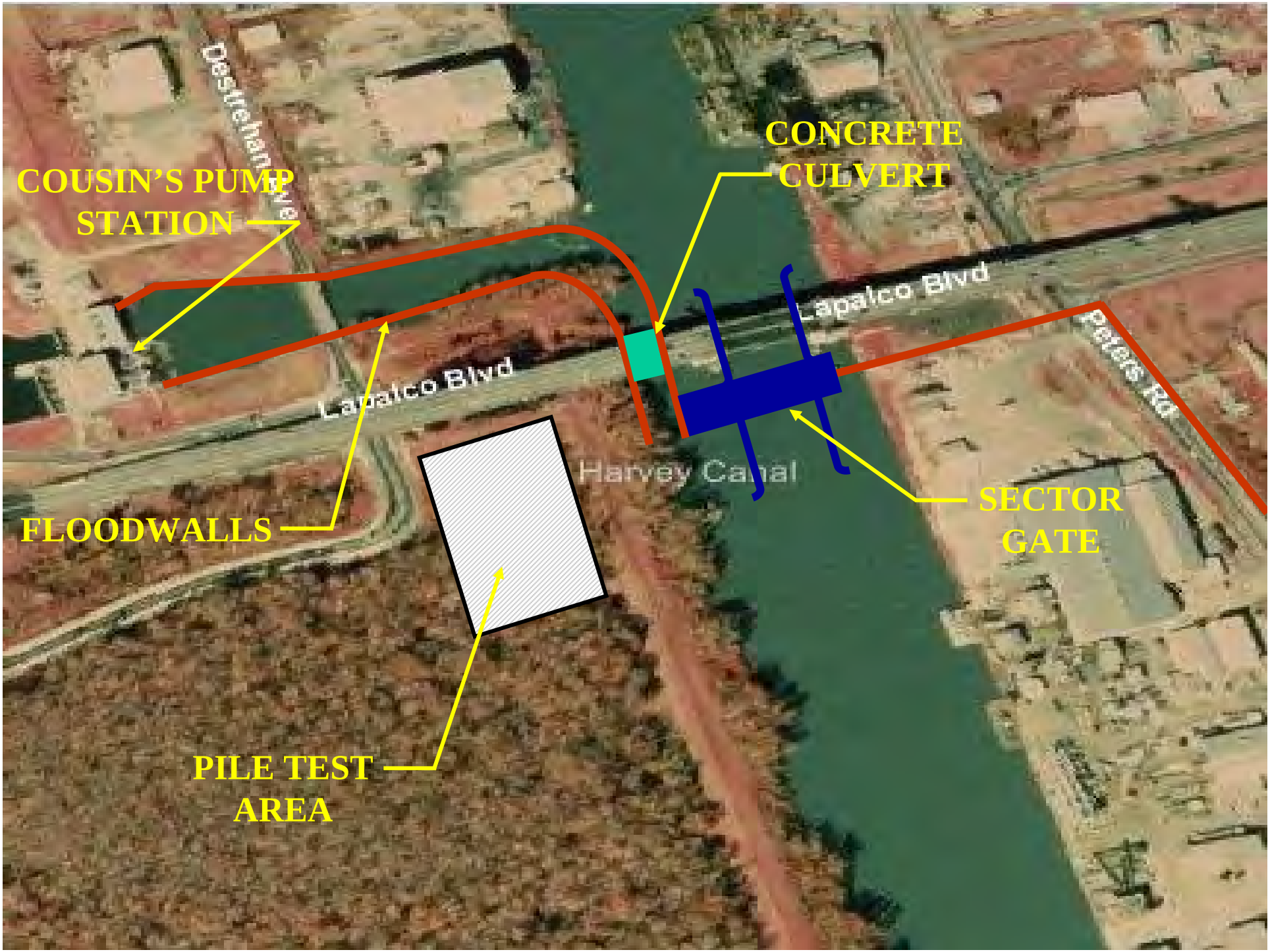
Road

Floodgate Structure



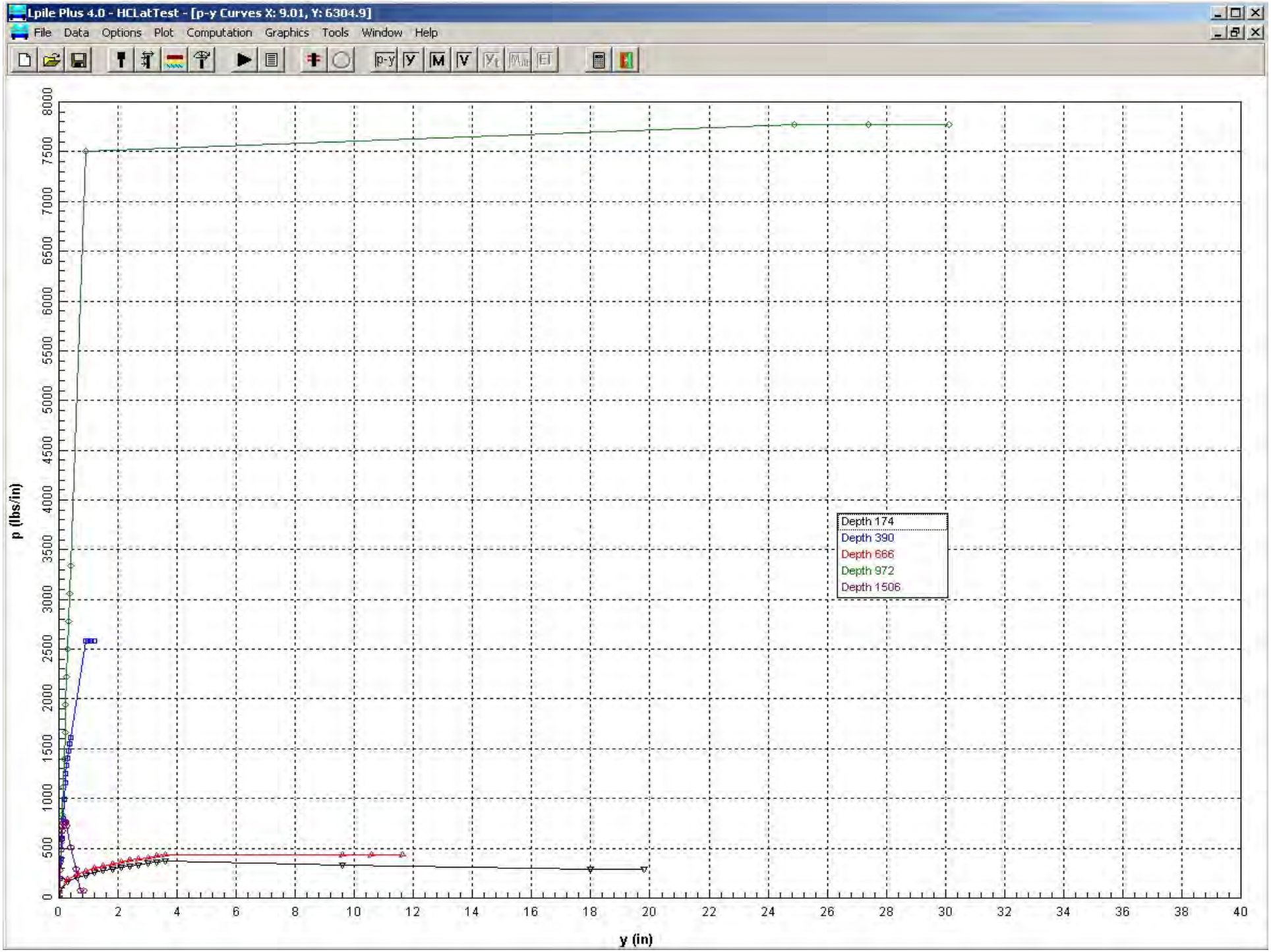
CONCRETE GRAVITY FLOODGATE
WITH
BUOYANT STEEL SECTOR GATES


TO GOLDEN MEADOW
TO GULF OF MEXICO
BAYOU LAFOURCH
LA. HWY. 1


COUSIN'S PUMP STATION
CONCRETE CULVERT
Destrehan Ave
Lapalco Blvd
Lapalco Blvd
Peters Rd
Harvey Canal
FLOODWALLS
SECTOR GATE
PILE TEST AREA

DESIGN ALTERNATIVES

- CASE Pile Group Analysis (CPGA)
  - Rigid Base Analysis
  - Single “Average” value of E_s
- G-Pile
  - Utilization of multiple p-y curves
  - Development of Pile Head Deflection curves
  - Develop Moment vs Deflection curves


Lpile Plus 4.0 - HCLatTest - [p-y Curves X: 9.01, Y: 6304.9]
File Data Options Plot Computation Graphics Tools Window Help
p (lbs/in)
y (in)
Depth 174
Depth 390
Depth 666
Depth 972
Depth 1506


Lpile Plus 4.0 - HCLatTest - [Load vs Top Deflection X: 7.9473, Y: 95.039]
File Data Options Plot Computation Graphics Tools Window Help
Lateral Load (kips)
0 10 20 30 40 50 60 70 80 90 100 110 120
Pile-Head Deflection (in)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50

G-PILE / CPGA COMPARISION (Normal Operating Case)

G-PILE RESULTS

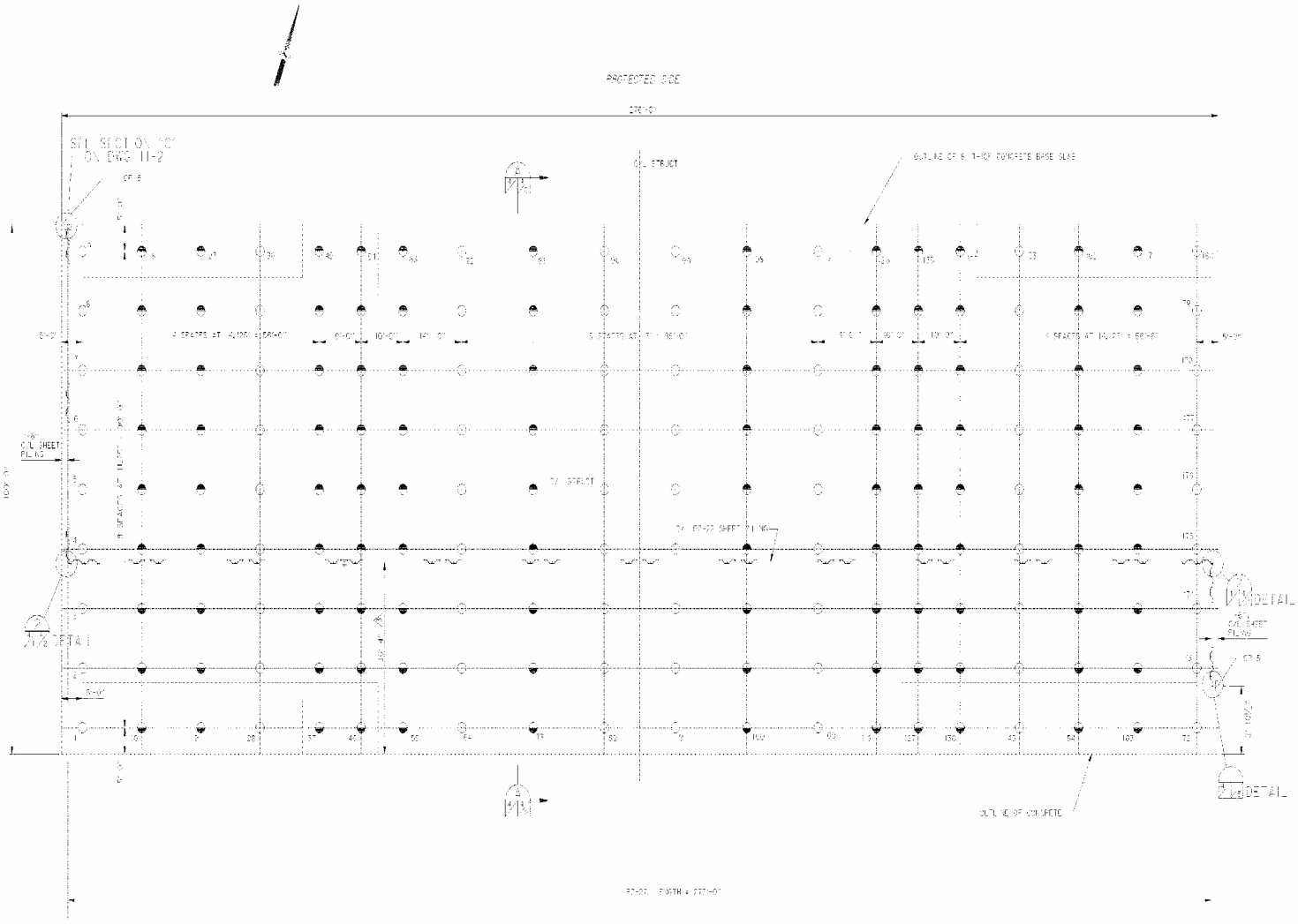
- Average E_s = 0.44 k/in^2
- CBF = 0.31
- δ_{max} = 0.125 in

CPGA RESULTS

- Average E_s = 0.17 k/in^2
- CBF = 0.59
- δ_{max} = 0.258 in

PILE FOUNDATION DESIGN HISTORY AND DETAILS

- Structure was designed as a Float-In Structure
  - 91 Piles (56 vertical – 35 battered)
  - 48” Dia. Pipe piles
- Solicited as a Best Value Contract - Contractor elected to construct in place
- Resulted in new pile foundation
  - 180 Piles (72 vertical – 108 battered)
  - 24” Dia. Pipe piles



SECTOR GATE STRUCTURE PILE SCHEDULE					
TOTAL NUMBER OF PILES	PILE BATTER	PILE TOP ELEVATION	PAYMENT LENGTH WITH 20' EMBED.	SERVICE LOAD COMP. KIP	SERVICE LOAD TENS. KIP
105 PILES	69 ON 1	+47	67 FT	500	90
77 PILES	VERTICAL	+61	49 FT	300	53

PILE NOTES:

1. ALL PILES ARE 24"Ø X 1/2" THK WALL STEEL PIPE PILES (OR EQUIVALENT) PER ASTM A252, GRADE 3.
2. EXACT ENDING OF SHEET PILE TIPS SHALL BE DETERMINED AFTER PILE TESTS ARE COMPLETED. LENGTHS SHOWN ARE FOR ESTIMATING PURPOSES ONLY.
3. FLOODWALL PILES SHOWN ON DWGS. 11-4 AND 11-5.

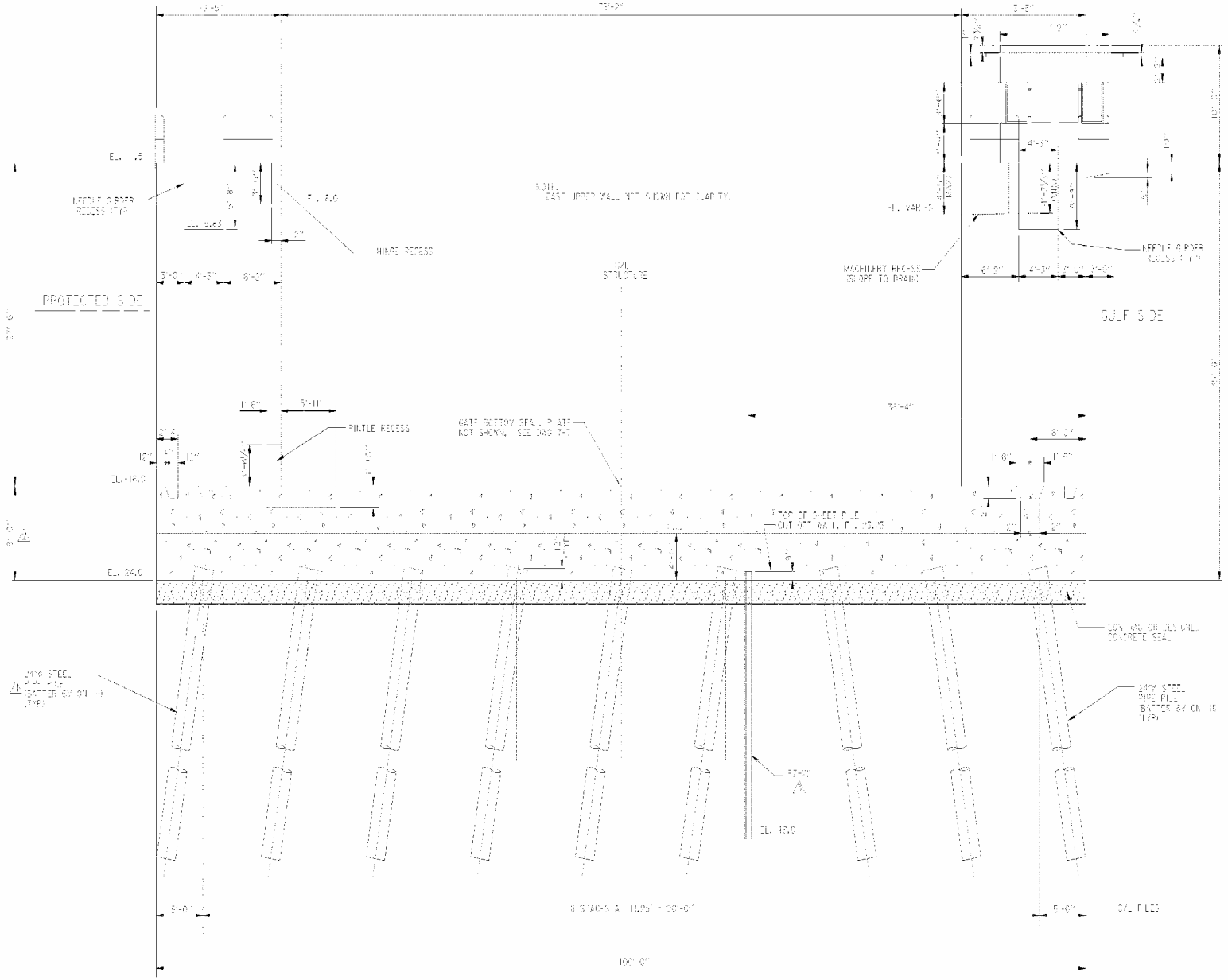
PILE AND SHEETPILE LAYOUT

SCALE: 1/8" = 1'-0"

NOTE:
PILE DIMENSIONS TAKEN AT EL +10.0

PILE LEGEND

- DIRECTION OF BATTER
- 69 ON 1 = 54.46° BATTER
- VERTICAL PILES
- 01 = PILE NUMBER



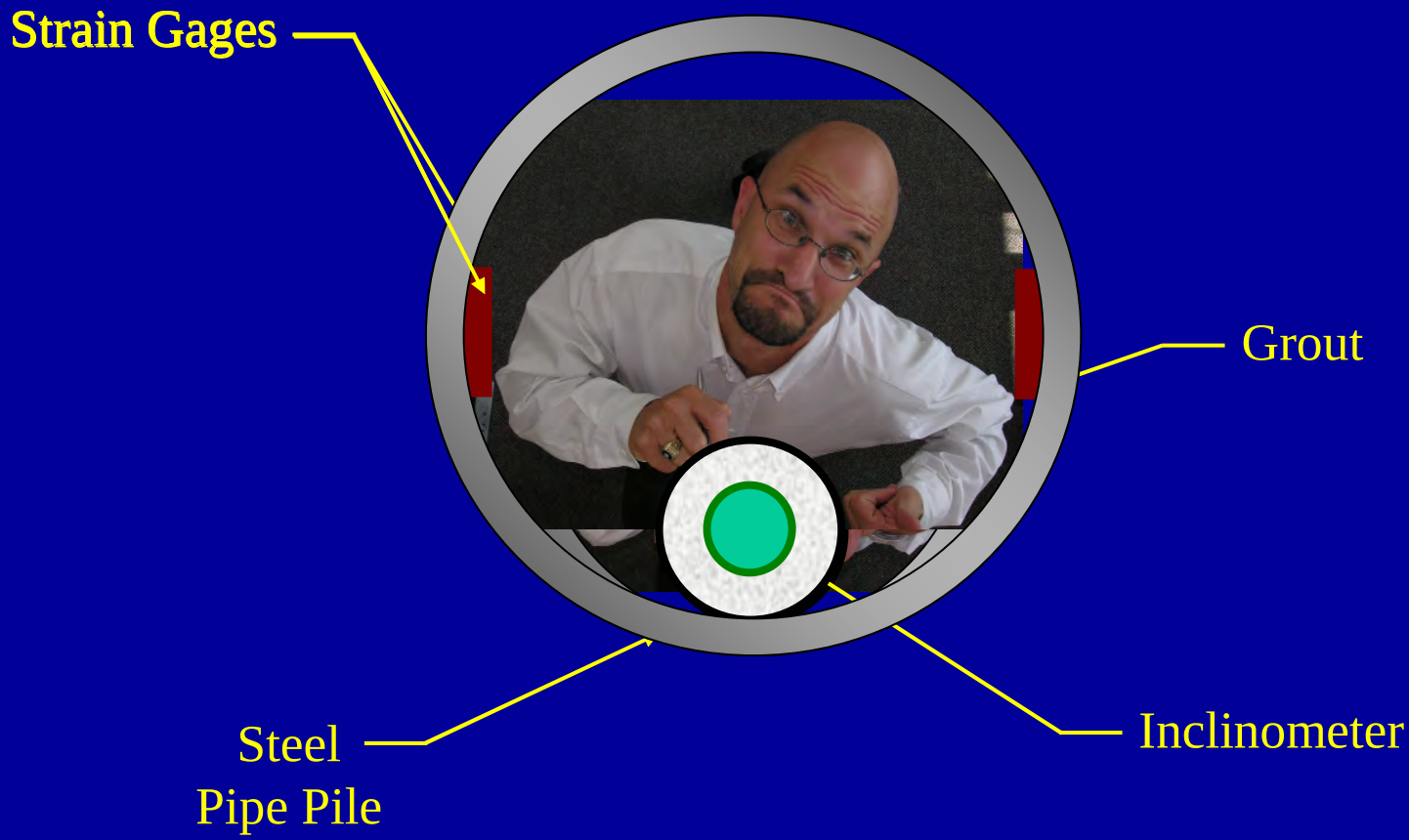
SECTION 4/P15

SCALE: 1/4" = 1'-0"

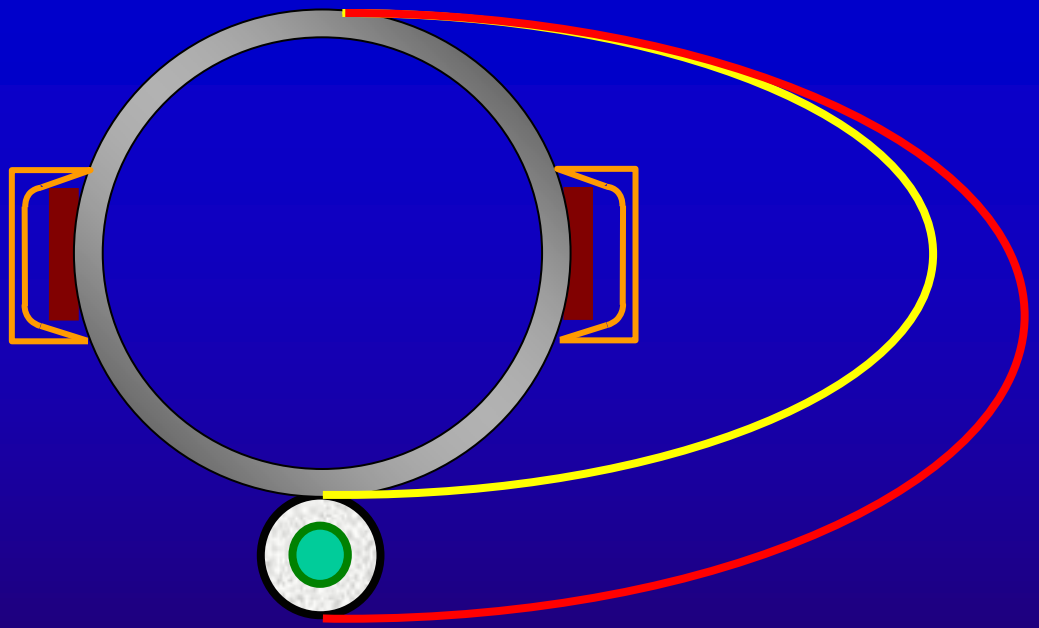
LATERAL PILE LOAD TEST REQUIREMENTS

- Apply/Record Lateral Load
  - Horizontal Jack
  - Load Cell
- Record Pile Head Deflections vs Load
  - Scales
  - Wire Lines
- Acquire p-y Data
  - Inclinometers
  - Strain Gages

PILE INSTRUMENTATION
48” DIA PIPE PILE

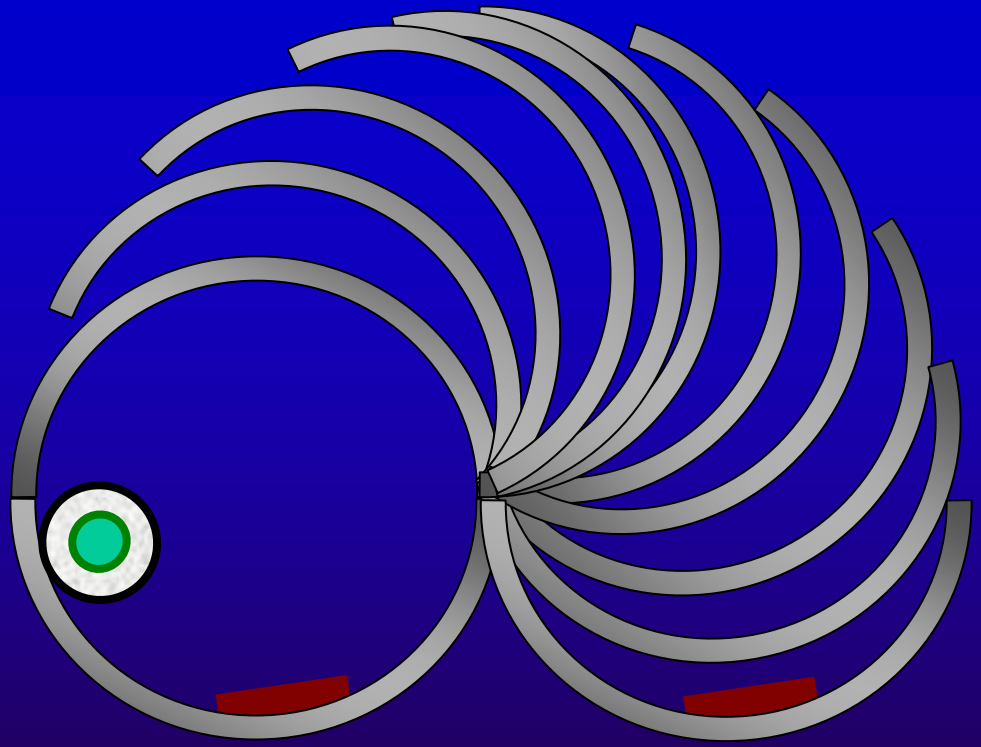


PILE INSTRUMENTATION
24” DIA PIPE PILE

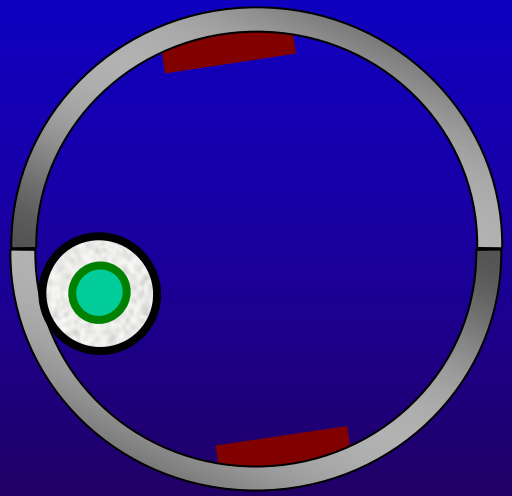


- Concerns with Additional Steel:
  - Increase pile stiffness
  - Alter/Widen pressure bulb

PILE INSTRUMENTATION
24” DIA PIPE PILE



PILE INSTRUMENTATION
24” DIA PIPE PILE





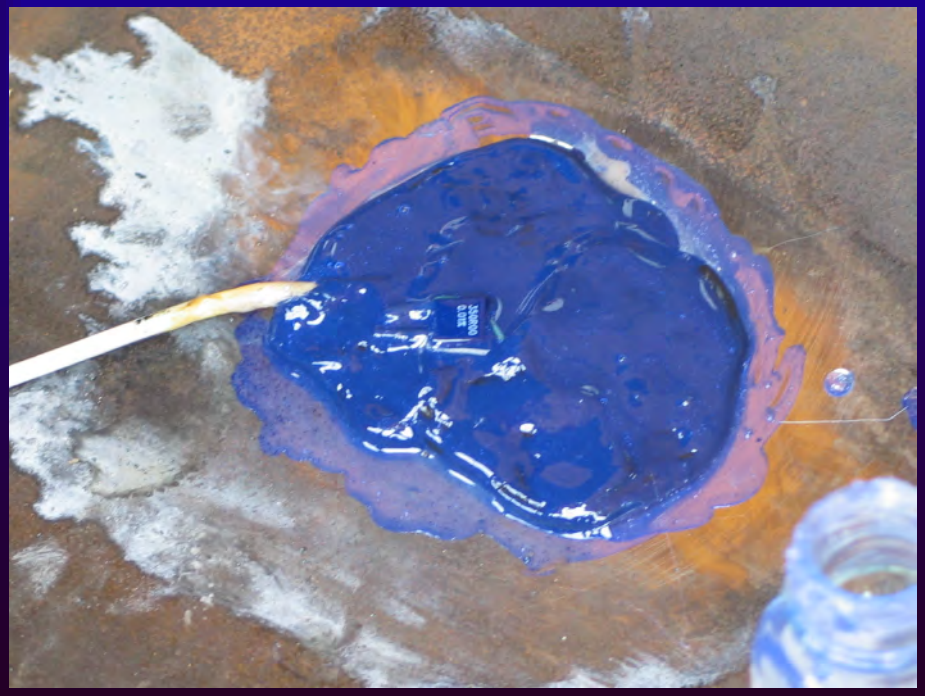
















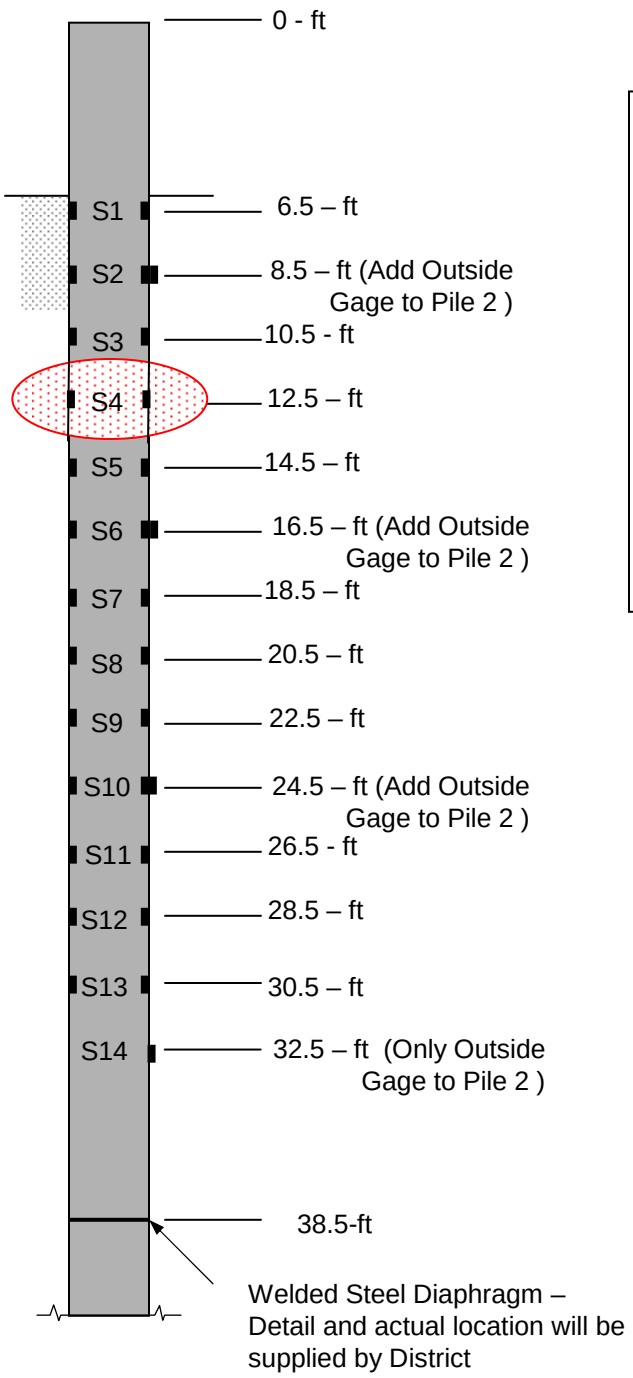


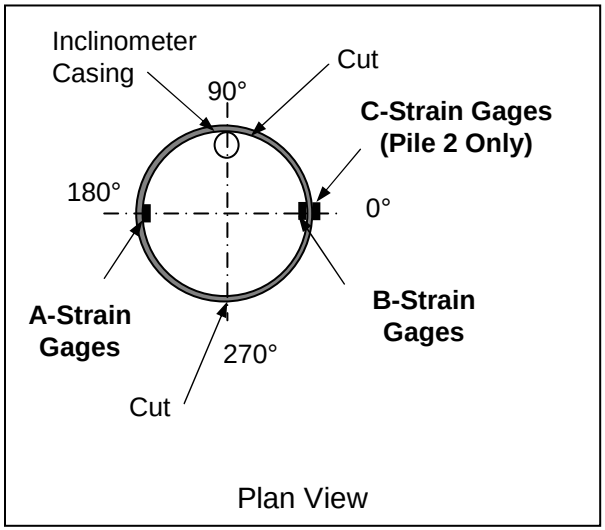


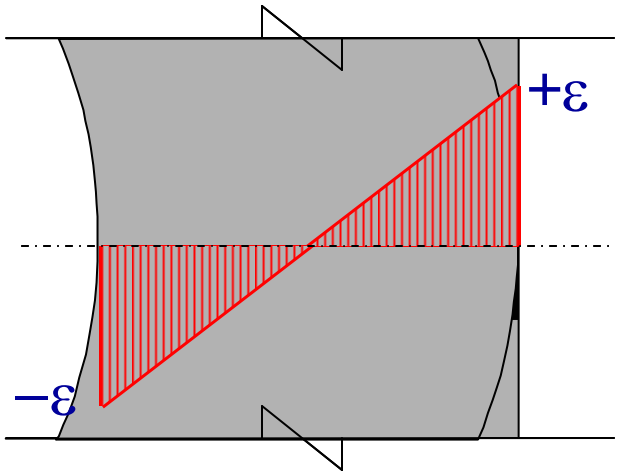




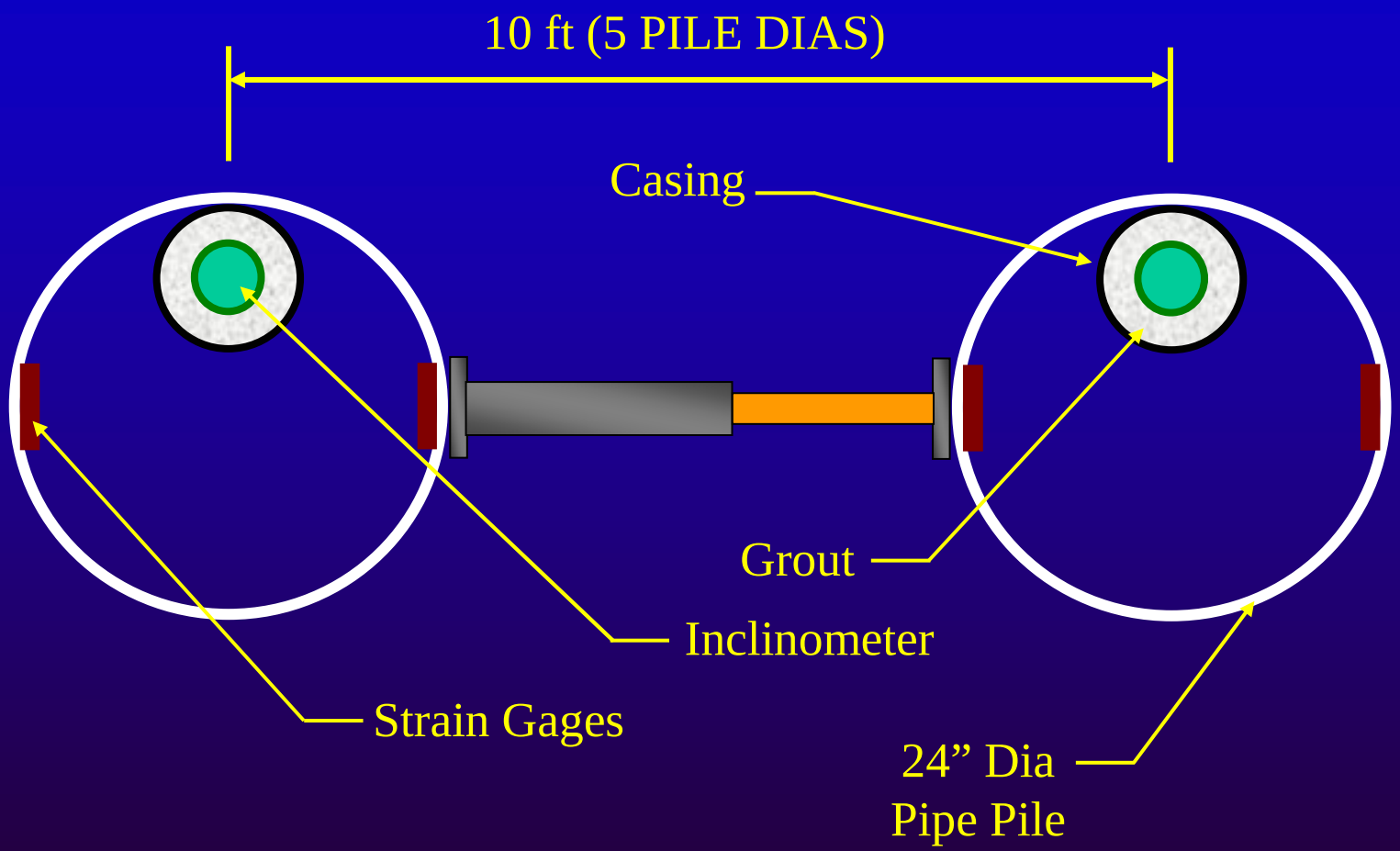



0 - ft
S1
6.5 – ft
S2
8.5 – ft (Add Outside Gage to Pile 2)
S3
10.5 - ft
S4
12.5 – ft
S5
14.5 – ft
S6
16.5 – ft (Add Outside Gage to Pile 2)
S7
18.5 – ft
S8
20.5 – ft
S9
22.5 – ft
S10
24.5 – ft (Add Outside Gage to Pile 2)
S11
26.5 - ft
S12
28.5 – ft
S13
30.5 – ft
S14
32.5 – ft (Only Outside Gage to Pile 2)
38.5-ft
Welded Steel Diaphragm – Detail and actual location will be supplied by District


Inclinometer Casing
Cut
90°
C-Strain Gages (Pile 2 Only)
180°
0°
A-Strain Gages
B-Strain Gages
270°
Cut
Plan View


+ε
−ε


POWER TEAM


10 ft (5 PILE DIAS)
Casing
Grout
Inclinometer
Strain Gages
24” Dia
Pipe Pile

LOAD APPLICATION

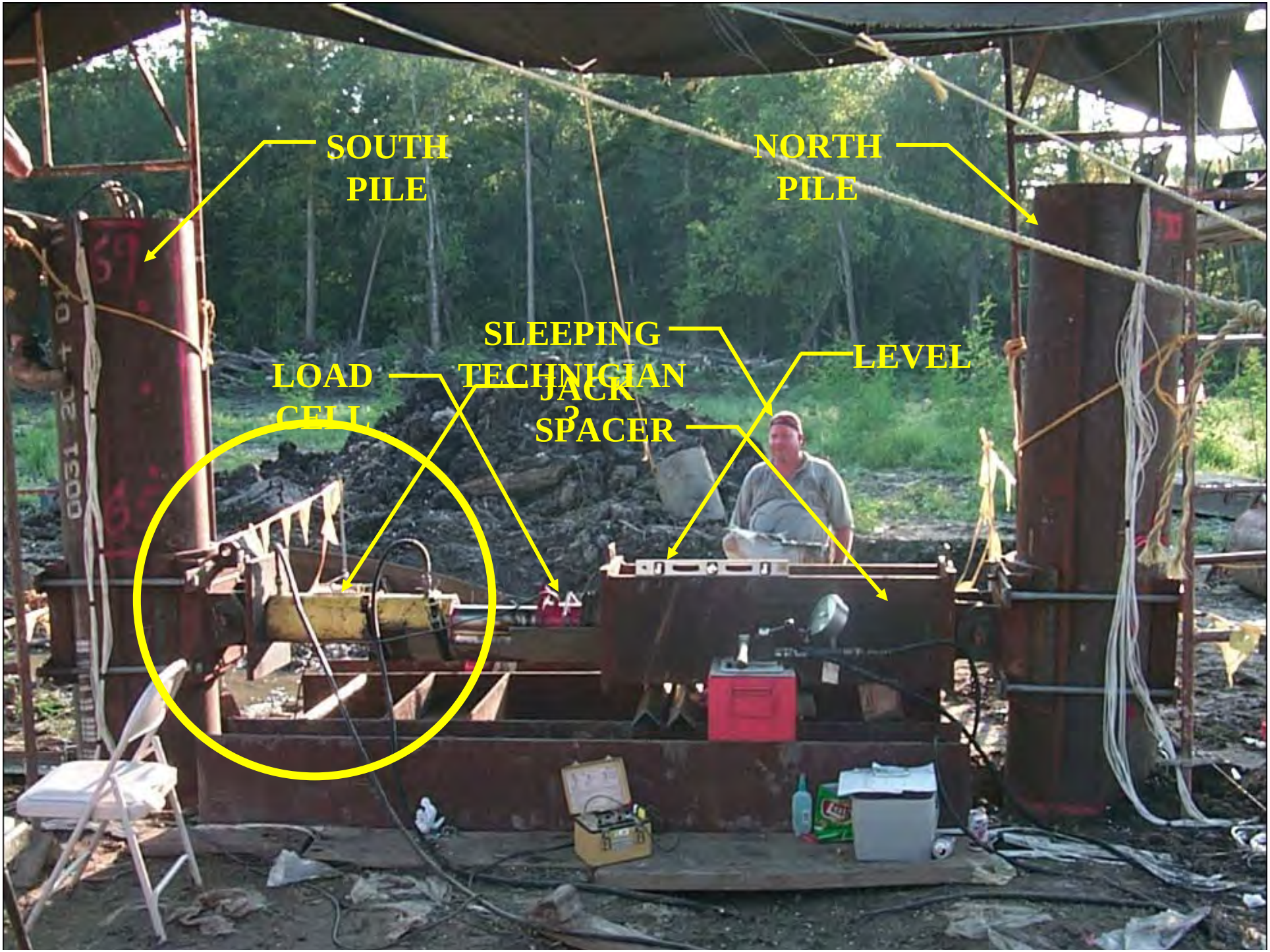
- Service Load = 30 Tons
- Load Increments:

  12.5%, 25%, 37.5%, 50%, 62.5%, 75%, 87.5%, 100%, 125%, 150%, 160%, 170%, 180%, 190%, 200%

- Load Decrements:

  150%, 100%, 50%

- Repeat Loading Procedure


SOUTH PILE
NORTH PILE
SLEEPING TECHNICIAN
LOAD CELL
JACK
LEVEL
SPACER

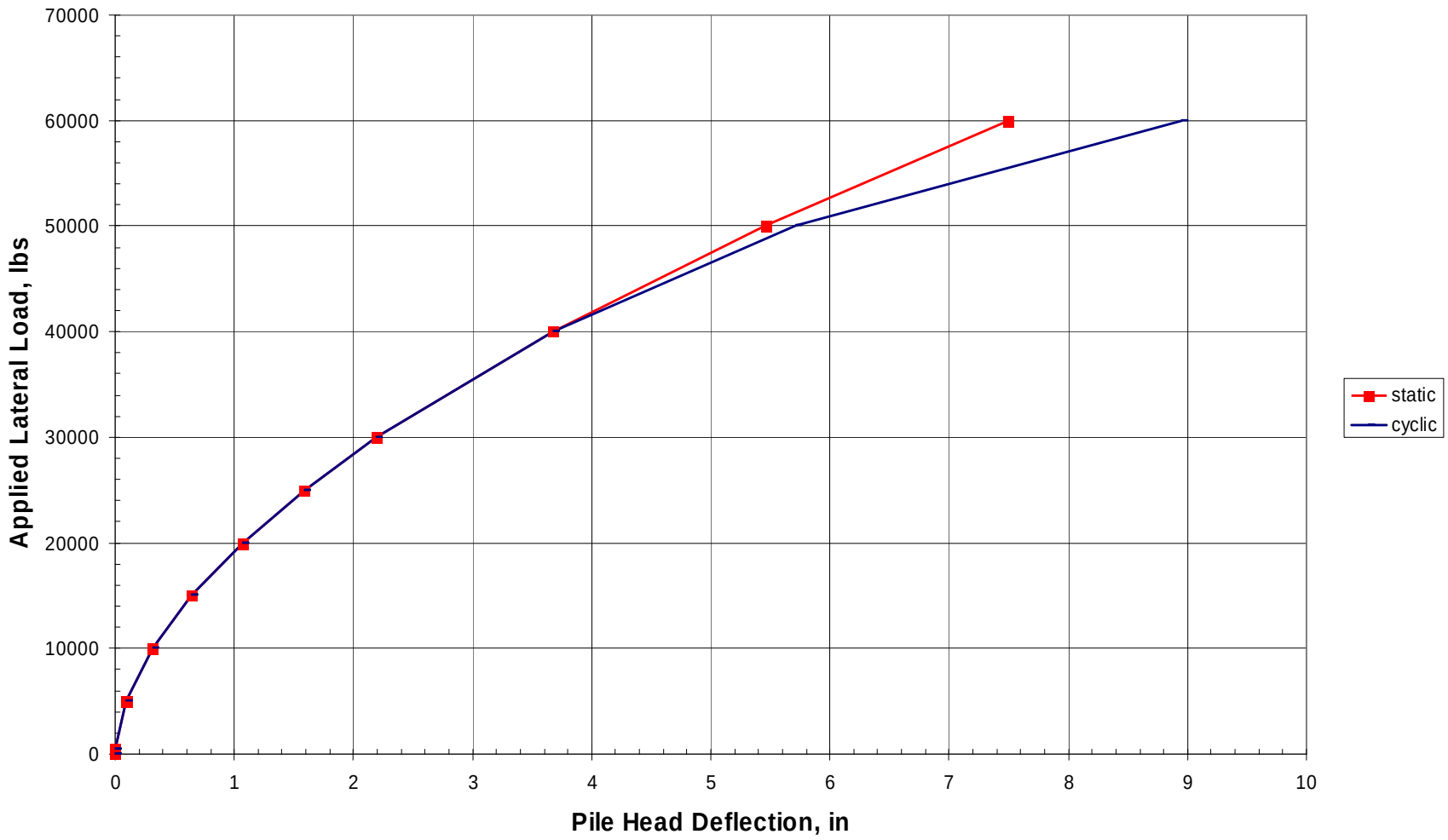




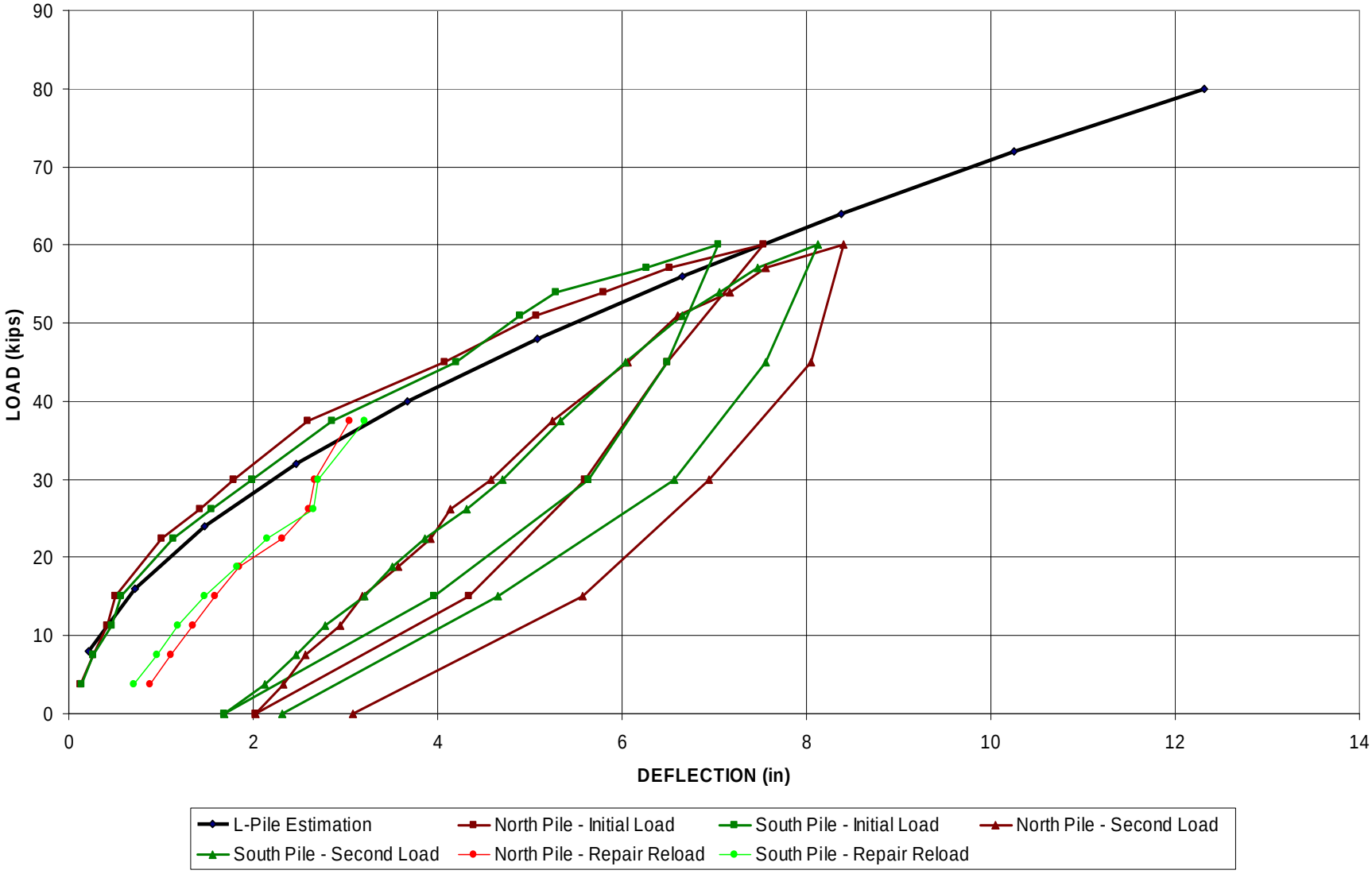




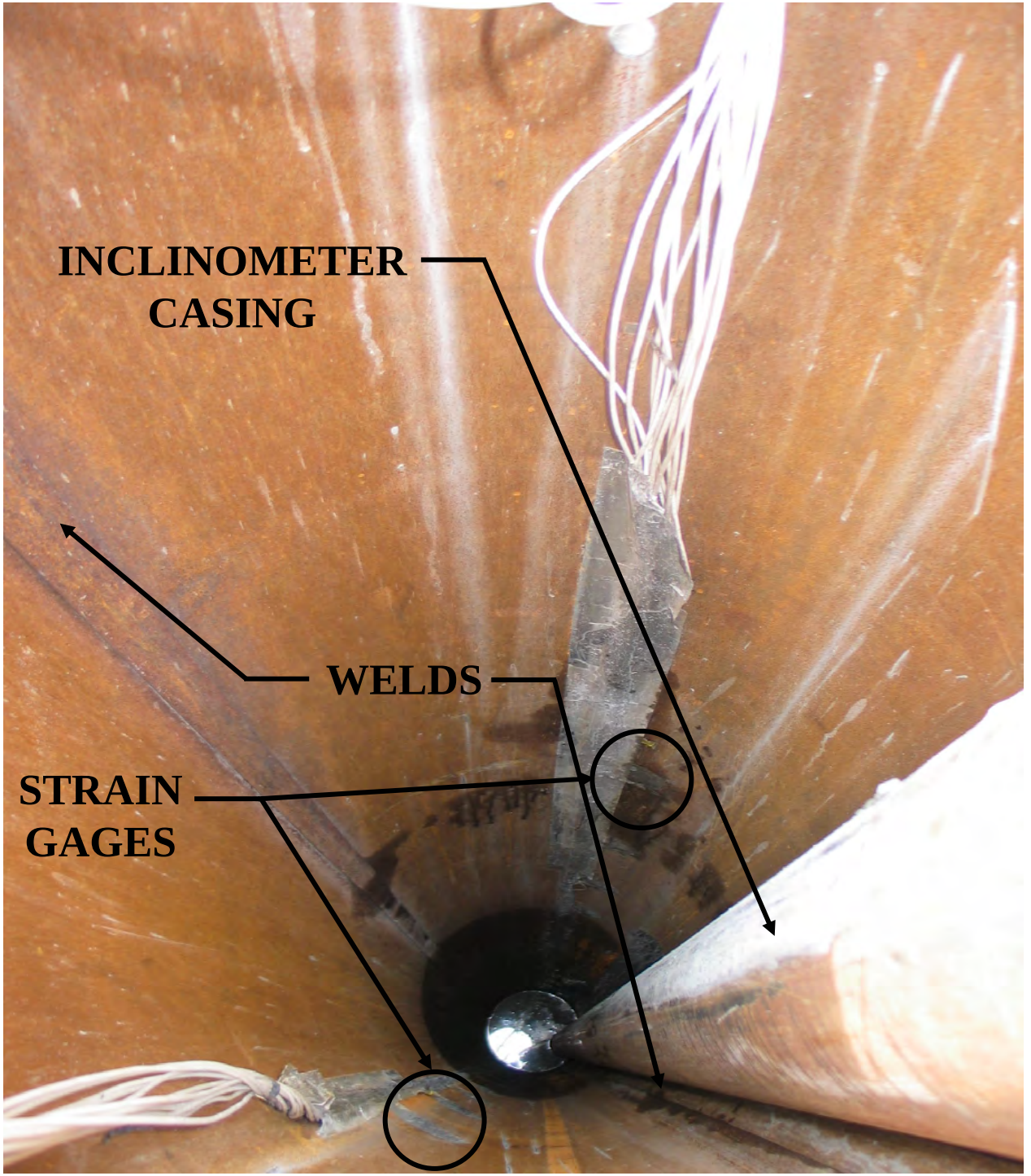
STATIC VS CYCLIC LOADING



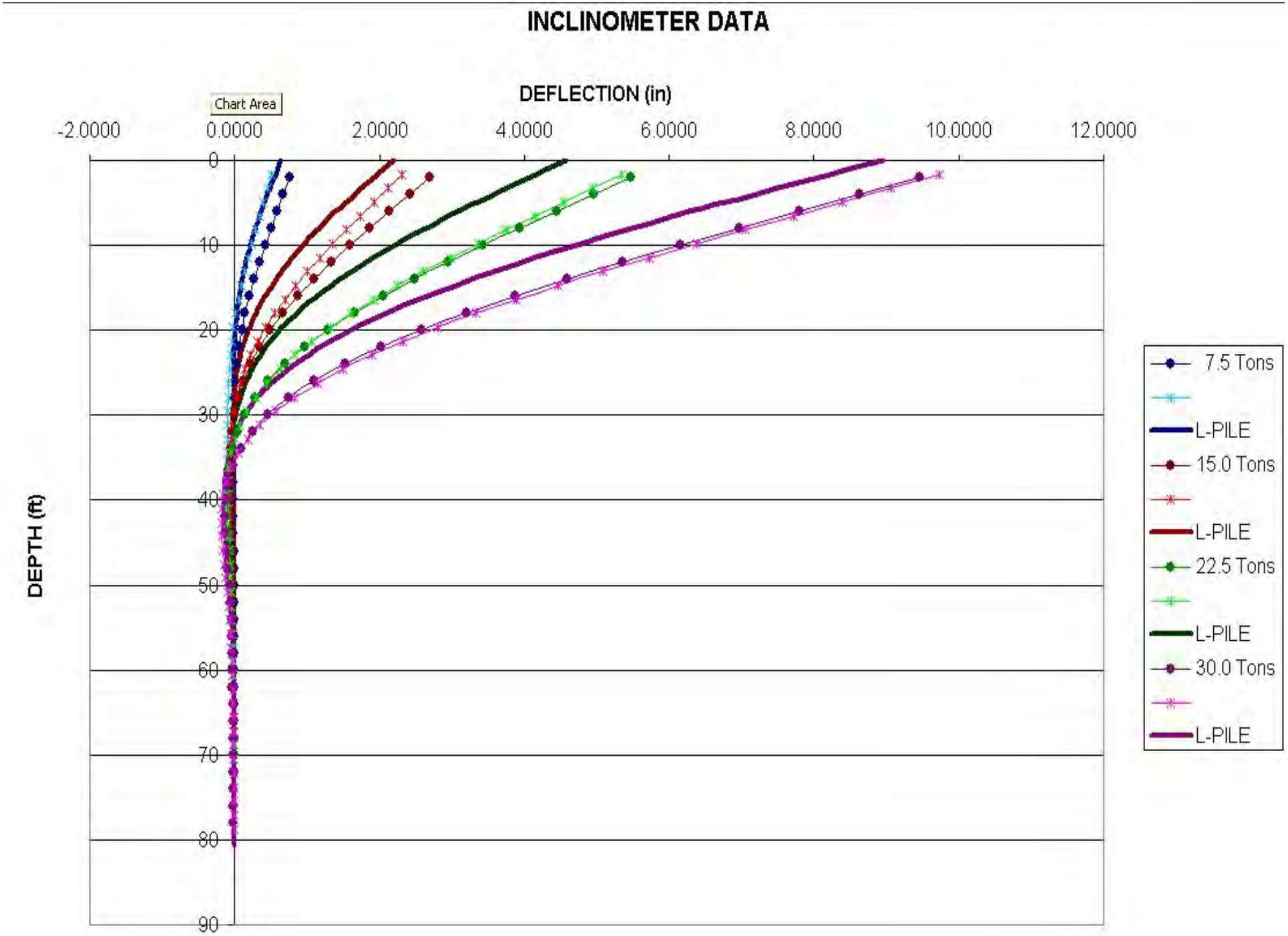
PILE HEAD DEFLECTIONS

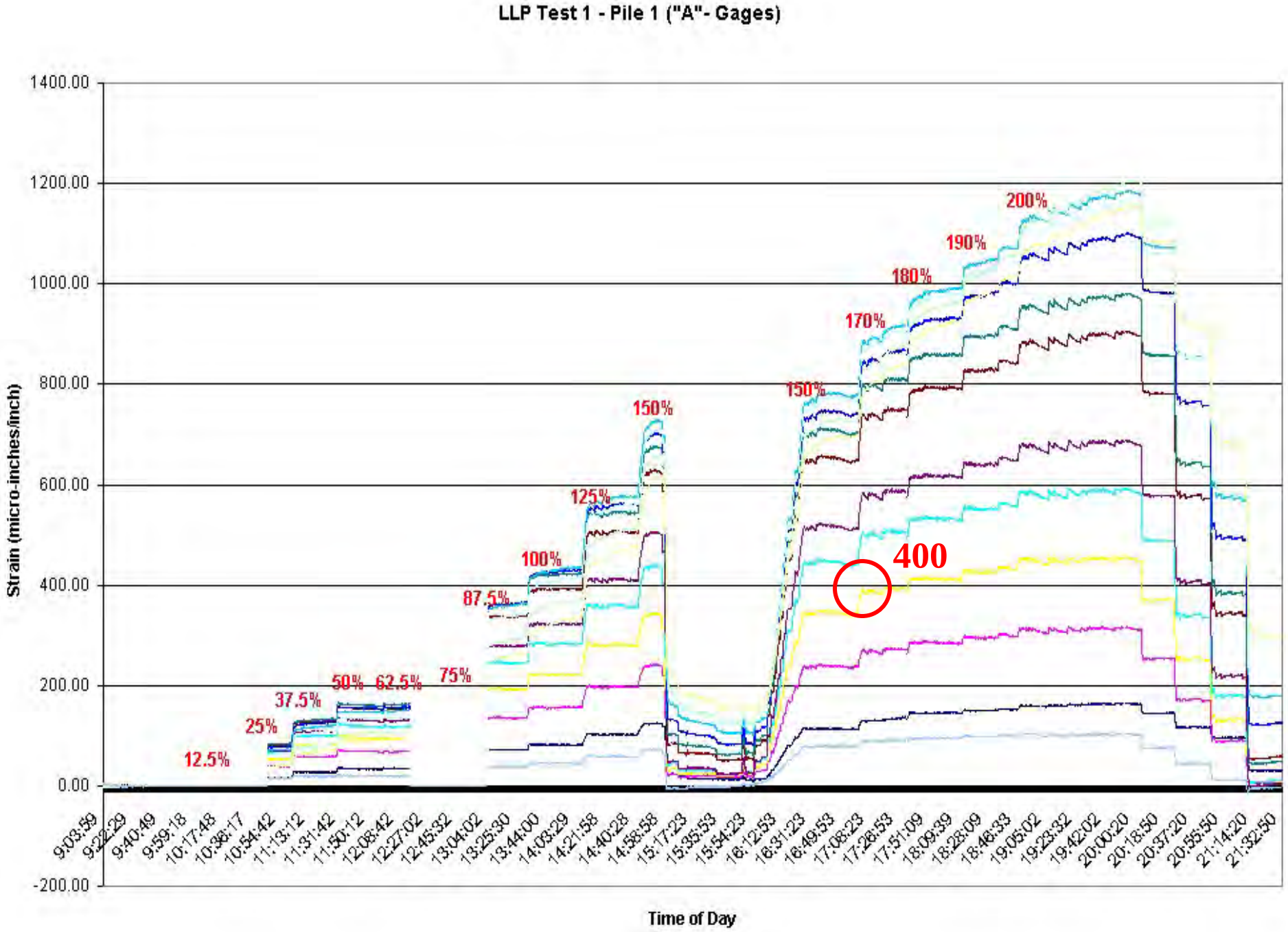


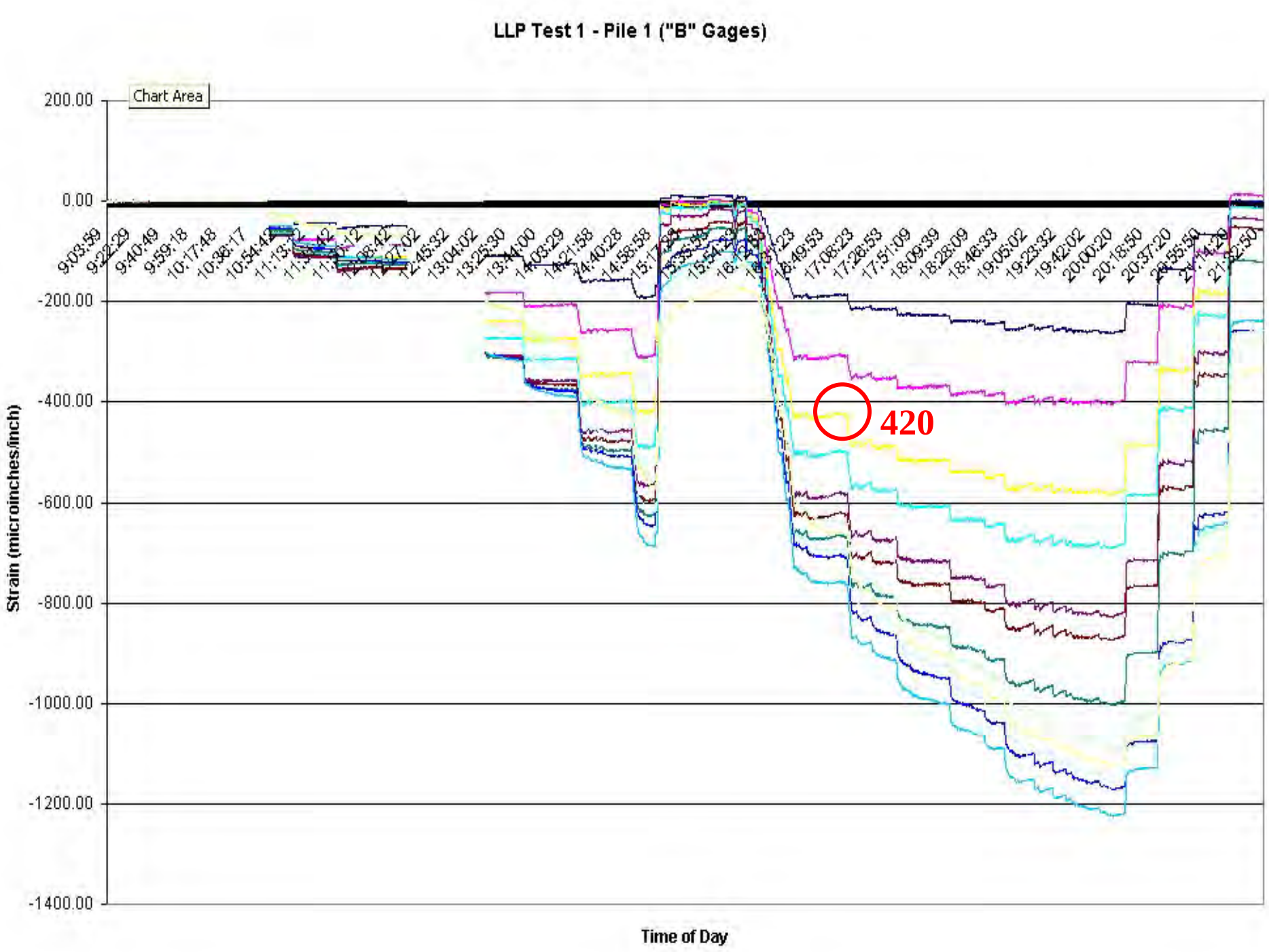


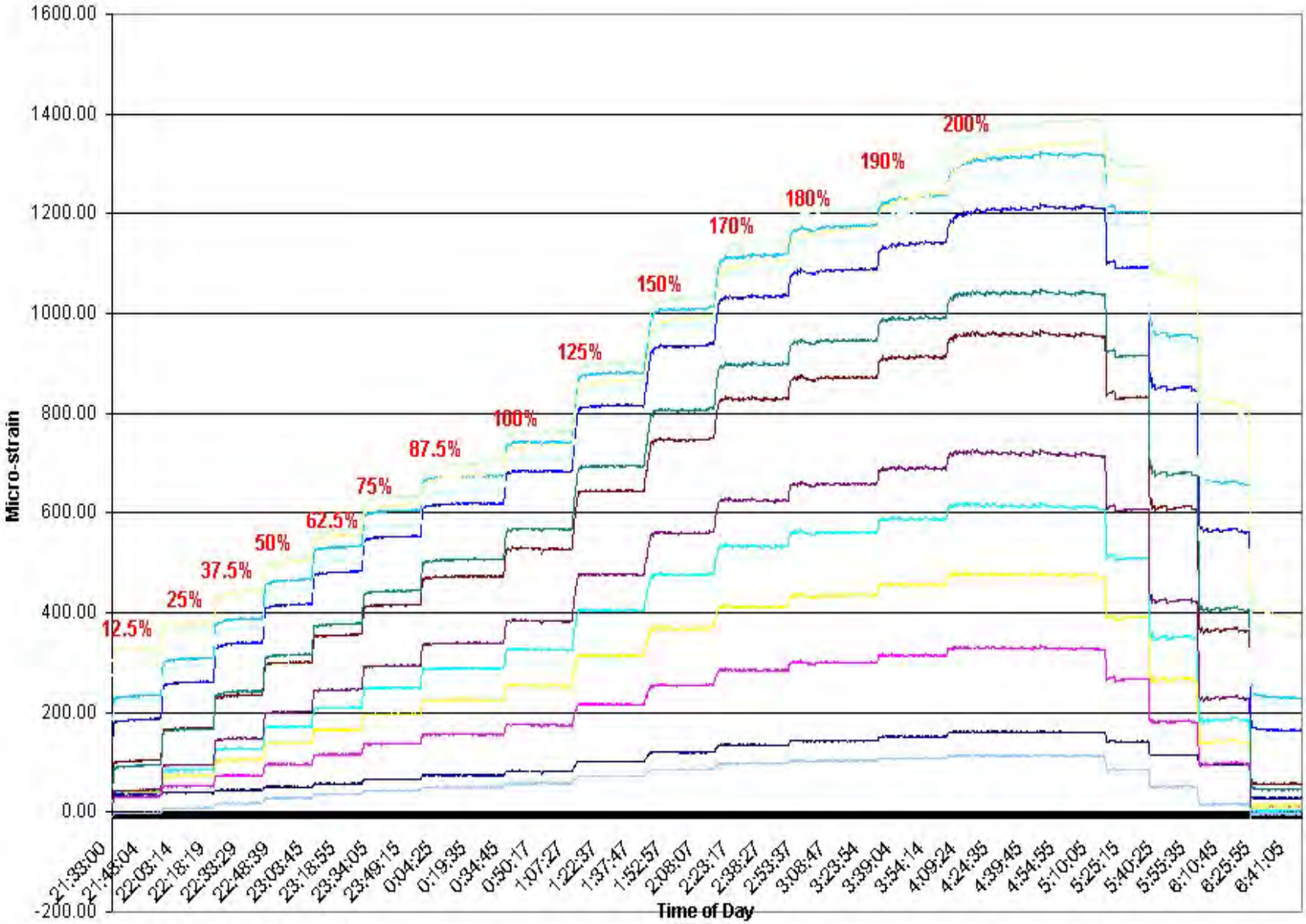

INCLINOMETER
CASING
WELDS
STRAIN
GAGES

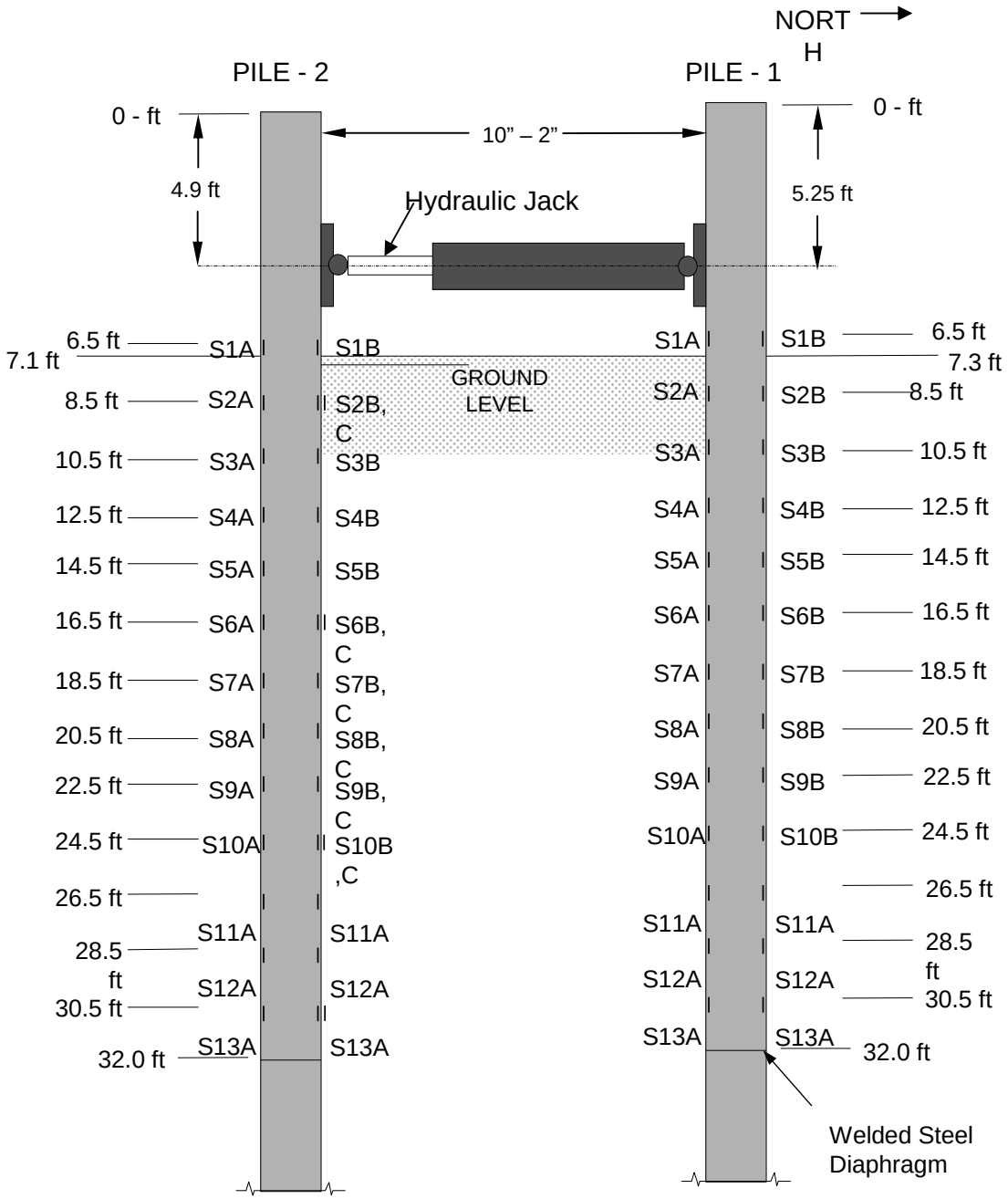



INCLINOMETER DATA
DEFLECTION (in)
Chart Area
-2.0000
0.0000
2.0000
4.0000
6.0000
8.0000
10.0000
12.0000
DEPTH (ft)
0
10
20
30
40
50
60
70
80
90
7.5 Tons
L-PILE
15.0 Tons
L-PILE
22.5 Tons
L-PILE
30.0 Tons
L-PILE


LLP Test 1 - Pile 1 ("A"- Gages)
Strain (micro-inches/inch)
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
-200.00
12.5%
25%
37.5%
50%
62.5%
75%
87.5%
100%
125%
150%
150%
170%
180%
190%
200%
400
9:03:59
9:22:29
9:40:49
9:59:18
10:17:48
10:36:17
10:54:42
11:13:12
11:31:42
11:50:12
12:08:42
12:27:02
12:45:32
13:04:02
13:25:30
13:44:00
14:03:29
14:21:58
14:40:28
14:58:58
15:17:23
15:35:53
15:54:23
16:12:53
16:31:23
16:49:53
17:08:23
17:26:53
17:51:09
18:09:39
18:28:09
18:46:33
19:05:02
19:23:32
19:42:02
20:00:20
20:18:50
20:37:20
20:55:50
21:14:20
21:32:50
Time of Day


LLP Test 1 - Pile 1 ("B" Gages)
Chart Area
200.00
0.00
-200.00
-400.00
-600.00
-800.00
-1000.00
-1200.00
-1400.00
Strain (microinches/inch)
Time of Day
420


LLP Test 2 - Pile 1 (A-gages)
Micro-strain
Time of Day
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
-200.00
12.5%
25%
37.5%
50%
62.5%
75%
87.5%
100%
125%
150%
170%
180%
190%
200%
21:33:00
21:48:04
22:03:14
22:18:19
22:33:29
22:48:39
23:03:45
23:18:55
23:34:05
23:49:15
0:04:25
0:19:35
0:34:45
0:50:17
1:07:27
1:22:37
1:37:47
1:52:57
2:08:07
2:23:17
2:38:27
2:53:37
3:08:47
3:23:54
3:39:04
3:54:14
4:09:24
4:24:35
4:39:45
4:54:55
5:10:05
5:25:15
5:40:25
5:55:35
6:10:45
6:25:55
6:41:05

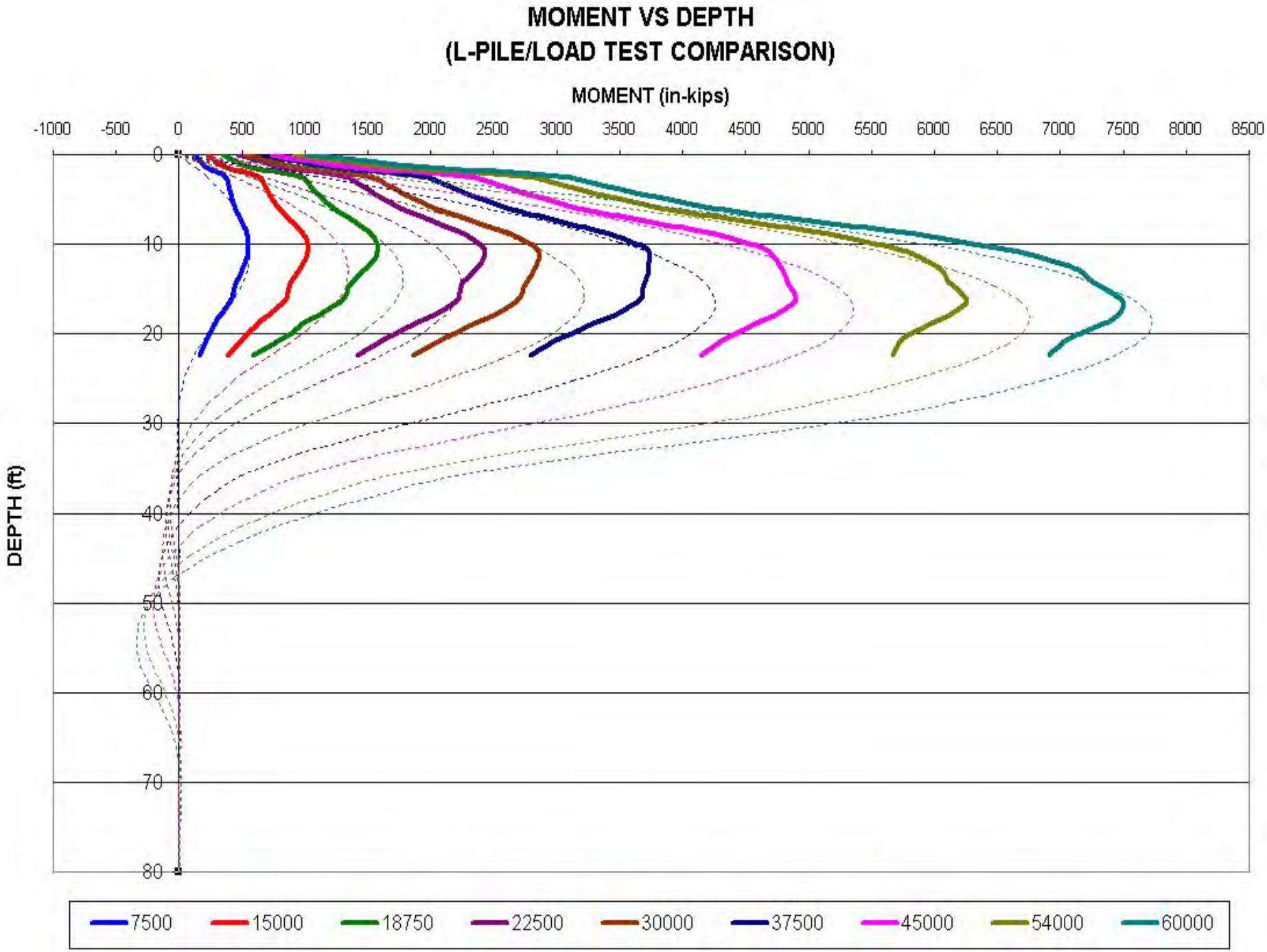


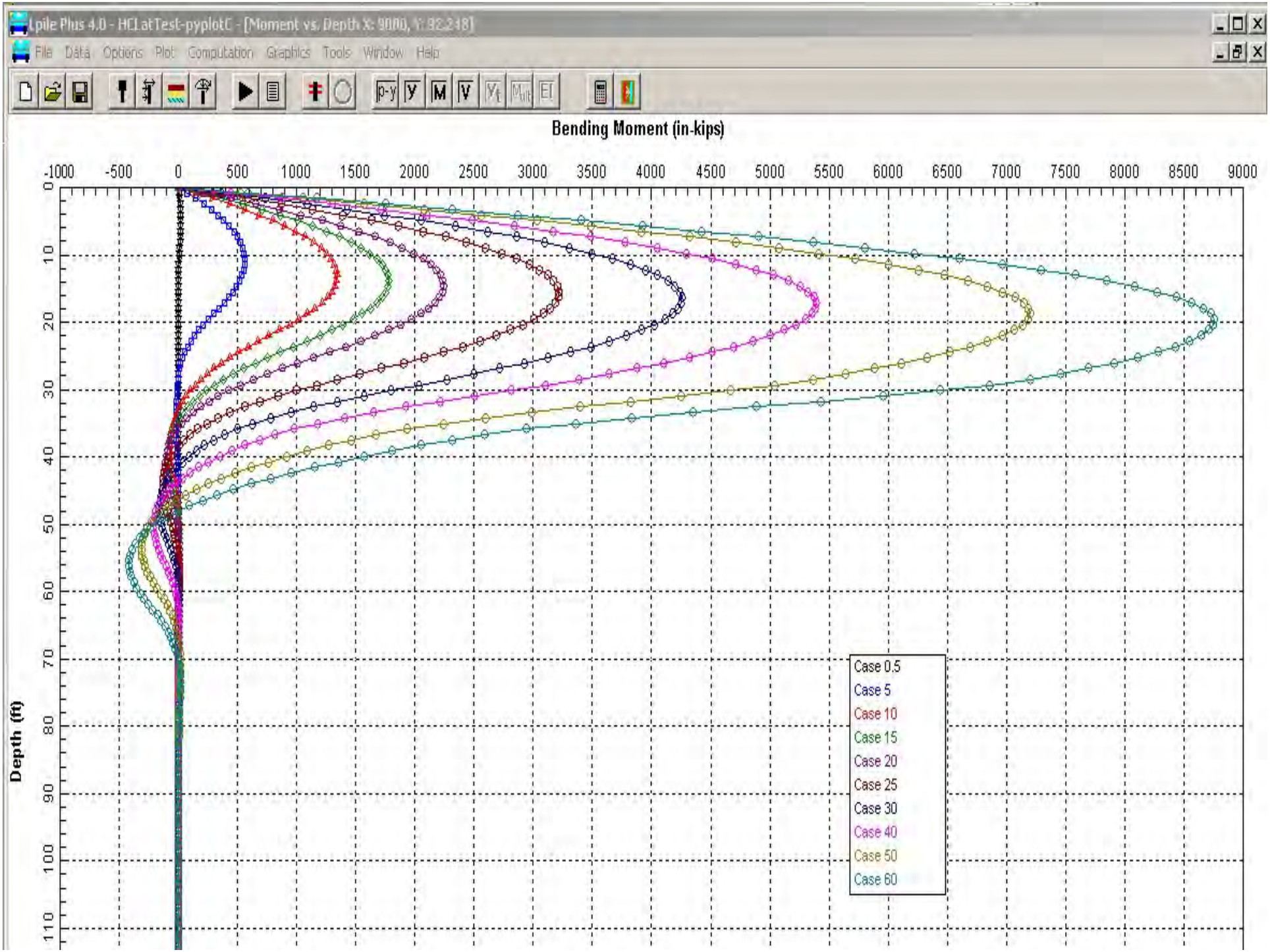
$$\sigma = E\varepsilon = \frac{P}{A} + \frac{M}{S}$$

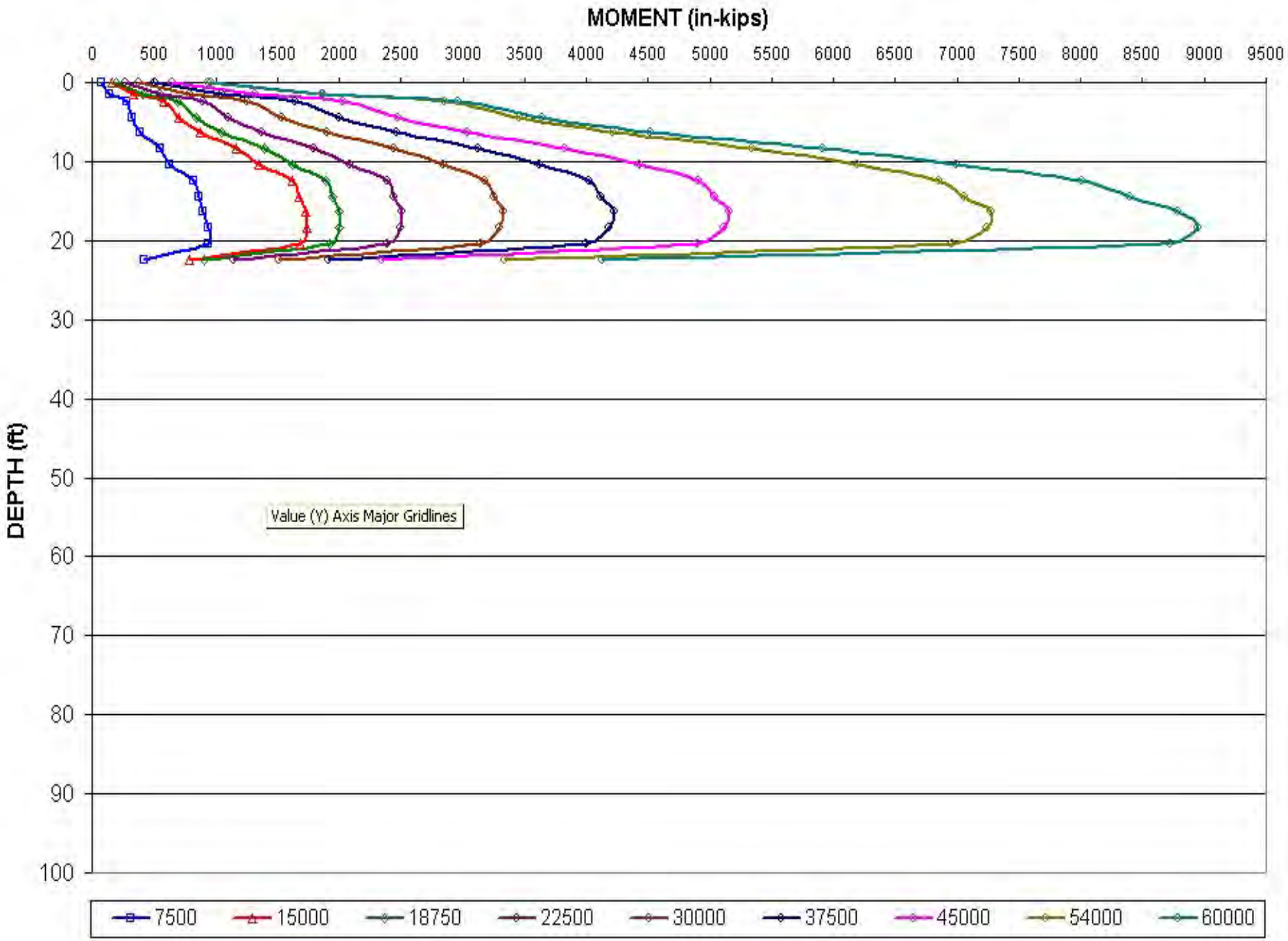
$$\sigma_A - \sigma_B = \frac{P_A}{A} + \frac{M_A}{S} - \frac{P_B}{A} - \frac{M_B}{S}$$

$$\Delta\sigma = \frac{2M}{S}$$

$$M = \frac{\Delta\sigma \cdot S}{2}$$


MOMENT VS DEPTH
(L-PILE/LOAD TEST COMPARISON)
MOMENT (in-kips)
-1000
-500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
DEPTH (ft)
0
10
20
30
40
50
60
70
80
7500
15000
18750
22500
30000
37500
45000
54000
60000


Lpile Plus 4.0 - HCLatTest-pyplotC - [Moment vs. Depth X: 9000, Y: 82.248]
File Data Options Plot Computation Graphics Tools Window Help
Bending Moment (in-kips)
-1000 -500 0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500 9000
Depth (ft)
0 10 20 30 40 50 60 70 80 90 100 110
Case 0.5
Case 5
Case 10
Case 15
Case 20
Case 25
Case 30
Case 40
Case 50
Case 60


MOMENT (in-kips)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
9500
DEPTH (ft)
0
10
20
30
40
50
60
70
80
90
100
Value (Y) Axis Major Gridlines
7500
15000
18750
22500
30000
37500
45000
54000
60000

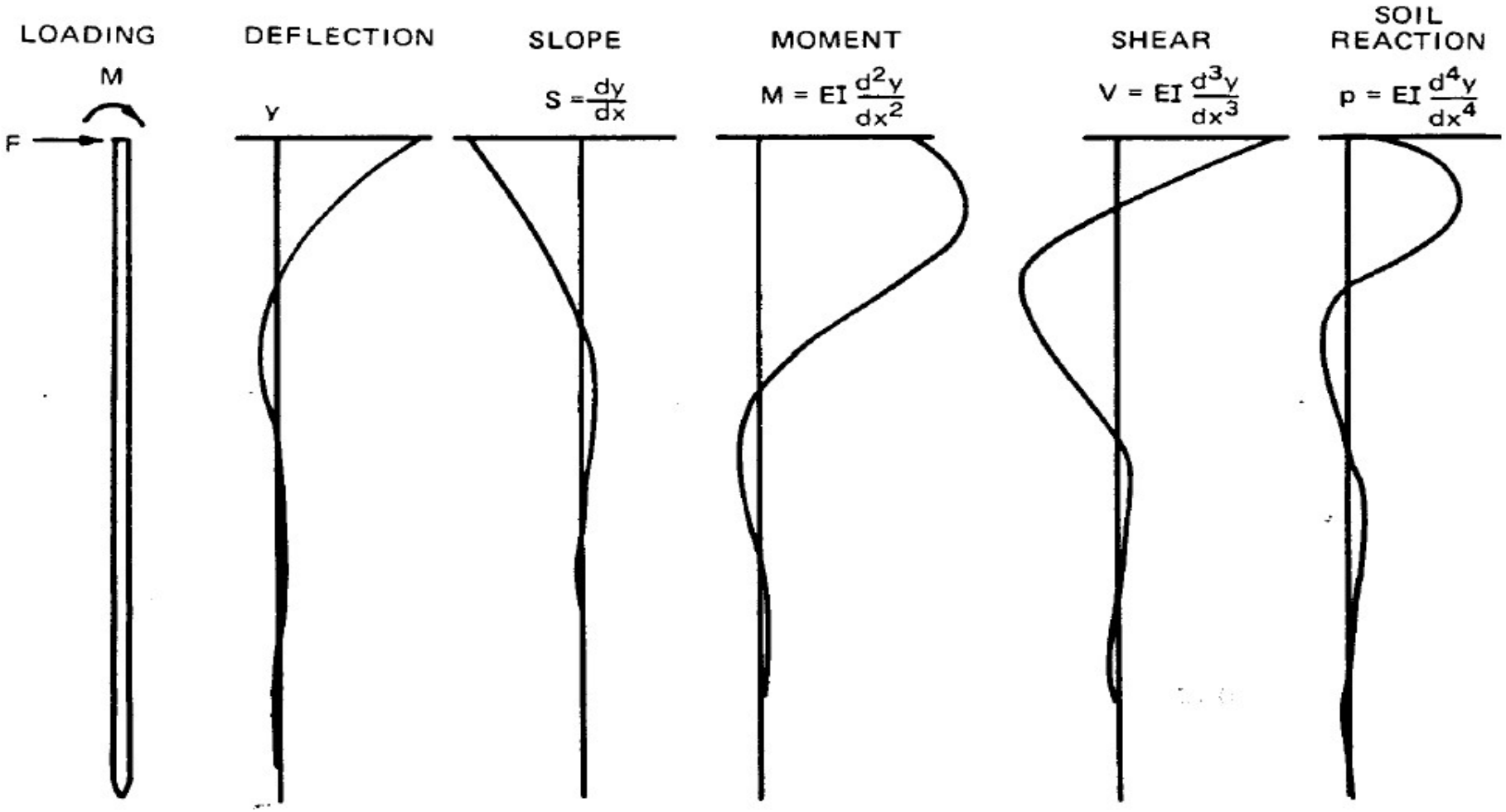
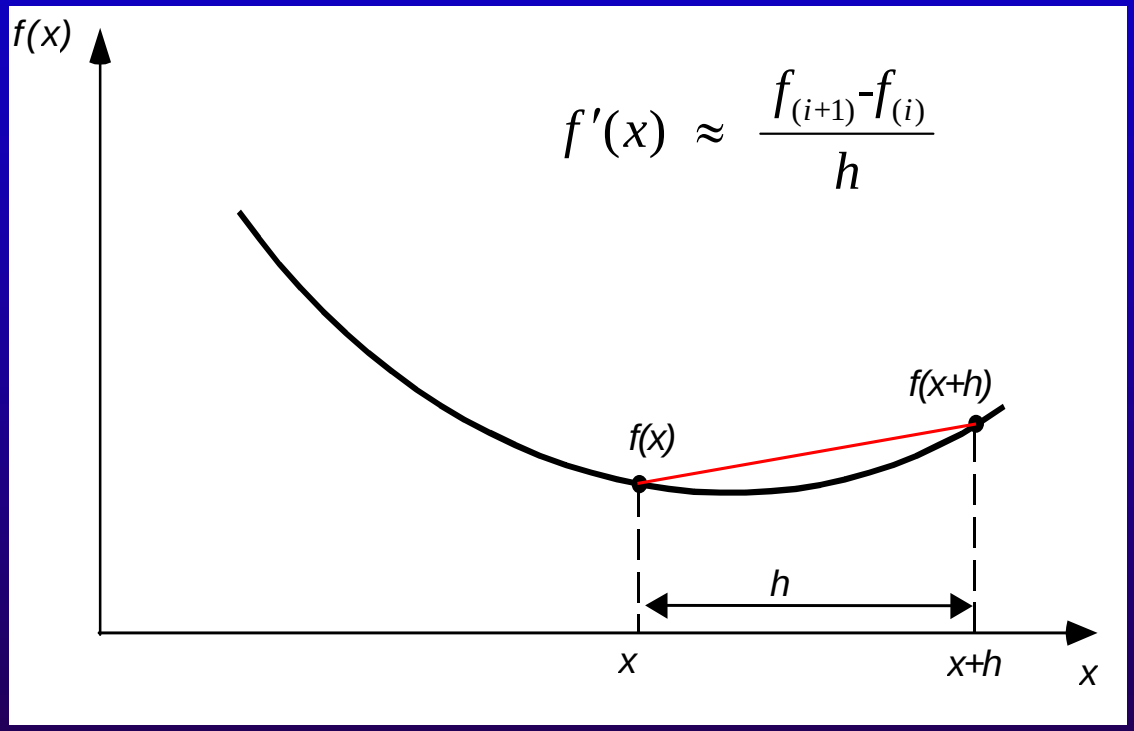


Figure 4. Form of the results obtained from a laterally loaded pile (Reese and Cox 1968)

$$p = \frac{d^2M}{dx^2}$$

- Consider the Taylor series expansion of *f(x)* near a point *x*

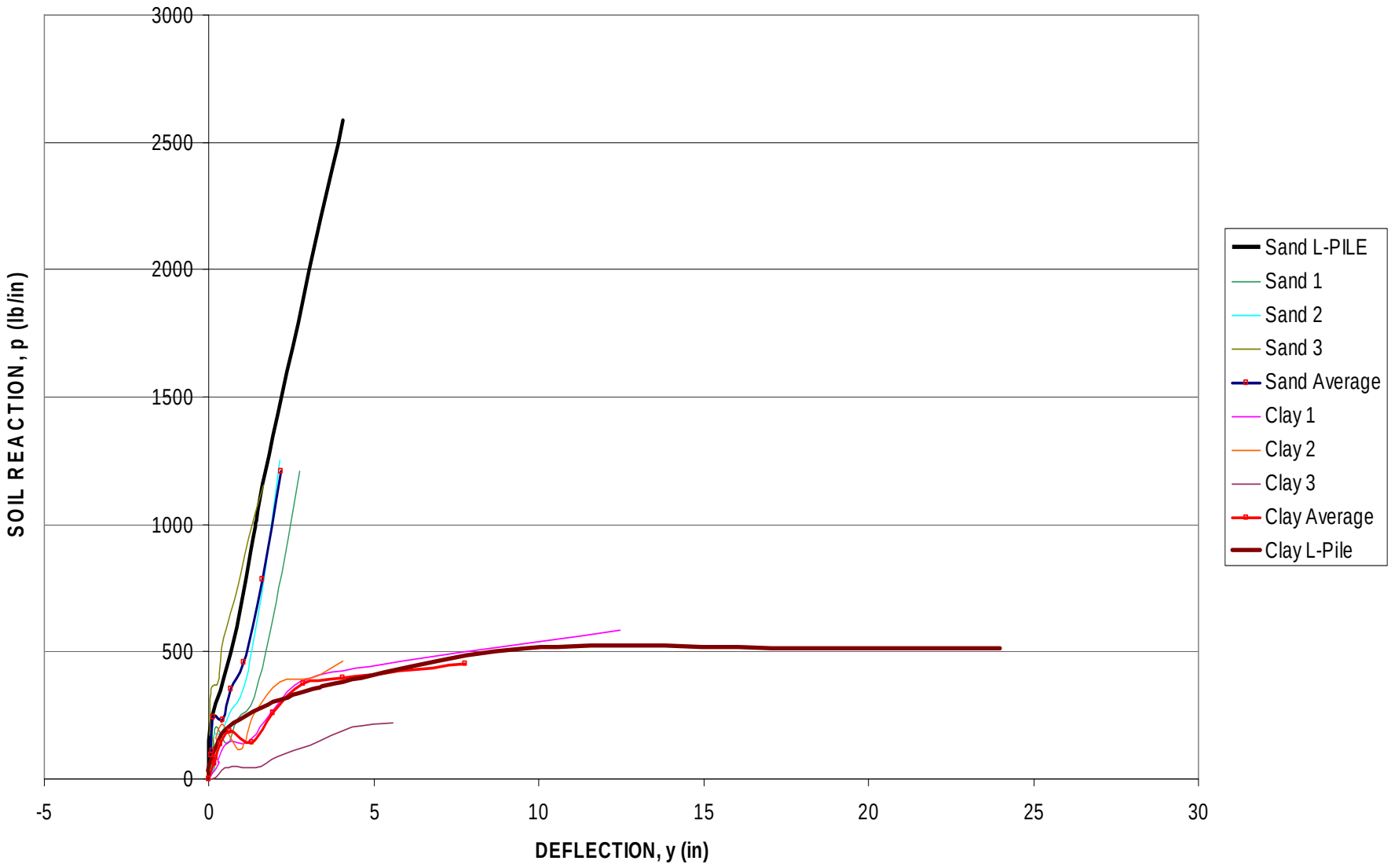
$$f(x+h) = f(x) + hf'(x) + \frac{h^2}{2!} f''(x) + \frac{h^3}{3!} f'''(x) + \cdots$$



$$f'(x) \approx \frac{f_{(i+1)} - f_{(i)}}{h}$$

$$f''(x) \approx \frac{f'_{(i+1)} - f'_{(i)}}{h}$$

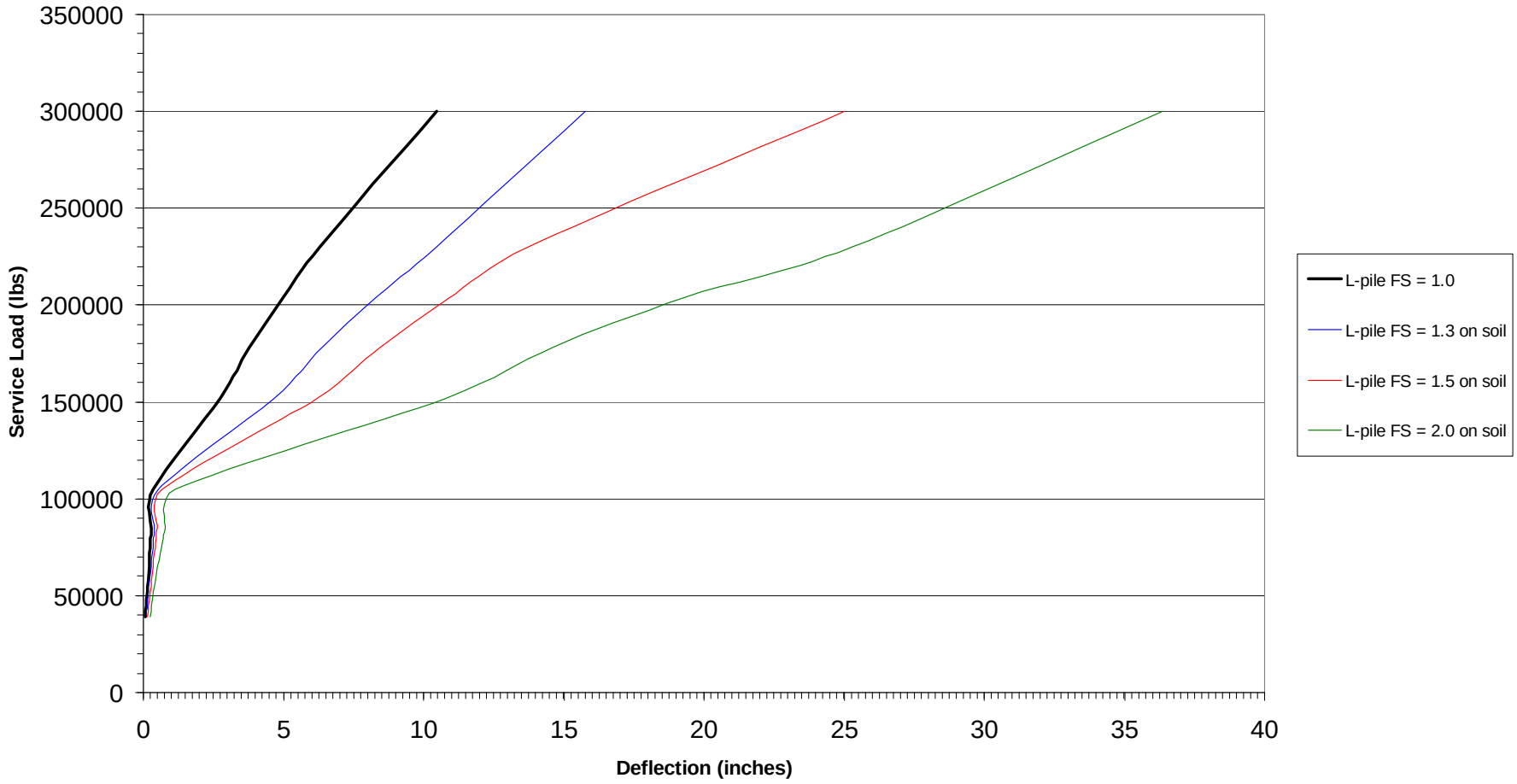
$$f''(x) \approx \frac{f_{(i+1)} - 2f_{(i)} + f_{(i-1)}}{h^2}$$


P-Y CURVE COMPARISON
(Upper Clay and Sand Strata)
SOIL REACTION, p (lb/in)
3000
2500
2000
1500
1000
500
0
-5
0
5
10
15
20
25
30
DEFLECTION, y (in)
Sand L-PILE
Sand 1
Sand 2
Sand 3
Sand Average
Clay 1
Clay 2
Clay 3
Clay Average
Clay L-Pile

BENEFITS OF LATERAL PILE LOAD TEST

- Establish Pile Head Deflections
  - Identify Plastic Limit of Soil
  - Verify Group Effects
- Develop Moment vs Depth Curves
  - Structural Analyses
  - Determine Pile Tip
- Develop p-y Curves
  - Pile Stresses & Deflections
  - G-Pile or CPGA

RESULTING PILE HEAD DEFLECTIONS
ALTERING SOILS FACTORS OF SAFETY



LESSONS LEARNED

- Strain gage/inclinometer system well suited for p-y data development
- Allow adequate time for inclinometer readings
- Mark piles and ground fully for alignment
- Cycle load during test before 200%
- Secure jacking device
- Two pile system effective/redundant

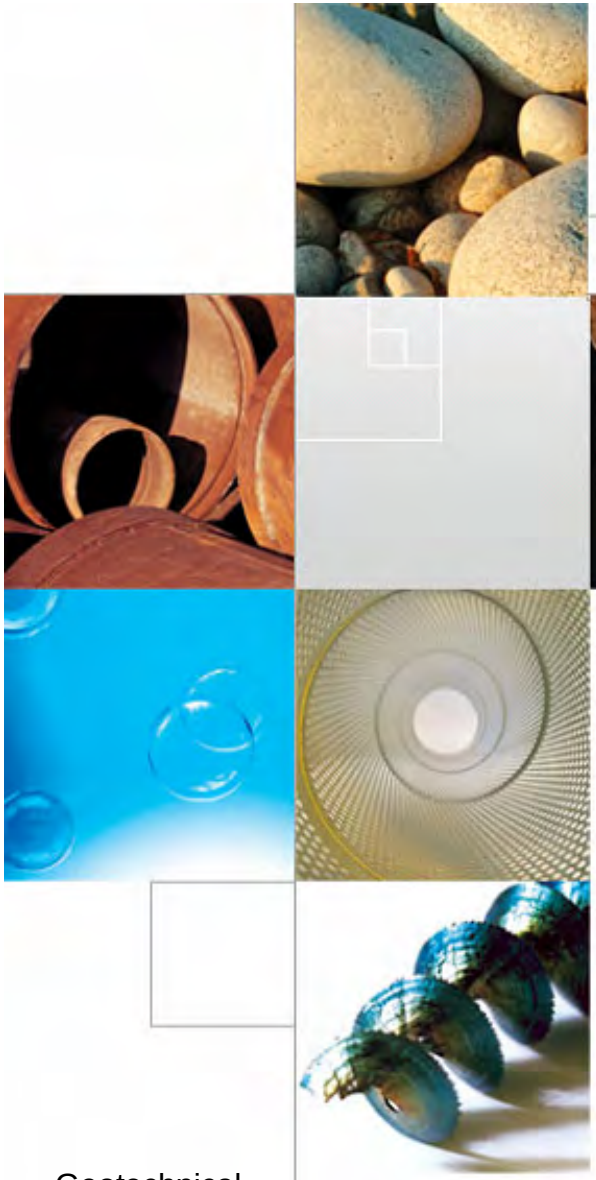
LESSONS LEARNED

- p-y development/utilization less conservative
- Apply adequate load to pile to develop full p-y data
- Outside gage coating successful
- Relatively inexpensive
- Utilize F.S. = 1.0 on soils when developing soil reaction data
- Update EM with design and F.S. criteria

ACKNOWLEDGEMENTS

- Bruce Barker – ERDC
- Leo Koestler – ERDC
- Robert Ebeling – ERDC
- Kevin Abraham – ERDC
- Alpha Testing & Inspecting, Inc.
- Applied Foundation Testing, Inc.

THANK YOU!



Presented By:

Francis D. Leathers, P.E. and
Michael P. Walker, P.E.

August 3, 2005

M^3 – Modeling, Monitoring and Managing

A Comprehensive Approach to Controlling Ground Movements for Protection of Existing Structures and Facilities

Geotechnical, Environmental and Water Resources Engineering

GEI Consultants

M^3 – Modeling, Monitoring and Managing

GEI Consultants

- Comprehensive approach to controlling ground movements during deep excavations
- Actively manage soil and structure performance to protect existing structures and facilities
  - Safety
  - Structural integrity
  - Operations
- Based on fundamental understanding of
  - Soil behavior
  - Structure behavior
  - Soil – Structure interaction

M^3 – Modeling, Monitoring and Managing

GEI Consultants

- Enhancement of the “Observational Method”
  - Pro-active approach to managing soil and structure behavior
  - Replaces “wait and see what happens, then adjust approach”
  - Invest in engineering and ability to control behavior
  - Better framework to utilize past experience in design
  - Better framework to evaluate and learn from current experience
- Benefits
  - Perform projects conventionally thought to be “too risky”
  - Improved risk management and confidence
  - Reduced chance of schedule delay
  - Potentially lower total cost

Case Studies

- U.S. Capitol Visitors Center
  - GEI was engineer for excavation support subcontractor, Nicholson Construction
  - Very strict movement criteria to protect very heavy, sensitive historic structure
  - Controlled ground movement to 0.4-inch settlement adjacent to 60-foot deep excavation
- Tunnel Jacking Pit Headwalls for Boston's Central Artery/Tunnel Project
  - GEI was engineer for general contractor, Slattery, Interbetton, White and Perini JV
  - Provided analysis and design of jacking pits
  - Pits subjected to very large and unusual loads from ground freezing and jacking
  - Designed headwalls to accommodate 8- to 15-inches of lateral movement due to ground freezing

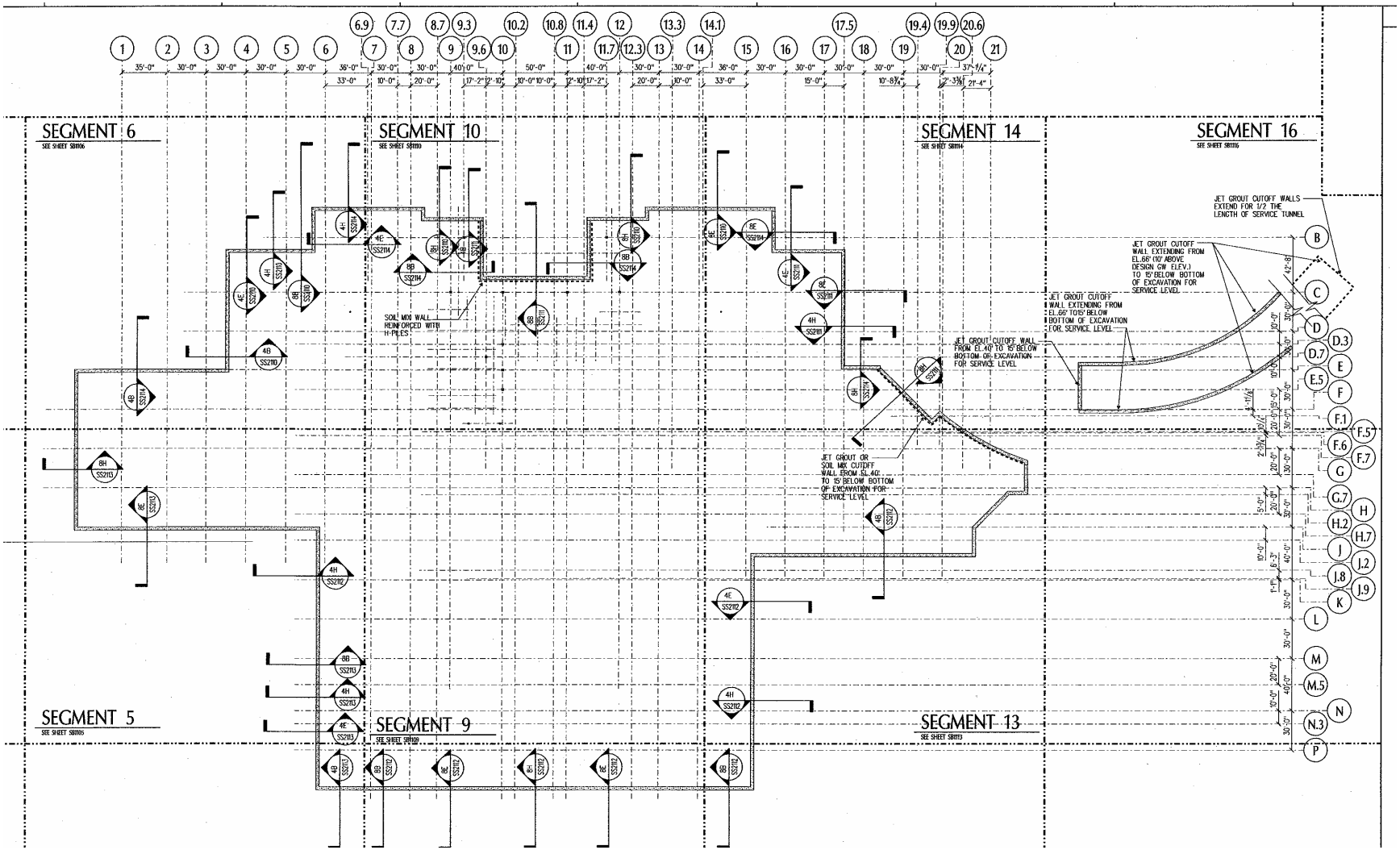
Project Goal -
U.S. Capitol Visitors Center



The Site



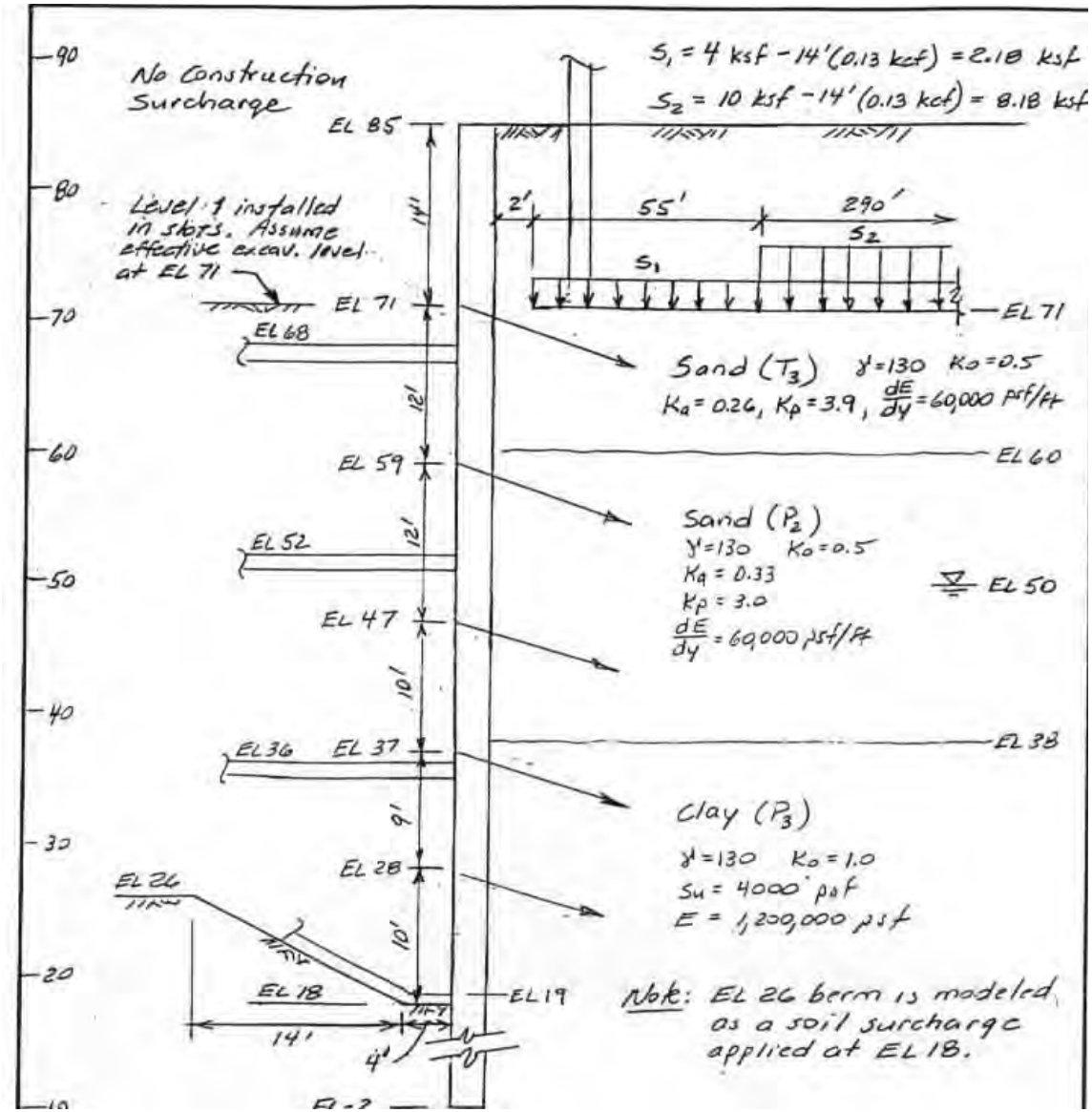
Plan of CVC


SEGMENT 6
SEE SHEET SB1106
SEGMENT 10
SEE SHEET SB1110
SEGMENT 14
SEE SHEET SB1114
SEGMENT 16
SEE SHEET SB1116
SEGMENT 5
SEE SHEET SB1105
SEGMENT 9
SEE SHEET SB1109
SEGMENT 13
SEE SHEET SB1113
SOIL MIX WALL REINFORCED WITH H-PILES
JET GROUT CUTOFF WALL EXTEND FOR 1/2 THE LENGTH OF SERVICE TUNNEL
JET GROUT CUTOFF WALL EXTENDING FROM EL.66' (10' ABOVE DESIGN GW ELEV.) TO 15' BELOW BOTTOM OF EXCAVATION FOR SERVICE LEVEL
JET GROUT CUTOFF WALL EXTENDING FROM EL.66' TO 15' BELOW BOTTOM OF EXCAVATION FOR SERVICE LEVEL
JET GROUT CUTOFF WALL FROM EL.40' TO 15' BELOW BOTTOM OF EXCAVATION FOR SERVICE LEVEL
JET GROUT OR SOIL MIX CUTOFF WALL FROM EL.40' TO 15' BELOW BOTTOM OF EXCAVATION FOR SERVICE LEVEL

Creative Construction Approach

- Original design based on top-down construction
  - Conventional slurry walls for excavation support
  - Columns installed in drilled holes
  - Top deck installed and used as bracing
  - Excavation under deck with conventional tieback support
    - Limited headroom, small equipment, slow construction
    - No pre-loading of top brace
    - Typical tieback pre-stress to 75% of design load
- Contractor's Creative Approach
  - Provide extra capacity in slurry walls and tiebacks along Capitol
  - Tiebacks pre-stressed up to 120% of design load or until net backward movement
  - Open excavation to subgrade followed by column installation
  - Top deck installation followed by interior construction
  - Experience suggested could meet movement control criteria
  - Resulted in lower cost ($8M savings) and faster construction

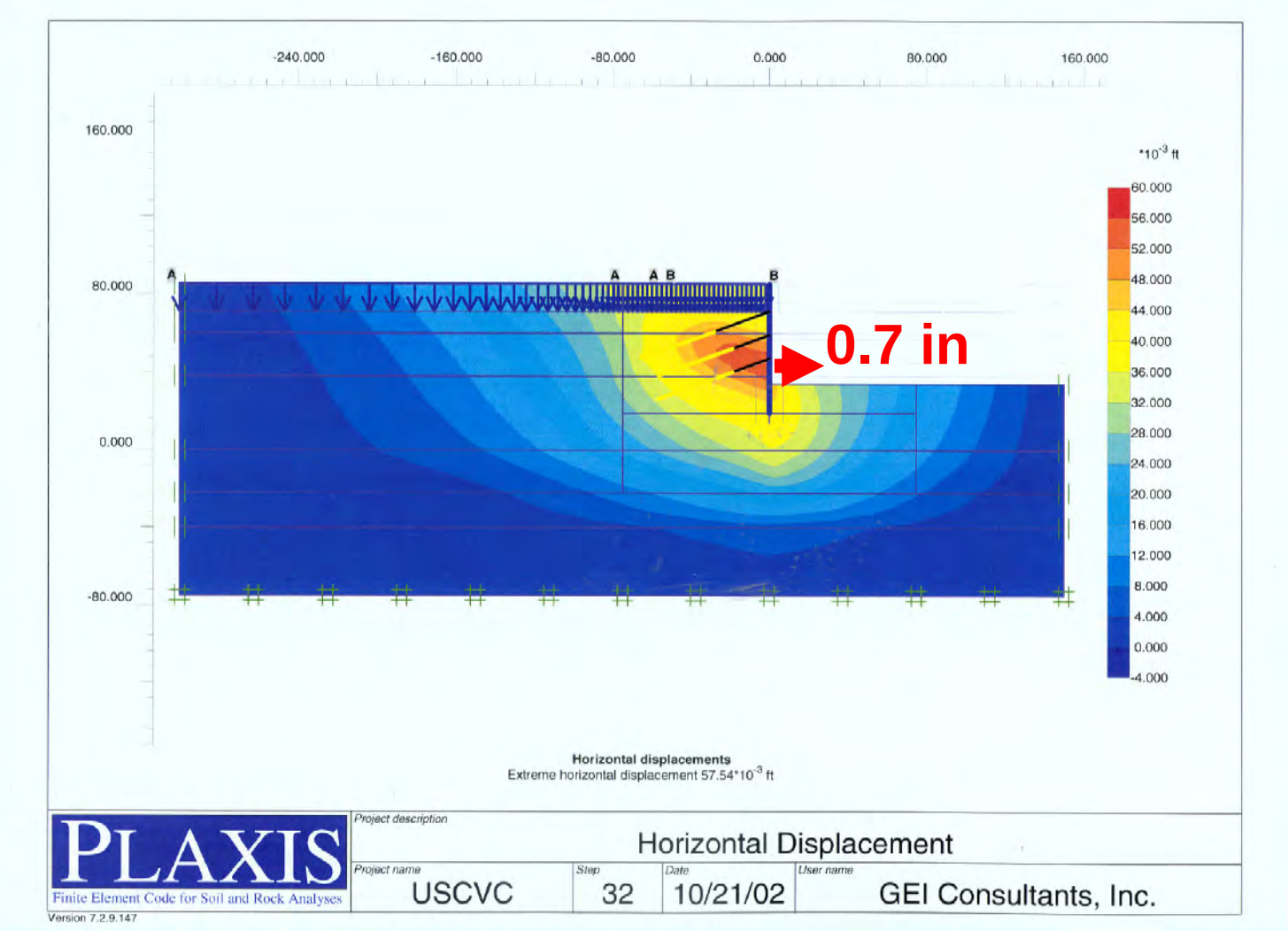
Simplified Design Profile



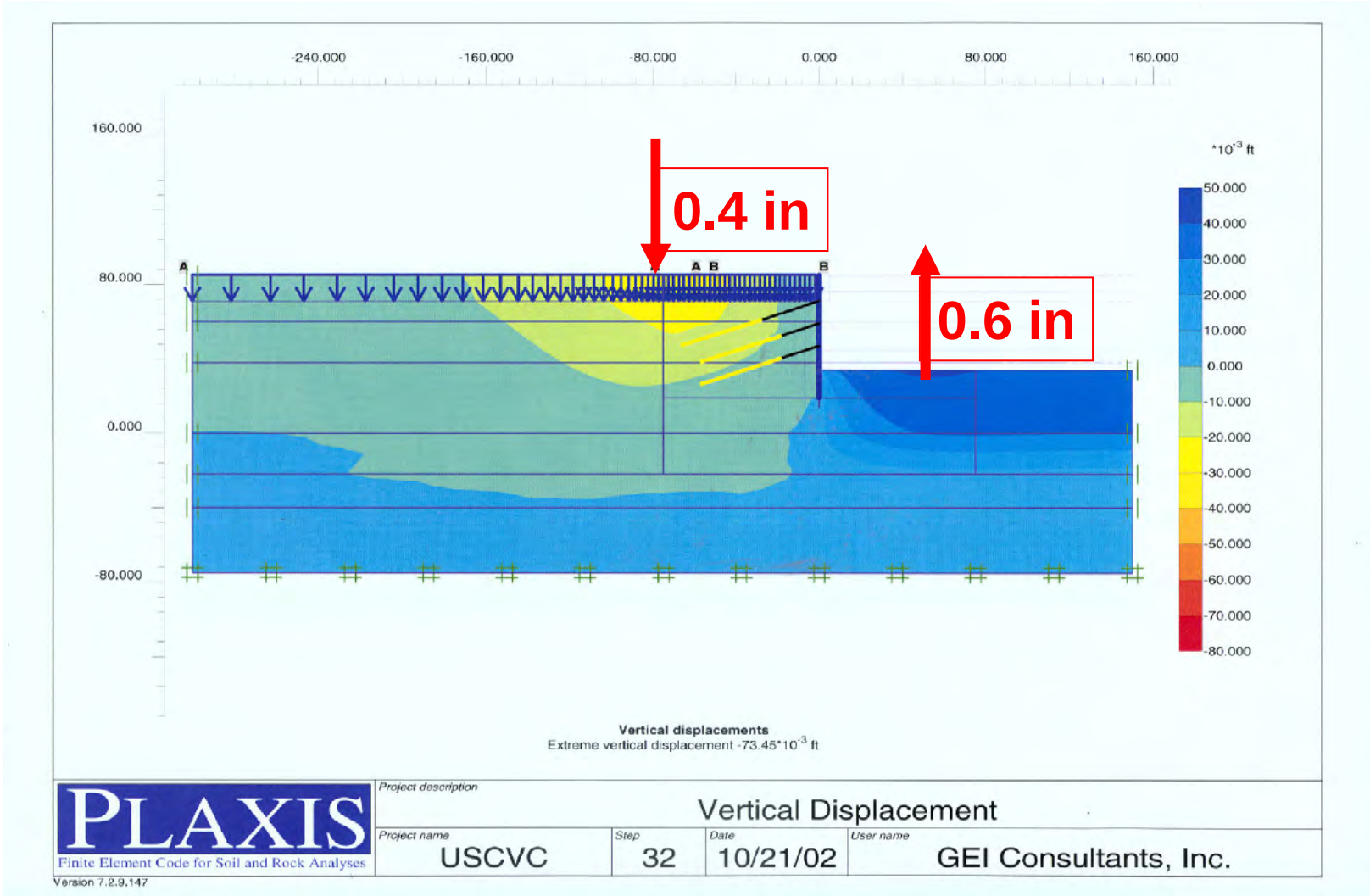
--- Depth of Typical Excavation

-- Depth at Deep Cuts Along Face of Capitol

Predicted Lateral Wall Movement
Typical 40-Foot Deep Cut

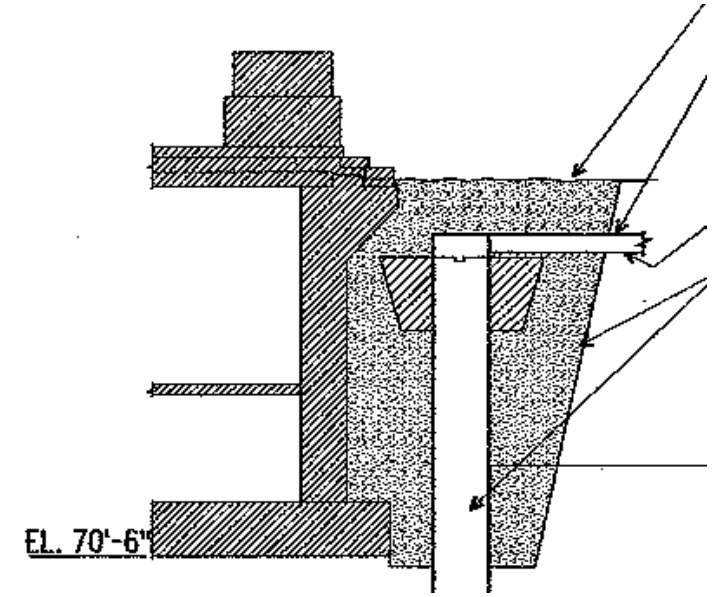


Predicted Vertical Ground Movement
Typical 40-Foot Deep Cut



Slurry Guidewalls





Hydraulic Clamshell for Slurry Wall Excavation

GEI Consultants





Slurry Wall Cage Installation





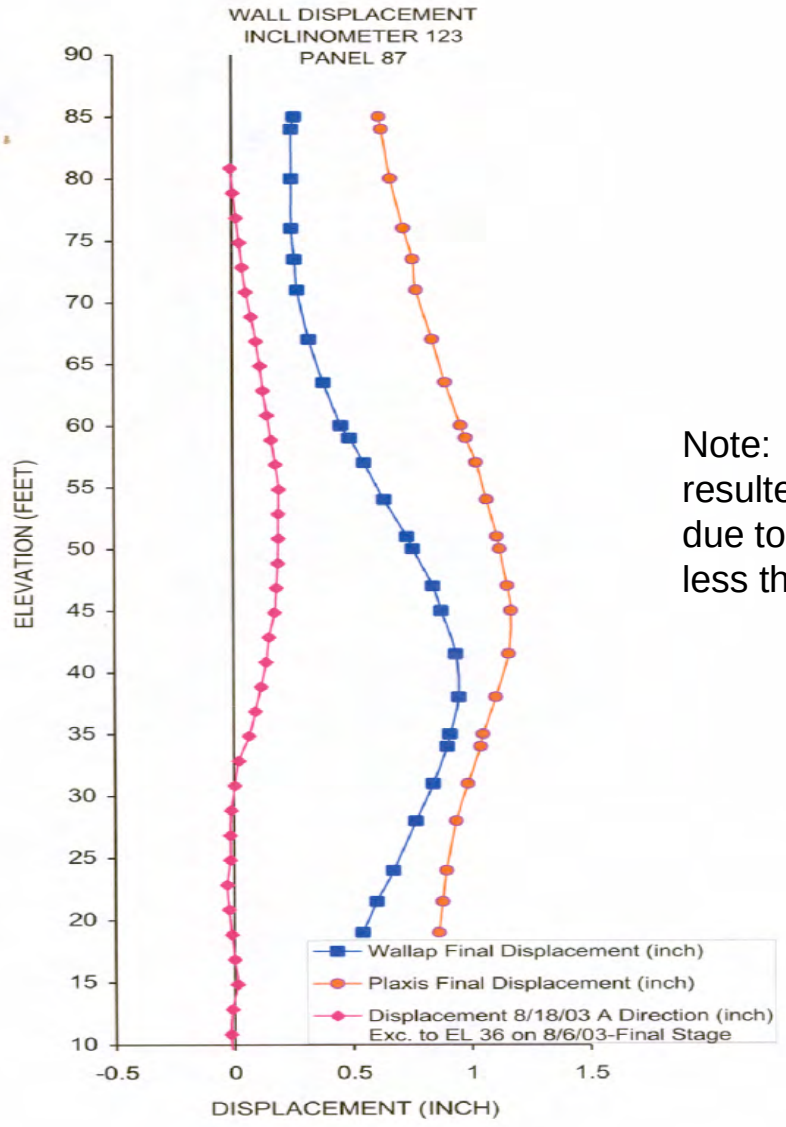
Tieback Installation



Completed Wall

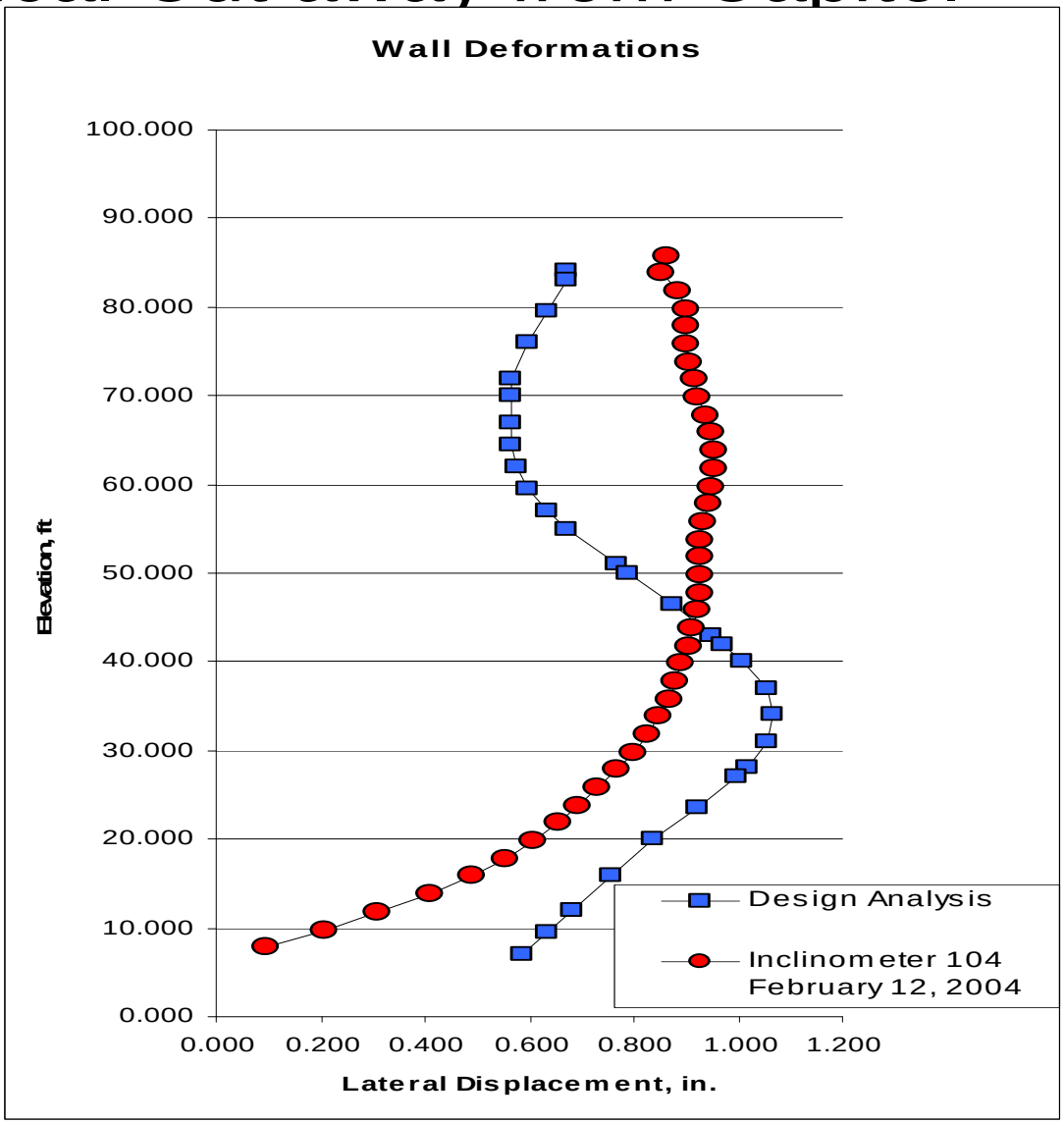


Predicted vs. Actual Wall Movements Deep Section along Capitol



Note: Actual lateral wall movements resulted in angular distortion of Capitol due to differential settlement that was less than allowable value of 1 : 1000.

Predicted vs. Actual Wall Deflection
Typical Cut away from Capitol



Results: Pro-active engineering with M^3 yields excellent movement control

GEI Consultants



CA/T Tunnel Jacking



CA/T Tunnel Jacking

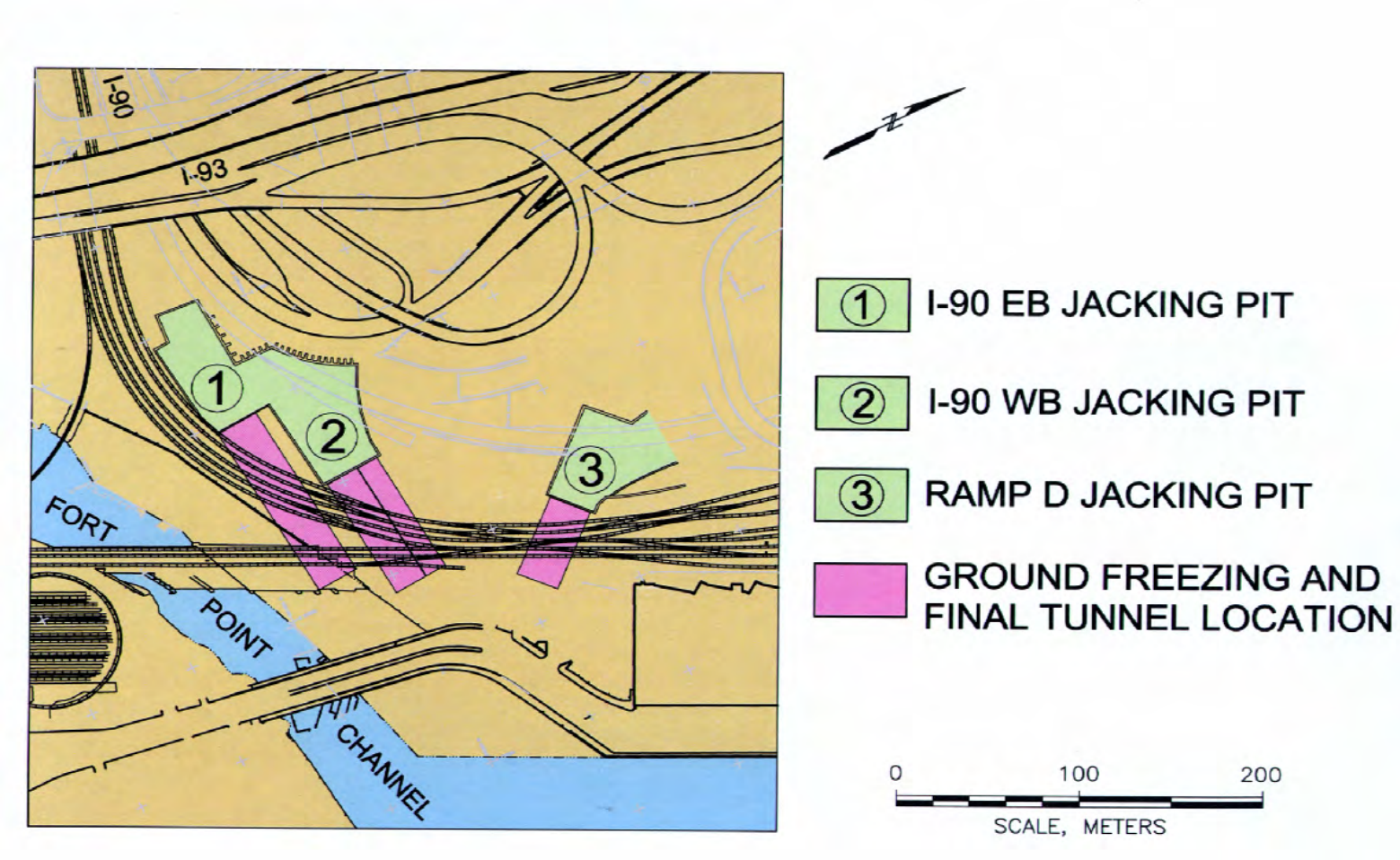


Re-Design of Tunnel Jacking Approach and Procedures

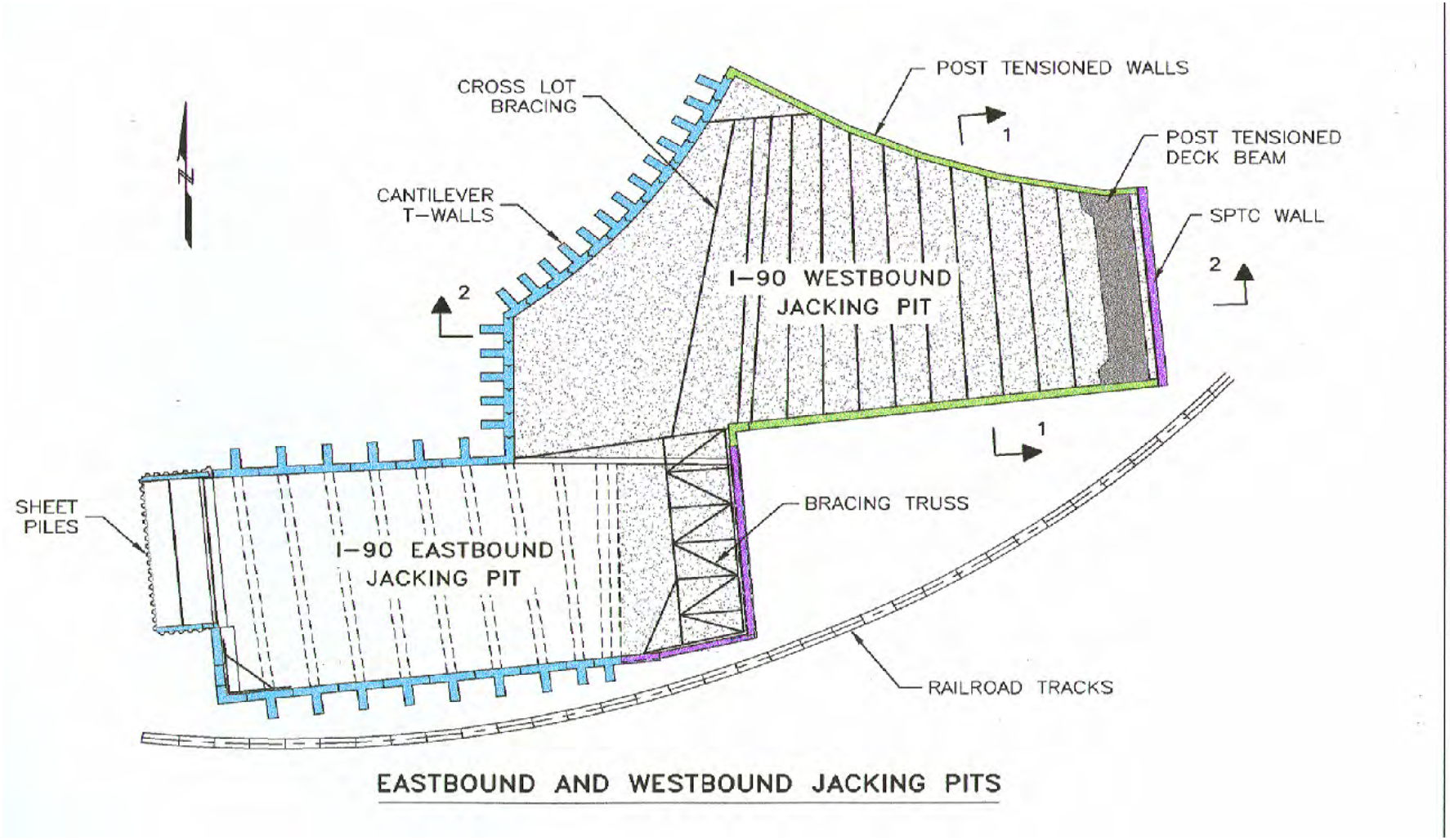
- Original Design
  - Tunnel jacking into existing soil
  - Soil grouting for roof stabilization ahead of face and ground water cutoff
  - Removal of obstructions as encountered
  - Three intermediate jacking stations to limit jacking loads
  - Risks from ground loss, obstructions, re-starting after stopping, tunnel diving in soft subgrade soils

- Value Engineering Approach
  - Ground freezing to stabilize soil in advance of jacking
  - Install walls before freezing, allow controlled yielding of headwalls
  - Removal of frozen soil and obstructions with road-headers
  - Fewer intermediate jacking stations and larger jacking forces
  - Design jacking pits to accommodate ground movements and loads from freezing
  - Reduced risks and better grade control

Jacking Pits

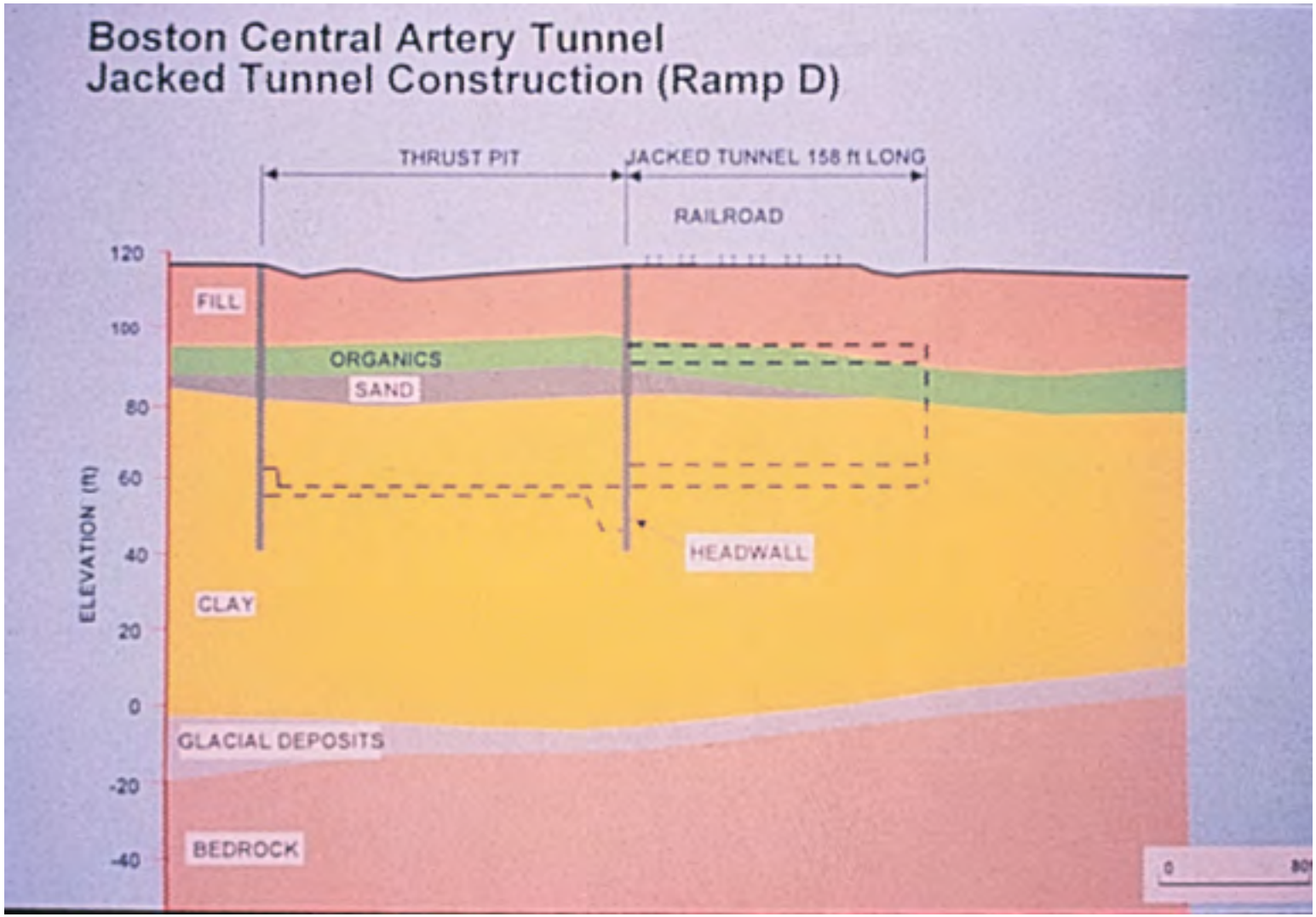


Layout of Jacking Pits

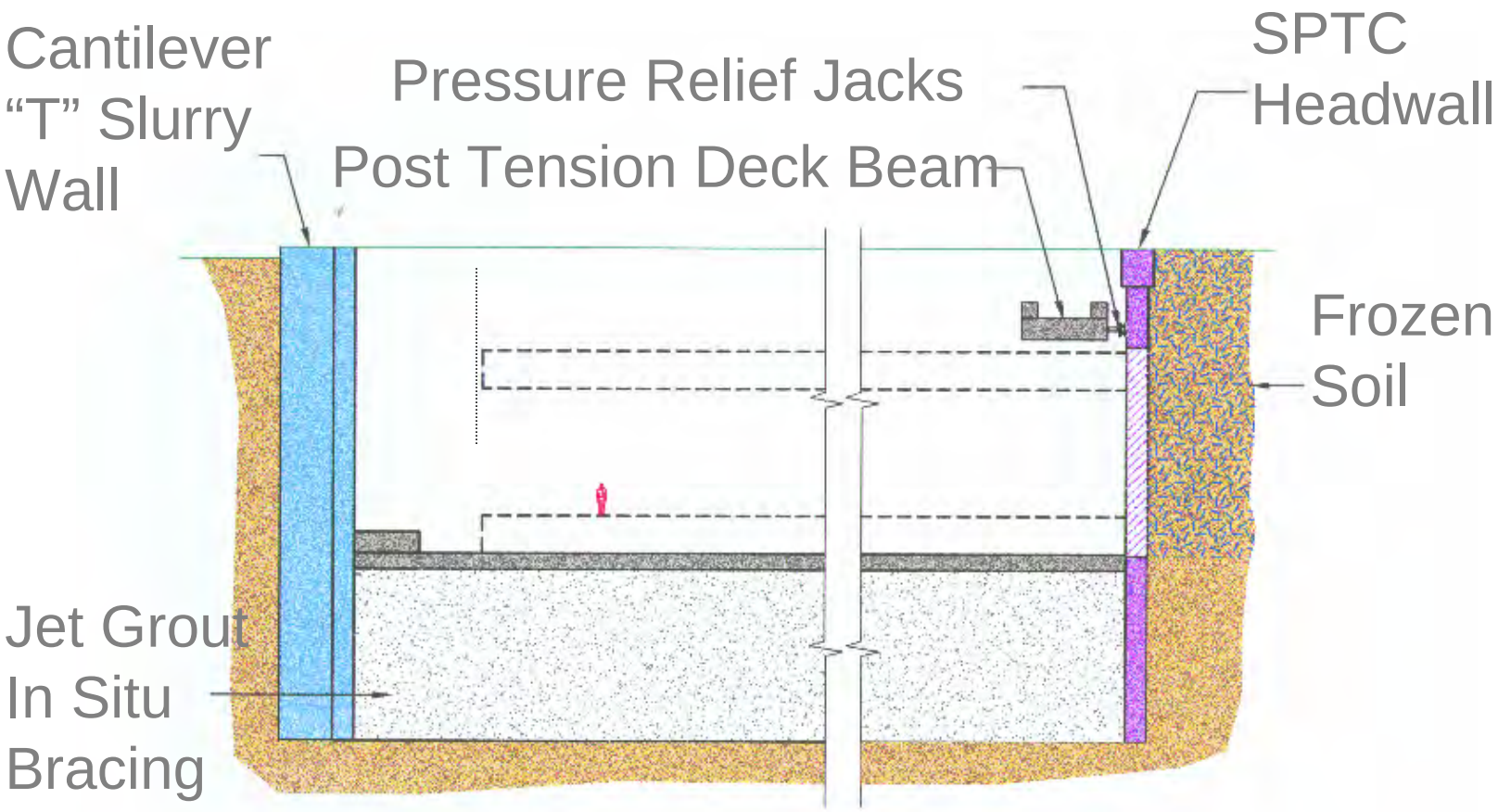


EASTBOUND AND WESTBOUND JACKING PITS

GEI Consultants

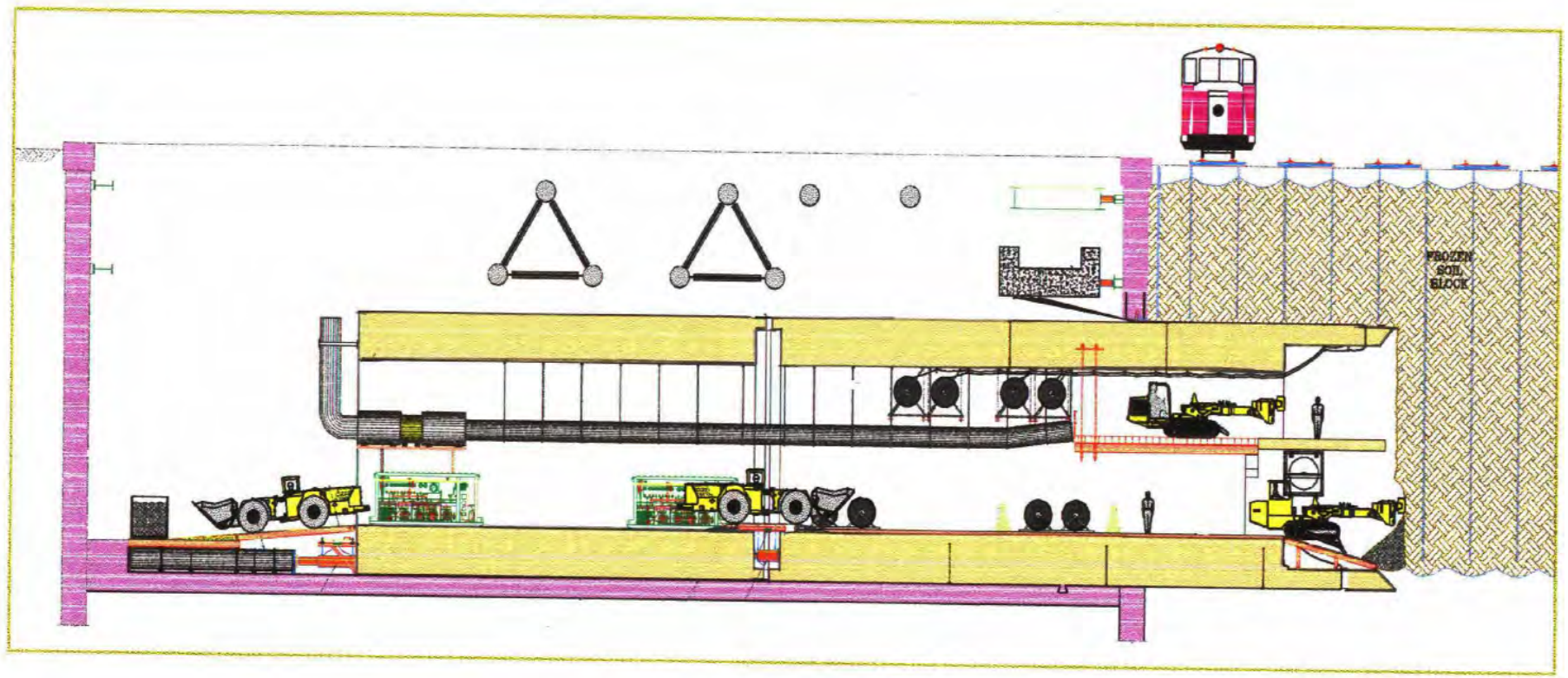


Longitudinal Section of Jacking Pit

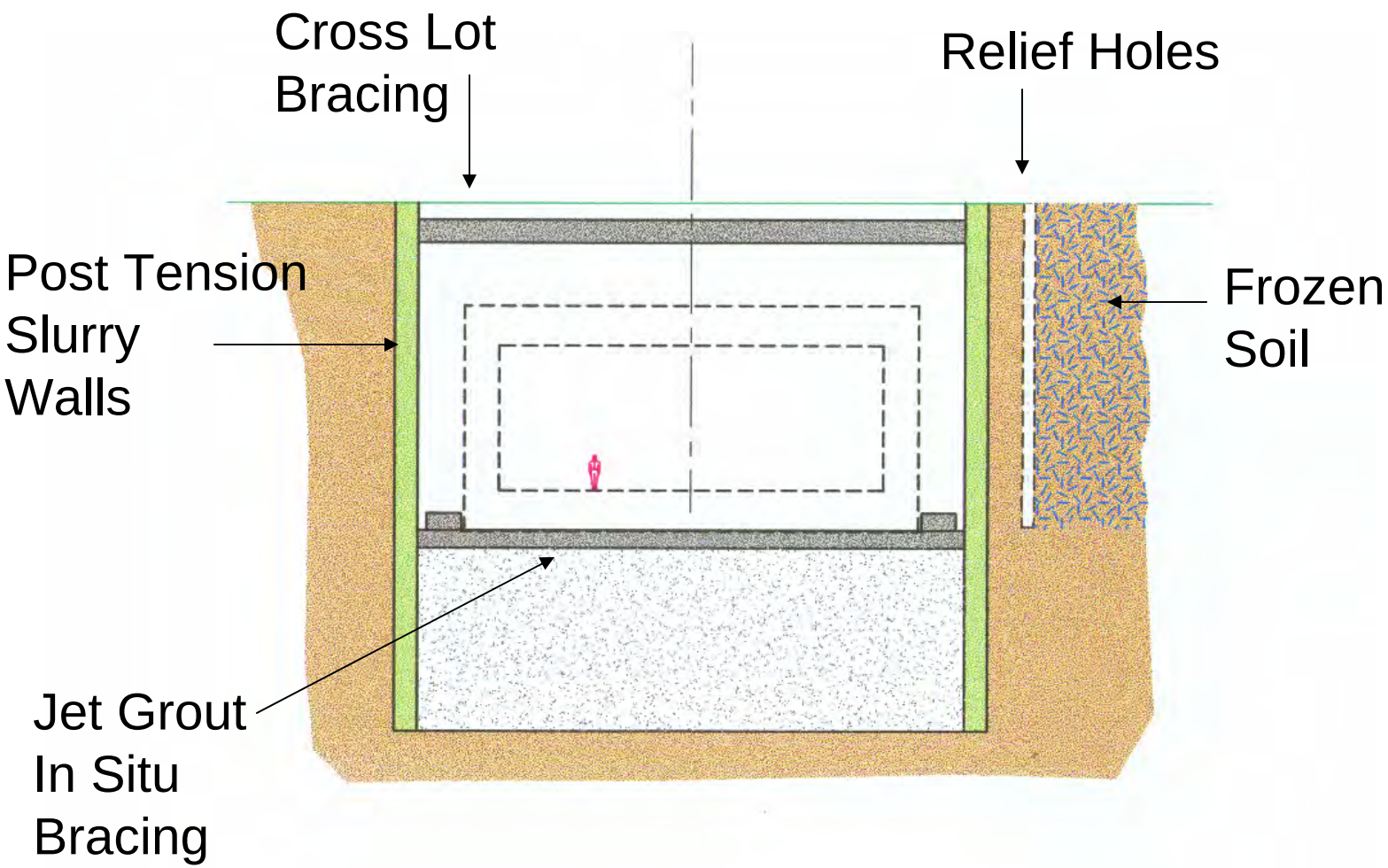


Typical Longitudinal Section of Tunnel Jacking

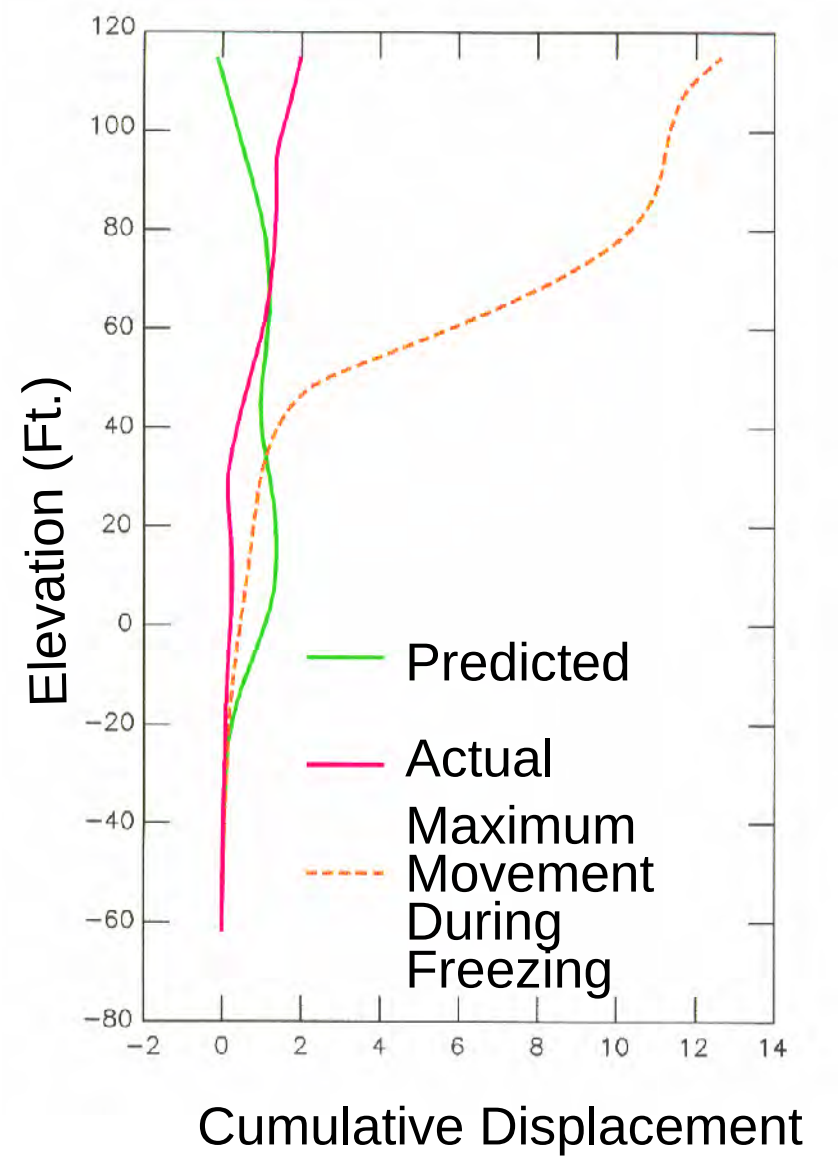
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Cross Section of Jacking Pit



Plot of Jacking Pit Wall Deflection



- **Within CA/T project limits for downstage excavation**
- **Wall behavior similar to walls with multiple levels of bracing**
- **Movements during freezing unprecedented**

Pit Wall and Reaction Truss Next to Railroad



Headwall Reaction Jacks and Truss

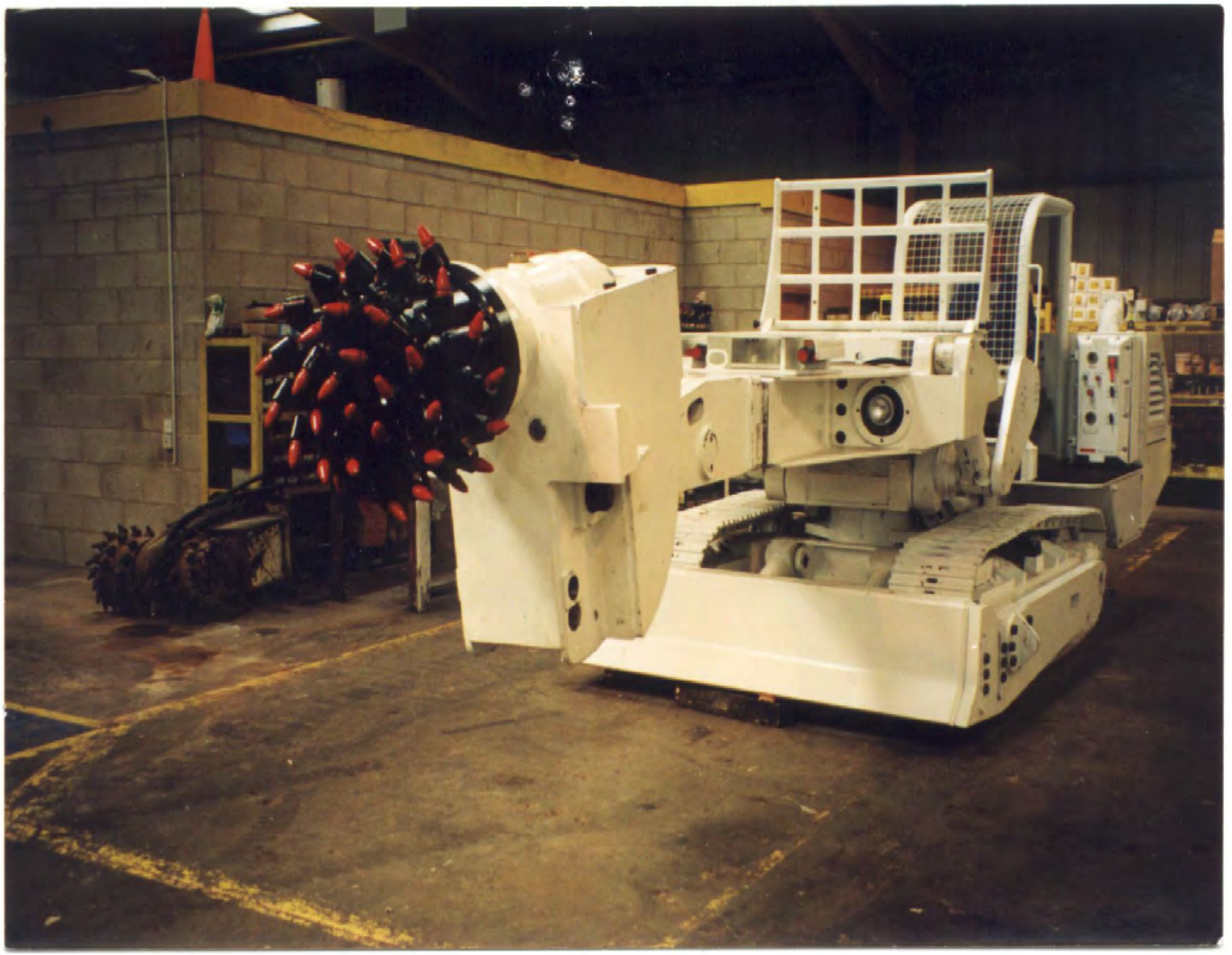


Freeze Pipes in Rail Track Area



Road Header for Excavating Frozen Soil and Obstructions

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Obstructions During Excavation at Tunnel Face

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Tunnel Jacks in Base of Pit



Results: Creative Engineering with M^3 Allow Safe, Very Large Wall Movements

