RECLAMATION

Managing Water in the West

Folsom Dam
Safety of Dams Project
Mormon Island Auxiliary Dam (MIAD)
Proposed Modifications

U.S. Department of the Interior
Bureau of Reclamation

Mormon Island Auxiliary Dam

Corrective Action Study Risk Issues

- Lower part of Upstream & Downstream Foundations Liquefiable During Large Earthquake.
- Static Stability Concern for Seepage and Piping
- Overtopping and Erosion During Major Flood
  - (>2000 year flood)
  - JFP Spillway reduces this risk

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Liquefaction

- Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. Liquefaction and related phenomena can trigger landslides and cause the collapse of dams.

- Liquefaction occurs in saturated soils, that is, soils in which the space between individual particles is completely filled with water. This water exerts a pressure on the soil particles that influences how tightly the particles themselves are pressed together. Prior to an earthquake, the water pressure is relatively low. However, earthquake shaking can cause the water pressure to increase to the point where the soil particles can readily move with respect to each other.

- Liquefaction of MIAD Tailings was Determined in 1980's

- Remediation of Tailings was Proposed and Implemented in the early 1990's

- Additional Investigation determined lower zones possibly liquefiable of alternatives and study of preferred alternatives under taken in 2004

Increased water pressure can also trigger landslides and cause the collapse of dams. Lower San Fernando dam (above) suffered an underwater slide during the San Fernando earthquake, 1971. Fortunately, the dam barely avoided collapse, thereby preventing a potential disaster of flooding of the heavily populated areas below the dam.

(video link)

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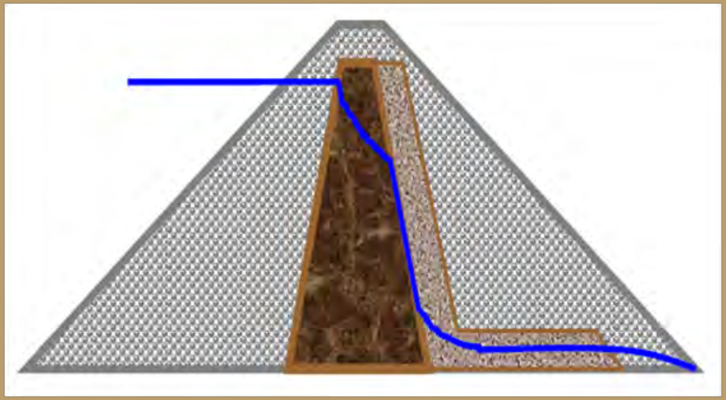
Static Seepage & Piping

- All earth dams have seepage resulting from water percolating slowly through the dam and its foundation. Seepage must, however, be controlled in both velocity and quantity. If uncontrolled, it can progressively erode soil from the embankment or its foundation, resulting in rapid failure of the dam.

- Erosion of the soil begins at the downstream side of the embankment, either in the dam proper or the foundation, progressively works toward the reservoir, and eventually develops a "pipe" or direct conduit to the reservoir. This phenomenon is known as "piping.“

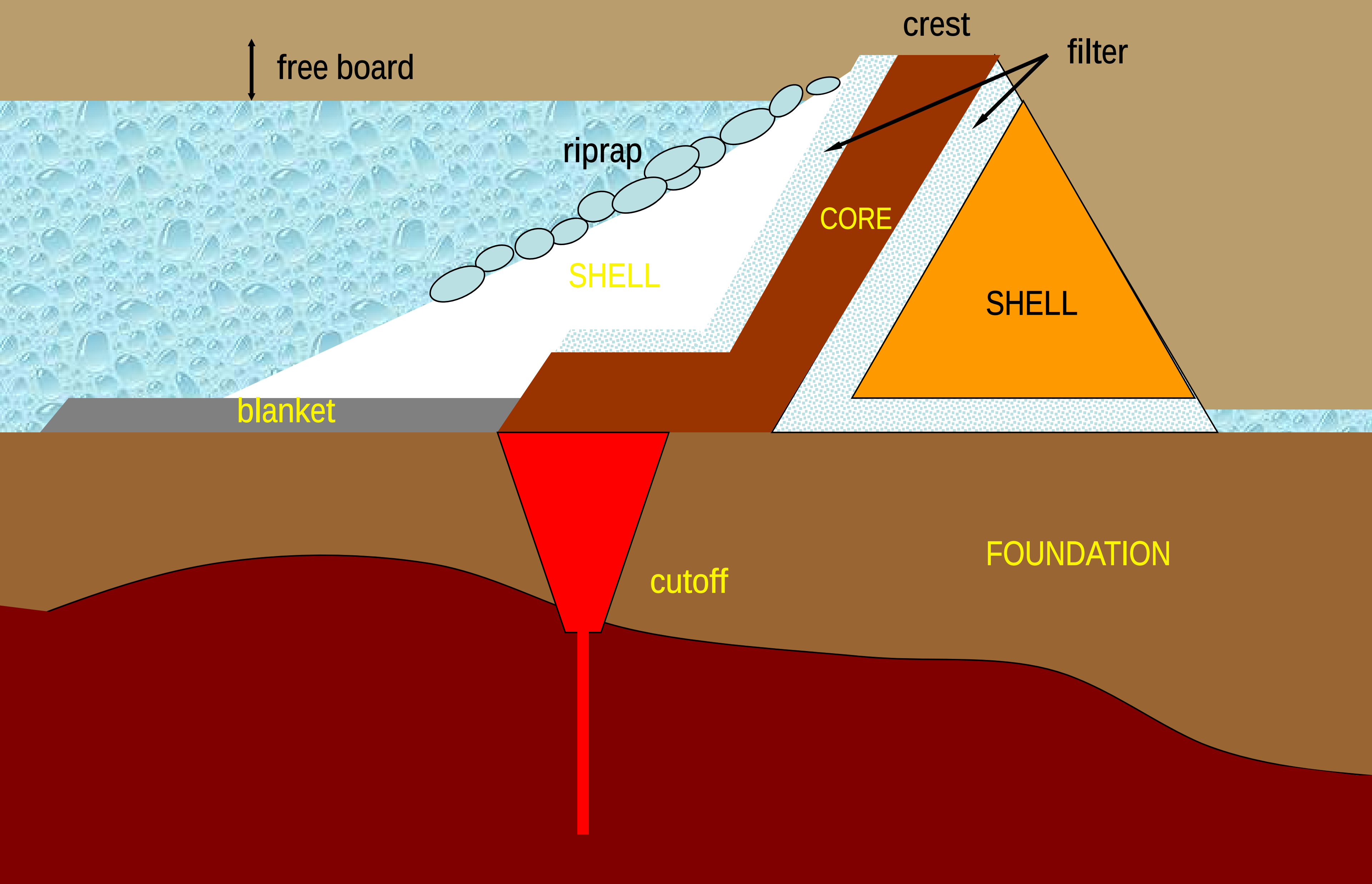
- Seepage, if uncontrolled, can erode fine soil material from the downstream slope or foundation and continue moving towards the upstream slope to form a pipe or cavity to the pond or lake often leading to a complete failure of the embankment.

- Seepage failures account for approximately 40 percent of all embankments or dike failures.

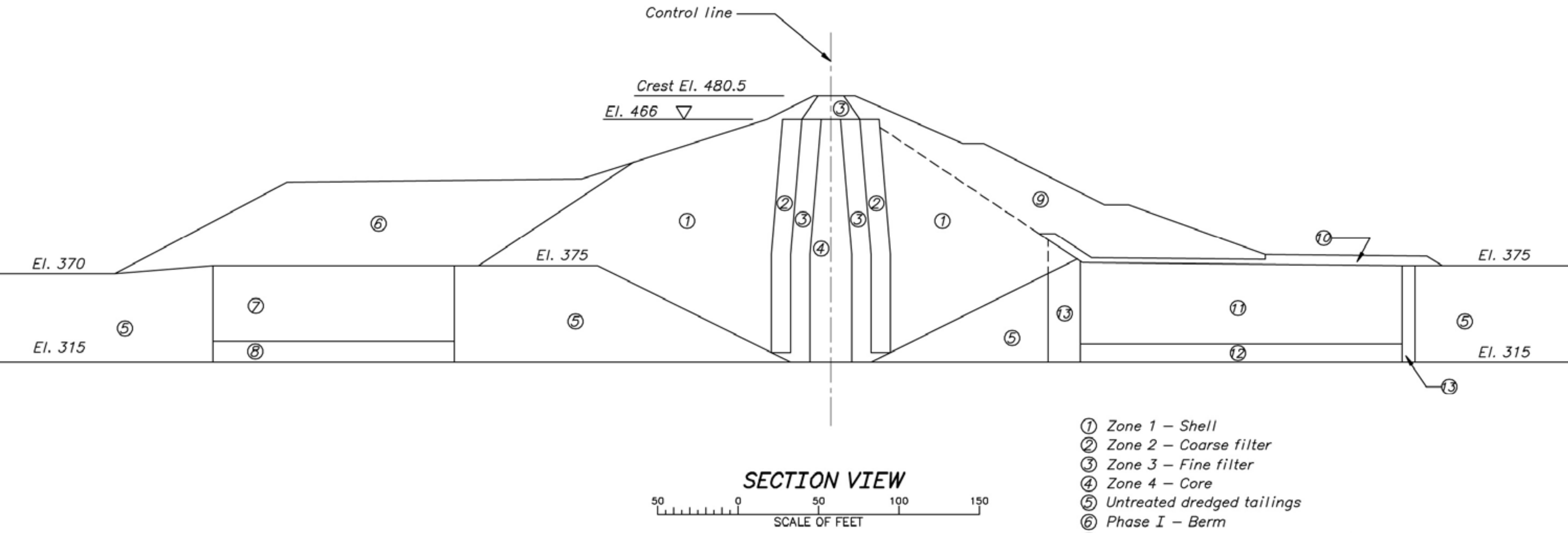


(video link)

Earth Dam Current Design



MIAD Typical Embankment Section



① Zone 1 – Shell
② Zone 2 – Coarse filter
③ Zone 3 – Fine filter
④ Zone 4 – Core
⑤ Untreated dredged tailings
⑥ Phase I – Berm
⑦ Phase I – (Dynamic compaction) Upper area
⑧ Phase I – (Dynamic compaction) Lower area
⑨ Phase II – Recompacted ① material
⑩ Phase II – Drainage blanket
⑪ Phase II – Upper BFSC* area
⑫ Phase II – Lower BFSC* area
⑬ Phase II – BFSC drainage elements
* Bottom Feed Stone Column

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Geology

- Foundation Rock
  - Metamorphic Rock of the Amador Group
  - Primarily Schists
  - Numerous Dioritic and Diobasic Dikes
- Blue Ravine
  - Old American River Channel
  - Filled with Alluvial Gravel Deposits
  - Gravels, Sands, Silts & Clays
  - Dredged Tailings - 1800’s and early 1900’s
  - (Sta. 445 to 455)

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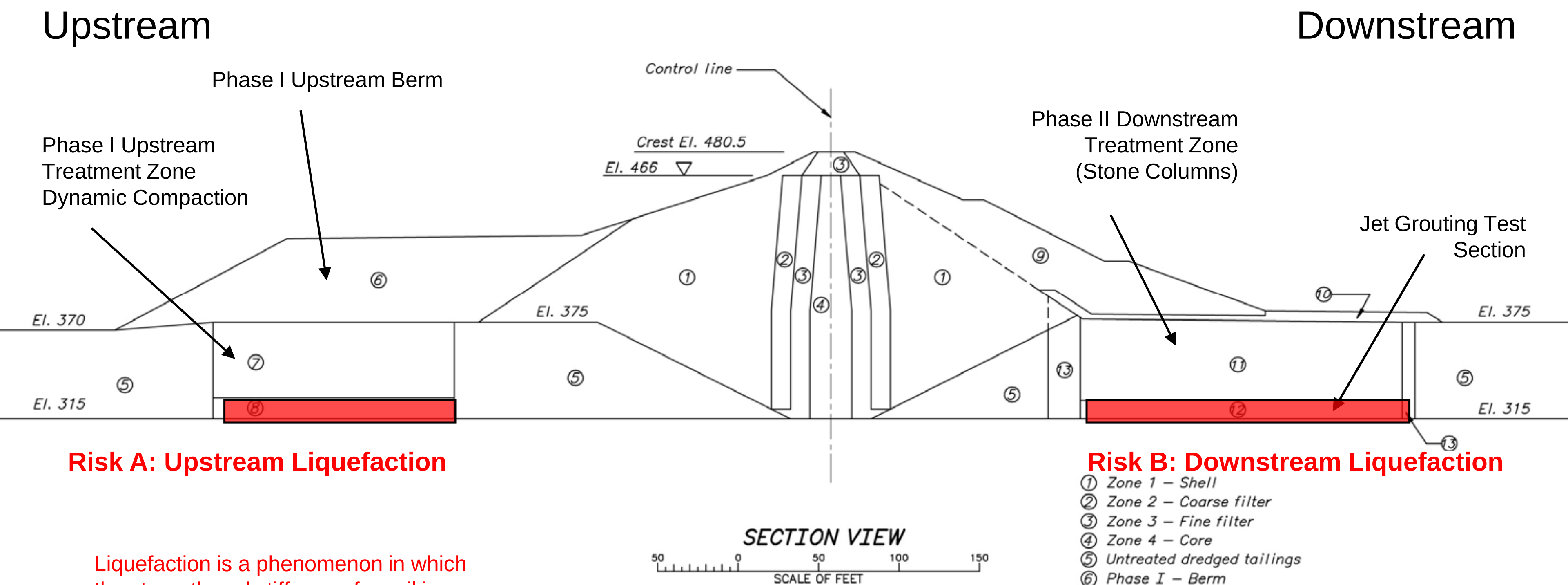
INVESTIGATIONS AND ANALYSES

- Drilling Investigations
  - SPT, BPT, Geophysical, Cone Testing, Block Samples, Test Trenches

- Analyses
  - Static, Dynamic, Liquefaction, Deformation, Structural, Other

- Risk Assessment
  - Upstream & Downstream
    - Conclusion: Above ALOL Guidelines
    - Recommend: Additional Treatment Measures Required
      - Increase Density of Lower ~10 feet of Tailings
      - Document Reduced Risk with Testing

MIAD Previous Modifications



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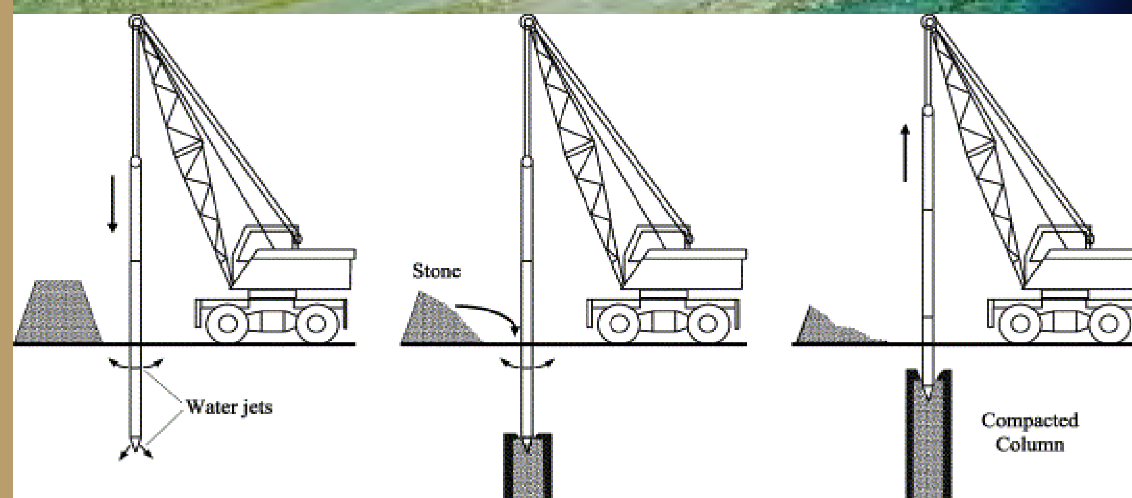
MIAD PHASE I & II MODIFICATIONS

Phase 1 (1990-91): Dynamic Compaction Upstream Constructed a 55-foot High Berm

Phase 2 (1993-94): Stone Columns Downstream



Mormon Island Auxiliary Dam Corrective Action Study

Seismic Alternatives Considered:

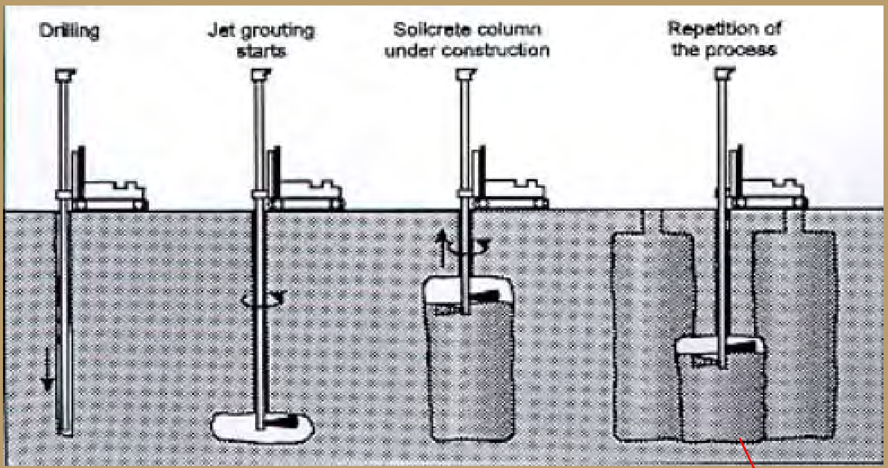
(To be combined with Static and Hydrologic Alternatives)

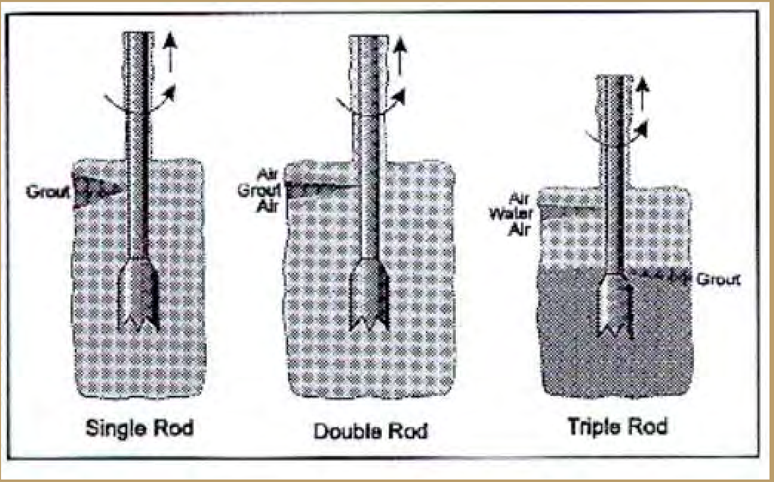
- **In-situ densification of upstream and downstream treatment zones – Jet Grouting**
- **Downstream overlay, Excavate and Replace with Soil or RCC**
- **Series of Concrete Walls in Foundation Perpendicular to Crest**
- **Continuously Dewater**

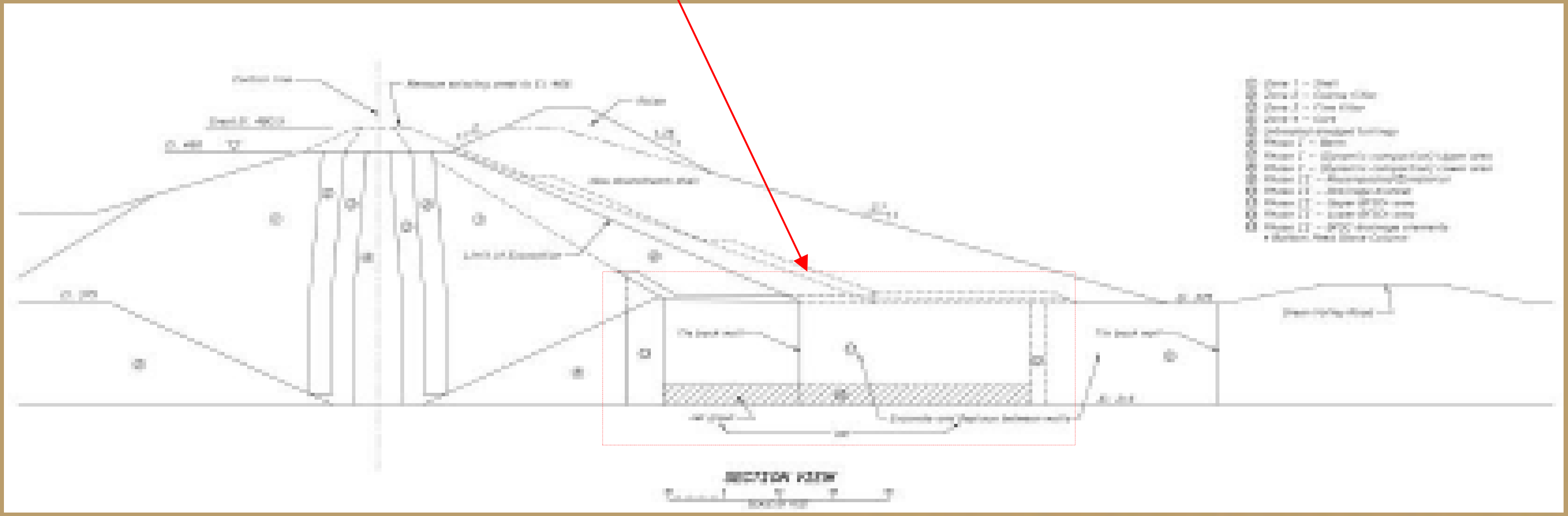
Jet Grouting Test Section

(Determined to be technically & economically not feasible)

Seismic Element Option
Jet Grouting - MIAD







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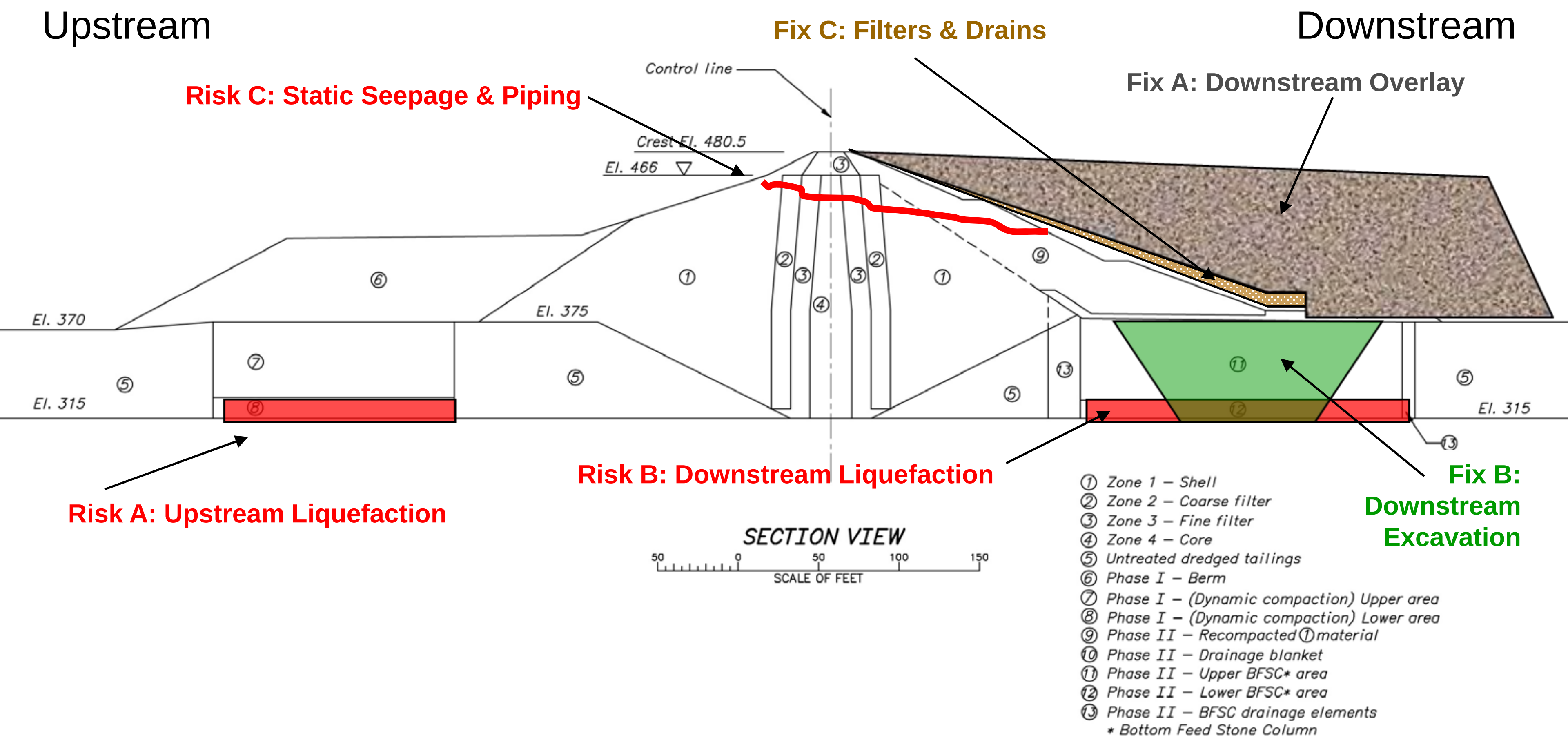
Risk and Risk Reduction Modifications

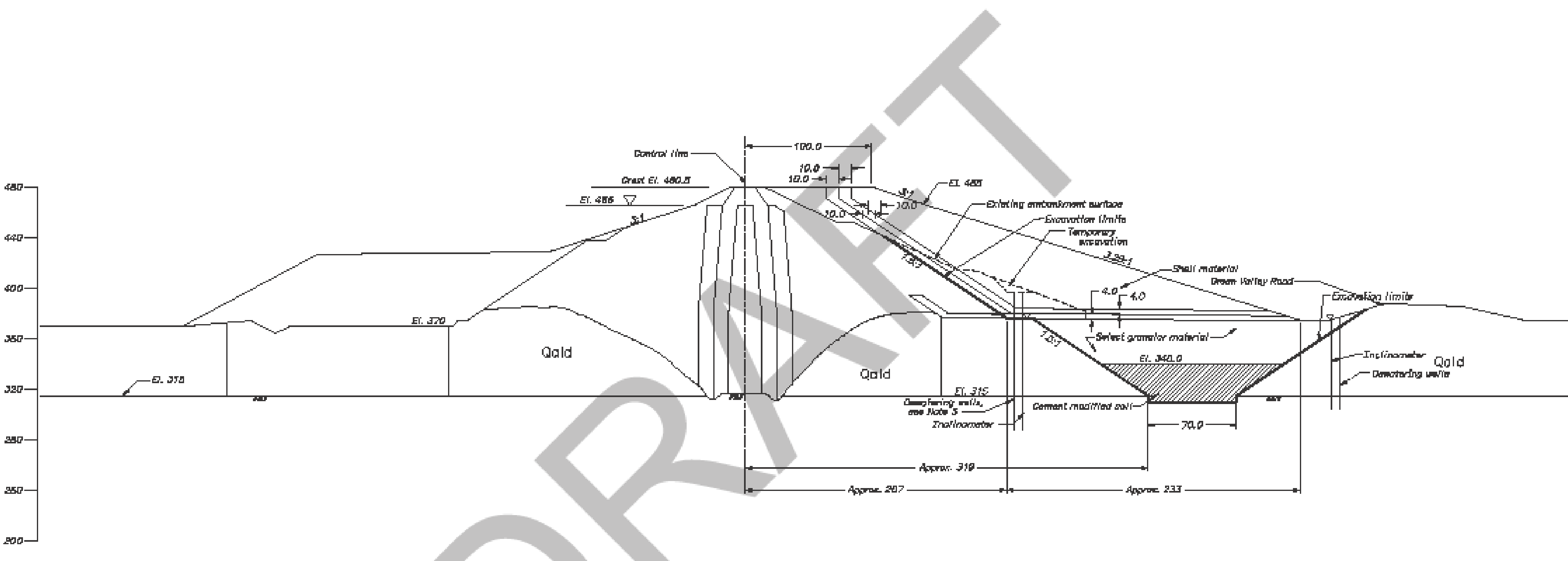


Filter elements allow water to safely pass and prevents internal soil erosion

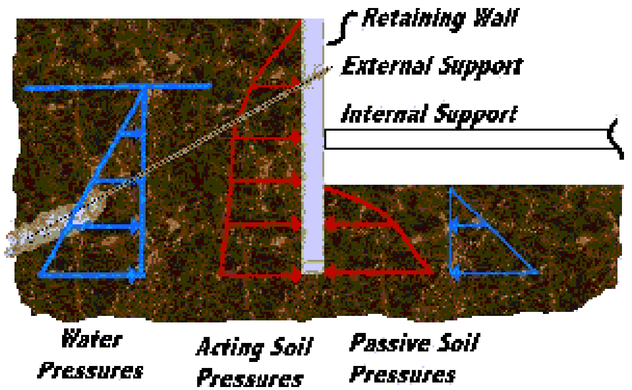
Conventional Excavate and Replace

Advantages: Known methods, Reclamation experience, may be least costly

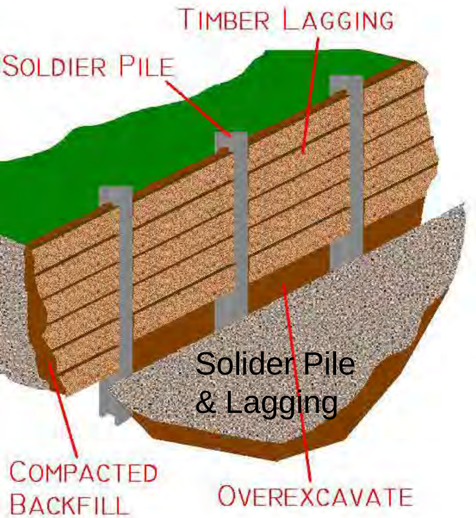
Disadvantages: Highest construction risk and environmental impacts including relocation of Green Valley Road



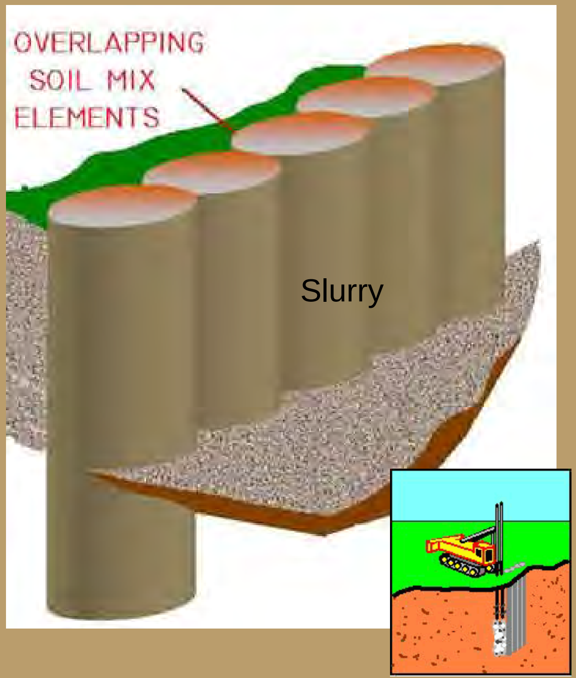
Walls Types



Basic Components and Forces in Deep Excavations

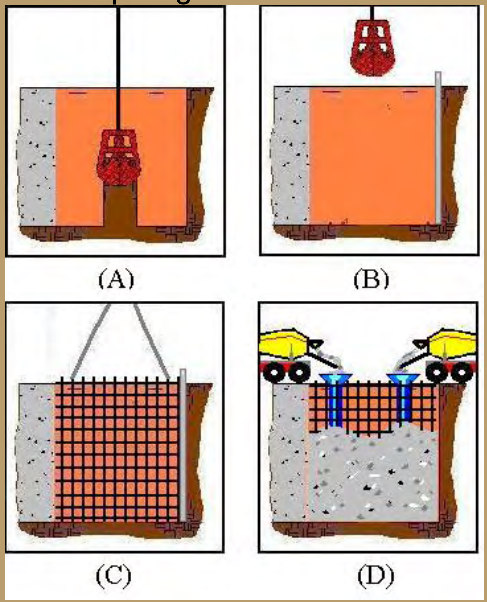


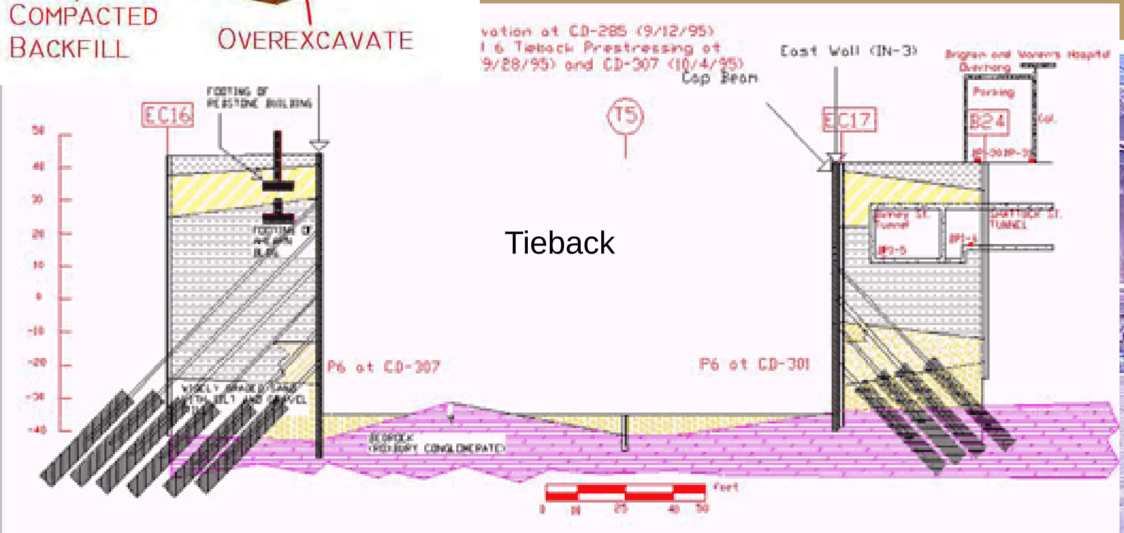
Solider Pile & Lagging



Slurry

Diaphragm





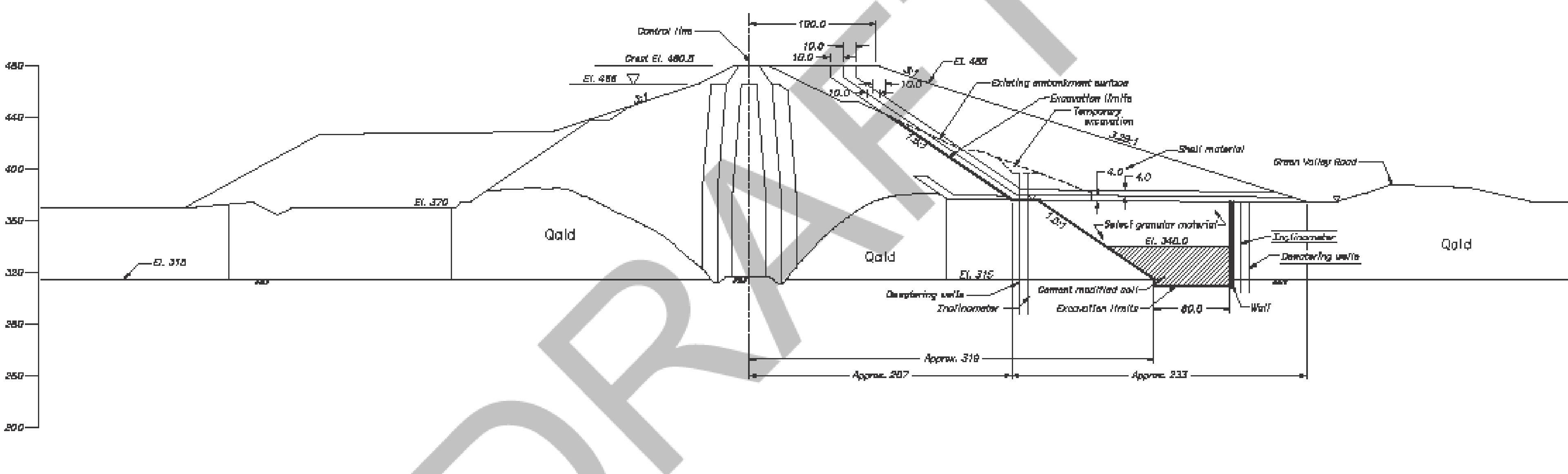
Tieback

Sheetpile

Single Wall Excavate & Replace

Advantages: Known methods, less Reclamation experience, reduces footprint

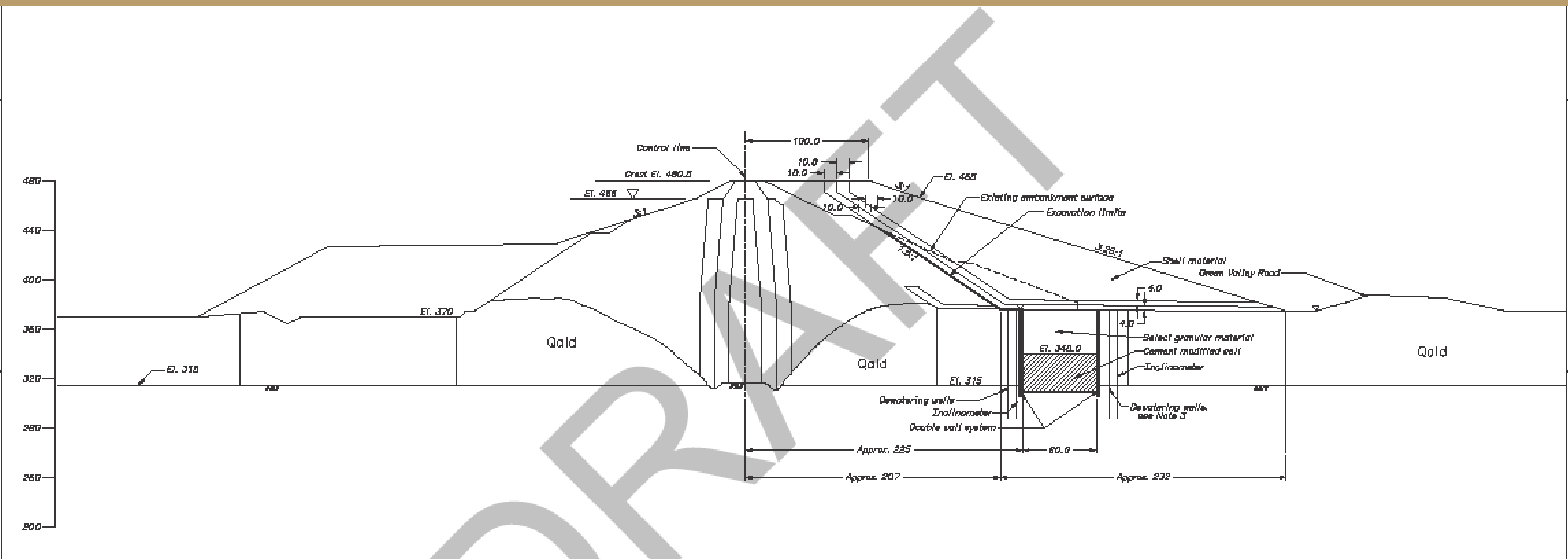
Disadvantages: Construction risk remains similar, environmental impacts reduced at the expense of cost and complexity



Dual Wall Excavate & Replace

Advantages: Known methods, little Reclamation experience, reduces footprint significantly

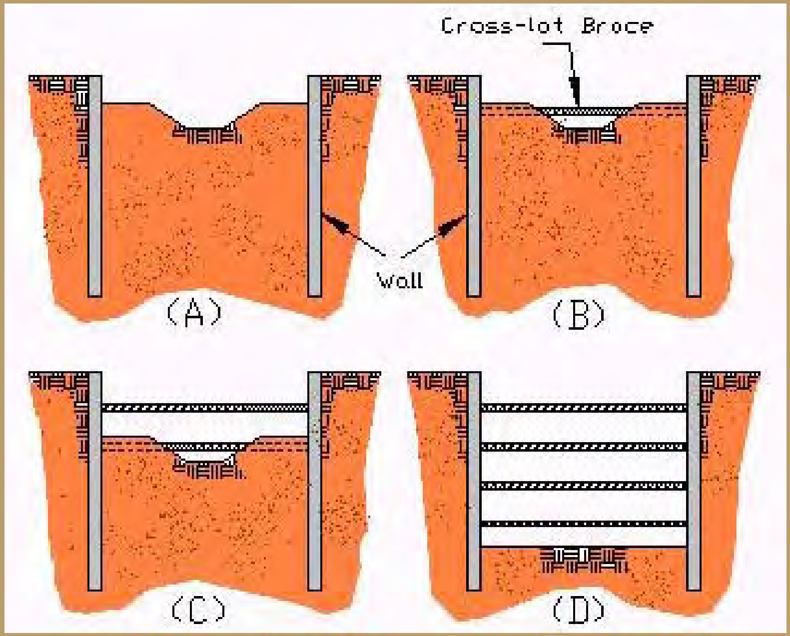
Disadvantages: Construction risk reduced, environmental impacts reduced at the expense of significant cost and complexity



Cellular Excavate & Replace

- Advantages: No Reclamation experience, reduces footprint dramatically Construction risk nearly eliminated along with many environmental impacts

- Disadvantages: Reductions come with increase time and cost



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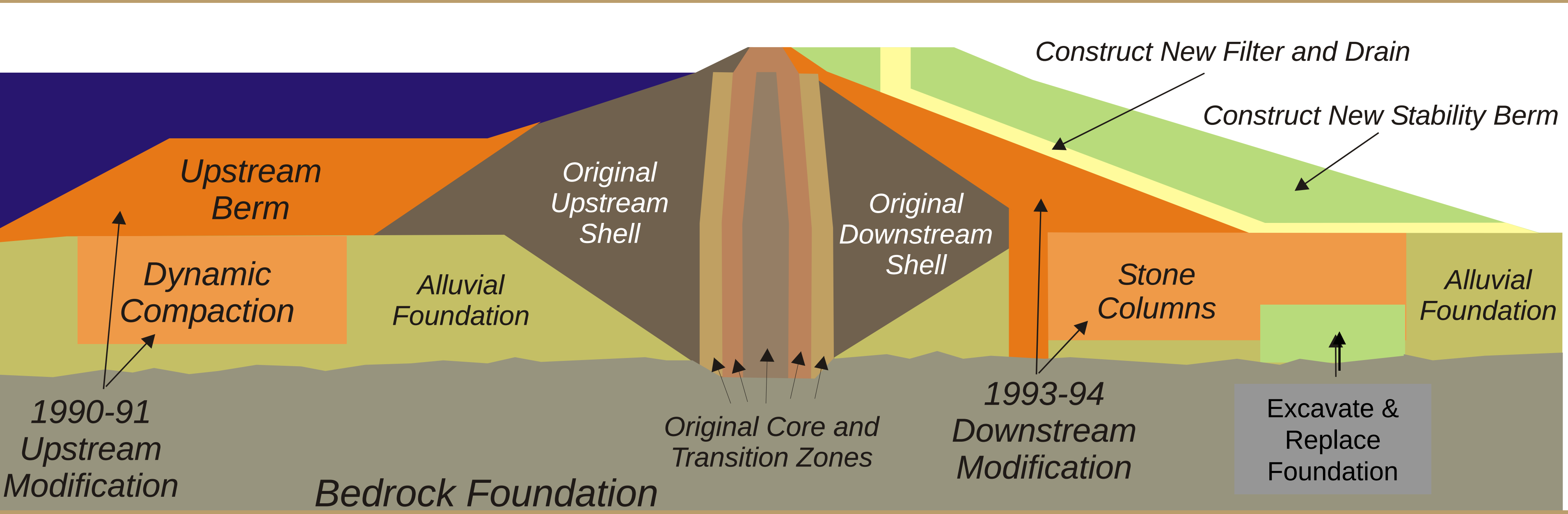
MIAD at Completion



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SUPPLEMENTAL ENVIRONMENTAL DOCUMENTATION

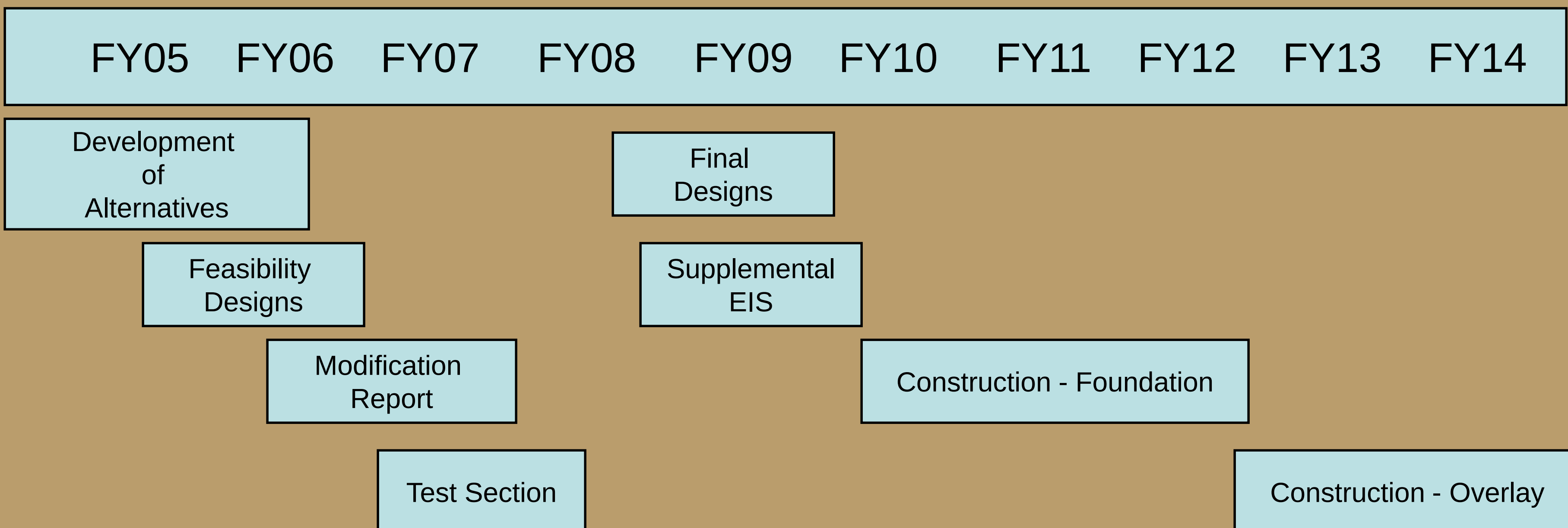
- PREVIOUS ENVIRONMENTAL STUDIES
- PREVIOUS ENVIRONMENTAL ANALYSIS
- FOLSOM EIS/EIR DOCUMENT
  - PLANNING DOCUMENT (ROD) WITH MOD REPORT
  - SUPPLEMENTAL DOCUMENT WITH FINAL DESIGNS
- REVISED ENVIRONMENTAL COMMITMENT PLAN
- REVISED MITIGATION PLAN

Potential Impacts of MIAD Modification Project

- Water quality concerns, ground water concerns
- Wetlands concerns (area across Green Valley Road)
- Air quality concerns:
  - Monitoring for naturally occurring asbestos
  - dust, construction equipment emissions
- Endangered species concerns
- Public safety during construction
  - Minimizing construction risks
  - Hours of construction
  - Noise from trucks and excavation activities
- Recreation, hiking, closure of trail and parking lot
  - When will closures begin
  - How long will closures last
  - Impacts to recreationists
  - Trail detours
- Potential impacts to Green Valley Road
  - Impacts to City of Folsom easement
  - Impacts to commuters
  - Traffic concerns
  - Signage, flagmen, etc.

MIAD

Safety of Dams Proposed Schedule



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END OF PRESENTATION

PLEASE VISIT OTHER
STATIONS FOR FURTHER
PROJECT INFORMATION

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