UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Commissioner's Office
Engineering Laboratories
Denver, Colorado
March 4, 1955

Laboratory Report No. Hyd-398
Hydraulic Laboratory
Compiled by: A. J. Peterka

Subject: Progress Report I--Impact Type Energy Dissipators for Flow at Pipe Outlets--Franklin Canal--Bostwick Division--Missouri River Basin Project

SUMMARY

This report is a summary of the design rules and criteria necessary to design stilling basins of the short impact type which require no tail water for acceptable performance. Nine basins, graduated in size, to handle increments of discharge up to 339 second-feet are presented. By interpolation and the use of multiple units side by side an almost limitless number of basins may be designed. The basins are designed for use on pipe outlets where the outlet velocity does not exceed 30 feet per second.

The basin type, shape, and proportions, as well as the limiting discharges and velocities, were obtained from hydraulic model tests. The design procedures and rules were worked out in cooperation with design personnel in the Canals Branch of the Commissioner's Office, Denver.

The usual data pertaining to the development tests have been omitted in this report. Only the data necessary for the design of the impact type stilling basin has been included in order to make this a handy reference report for use by design personnel. A more detailed and explanatory type of writeup will be included in Hydraulic Laboratory Report No. Hyd-399, to be published at an early date. It is also intended to continue the development of this basin in order to further refine the design and extend its range. This will be done as time and funds permit under a research program.

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IMPACT-TYPE STILLING BASIN

The attached prints show the essential features of an impact-type stilling structure developed from hydraulic model tests in the Hydraulic Laboratory. The design has been generalized to cover a range of discharges, providing minimum dimensions for acceptable hydraulic performance. The design given here represents the combined efforts of hydraulic laboratory and design personnel.

Energy dissipation is initiated by flow striking the vertical hanging baffle and being turned upstream by the horizontal portion of the baffle and by the floor in vertical eddies. The structure therefore requires no tail water to be effective, although tail water will reduce erosion tendencies in the riprapped area.

A considerable number of these structures have been constructed using the dimensions given in the table. Performance in the field has not been observed but it is believed that operation will be satisfactory, particularly for the smaller sizes.

The attached table may be used to obtain dimensions for the usual structure operating within usual ranges. However, an understanding of the design limitations may help the designer to modify these dimensions when necessary for different ranges of operating conditions.

The basin dimensions, Columns 4-13, are a function of the discharge. Velocity at the stilling basin entrance need not be considered except that it should not exceed about 30 feet per second.

The parallel lines on the accompanying chart show for a given basin width W, the range of discharges over which best operation is obtained. The lower limit line should not be exceeded appreciably because dangerous operation will result. The upper limit may of course be extended but represents the point at which no appreciable improvement in performance results from a larger basin. The dimensions given in the table are for a line about midway between the two shown on the chart. If the entrance velocity approaches the 30 feet per second limit and the basin is expected to operate in the upper discharge limit range as well, it is recommended that the lower limit line be used to obtain W. Other basin dimensions should be enlarged proportionally.

The drawing of the stilling structure gives the recommended dimensions for a complete range of sizes utilizing discharges from 21 to 339 second feet. For larger sizes, multiple units placed side by side are recommended.

Columns 4 through 13 give the structure dimensions for the discharges shown in Column 3. If the entrance velocity is assumed to be 12 feet per second, pipe of the diameter shown in Column 1 will run full, or at 24 feet per second, half full. The entrance pipe size may be changed to larger or smaller, depending on the expected velocity but the relation between structure size and discharge should be maintained as given in the table.

Columns 14-18 give the thickness of concrete for various parts of the structure as determined in the Denver office. These may be modified, if necessary, without changing the hydraulic performance.

The invert of the entrance pipe should be held at the elevation shown on the drawing, in line with the bottom of the baffle and the top of the end sill, regardless of the size of pipe selected. The entrance pipe may be tilted downward somewhat without affecting performance adversely. A limit of 15 degrees is a suggested maximum. For greater slopes use a horizontal or sloping pipe (up to 15 degrees) two or more diameters long just upstream from the stilling basin.

Under certain conditions of flow a hydraulic jump may be expected to form in the downstream end of the pipe, sealing the exit end. If the upper end of the pipe is also sealed by incoming flow, a vent may be necessary to prevent pressure fluctuations in the system. A vent to the atmosphere, say one-sixth the pipe diameter, should be installed upstream from the jump.

The notches shown in the baffle are provided to aid in cleaning out the basin after prolonged nonuse of the basin. When the basin has silted level full of sediment before the start of the spill, the notches provide concentrated jets of water to clean the basin. The basin is designed, however, to carry the full discharge shown in the table over the top of the baffle if for any reason the space beneath the baffle becomes clogged. Performance is not as good, naturally, but acceptable.

With the basin operating normally the notches provide some concentration of flow passing over the end sill, resulting in some tendency to scour in the vicinity of the wing walls.

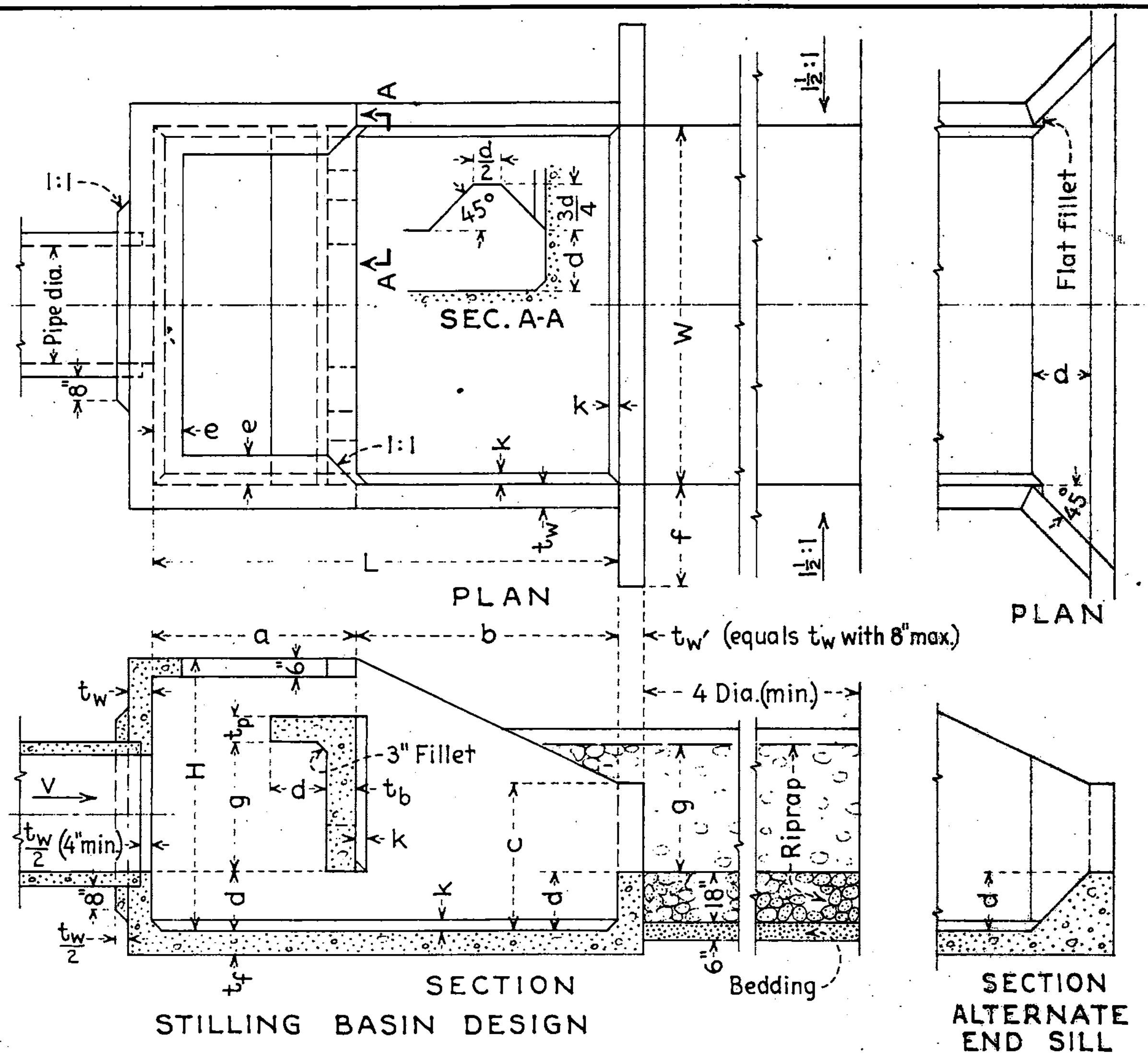
Riprap, as shown on the drawing, will provide ample protection in the usual installation, but if the best possible performance is desired, it is recommended that the alternate end sill and 45 degree end walls be used. The extra sill length reduces flow concentrations, scour tendencies, and the height of waves in the downstream channel.

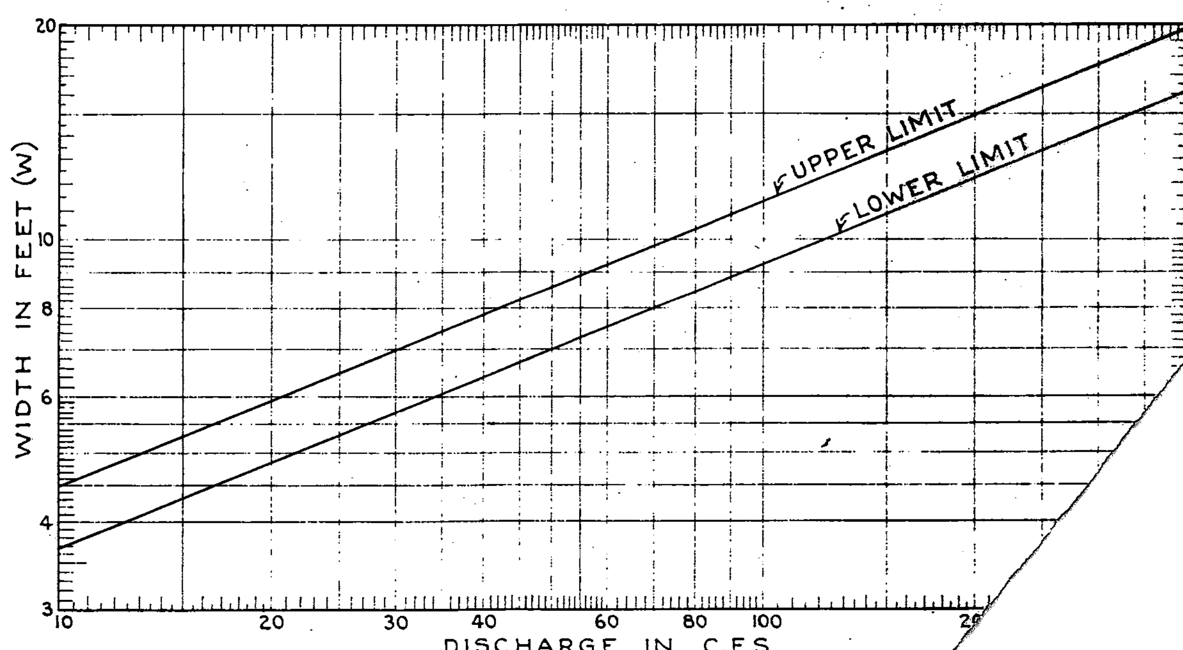
It is the intention of the Hydraulic Laboratory to refine the design of this type of structure by means of additional laboratory studies. Photographs of structures operating in the field, notes on performance, difficulties in design, construction or operating problems will all prove helpful in obtaining the best structure at the least cost. Data and comments are therefore invited.

STILLING BASIN DIMENSIONS

Impact-type Energy Dissipator

Pipe		Q for	Feet and inches										Inches				
Dia in. (1)	Area (sq ft) (2)	(V = 12) (3)	W (4)	H (5)	L (6)	a (7)	b (8)	c (9)	d (10)	e (11)	f (12)	g (13)	t_w (14)	t_f (15)	t_b (16)	t_p (17)	K (18)
18	1.7672	21	5-6	4-3	7-4	3-3	4-1	2-4	11"	6"	18	2-1	6	6-1/2	6	6	3
24	3.1416	38	6-9	5-3	9-0	3-11	5-1	2-10	14	6	24	2-6	6	6-1/2	6	6	3
30	4.9087	59	8-0	6-3	10-8	4-7	6-1	3-4	16	8	2-6	3-0	6	6-1/2	7	7	3
36	7.0686	85	9-3	7-3	12-4	5-3	7-1	3-10	19	8	3-0	3-6	7	7-1/2	8	8	3
42	9.6211	115	10-6	8-0	14-0	6-0	8-0	4-5	21	10	3-0	3-11	8	8-1/2	9	8	4
48	12.5664	151	11-9	9-0	15-8	6-9	8-11	4-11	24	10	3-0	4-5	9	9-1/2	10	8	4
54	15.9043	191	13-0	9-9	17-4	7-4	10-0	5-5	2-2	12	3-0	4-11	10	10-1/2	10	8	4
60	19.6350	236	14-3	10-9	19-0	8-0	11-0	5-11	2-5	12	3-0	5-4	11	11-1/2	11	8	6
72	28.2743	339	16-6	12-3	22-0	9-3	12-9	6-11	2-9	15	3-0	6-2	12	12-1/2	12	8	6





DISCHARGE LIMITS

IMPACT TYPE ENERGY DISSIPA