

RECLAMATION

Managing Water in the West

Fontenelle Dam Incident, Wyoming, USA

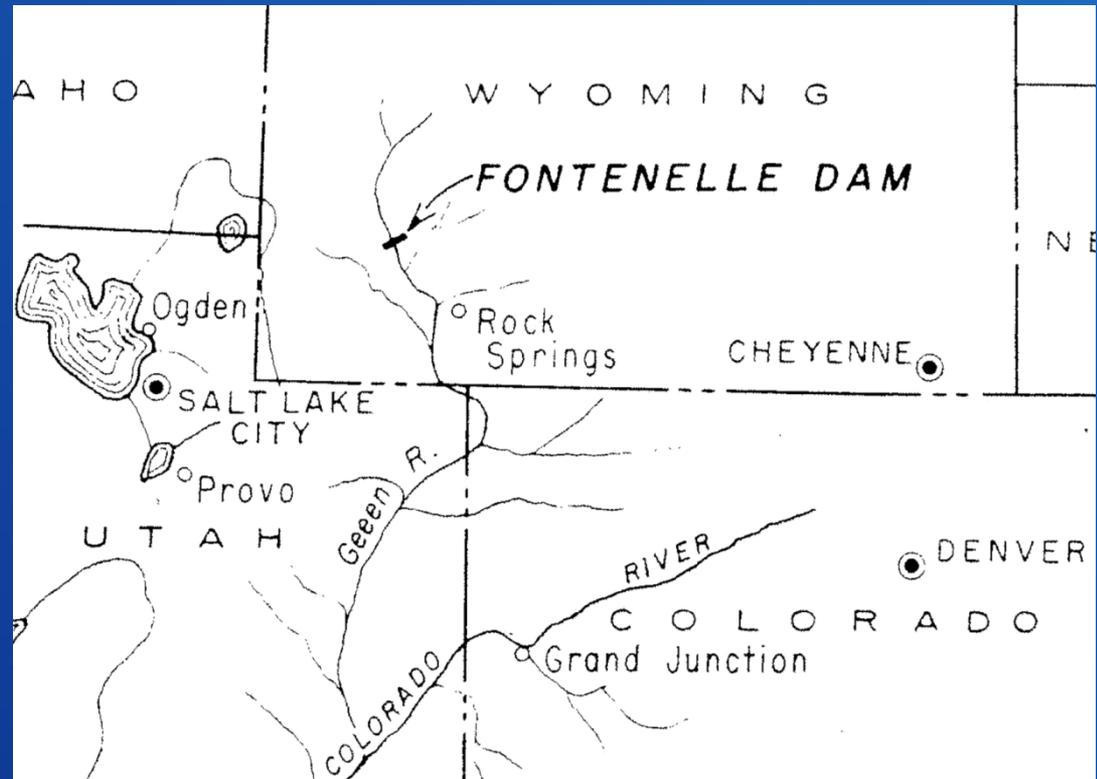
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U.S. Department of the Interior
Bureau of Reclamation

Presentation Outline

Overview
Site Geology
Dam Design
1965 Incident
Identify Problem
Mitigation
1980 Incident
Seepage Cutoff Wall
Lessons Learned



Fontenelle Dam Overview

Located 45 miles NW of Green River, WY

127 feet high embankment dam, 5,540 ft. long

Reservoir storage capacity 345,000 acre-feet

Outlet Works 16,800 ft³/s

West Canal Outlet Works 780 ft³/s

East Canal Outlet Works 585 ft³/s

Spillway 20,000 ft³/s

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Fontenelle Dam Overview



Green River Formation Sandstones and Shales



Stress Relief Joints



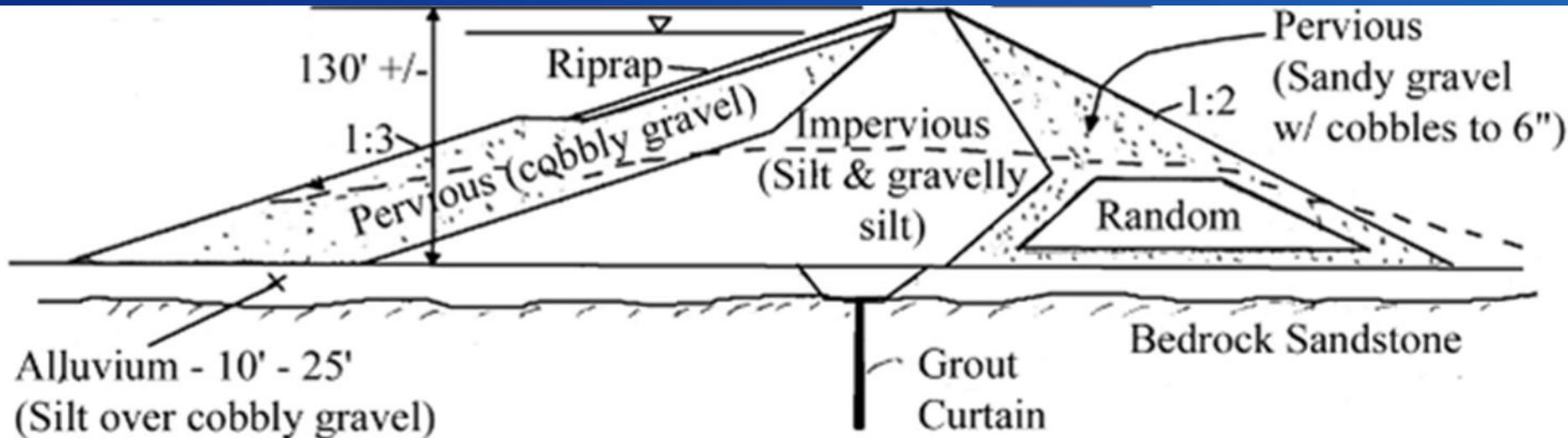
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Dam Design

Low PI Core Material – silt, sand, gravel

Shell – sandy gravel, it should filter the core

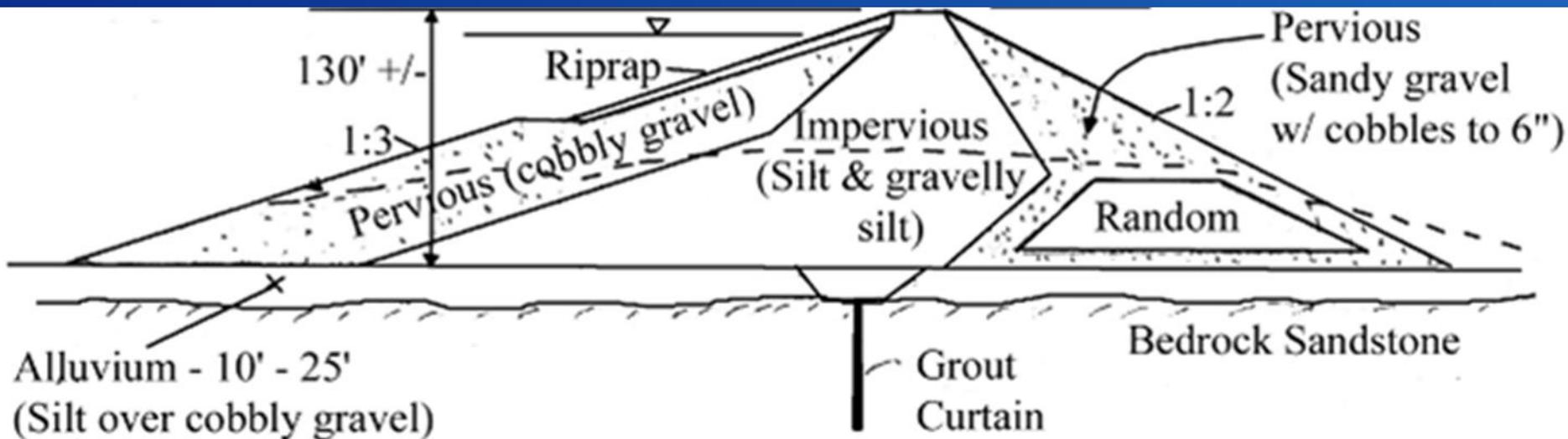
Alluvium left under most of the dam



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Dam Design

Cutoff trench to bedrock under the core
One line of grout curtain holes
Grouting in abutments



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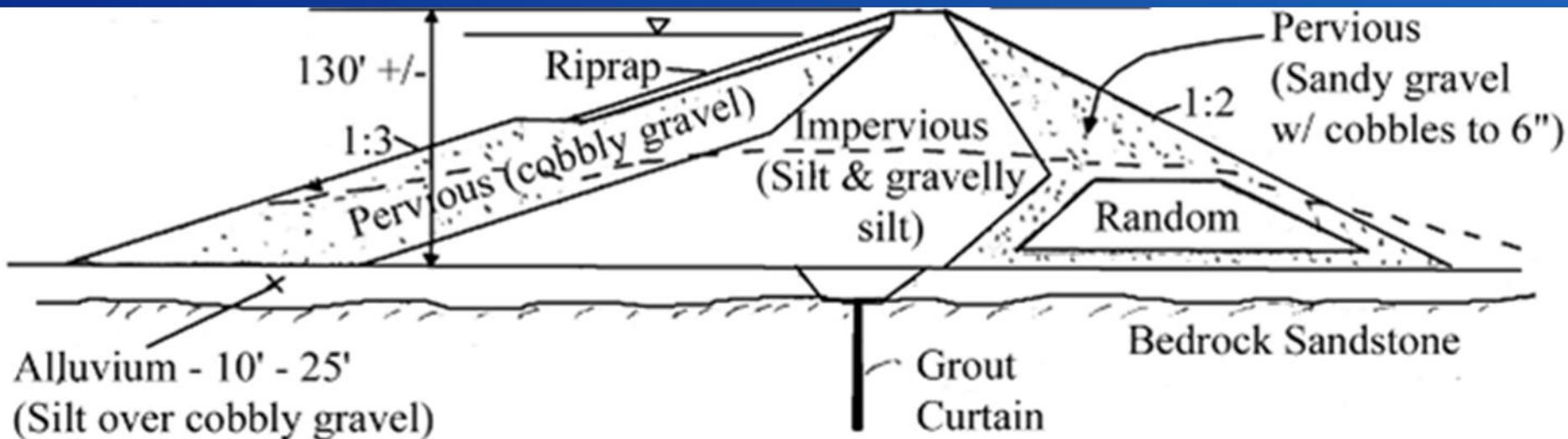
Cutoff Trench Grout Holes



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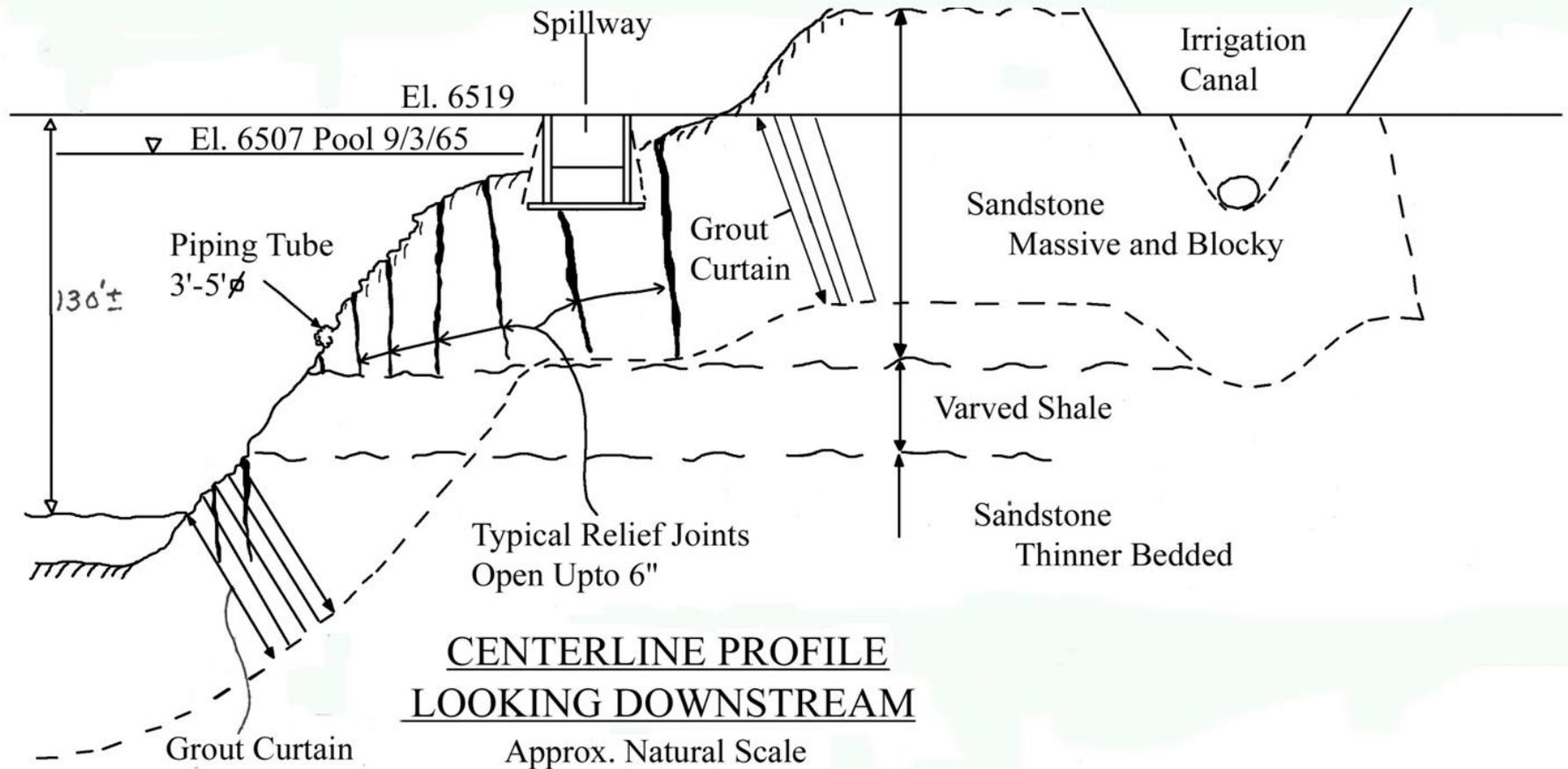
Dam Design

Cutoff trench to bedrock under the core
One line of grout curtain holes
Grouting in abutments



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Right Abutment



Weeping Rock



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Town on Green River in 1965



Sat. Morning Sept. 4, 1965



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1965 Incident



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1965 Incident



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Noon - decided to open outlet works



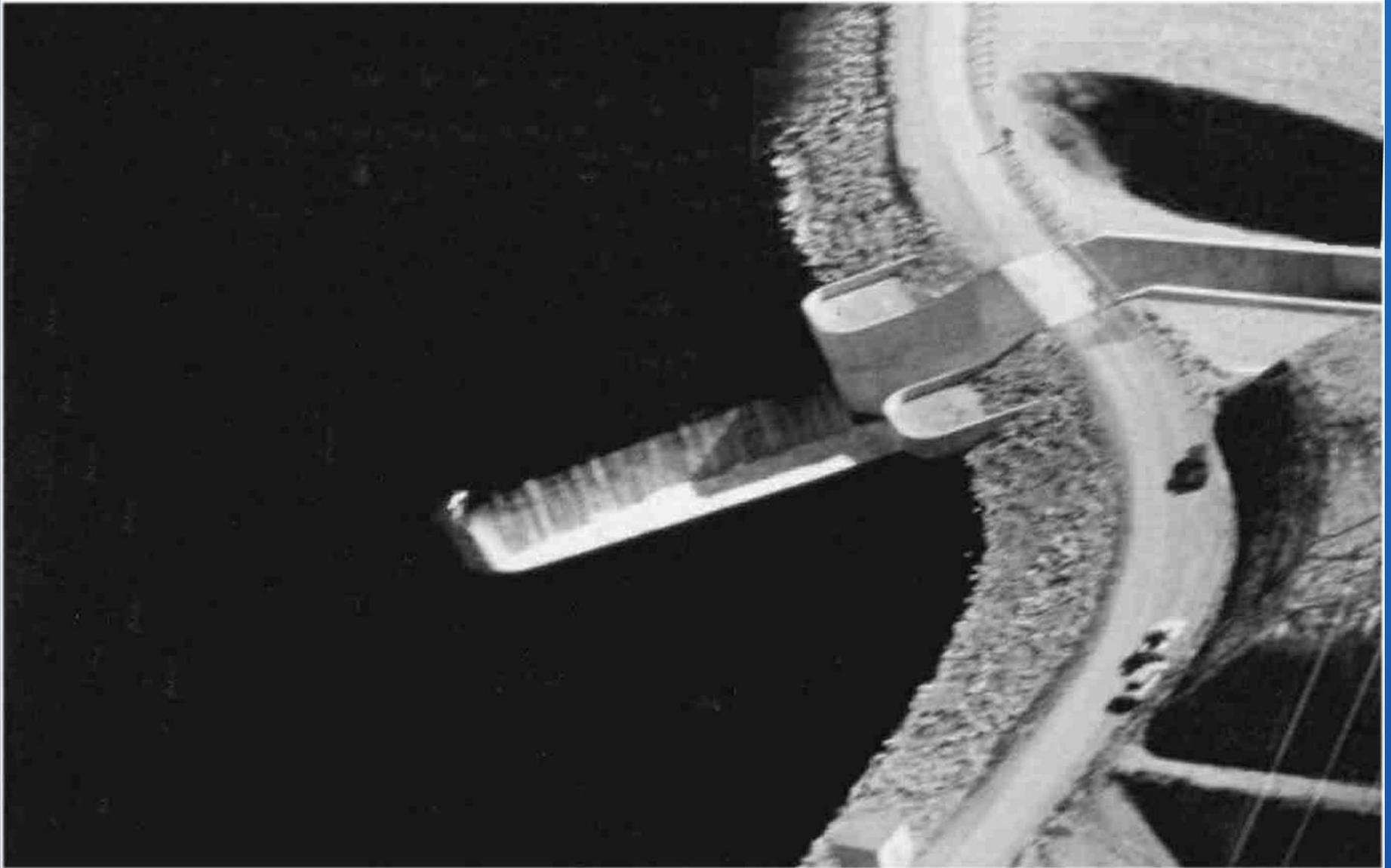
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1965 Incident



RECLAMATION

1965 Incident



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1965 Incident



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Noon Sat. Sept. 4, 1965



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1965 Incident 4:00 PM Saturday



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Sunday Sept 5, 1965



RECLAMATION

Sunday Sept. 5, 1965



RECLAMATION

Sunday Sept. 5, 1965



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Star - Tribune

Newspaper—Every Day

Rockies — MONDAY MORNING, SEPTEMBER 6, 1965

Twelve Pages

Fontenelle Dam Leak Worsening

Green Will Overflow Banks at Some Places

GREEN RIVER, Wyo. (UPI)—The regional director of the Bureau of Reclamation said late Sunday the Green River would overflow its banks at some points from heavy releases of water from the Fontenelle Reservoir.

David L. Crandall of Salt Lake City said two canals had had been opened and they would be in addition to the flow of 17,000 cubic feet per second now being ing," but the 40-foot hole in the dam suffered further erosion and water flow increased in spurts.

Casper Star-Tribune

Monday, September 6, 1965

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Monday Sept. 6, 1965



Sinkhole forming



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Tuesday, Sept. 7, 1965

DROP IN ROADWAY ON DAM DISCLOSES LEAK COMING FROM ROCK STRATA IN ABUTMENT

Monday, a drop of earth from the top of Fontenelle dam into a cavern-like hole that had been washed out by a leak in the west end of the lower side of the dam disclosed a stream of water coming through a seam of rock in the right abutment, and not through the dam itself. This gave assurance that the dam was structurally safe, although the influx of the water was regarded as serious because of the damage to the face of the dam.

The leak, which Friday afternoon first appeared to have serious proportions, had cut a huge hole 40 feet wide and 60 feet deep into the lower face of the dam, as fill dirt continued to fall into the channel being cut by the leak, which finally levelled off at about 20 cubic feet of water per second. The roadway of the dam at this point then caved down and disclosed the stream of water coming out of strata in

flow of the seep water through the cliff or to replace the destroyed fill on the dam can be undertaken until water in Fontenelle reservoir has been lower below the level that feeds water into the rock strata from which the leak comes.

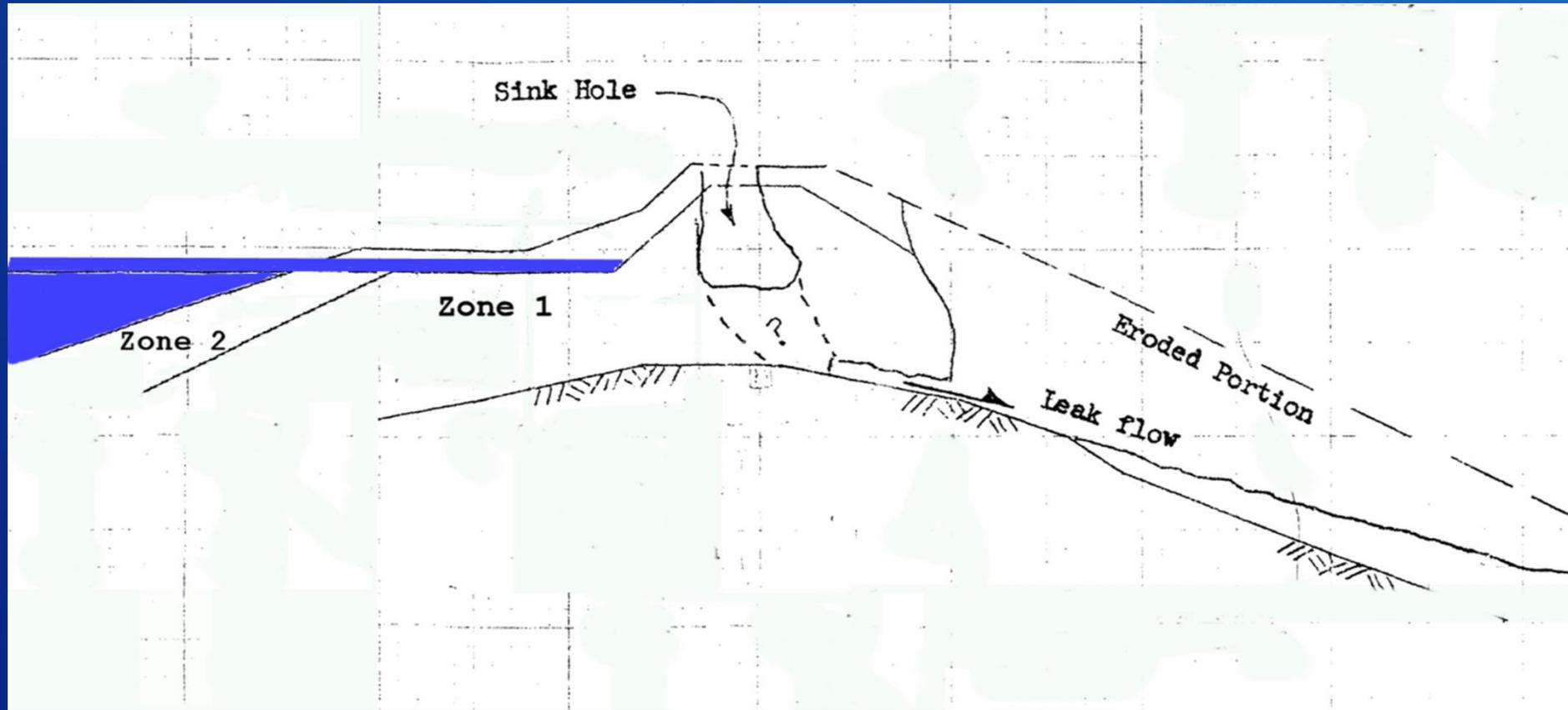
News of the drop of the roadway was brought to Green River by travelers and caused new apprehension as to a break in the dam itself, although the bottom of the dropped portion was several feet above the level of the lake, and above the danger zone for overflow. The news spread rapidly in Green River and resulted in many families moving out of the low areas on the South Side.

The caving area of the dam was filled with heavy rock to prevent continuance of the erosion.

During construction of the dam, areas which might seep and cause damage were grouted

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Wednesday, September 8



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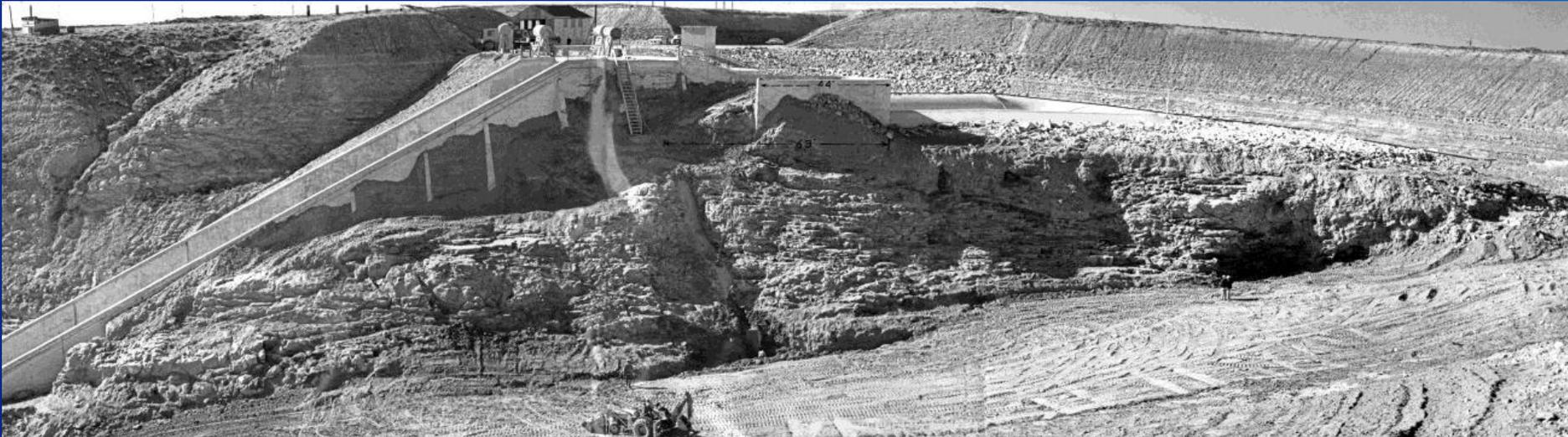
Friday Sept. 10, 1965



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Alert lifted Sunday Sept. 12

Problem is leakage through bedrock.
Excavation in November 1965



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Findings by COE

Designers must inspect construction

Remove all overhangs from rock

Use conservative treatment of rock

Problem Mitigation

Inadequate grouting of open joints

**Affected areas excavated, more
grouting done**

Embankment replaced

1980 Incident

Second Time Reservoir Filled

Numerous seepage areas downstream

Reservoir drawn down

Three years of Investigation

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\$55 Million Cutoff Wall

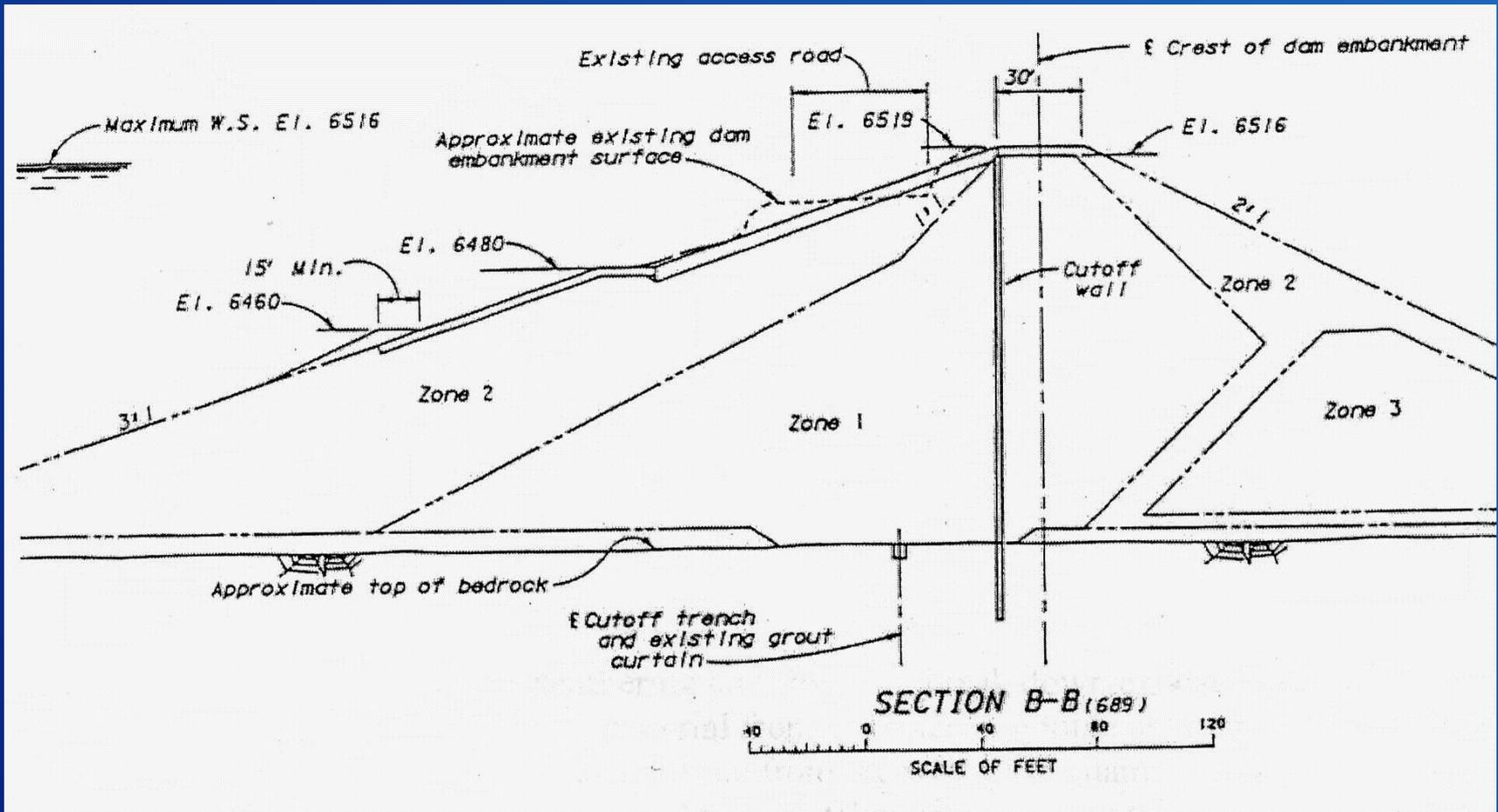
Problem was core not properly filtered

Concrete unreinforced seepage cutoff wall built 1985-1988

Extended into bedrock 20 feet

A lot of instrumentation added to dam

Cutoff Wall



Instrumentation Issues

EMBANKMENT EXPLANATION

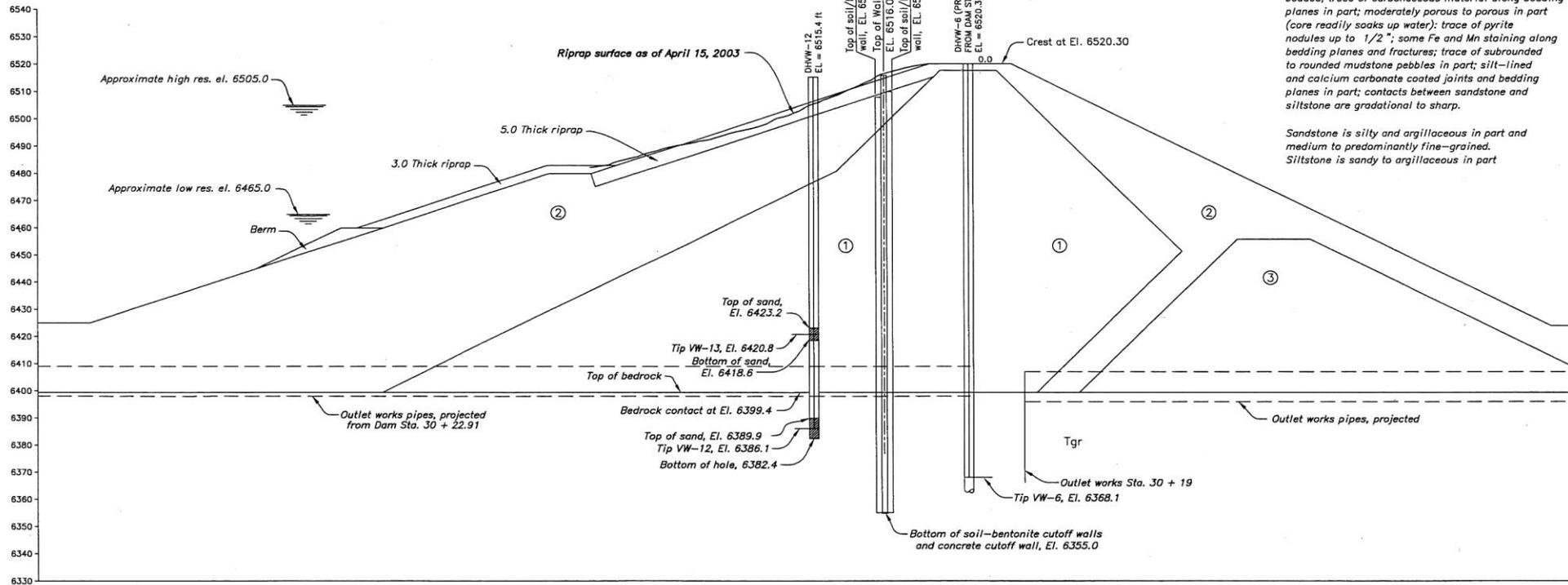
- ① Selected clay, silt, sand and gravel compacted by tamping rollers to 6-inch layers.
- ② Selected sand, gravel and cobbles compacted by crawler-type tractor to 8-inch layers.
- ③ Miscellaneous material compacted by tamping rollers to 12-inch layers.

GEOLOGIC LEGEND

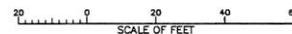
Tgr Tertiary Green River Formation

Sandstone and siltstone with some shale interbeds locally; gray to black (unweathered) and tan to brown (weathered); soft and friable to hard, can be scratched with heavy knife pressure; weakly to well cemented; slightly calcareous to predominantly calcareous; massive to very thin bedding; cross-bedded; trace of carbonaceous material along bedding planes in part; moderately porous to porous in part (core readily soaks up water); trace of pyrite nodules up to 1/2"; some Fe and Mn staining along bedding planes and fractures; trace of subrounded to rounded mudstone pebbles in part; silt-lined and calcium carbonate coated joints and bedding planes in part; contacts between sandstone and siltstone are gradational to sharp.

Sandstone is silty and argillaceous in part and medium to predominantly fine-grained.
Siltstone is sandy to argillaceous in part



SECTION



Lessons Learned

Its not the grout, it's the erodible core

Use multiple defensive measures to protect all of the core with:

Proper shaping of bedrock

Robust bedrock grouting

Foundation surface treatment

Engineered downstream filter zone

Questions



You can avoid dangerous flying maneuvers by using proper foundation treatment and filters

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