TEXAS

ENGINEERING TECHNICAL NOTE

Subject : *HYDROLOGY*

No *210 18 TX7*

Reference : *GUIDE FOR POND HAZARD CLASSIFICATION*

Date : *MARCH 1983*

SOIL CONSERVATION SERVICE
U.S. DEPARTMENT OF AGRICULTURE

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HYDROLOGY

GUIDE FOR POND HAZARD CLASSIFICATION

INTRODUCTION

The Soil Conservation Service is directly involved in planning, design, and construction of dams. The majority of these are Class (a) dams with the product of capacity in acre-feet and height of dam in feet less than 3,000.

Soil Conservation Service TR-60 provides criteria for design of Class (a) dams with product of storage and effective height of dam of 3,000 or more, those more than 35 feet in effective height and all Class (b) and (c) dams. Class (a) dams are those located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

SCS policy requires that a hazard classification be made for each farm pond site. It is recognized that most sites will be Class (a), and that the classification can be determined through a series of screening processes. This technical note describes the screening procedure. Where the screening procedure indicates that the dam would be other than Class (a), the project should be discontinued or a detail breach analysis made.

Simplified Dam-Breach Routing Procedure, Technical Release No. 66, presents a simplified dam-breach routing procedure. This procedure develops an analytic breach hydrograph from a breached dam and routes the floodwave downstream using hydraulically rated valley cross-sections. These ratings and the breach routings can be accomplished by computer programs. State office assistance should be requested when the screening process indicates that the dam may be other than Class (a).

MINIMUM BREACH DISCHARGE

Criteria on the minimum discharge to be used in evaluating inundated areas downstream of a dam failure resulting from a breach are provided in NEM Circular No. 1. The minimum breach discharge is:

$$Q_{max} = 1100\ B_r^{1.35}$$

Where:

Q_{max} = the breach discharge, cfs

$B_r = \frac{V_s H_w}{A}$ = breach ratio, acre

V_S = reservoir storage at the time of failure, acre feet

H_W = depth of water at dam at time of failure, feet

A = cross sectional area of embankment at the point of breach, usually at the general flood plain template section, square feet

Except that Q_{max} is not to be less than $Q_{max} = 3.2\ H_W^{5/2}$

However, Q_{max} need not exceed $Q_{max} = 65\ H_W^{1.85}$

Plate 1 may be used to determine the applicable equation for the breach analysis.

The depth of water at the dam at the time of failure should be the larger of that associated with passage of the 100-year storm or the depth at the emergency spillway crest.

Soil Conservation Service Engineering Standard 378 establishes minimum acceptable quality for the design and construction of ponds. It states that the minimum design storm shall be 24 hours duration and that the emergency spillway shall: (1) safely pass the peak flow, or (2) the storm runoff shall be routed through the reservoir. Also, it states that the minimum elevation of the top of dam shall be 1.0 foot above the water surface in the reservoir with the emergency spillway flowing at design depth. The top of the dam elevation is approximately equal to the 100-year frequency reservoir stage.

BREACH PROCEDURE

General

Breach procedures are illustrated by use of the Don Lewis Farm Pond data. The pond is located in Bell County, Texas. The drainage area is 270 acres or .42 square mile and the average slope is 2 percent. The runoff curve number is 80. The structure is located 3500 feet upstream of Interstate Highway 35. Figure 1 shows the location and topography of the pond area.

Breach Analysis Without Structure Routing

1. 100-year, 24-hour rainfall - 9.90 inches (Technical Note 210-18-TX5).
2. Peak discharge Q_{100} = (580)(1.16) = 673 cfs (Technical Note 210-18-TX5).
3. With total spillway discharge of 673 cfs the dam height is about 16.2 feet and the storage capacity is 44 AF (Table 1).
4. From Plate 1 the applicable breach equation is $Q = 3.2\ H^{2.5}$

   Then $Q = 3.2\ (16.2)^{2.5}$ = 3380 cfs.

5. The discharge at the dam is 3380 cfs. If it is evident that this discharge would not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities; no other investigations would be needed.

A drainage area ratio may be used to determine how far downstream a breach discharge would exceed the discharge if no structure existed.

This can be approximated by solving the following equation:

$$\frac{A_1}{A_2} + \left(\frac{q_b}{q_2}\right)^2 \frac{Q_s}{Q_i}$$

Where $\frac{A_1}{A_2}$ = Ratio of downstream drainage area to site area

q_b Breach peak discharge - 3380 cfs

q_2 = Peak inflow at structure site - 673 cfs

Q_i = Storm runoff volume - 6.74 inches

Q_s Storage Volume at time of breach

$$\frac{\text{(Acre-feet) (.01875)}}{\text{Sq. Mi.}} \quad \frac{\text{DA}}{} = \frac{(44.2)(.01875)}{.42} = 1.97 \text{ inches}$$

$$\frac{A_1}{A_2} \quad 1 + \left(\frac{3380}{673}\right)^2 \frac{1.97}{6.47} = 7.7$$

$A_1 = (.42)(7.7) = 3.2$ square miles

The breach discharge would not exceed the without structure discharge when the drainage area is 3.2 square miles. Thus, improvements beyond this point need not be considered.

ESTIMATING DOWNSTREAM BREACH FLOW STAGE

Where there are downstream developments that could be in the breach flood area, additional studies may be needed. The stage of a breach discharge at a downstream development can be estimated by determining the depth of breach flow at the dam and assuming this depth would continue downstream. This requires that the valley cross-section at the dam be hydraulically rated. This can be accomplished by use of valley slopes from Geological Survey Quadrangle maps in Manning's equation. Table 2 illustrates this for the Don Lewis farm pond dam. The 3380 cfs breach discharge would be about 6.4 feet deep. Downstream developments above this valley depth would not be affected by a breach.

Generally, the valley cross-section area-depth relationship increases in a downstream direction. Where this is significant, a surveyed valley section at the development can be rated as above to determine the breach flow stage with respect to the development.

Neither of these procedures consider the effect of valley storage on the breach flow. Thus, the results generally are conservative. In the event that the development is flooded, a breach routing should be made or consideration of the site discontinued.

POTENTIAL IMPACT AREAS

The procedures described above for estimating downstream breach flow stages may also be used in the development of potential impact area maps for all Class (a) dams of inventory size and all Class (b) dams. (Ref. 210-520.28 and TX 520.28 of the NEM.)

Table 1

Don Lewis Farm Pond Structure Data

Elevation Feet	Storage AF	Spillway Capacity		
		Principal CFS	Emergency CFS	Total CFS
80	0	0	0	0
84	.93	0	0	0
86	2.59	0	0	0
88	5.90	0	0	0
90	11.3	0	0	0
91	15.0	37	0	37
92	19.1	38	0	38
92.8	23.3	38.5	0	38.5
93.3	26.0	39	21.8	60.8
93.8	28.7	40	67.8	107.8
94.3	31.7	41	148.2	189.2
94.8	35.0	42	248.0	290.0
95.3	38.3	43	381.0	424.0
95.8	41.6	44	516.0	560.0
96.3	44.9	45	650.0	695.0
96.8	48.2	46	783.0	829.0

Table 2

Cross Section Rating - Don Lewis Farm Pond Dam Section

	Width Ft	Area Ft^2	Wetted Perimeter Ft	Hydraulic Radius Ft	Velocity Ft/Sec	Discharge Ft^3/Sec
80	0	0	0	0	0	0
81	25	12	26	.46	1.76	21
82	55	52	58	.90	2.76	144
83	85	122	87	1.40	3.72	454
84	105	217	107	2.03	4.76	1033
85	125	332	128	2.59	5.60	1859
86	145	467	148	3.16	6.40	2989
87	205	642	205	3.07	6.27	4025
88	235	862	239	3.61	6.99	6025

Note: Mannings equation n value .05

Figure 1

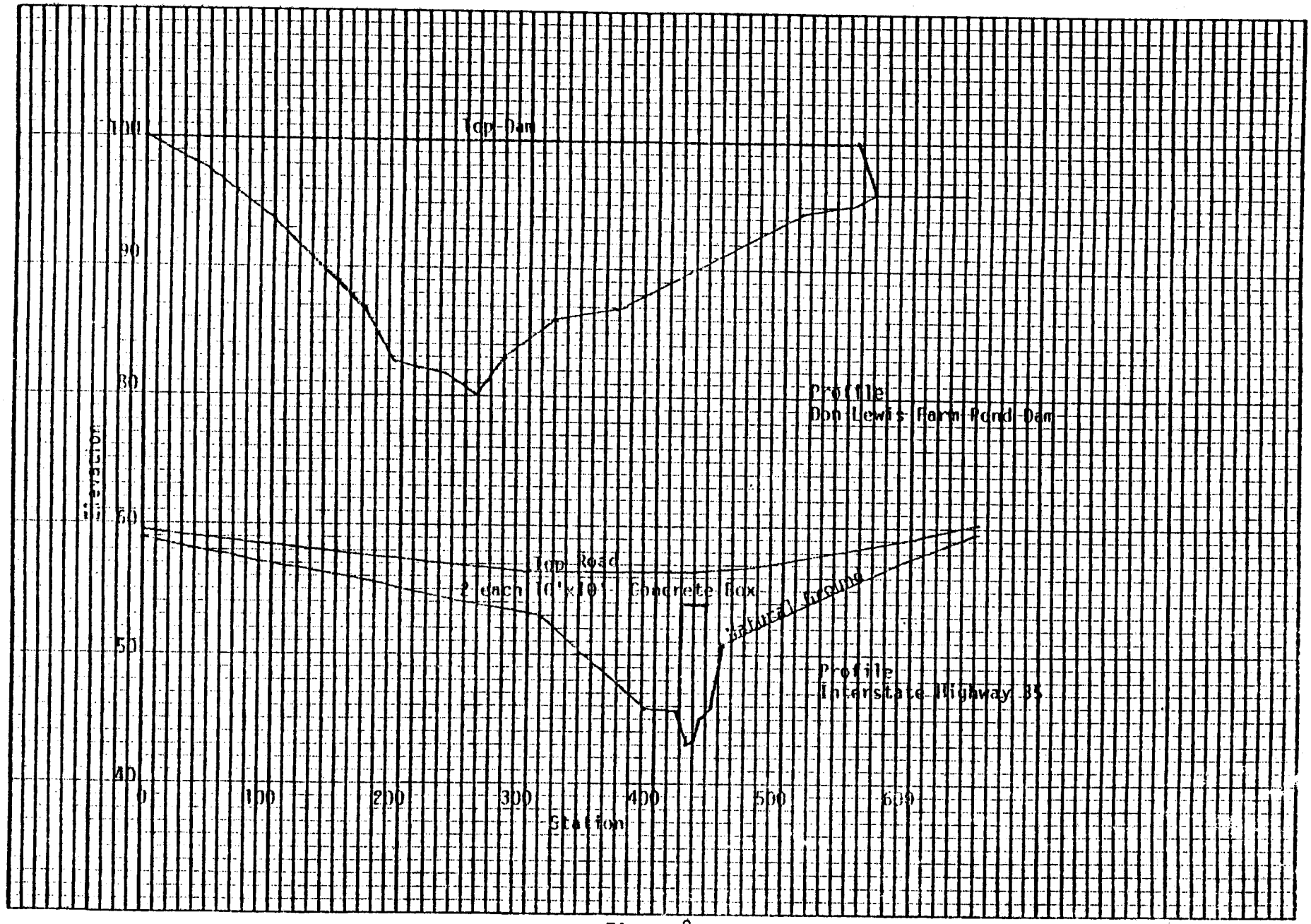

Figure 2

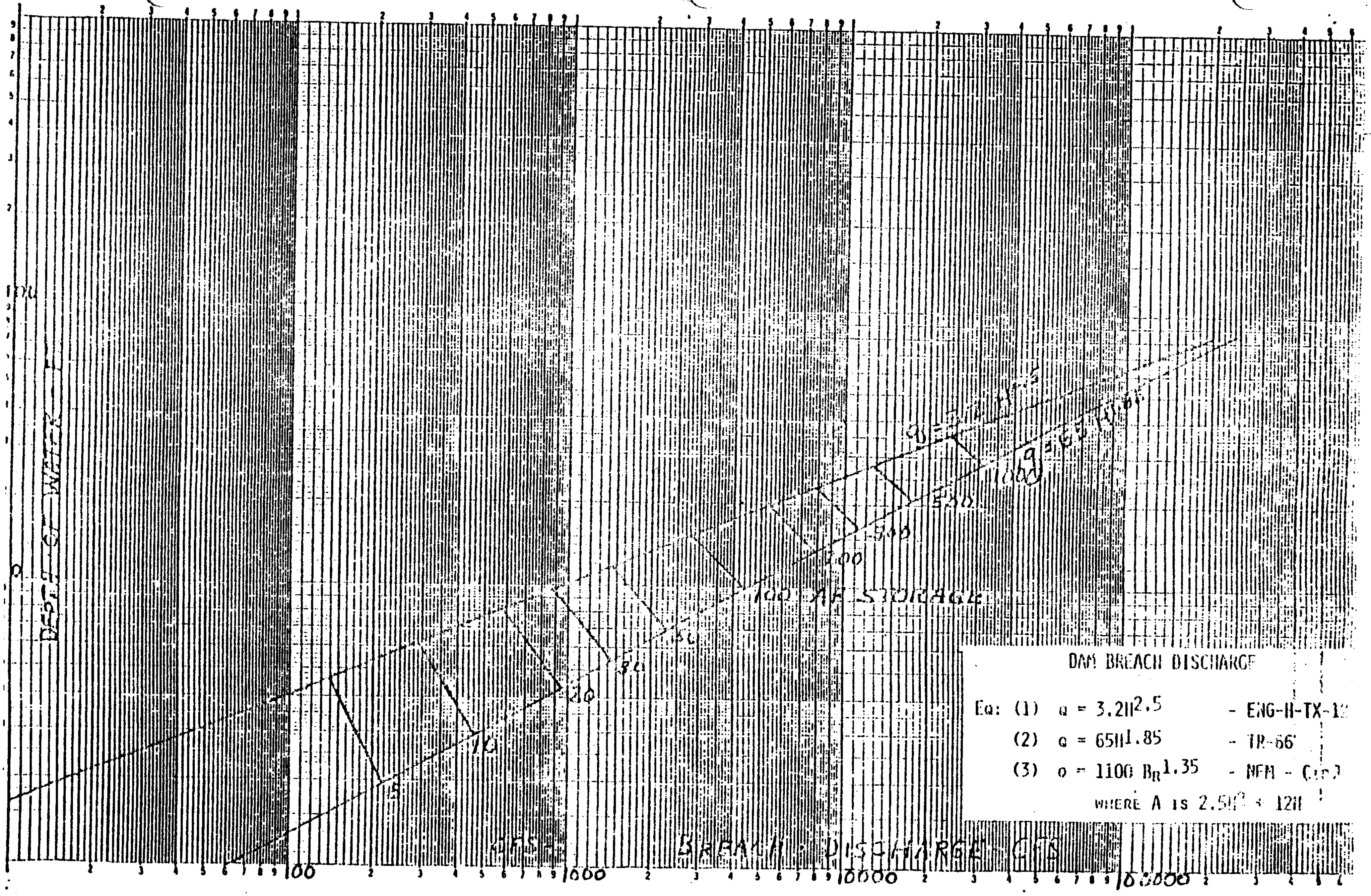
DEPTH OF WATER - FT
DAM BREACH DISCHARGE
Eq: (1) q = 3.2H^2.5 - ENG-H-TX-1?
(2) q = 65H^1.85 - TR-66
(3) q = 1100 B_R^1.35 - NFM - (?)
WHERE A IS 2.5H? + 12H
100 AF STORAGE
BREACH DISCHARGE CFS
100
1000
10000
100000

Plate 1