What's in Your Pond?

TECHNICAL ISSUES

October 14, 2020

Presentation Two

Common Mistakes, Problems, and Misconceptions

Hal Van Aller, PE
Dam Safety Inspection and Compliance Division

I've done it this way for years. Now you're telling me it's wrong?

- Cutoff trench meets the requirements of MD-378: we have shown it as 4 feet deep and 4 feet wide at the bottom with 1:1 side slopes.

  Q: Why do we need to go deeper?

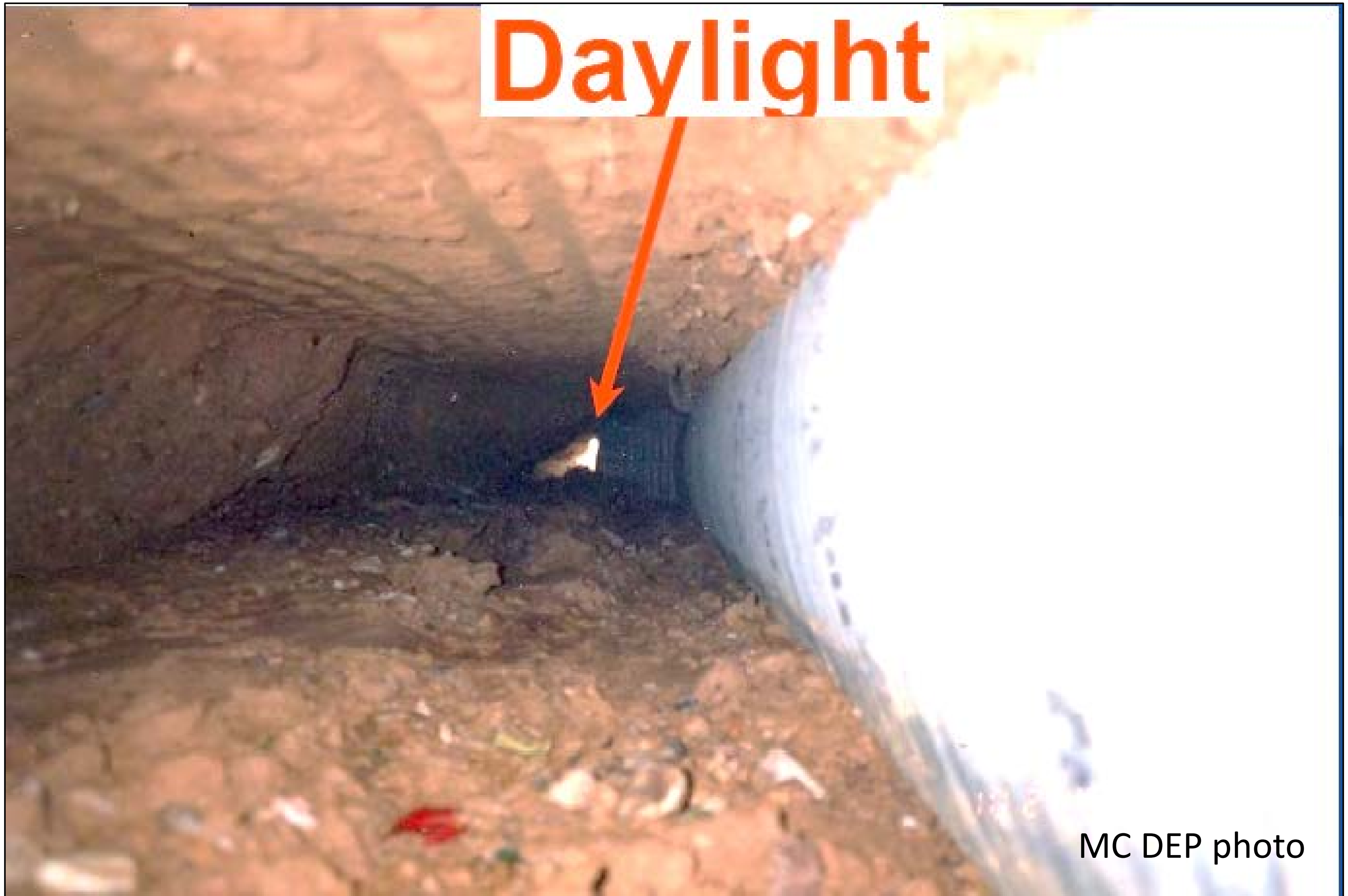
  A: To extend to impervious foundation soils.

- MD-378: Seepage control is to be included:
  1. **if pervious layers are not intercepted by the cutoff**;
  2. if seepage from the abutments may create a wet embankment;
  3. if the phreatic line intersects the downstream slope; or
  4. if special conditions require drainage to insure a stable dam

Sequence of construction is important

- Q: What is wrong with building the embankment first and then cutting a notch to put in the barrel? That’s how we do road culverts, and the contractor says they can get the job done faster with better compaction.
- A: MD-378 states that the principal spillway must be installed concurrently with fill placement and not excavated into the embankment.
- Also: In a trench, steep side slopes create potential for arching of the backfill, which reduces soil pressure on, and along, the pipe. If the reduced soil pressures are less than the hydrostatic pressures from the impoundment then soil can wash away by seepage.

Here is an example showing void along the pipe installed in a trench after backfill washed away



MC DEP photo

MDE Photo, J Gravette, December 2000

MDE Photo, J Gravette, November 2000

MDE Photo, J Gravette, November 2000

MDE Photo, J Gravette, October 2000

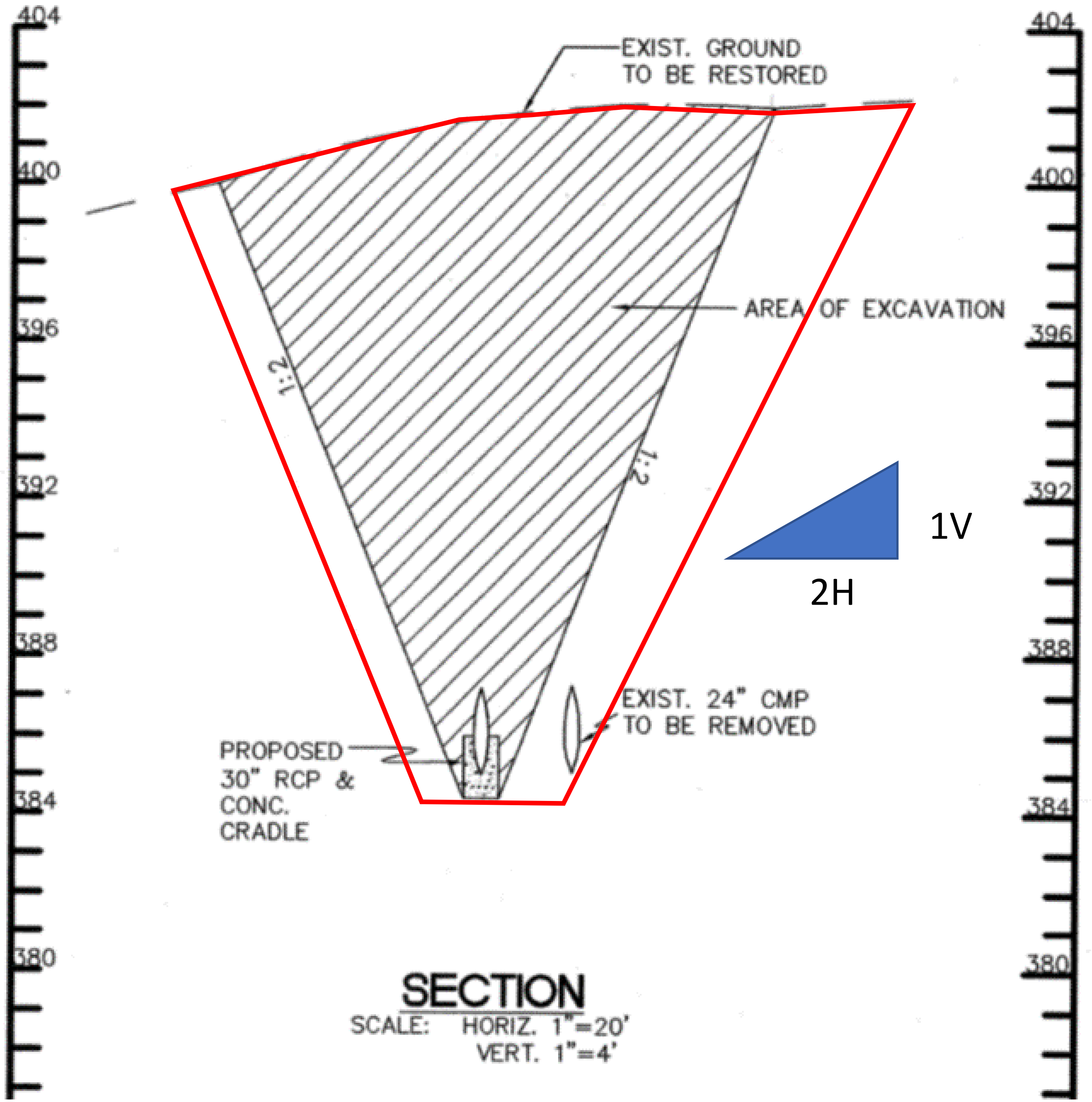
MDE Photo, J Gravette, December 2000

MDE Photo, J Gravette, December 2000

MDE Photo, H Van Aller, April 2001


MDE photo H Van Aller

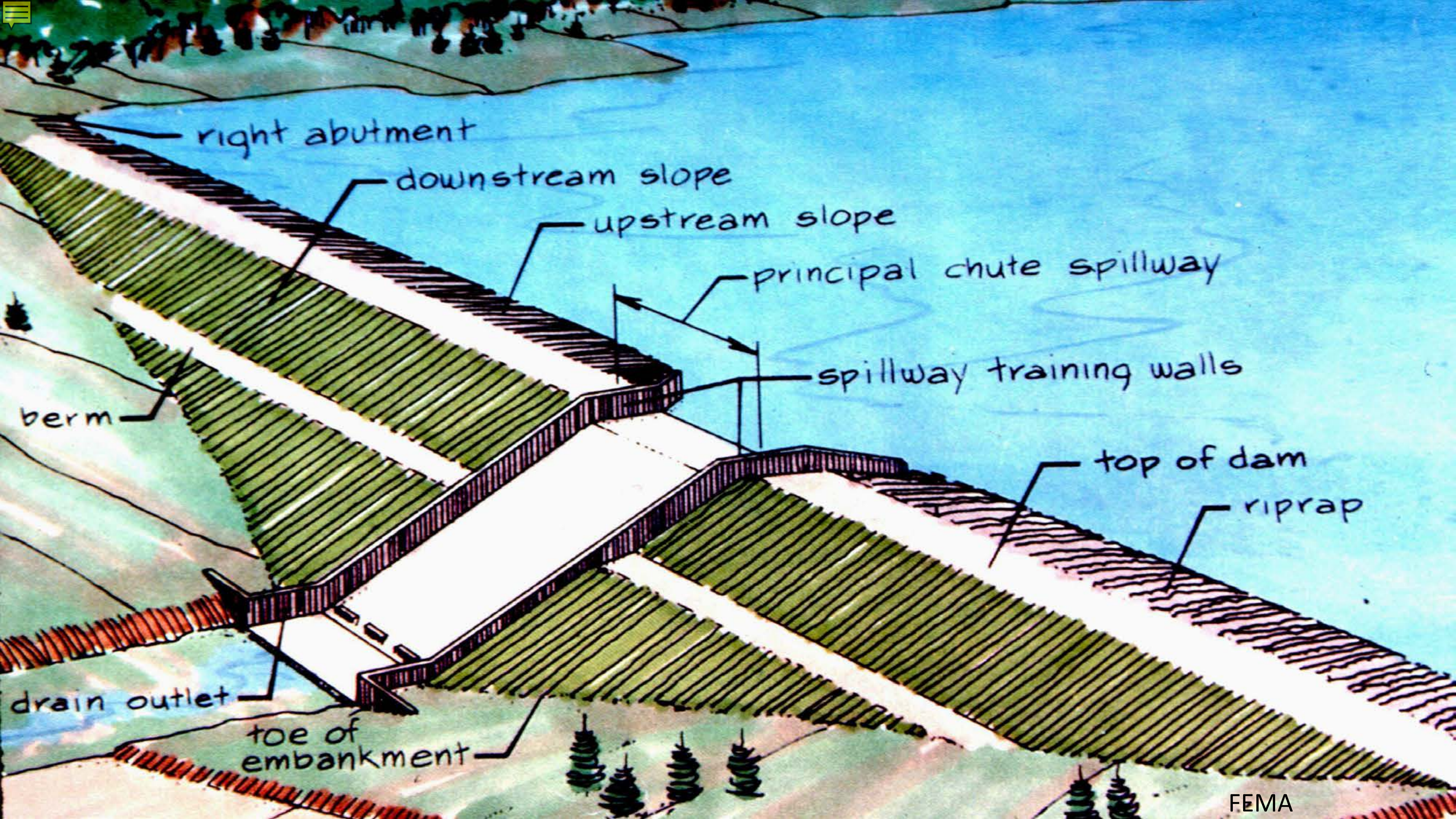
NRCS photo



404
400
396
392
388
384
380
EXIST. GROUND
TO BE RESTORED
AREA OF EXCAVATION
1:2
1:2
1V
2H
EXIST. 24" CMP
TO BE REMOVED
PROPOSED
30" RCP &
CONC.
CRADLE
SECTION
SCALE: HORIZ. 1"=20'
VERT. 1"=4'

Seepage control

- Anti-seep collars do not prevent seepage failures
- MD-378: Filter and drainage diaphragms are **always recommended**, but are **required** when the following conditions are encountered:
    1. The pond requires design according to TR-60
    2. **Embankment soils with high piping potential such as Unified Classes GM, SM, and ML**


right abutment
downstream slope
upstream slope
principal chute spillway
spillway training walls
berm
top of dam
riprap
drain outlet
toe of embankment
FEMA

USBR Photo

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Brick riser

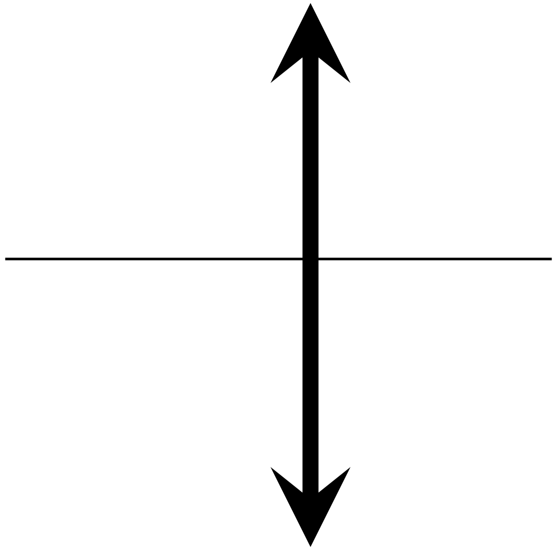

MC DEP Photo

Pre-cast riser structures

MDE photo

Anchor Plates

Movement



MDE photo

MDE photo

Geology/Geotech report

- Engineer: “The owner’s geotech did borings at the development site and a few in the pond area, but none along the dam or spillway. They sent us a copy of the report but we never looked at it.”
- MD-378: A soils investigation is required on all ponds. As a minimum it shall include information along the centerline of the proposed dam, in the emergency spillway location, and the planned borrow area. The type of equipment used and the extent of the investigation will vary from site to site.
- Engineer should also require borings at proposed riser location


USDA
United States Department of Agriculture
Technical Release 210-60
Earth Dams and Reservoirs
March 2019
Conservation Engineering Division
Natural Resources Conservation Service
nrcs.usda.gov/
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05/29/2013
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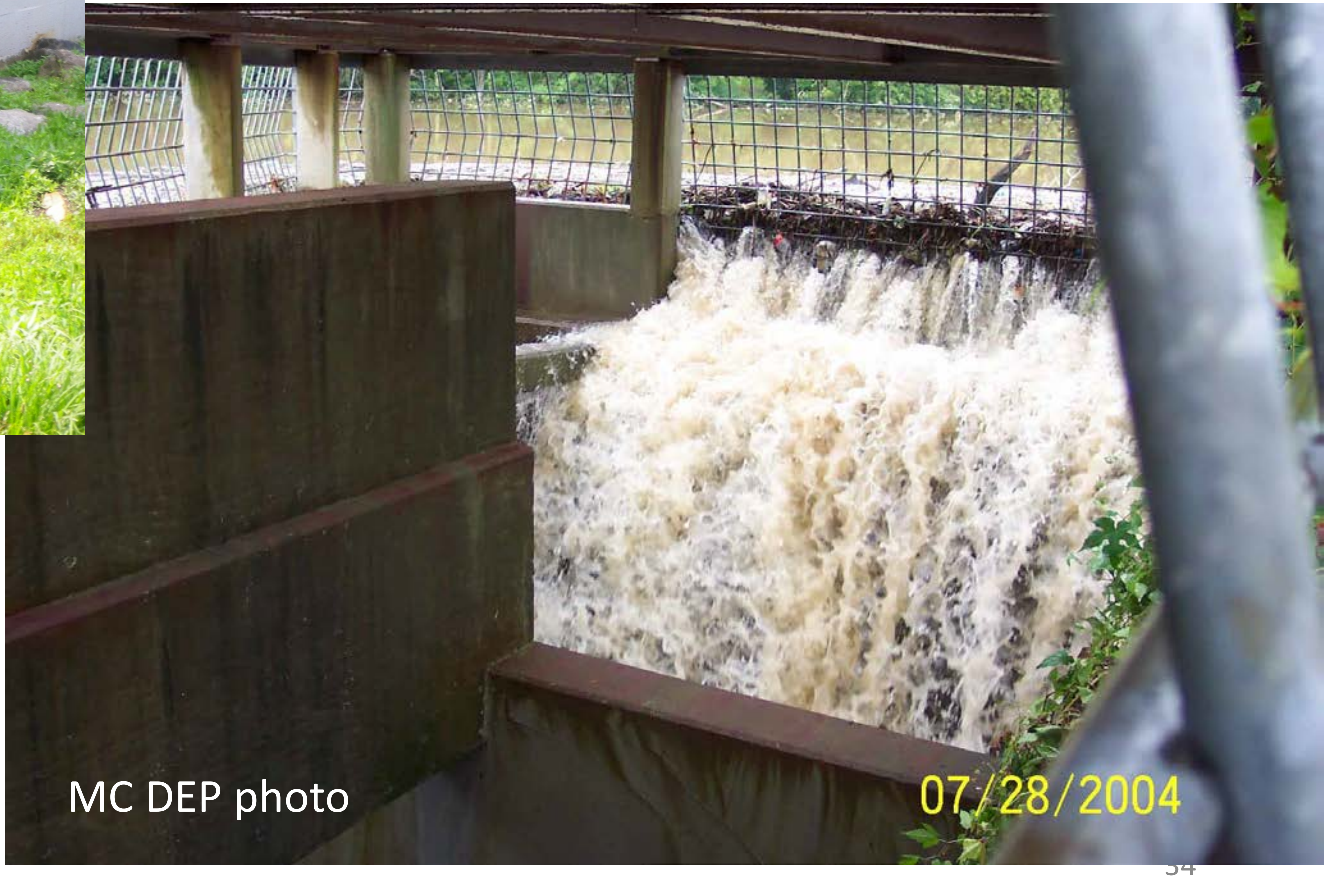

MC DEP photo
07/28/2004

Factors of safety

- MD-378: The riser shall be analyzed for flotation assuming all orifices and pipes are plugged. **The factor of safety against flotation shall be 1.2 or greater.**
- COMAR 26.17.04.05: The safety factor shall be that used in good engineering practice in dam design. In all important structural features, the safety factor used shall be shown in the design assumptions. **The Department requires a safety factor of at least 1.5 to be included in the structural design of the dam or any of its components** during steady state seepage conditions, and at least 1.2 during rapid drawdown of the reservoir pool from the spillway crest. If site conditions or the downstream hazard category warrants, the Administration may require a safety factor of greater than specified in this section.
- What should we do about this inconsistency?

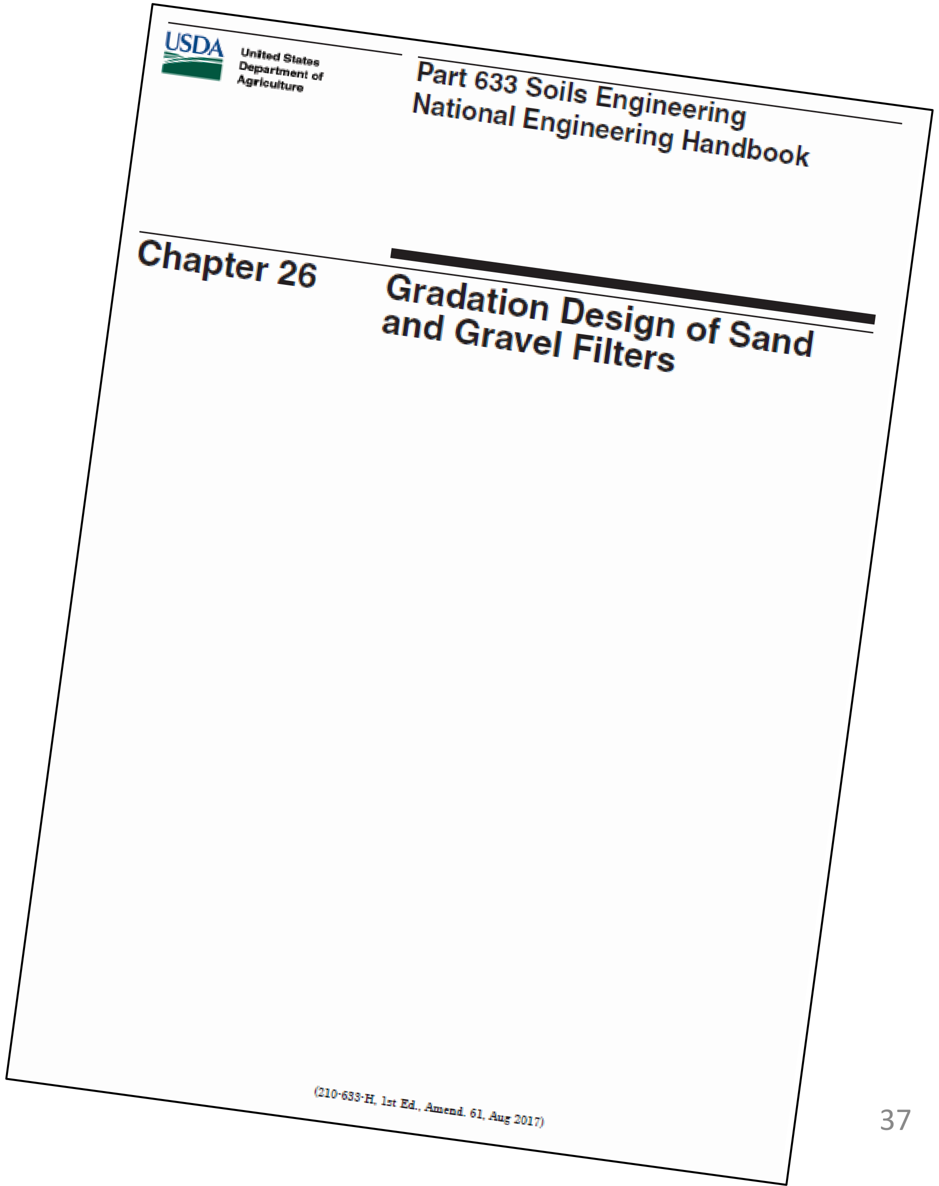
Review issues

- Emergency or principal spillways which discharge along toe of dam
- Or embankment constructed along the edge of a stream, often in the 100 year floodplain

No geotextiles in critical features of dams

- Filter fabric not allowed for construction of filters/filter diaphragms
- Not allowed for internal drains
- Filters should be designed properly (NRCS Chapter 26) so that finer materials do not migrate into coarser zones

- Geotextile is acceptable to use under riprap, where it is accessible and can be replaced in the future if needed


USDA United States Department of Agriculture

Part 633 Soils Engineering
National Engineering Handbook

Chapter 26

Gradation Design of Sand and Gravel Filters

(210-633-H, 1st Ed., Amend. 61, Aug 2017)

Why do we care if utilities are installed in embankment (especially road dams)

- We do it all the time
- It’s our road and we need to install the sewer/water/gas main there

- Utilities in or near the pond embankment or spillways need to be shown on drawings reviewed by SCD for small pond approval
- If failure of the dam will result in interruption of the utility the hazard classification of the dam may need to be increased from “low”
- MD-378: Pipes / utilities not parallel to the axis of the dam shall meet all principal spillway requirements (i.e. filter diaphragm, embankment soils, etc.). Pipes/utilities parallel to the axis of the dam shall be constructed with no granular bedding.
- Future work (excavation) would require review of agency which approved the pond

Case History

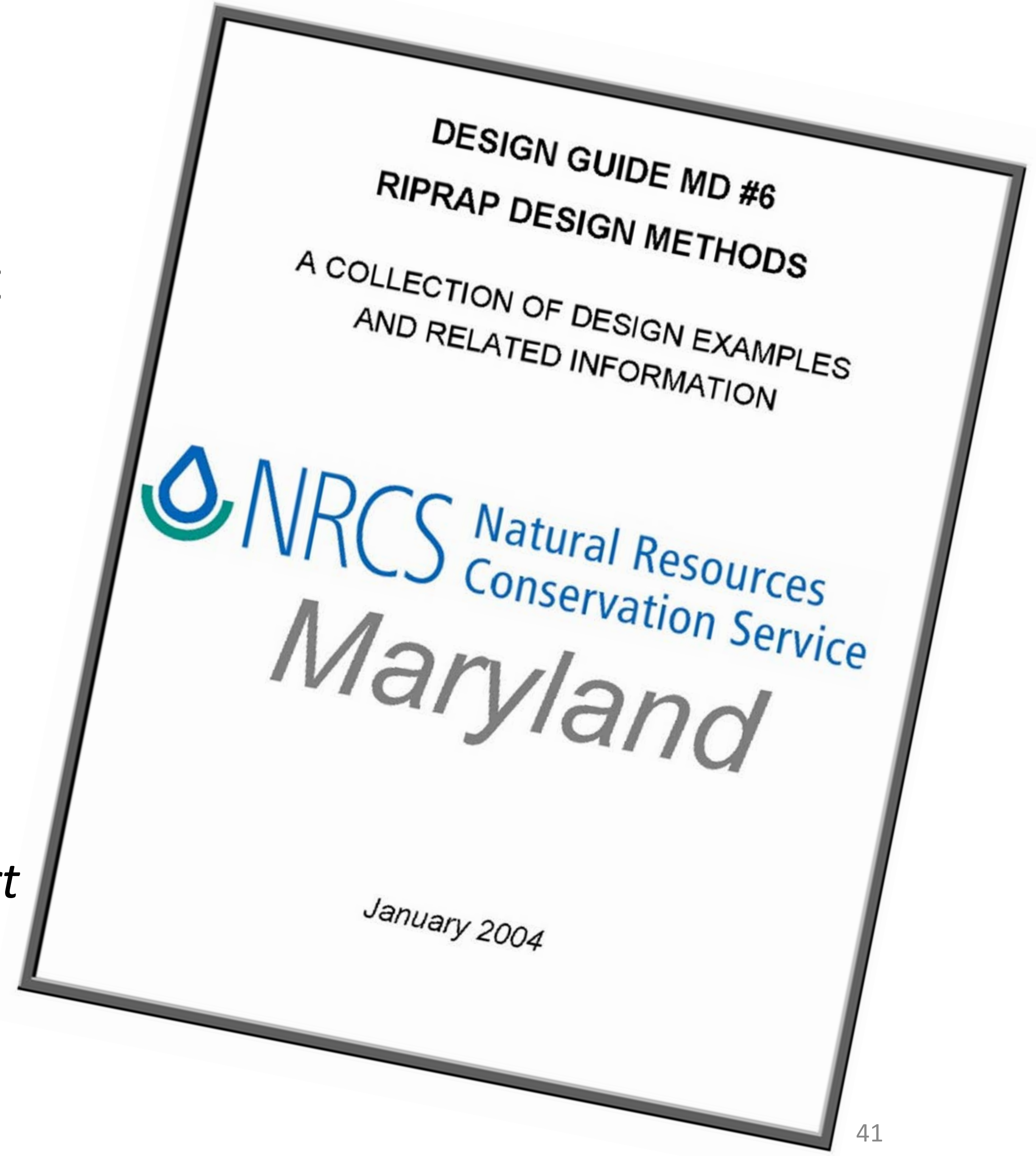
Google streetview

Case History (continued)

MDE photo

Outfall Design

- Design requirements for outfalls must use full pipe flow
- A riprap lined ditch or level apron is not acceptable
- NRCS Design Guide MD #6: Riprap design methods, Section IV (October 2003)
- Adapted from 1972 "*Practical Guidance for Estimating and Controlling Erosion at Culvert Outlet*" US Army Waterways Experiment Station, Misc. Paper H-72-5



Example:

Given $Q = 65$ cfs
$D_0 = 30$ inch CMP

Step 1 $d_0 = 0.5(30in)(1ft/12in) = 1.25$ feet

Step 2 $Q = 65$ cfs

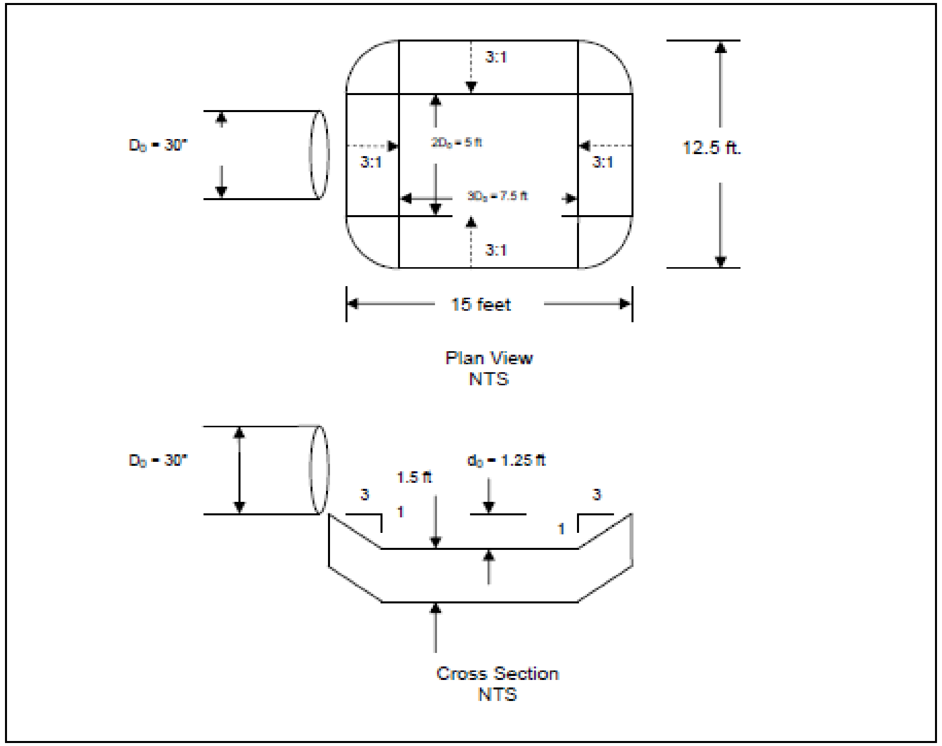
$TW = (30in/2)(1ft/12in) = 1.25$ feet
Minimum TW selected is ½D_0 (Wide floodplain downstream).

Step 3 $C = 0.0125$ for $d_0 = 0.5D_0$

Step 4 $d_{50} = C(D_0^2/TW)(Q/D_0^{5/2})^{4/3}$

$d_{50} = 0.0125(2.5^2/1.25)(65/2.5^{5/2})^{4/3}$
$d_{50} = 0.0125(5.0)(12.32) = 0.77$ feet
$d_{50} = 0.77$ feet use 9" to 10" stone

Step 5



Step 6

Surface Area = $(L + 2(3d_0^2 + d_0^2))^{1/2}(w + 2(3d_0^2 + d_0^2))^{1/2}$
Surface Area = $(7.5 + 2(3.75^2 + 1.25^2))^{1/2}(5 + 2(3.75^2 + 1.25^2))^{1/2}$
Surface Area = $(15.4)(12.9)$
Surface Area = $198.7 ft^2$

Volume = $((1.5')(198.7ft^2))/27ft^3/yd^3 = 11.04\ yd^3$ Use $11\ yd^3$

Convert to Weight
$(11\ yd^3)(1.5\ ton/yd^3) = 16.5$ ton

Other things to consider

- What changes need to be made to COMAR regulations?
- What changes should be made to NRCS MD-378?
- Show cross sections on plans as perpendicular to centerline of embankment rather than along the spillway pipe
- Measurement of dam height at the pipe without recognizing that the lowest point on the crest may be at another location along the embankment
- Core should run entire length of embankment to design storm elevation
- ACI 318 vs. ACI 350 (thicker walls, closer rebars to minimize cracking)
- Who is doing construction inspection in your jurisdictions?
- Construction issues are a topic for another workshop