



GUANELLA DAM: COOPERATIVE DROUGHT RESPONSE

**Steve Jamieson, PE
W. W. Wheeler and Associates, Inc.**

**AWSE 2005 Spring Workshop
May 18, 2005**

Project Team

- **Engineering Team**

- **Wheeler**

- Project management
 - Civil design
 - Hydraulics & hydrology
 - Plans & specs
 - Resident engineer

- **URS**

- Geotechnical
 - Structural
 - Mechanical/Electrical
 - Materials testing

- **City of Golden**

- **Dan Hartman**
 - **Vince Auriemma**

- **Colorado SEO**

- **Jack Byers**
 - **Mark Haynes**
 - **BasePoint Design Corp**

- **Kiewit Western Company**

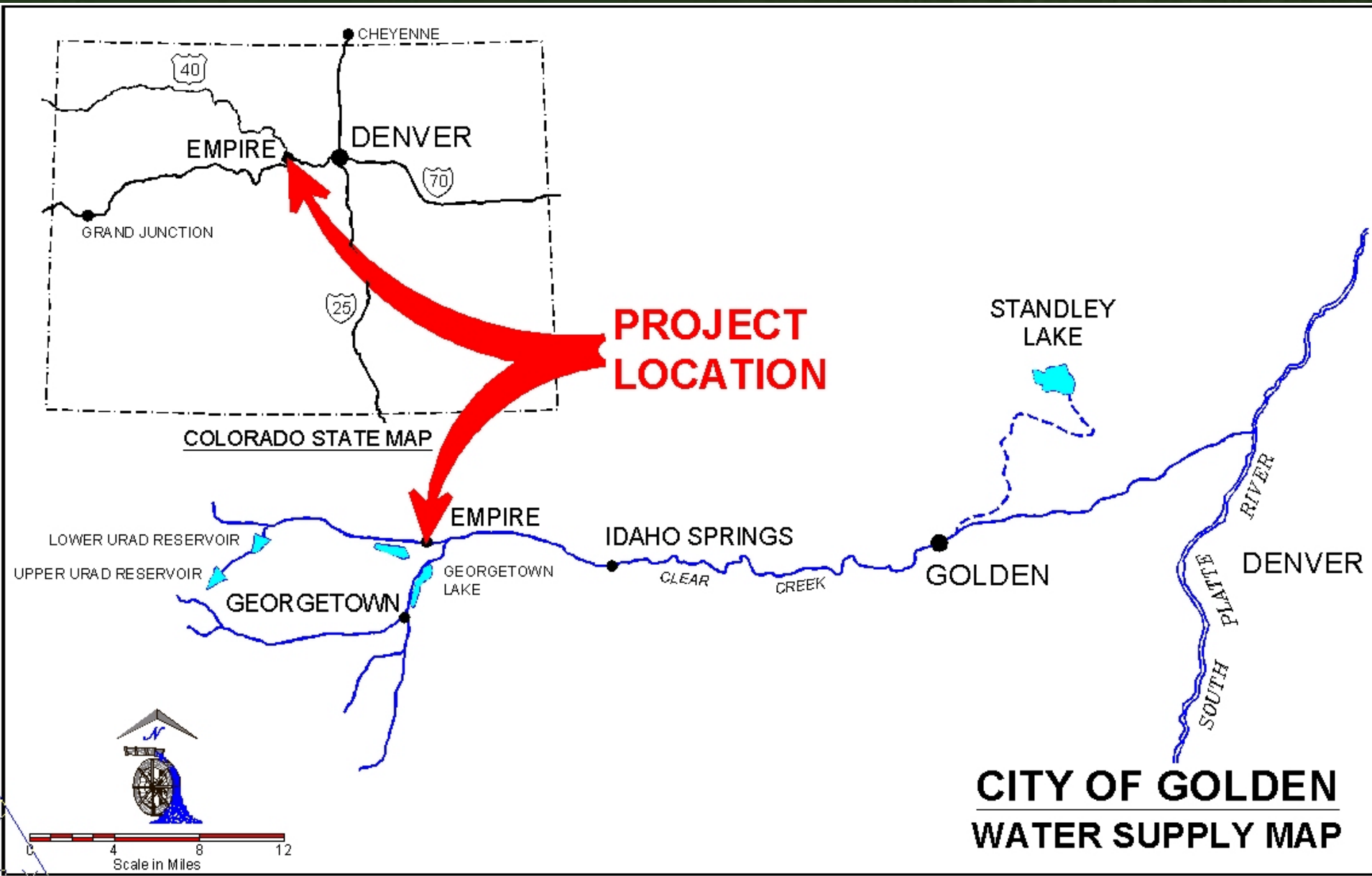
- **R.E. Monks Construction Company**
 - **Geo-Con**
 - **Ludvik Electric**

City of Golden



- Located about 12 miles west of Denver, Colorado
- 17,500 residents
- Home to Colorado School of Mines
- Home of the Coors Brewery !!

City of Golden Water Supply

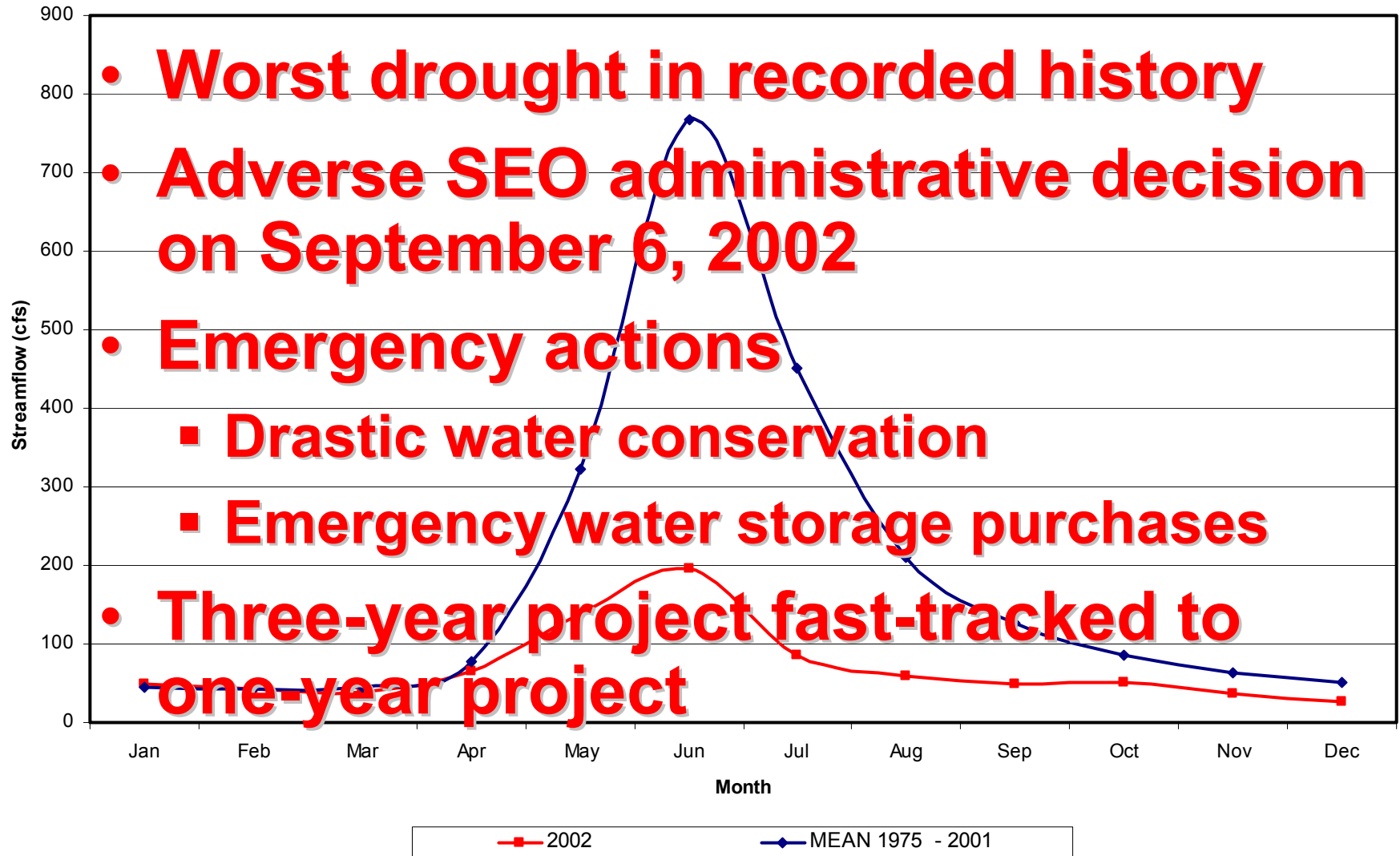


PROJECT OVERVIEW

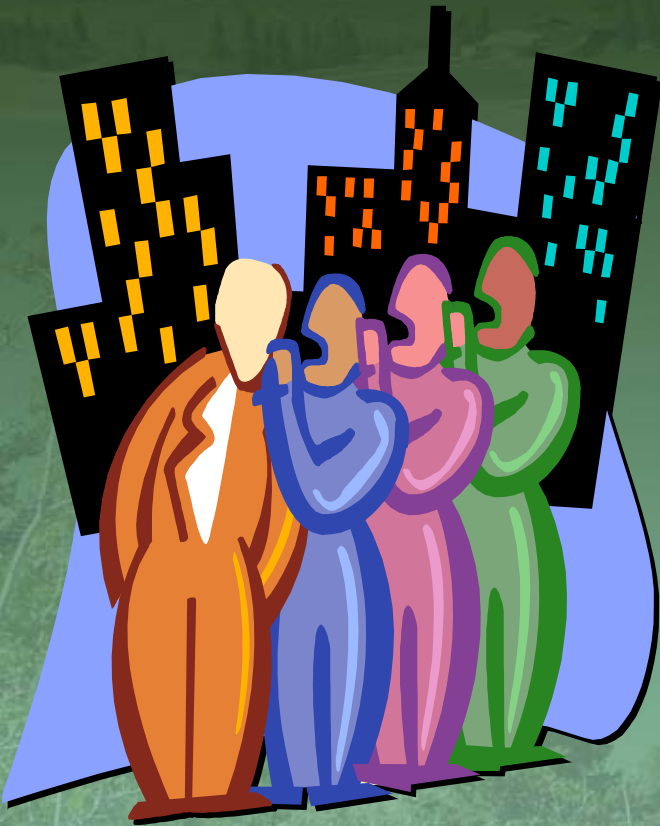
- **34-foot-high, Class I dam**
- **2,140 acre-feet of storage**
 - **1,340 acre-feet open reservoir**
 - **800 acre-feet alluvial bank storage**
- **Off-channel storage adjacent to West Fork Clear Creek**
- **Originally planned for 2005 completion**
- **The drought accelerated completion to 2003**

The Challenge

Average Monthly Flows in Clear Creek Near City of Golden Water Treatment Plant

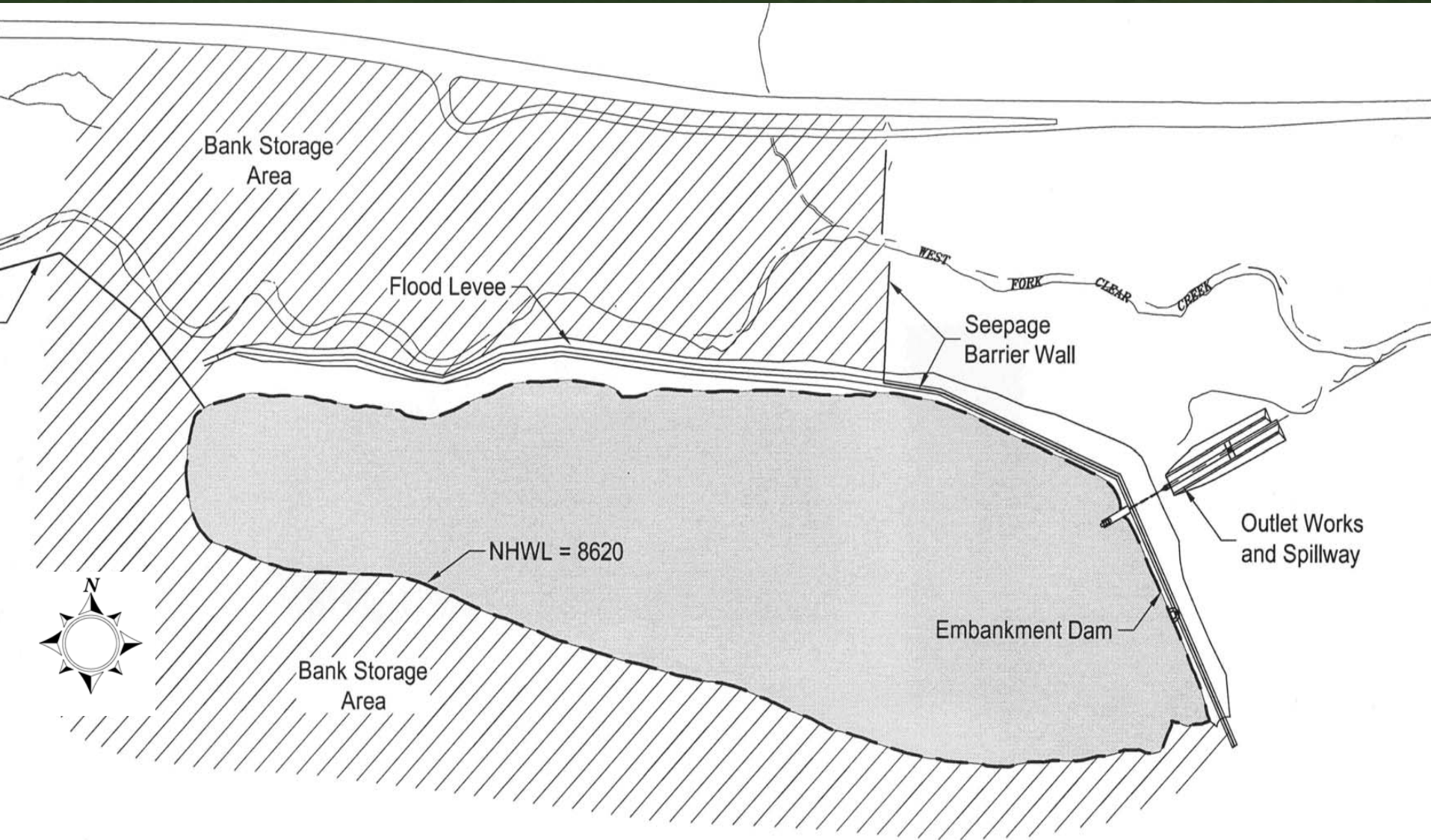


The Solution



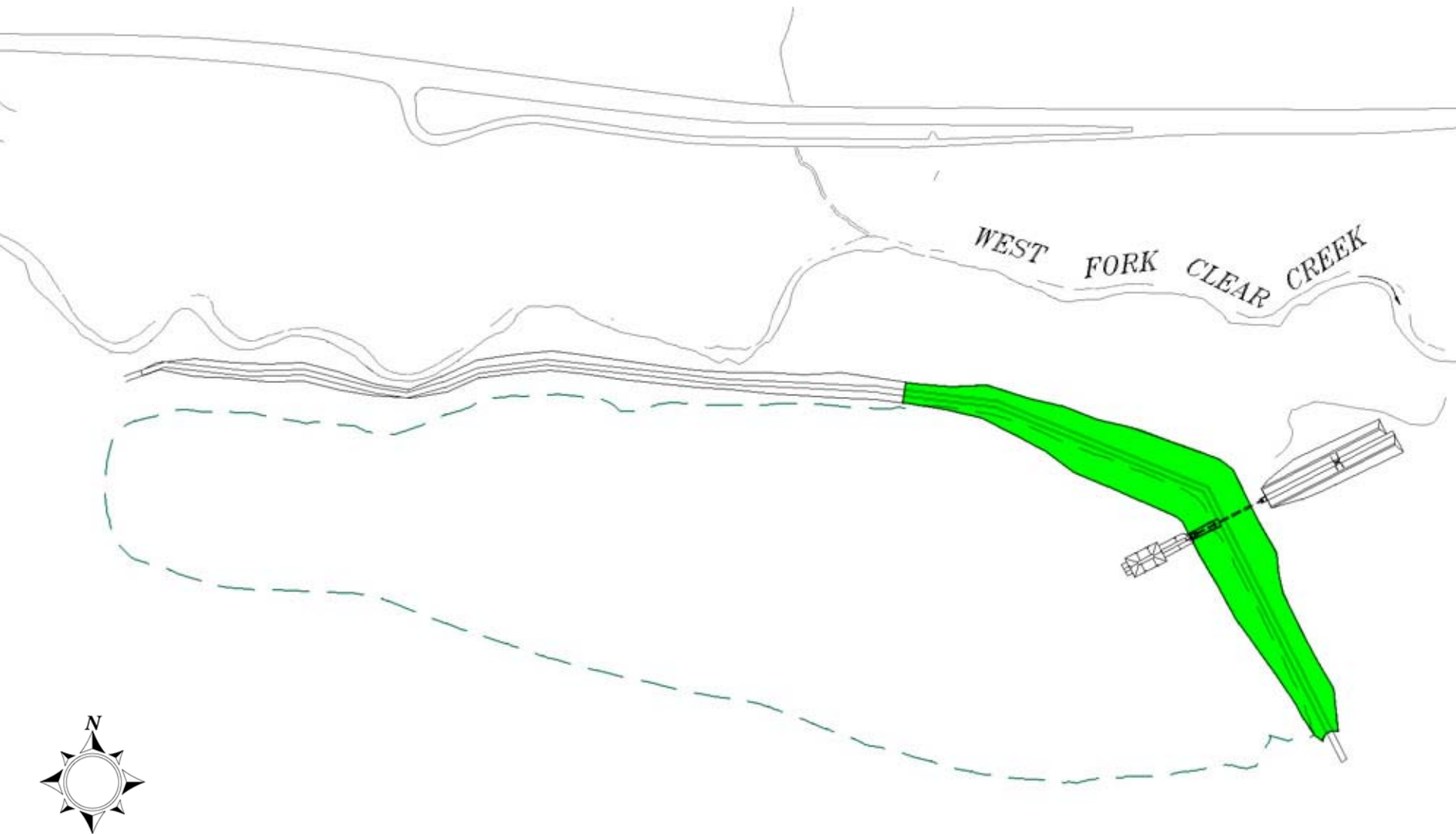
- **Four-way partnership**
 - City of Golden
 - State Engineer's Office
 - Engineering Team
 - Contracting Team
- **Third-party SEO review**
- **CM/GC construction**
- **Innovative design concepts**
- **Innovative permitting strategies**

PROJECT FEATURES



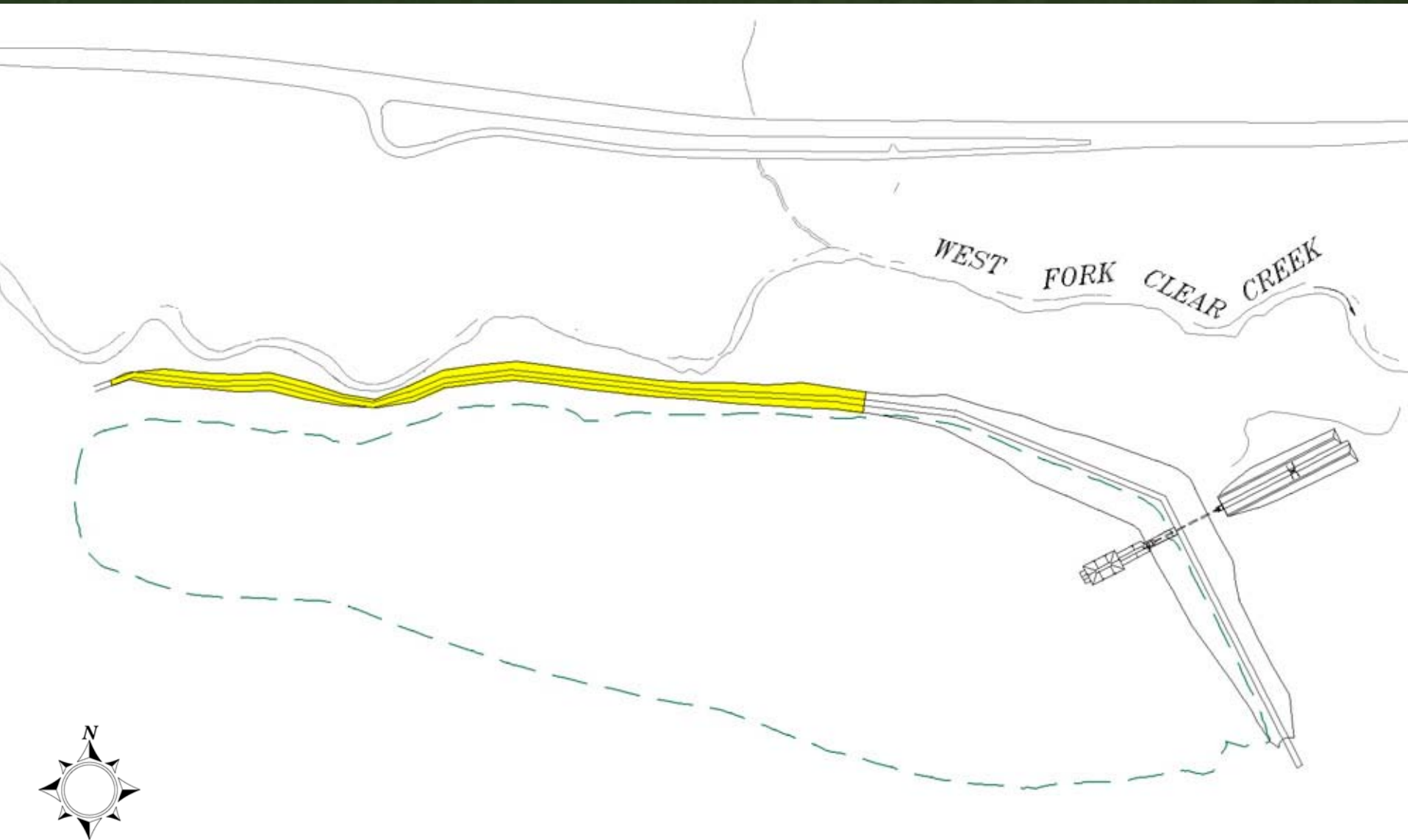
PROJECT FEATURES:

1,925 foot-long embankment dam



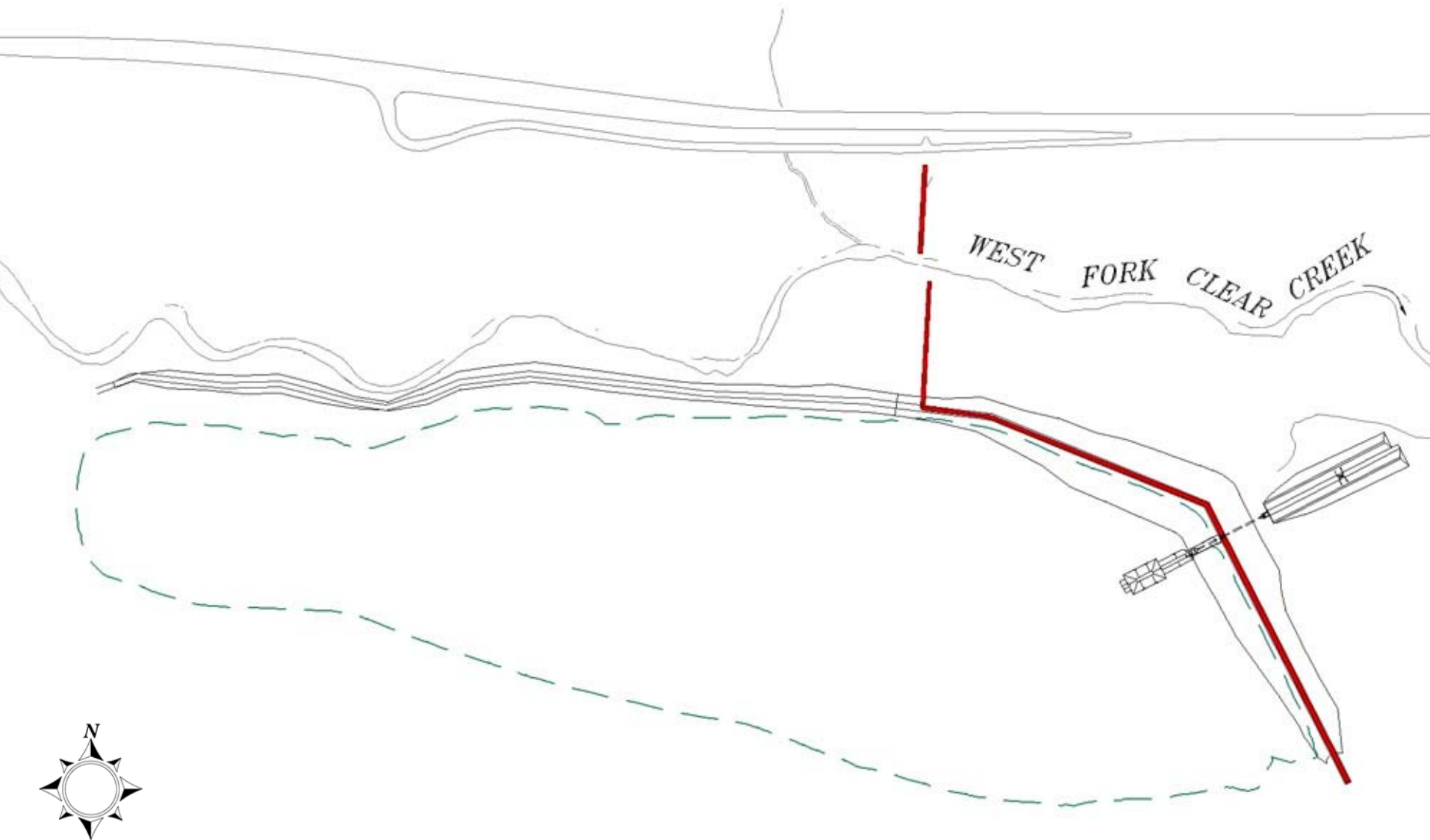
PROJECT FEATURES:

1,975 foot-long flood levee



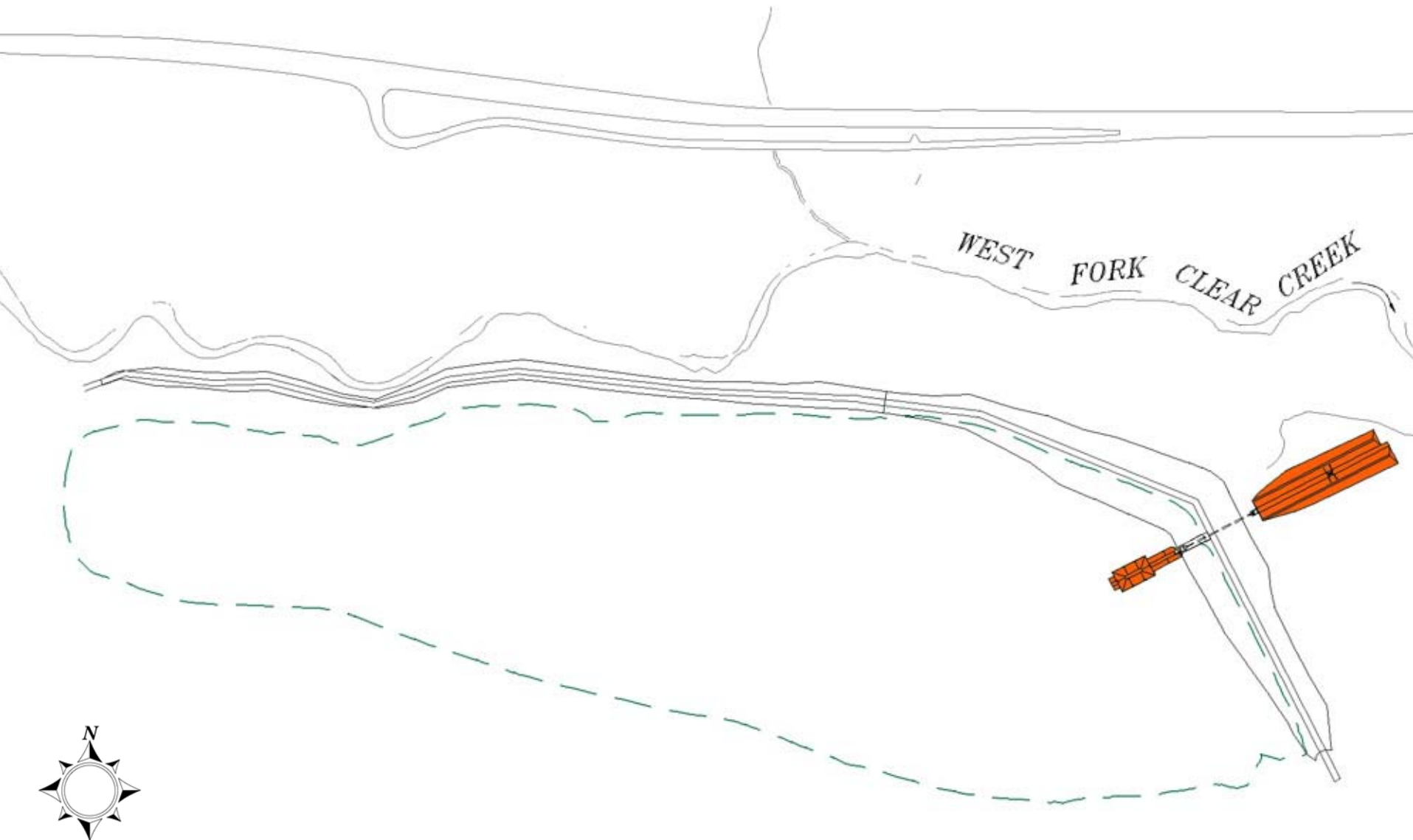
PROJECT FEATURES:

2,160 foot-long seepage barrier wall



PROJECT FEATURES:

Combined spillway/outlet tower



PROJECT FEATURES:

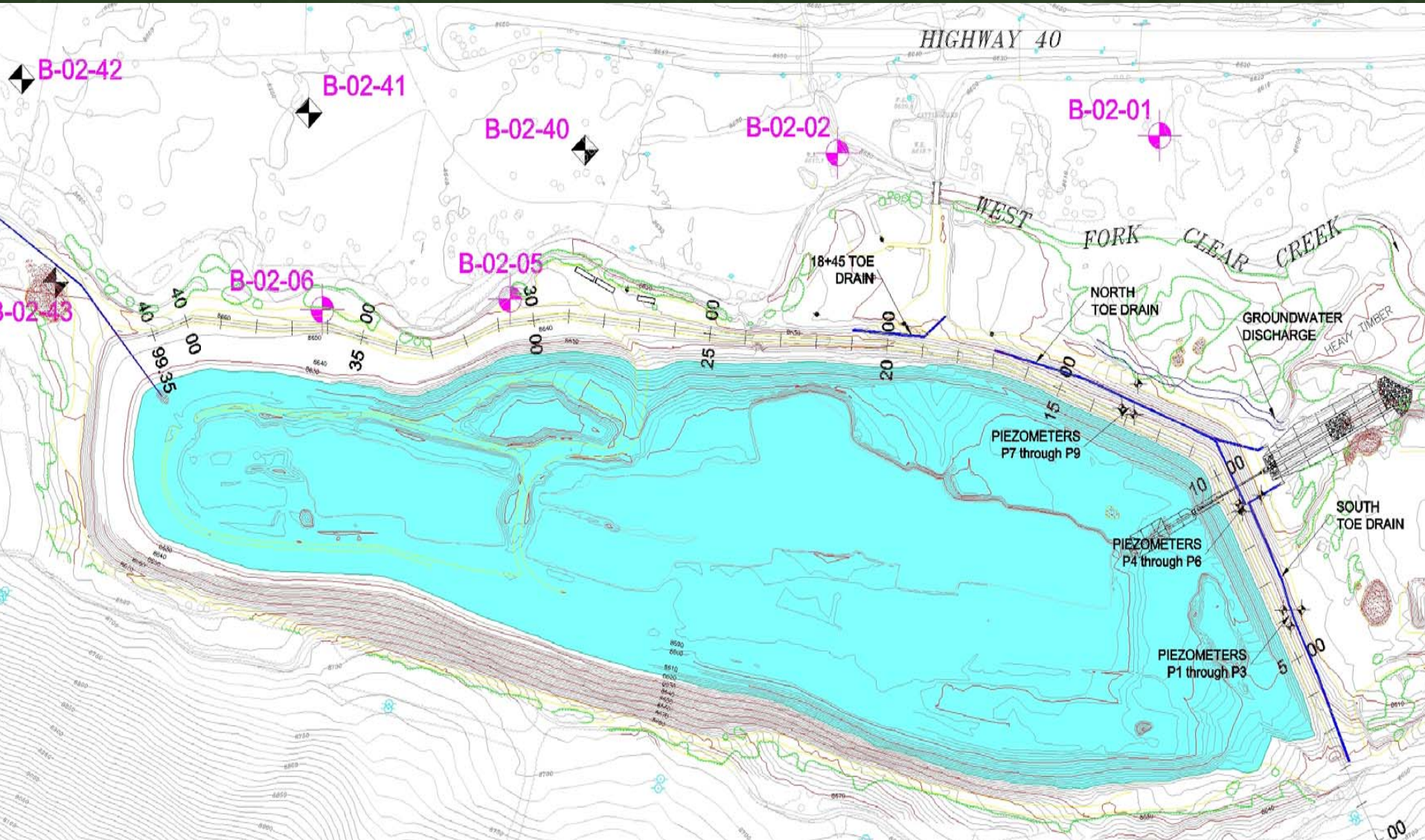
Bank storage adjacent to the reservoir



Guanella Reservoir Decree

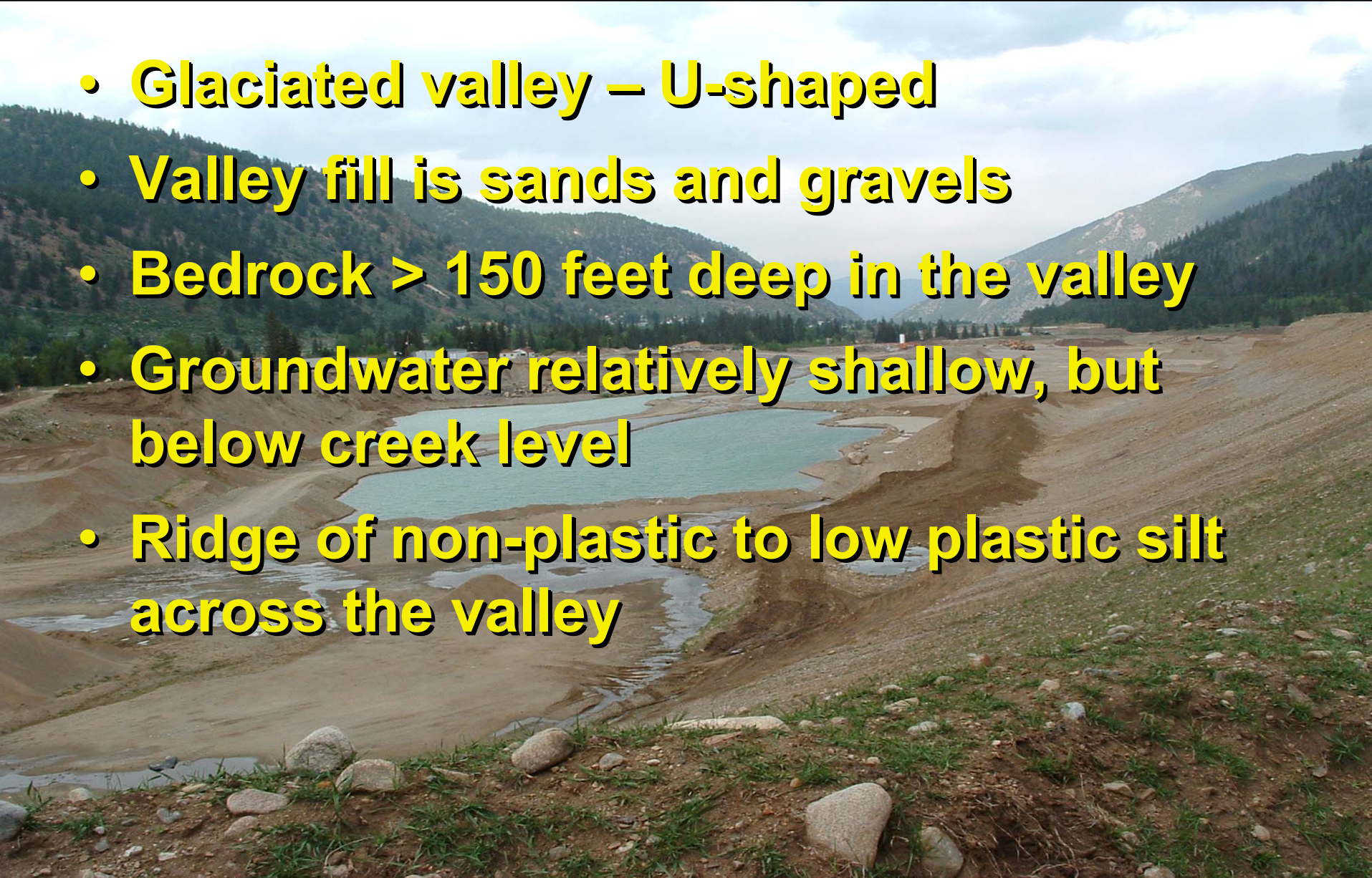
- **Direct Flow Rights of 60 cfs**
- **Total storage rights of 2,600 acre-feet**
- **Adjudication in 1985**
 - **Predates Senate Bill 120**
- **Reservoir capacity shall include bank storage**
- **Includes the right for continuous diversions to offset seepage losses**

Bank Storage Monitoring Wells



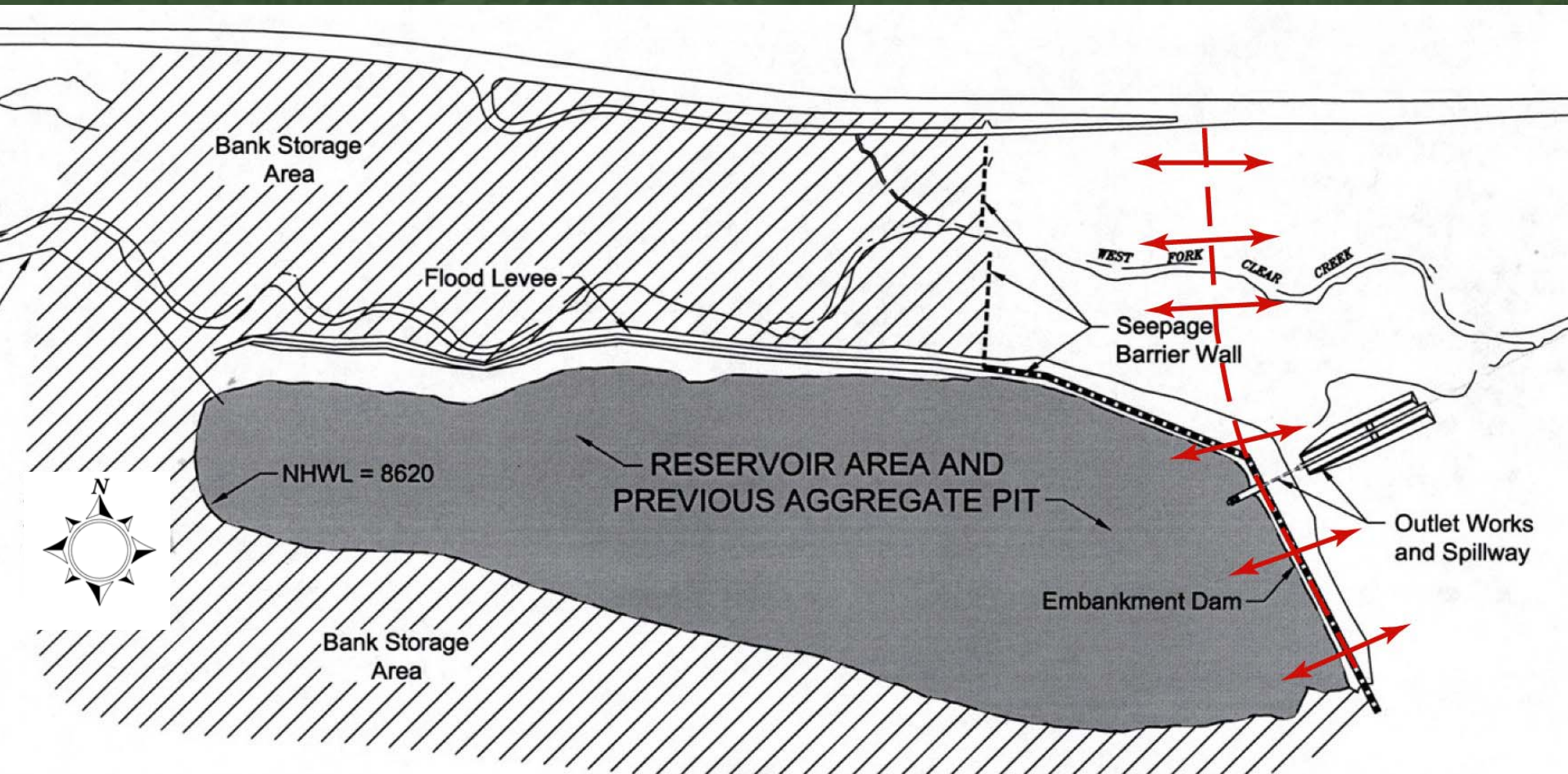
SITE GEOLOGY

- **Glaciated valley – U-shaped**
- **Valley fill is sands and gravels**
- **Bedrock > 150 feet deep in the valley**
- **Groundwater relatively shallow, but below creek level**
- **Ridge of non-plastic to low plastic silt across the valley**



DAM ALIGNMENT

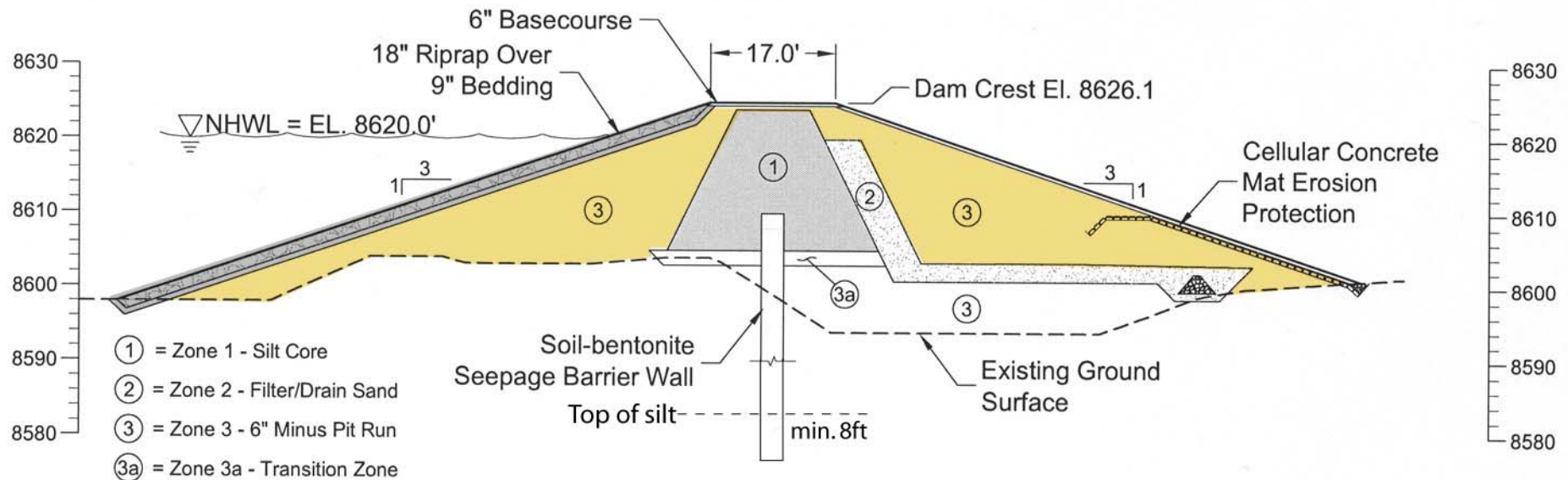
- Minimize depth to top of silt
- Impound normal pool to El. 8620



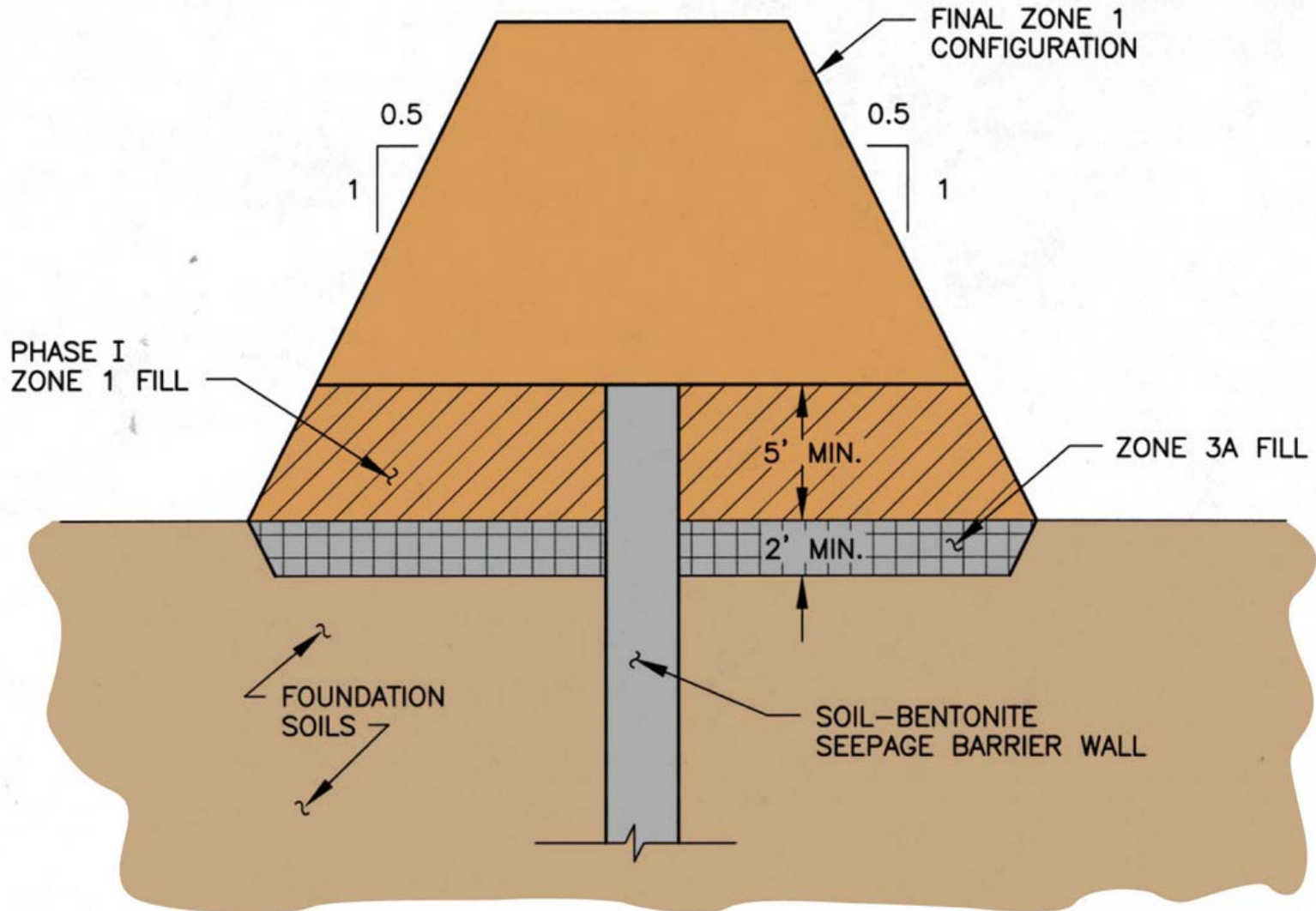
DAM FOUNDATION SEEPAGE CONTROL

- **Depth to top of foundation silt varied from 20 to 70 feet**
- **Groundwater was shallow (< 10 feet deep)**
- **Conventional cutoff trench would be difficult and expensive because of dewatering requirements**
- **Soil-bentonite barrier wall selected**

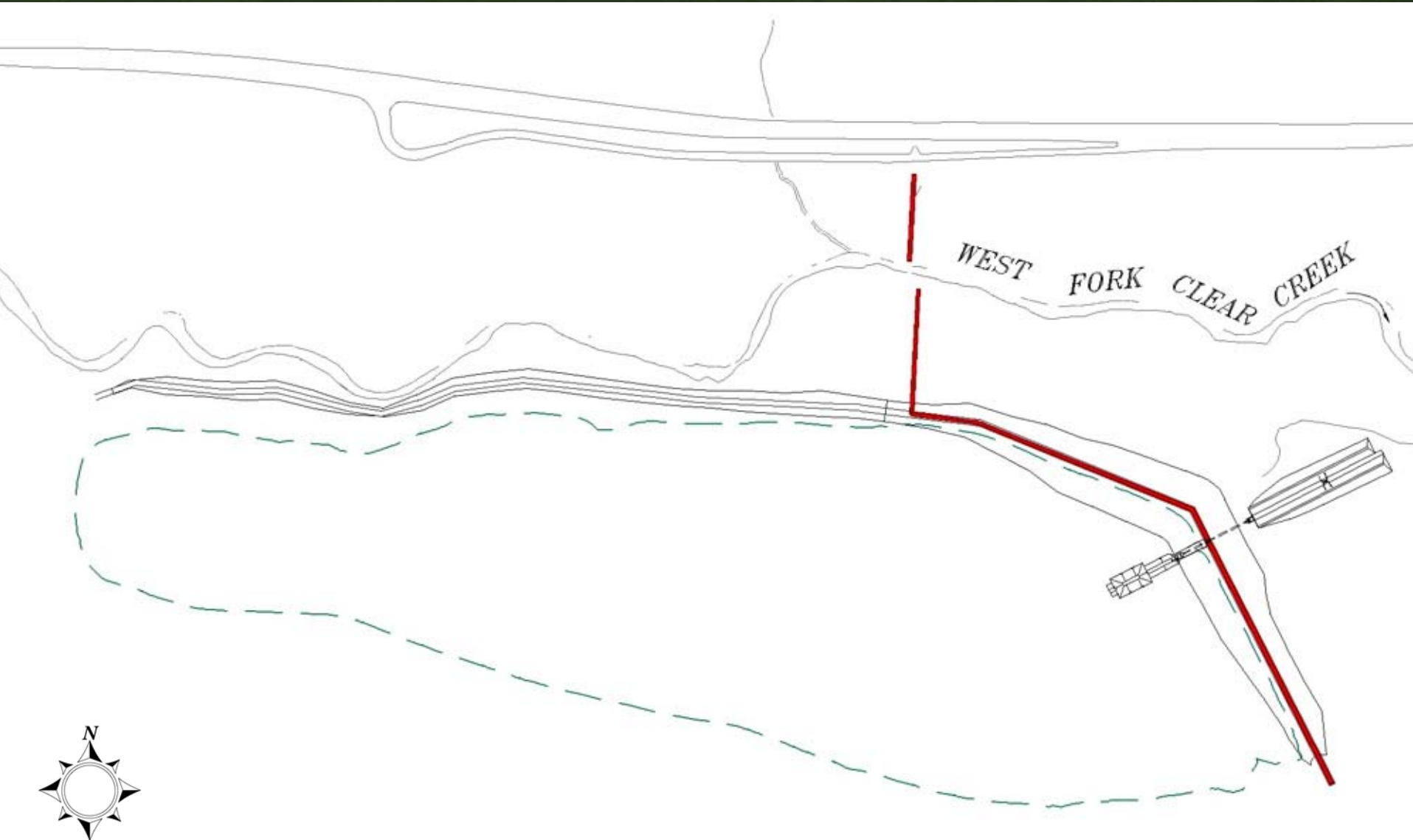
EMBANKMENT DAM CROSS SECTION WITH SB WALL



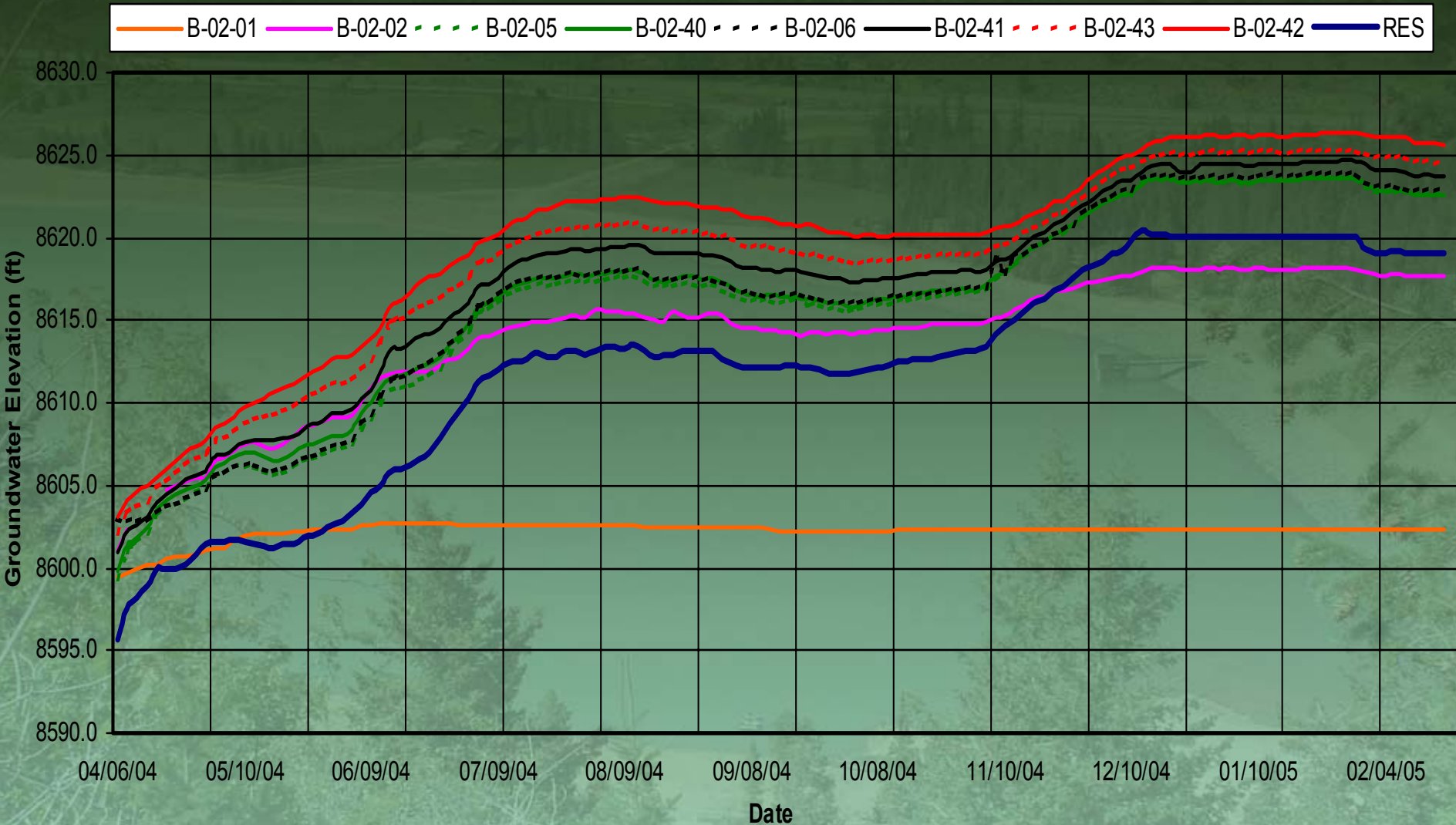
ZONE 1 – SB WALL CONNECTION DETAIL



SB WALL ALIGNMENT WITH WINDOWS



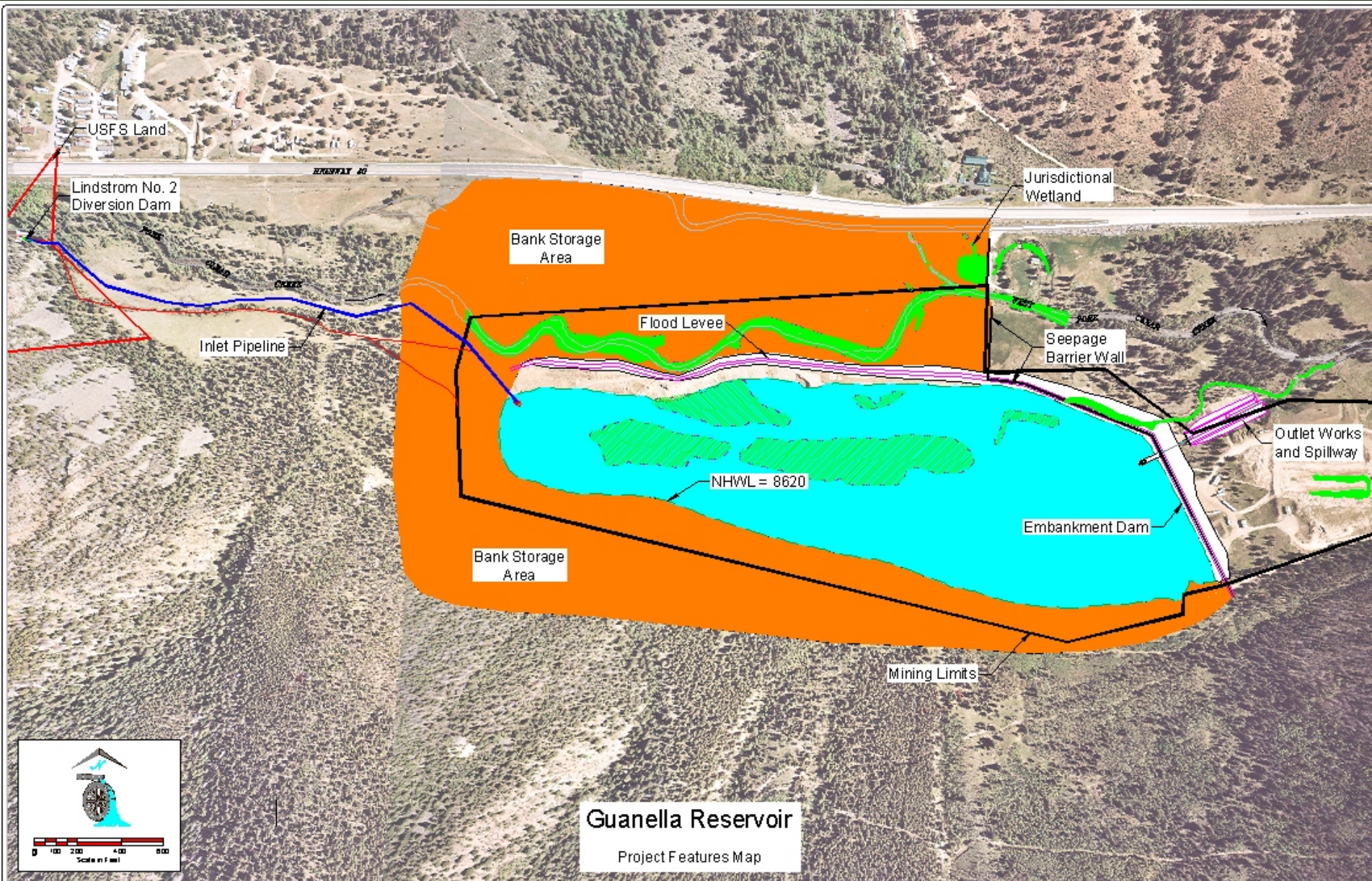
Seepage Barrier Wall Performance



Site Challenges

- **Permitting**
- **Active gravel operation**
- **Explosives storage**
- **Elevation at 8,600 feet**

USACE & USFS Permitting

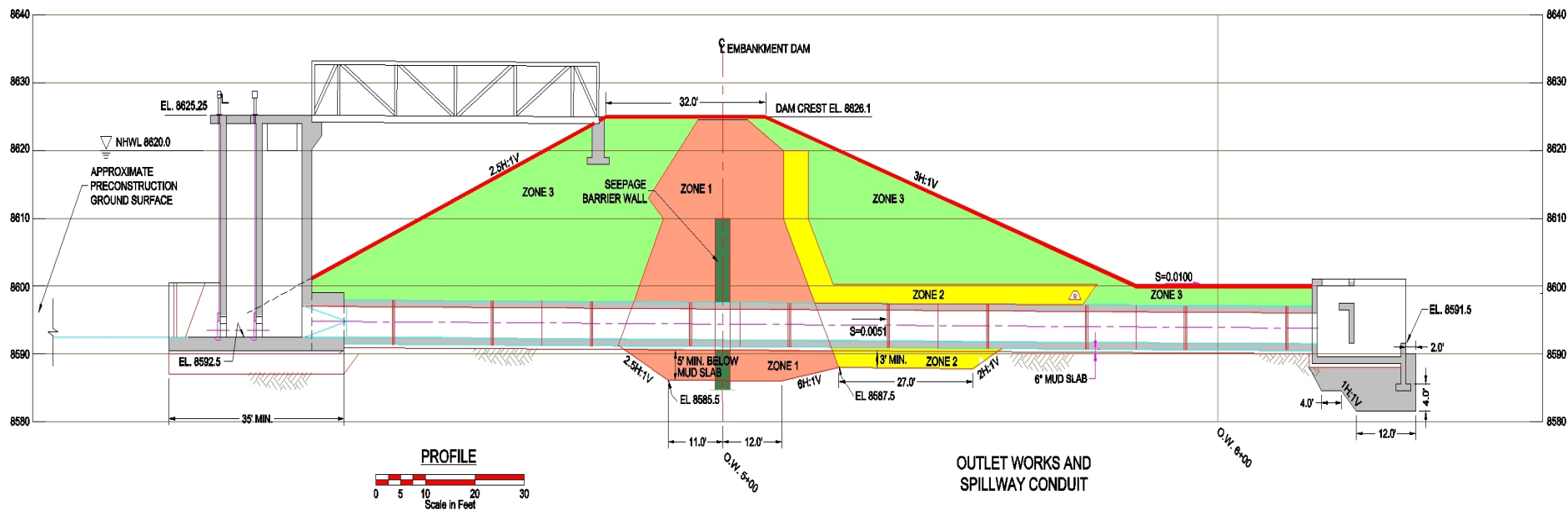


Flood Levee

- 
- **Designed for PMF**
 - IDF = 46,600 cfs
 - 3 feet of freeboard
 - **Saved about \$ 3 million when compared to conventional spillway**

Spillway/Outlet Works

- Spillway design discharge = 230 cfs
- 54-inch-diameter outlet conduit
- Baffled outlet terminal structure
- Excavated earth discharge channel



Diversion and Inlet Pipeline



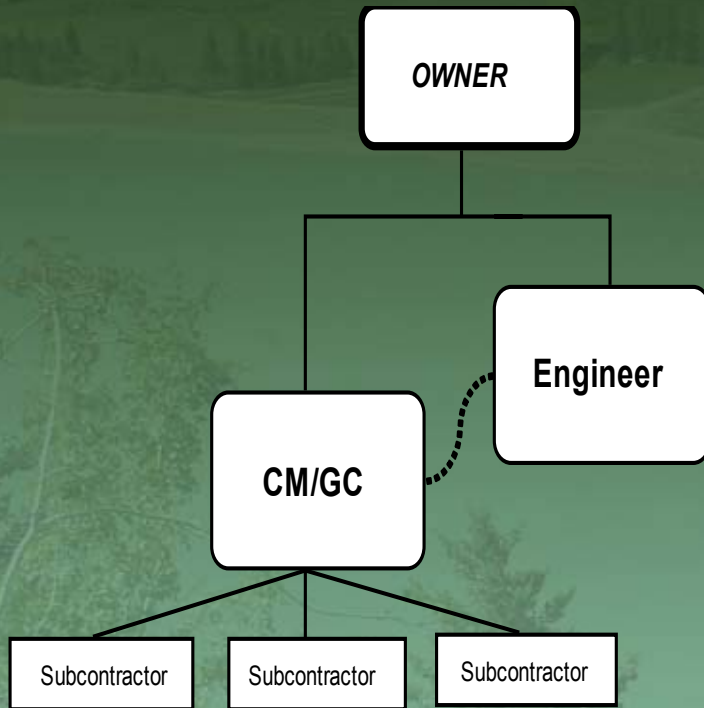
- Sediment Trap Structure
- 24-inch and 30-inch plastic & concrete pipe

Mass Reservoir Excavation

- **450 acre-feet of additional storage created during construction**
- **Allows continued gravel operations**
- **Provides additional royalty revenue**



CM/GC Construction



- **Construction Management at Risk**
 - Owner/Engineer contract for design
 - CM/GC manages construction for a fee
 - Significant contractor involvement in design
 - **Guaranteed Maximum Price**

Fourth Quarter of 2002

- **Completed final drilling phase**
- **Third-party SEO review approval**
- **Completed final designs**
- **Completed 404 permitting**
- **Initiated landowner & leasee negotiations**

First Quarter of 2003

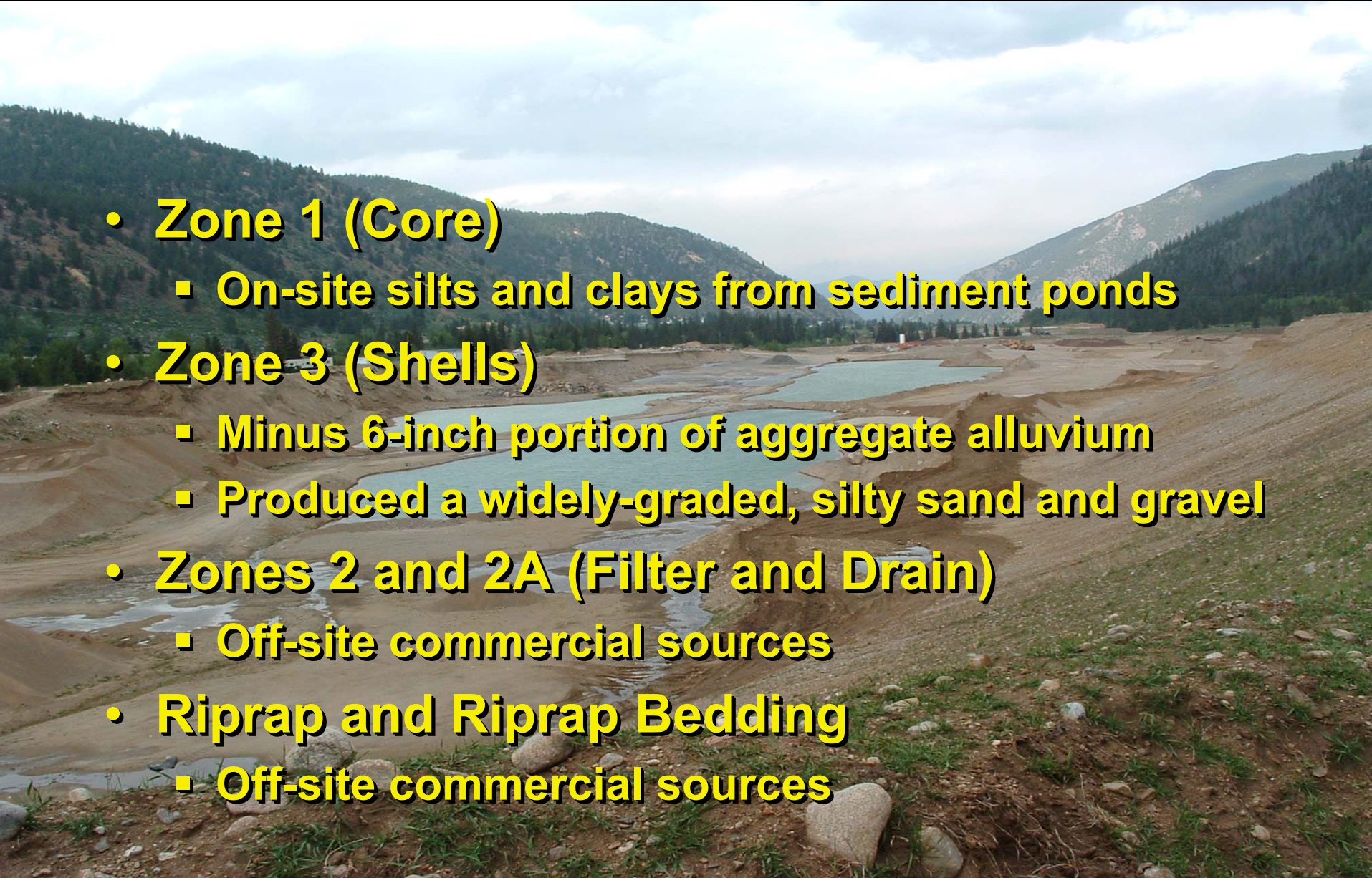
- **Completed internal review**
- **SEO design submitted**
- **Selected CM/GC**
- **Bid subcontractor packages**
- **Developed GMP Contract**

Second Quarter of 2003

- **SEO approval**
- **Site preparation**
- **Initiated Zone 3 production**
- **Intake tower foundation**
- **Initiated Phase I embankment**

Site Preparation/Zone 3 Production

- **Zone 1 (Core)**
 - On-site silts and clays from sediment ponds
- **Zone 3 (Shells)**
 - Minus 6-inch portion of aggregate alluvium
 - Produced a widely-graded, silty sand and gravel
- **Zones 2 and 2A (Filter and Drain)**
 - Off-site commercial sources
- **Riprap and Riprap Bedding**
 - Off-site commercial sources



Intake Tower



PHASE I EMBANKMENT PLACEMENT



Third Quarter of 2003

- **Outlet conduit**
- **SBW in dam foundation**
- **Flood levee**
- **Inlet pipeline**

Outlet Conduit



Foundation Seepage Barrier Wall



Flood Levee



Inlet Pipeline



Fourth Quarter of 2003

- **Phase II embankment construction**
- **Completed SBW for bank storage area**
- **Completed intake tower**
- **Completed terminal structure & discharge channel**
- **Booked water to existing gravel ponds**

Phase II of Embankment Dam





2004 Activities

- **Conditional SEO filling approval**
- **Initial filling & monitoring**
- **Completed crest basecourse**
- **Installed dam safety instrumentation**
- **Installed electrical & controls**

Initial Filling



Keys to Success

- **Attitude of Partnership**
- **Effective construction schedule**
- **One point of construction responsibility**
- **Weekly progress meetings**
- **Third-party construction approvals**



The Result

- **Design, Permitting, Construction < 15 months**
- **Completed 2 years ahead of schedule**
- **Completed within budget**
- **Drought Protection for more than 17,000 people**
- **Awards to Date**
 - **American Council of Engineering Companies**
 - 2005 National Award of Merit
 - **American Public Works Association**
 - 2005 Public Works Project of the Year



A scenic landscape photograph featuring a large concrete dam and a reservoir. The reservoir's water is a deep blue, contrasting with the light-colored, sandy or silty shore in the foreground. A dirt road runs along the right side of the reservoir, where a red pickup truck is parked. In the background, a dense forest of evergreen trees covers the lower slopes of the mountains. The mountain peaks are rugged, with patches of snow or light-colored rock visible against a bright blue sky with scattered white clouds. The entire scene is framed by the green branches and needles of evergreen trees in the foreground.

QUESTIONS?