ANALYSIS OF DAM SAFETY
AND
FLOOD RISK FACTORS
FROM
CLOSURE OF A BREACH IN MCMICKEN DAM

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ANALYSIS OF DAM SAFETY AND FLOOD RISK FACTORS FROM CLOSURE OF A BREACH IN MCMICKEN DAM

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Hydrology Division
May 24, 1984

I. General

A. Purpose: The contractor repairing McMicken Dam has requested to be permitted to fill the smaller of the two breaches in the dam while work progresses to facilitate the repair effort. This report presents the results of a study conducted by the Flood Control District to determine what effect closing the breach might have on dam safety and flood risk.

B. Scope: This report investigates the probability relationships governing the occurrence of severe storms in the McMicken Dam watershed in June of any year (the time during which the breach will be closed). The hydraulics of the structure before and after closure of the breach are also presented. A general familiarity with the structure and watershed is assumed.

C. Methods: A stochastic rainfall generator was used to synthesize a rainfall/storm record for the McMicken Dam watershed. The output from the rainfall generator was analyzed to determine the probability distribution function for severe storms in June on the watershed. A storm depth was selected and input to a watershed hydrology model. The resulting hydrograph was routed through McMicken Dam under a variety of conditions to ascertain the effect of closure of the breach. A more detailed account of the methods is included in the following sub-sections.

D. Summary of results: This report concludes that filling the smaller breach will have only a small and insignificant effect on the performance of structure in a storm having a 1% chance of occurrence.

II. Stochastic Analysis

A. Discussion: Rainfall depth/frequency relationships as presented in NOAA Atlas 2 (Ref 1) are based on annual series data and do not account for seasonal variations. The proposed filling of the smaller breach at McMicken Dam would occur during the month of June, a month of scant rainfall in this area. For a given return period (i.e. 50 year, 100 year) it seems likely that the associated storm rainfall depth would be less in June than in a wetter month of the year, but because of a lack of long-term data for Arizona there are no generally available assessments of storm depth probabilities for months of the year. There are, however, methods for estimating these probabilities.

In this analysis, a stochastic rainfall generator was used to synthesize fifty years of "Junes" on the McMicken Dam watershed. The generator is a computer program, SATDOR (Ref. 3), which simulates daily precipitation in Arizona and New Mexico. The program includes such features as probabilistic determination of storm type, number of storm cells, storm direction and distribution, and storm duration.

The fifty years of data generated by the model were analyzed to create a probability curve for depth of rainfall from a storm in June. It was then decided that a storm rainfall depth which would occur in a June storm which had no greater than 1% chance of occurrence was the acceptable level of risk. This level is the seasonally adjusted 100 year storm.

Results: The results of the stochastic analysis are presented graphically in Figure 1. A tabular presentation of the storm depths generated by the model is given in Table 1. The following statements are derived from examination of Figure 1:

1. The average depth of storm rainfall is about .13 inches.
2. Almost 95% of the time storms yield less than one inch of rain.
3. In about one-third of all years there is no rainfall at all during June.
4. The "acceptable" storm depth is about 2.1 inches.

As a matter of information, the 2.1 inch, 100-year June storm is equivalent to a 10-year storm when the entire year is considered. The annualized 100-year storm depth is about 3.3 inches.

III. Hydrologic and Hydraulic Analysis

A. Discussion: The storm depth abtained by stochastic methods was distributed in time over the McMicken Dam watershed in accordance with the curves developed by the U S Army Corps of Engineers shown at Plates 19 and 20 of Ref. 2. This distribution is used in dam design studies in this area. The distribution is highly conservative in that over 97% of the storm total occurs in a two hour period with almost 60% occurring in a 1 hour period. The total storm time is 7 hours. The rainfall was input into a HEC-1 computer model of the McMicken Dam system prepared by Sargent, Hauskins and Beckwith Consulting Engineers as part of the work done under the repair plan. The HEC-1 model was developed for the required probable maximun flood analysis. The model was run three times to simulate different conditions at the damsite. In the first run, the dam was considered to be repaired and operational. The only outlet other than the emergency spillway was the principle outlet structure. In the second run the dam was simulated under existing conditions. Here, it was necessary to construct rating curves for each of the two breaches. These were obtained from the following expression:

$$Q = C1\ (B)(W-D)1.5+C2(W-D)2.5$$

Where

C1 = 3.08, the rectangular weir coefficient
C2 = 2.44 Z, the V-notch weir coefficient
W = water surface elevation
D = breach bottom elevation
B = width at base of breach
Z = side slope of breach, horizontal to vertical

The rating curves used are attached as Figures 2,3, and 4. The breach geometrics are shown on Figures 5 and 6. A final run was made in which the small breach was filled but the large breach remained open. This is the proposed configuration.

B. Results: The important results of this analysis are summarized as follows:

Condition	Storage (Ac-ft)	Discharge (cfs)	Water Surface Elev.
Repaired	13630.	3270.	1350.10
Both Breaches	5469.	23858.	1344.38
Large Breach only	5830.	22032.	1344.66

Spillway Crest elevation = 1354.
Top of dam = 1361.

It can be seen from this table that filling in the smaller breach would result in a .28 foot increase in the depth of water behind the dam in the selected storm. The total storage would increase by 361 acre-feet. From examination of the rating curves it can also be determined that the discharge through the large breach would be increased by about 1600 cfs if the smaller breach were filled. The flow from the small breach would decrease to nothing and the overall discharge would decrease by 1826 cfs.

IV. Conclusions

The change in water level which would result from filling the smaller breach is only marginally higher than the water level which would occur if the breach remainded open. The difference of about three inches would not increase hazards associated with McMicken Dam. The composite outflow from the dam in the selected storm is actual decreased somewhat when the smaller breach is eliminated, although there is a slight increase in the discharge from the larger breach. This slight increase would quickly be dissipated in the floodplain below the structure and would not reasonably be expected to increase flood depths very far downstream of the breach. In as much as the composite discharge is reduced, the flood depths further downstream would either decrease slightly or remain the same. This study finds that there will be no adverse effects from the proposed change.

References

1. National Weather Service, NOAA Atlas 2, "Precipitation Frequency Atlas of the Western United States," 1973.

2. U. S. Army Corps of Engineers, Los Angeles District, "Gila River Basin, New River and Phoenix City Streams, Arizona," Design memorandum number 2, Hydrology, Part 2, 1982.

3. U. S. Department of Agriculture, Science and Education Administration, "Model of Time and Space Distribution of Rainfall in Arizona and New Mexico," ARM-W14, 1980.

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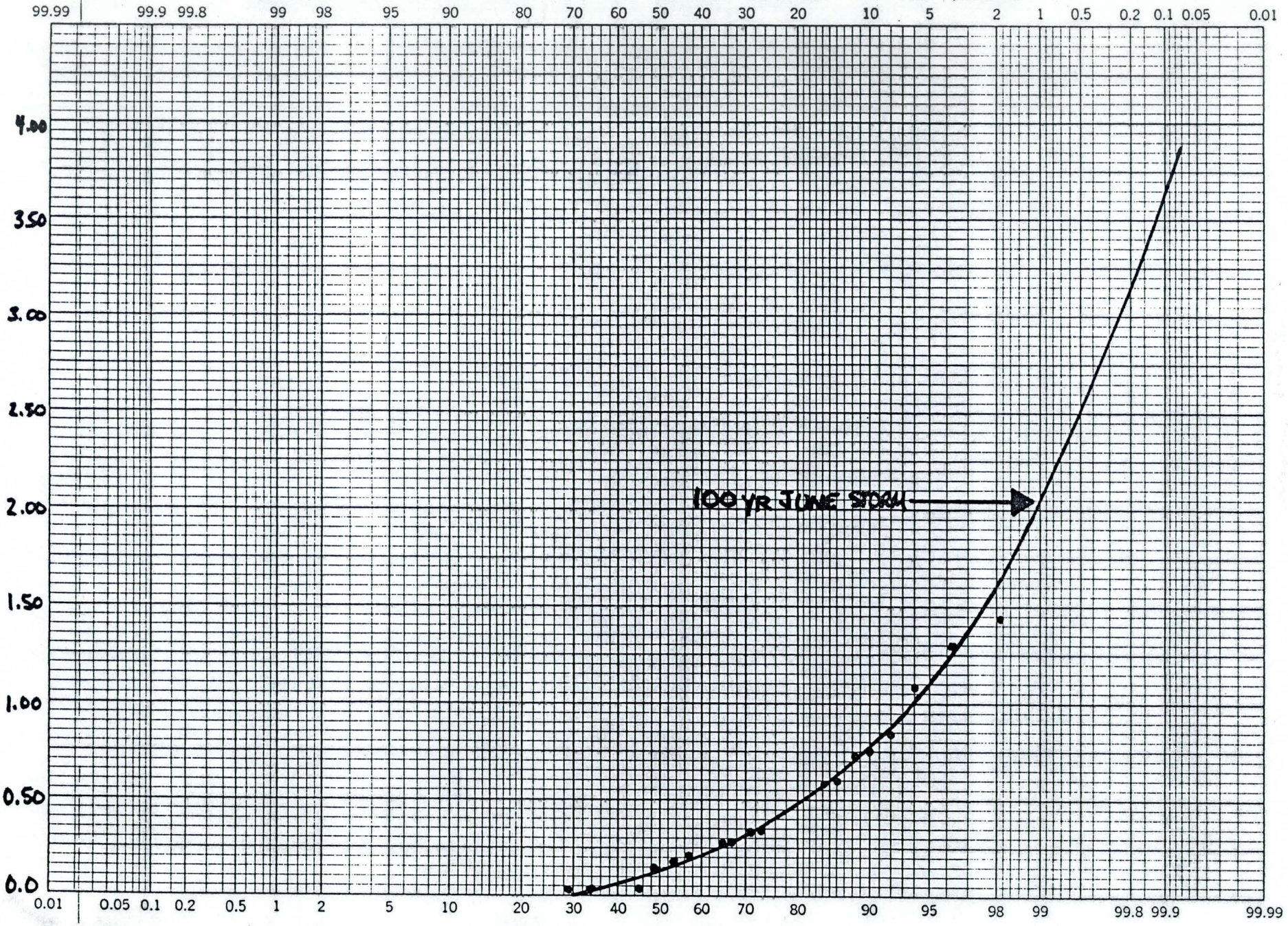
NUMBER OF TIMES RAINFALL WILL EXCEED AMOUNT IN 100 YEARS



PERCENT OF TIME THAT RAINFALL IS LESS THAN THE AMOUNT

FIGURE 1 - PROBABILITY CURVE FOR JUNE STORM

SIMULATED JUNE STORM MAXIMUM RAINFALL

RAIN(mm)	RANK	REL.FREQ.	RAIN	RANK	REL.FREQ.	RAIN	RANK	REL.FREQ.
8.20	15	.294	13.10	9	.176	14.70	7	.137
3.10	26	.510	0.76	31	.608	3.13	25	.490
8.70	11	.216	5.20	20	.392	18.18	5	.098
7.70	17	.333	0.00	36	.706	14.56	8	.157
4.70	23	.451	27.70	3	.059	0.00	37	.706
4.85	22	.431	1.64	29	.569	4.99	21	.412
8.27	14	.275	0.50	33	.647	36.15	1	.0196
0.00	38	.706	0.43	34	.667	5.79	19	.373
6.83	18	.353	3.75	24	.471	2.92	27	.529
10.29	10	.196	0.00	39	.706	0.00	40	.706
0.00	41	.706	0.00	42	.706	8.59	13	.255
32.80	2	.0392	17.89	6	.118	0.00	43	.706
0.00	44	.706	1.00	30	.588	0.00	45	.706
0.08	35	.686	0.00	46	.706	21.34	4	.0784
0.00	47	.706	0.66	32	.627	0.00	48	.706
2.76	28	.549	0.00	49	.706	0.00	50	.706
8.07	16	.314	8.84	12	.235			

TABLE 1

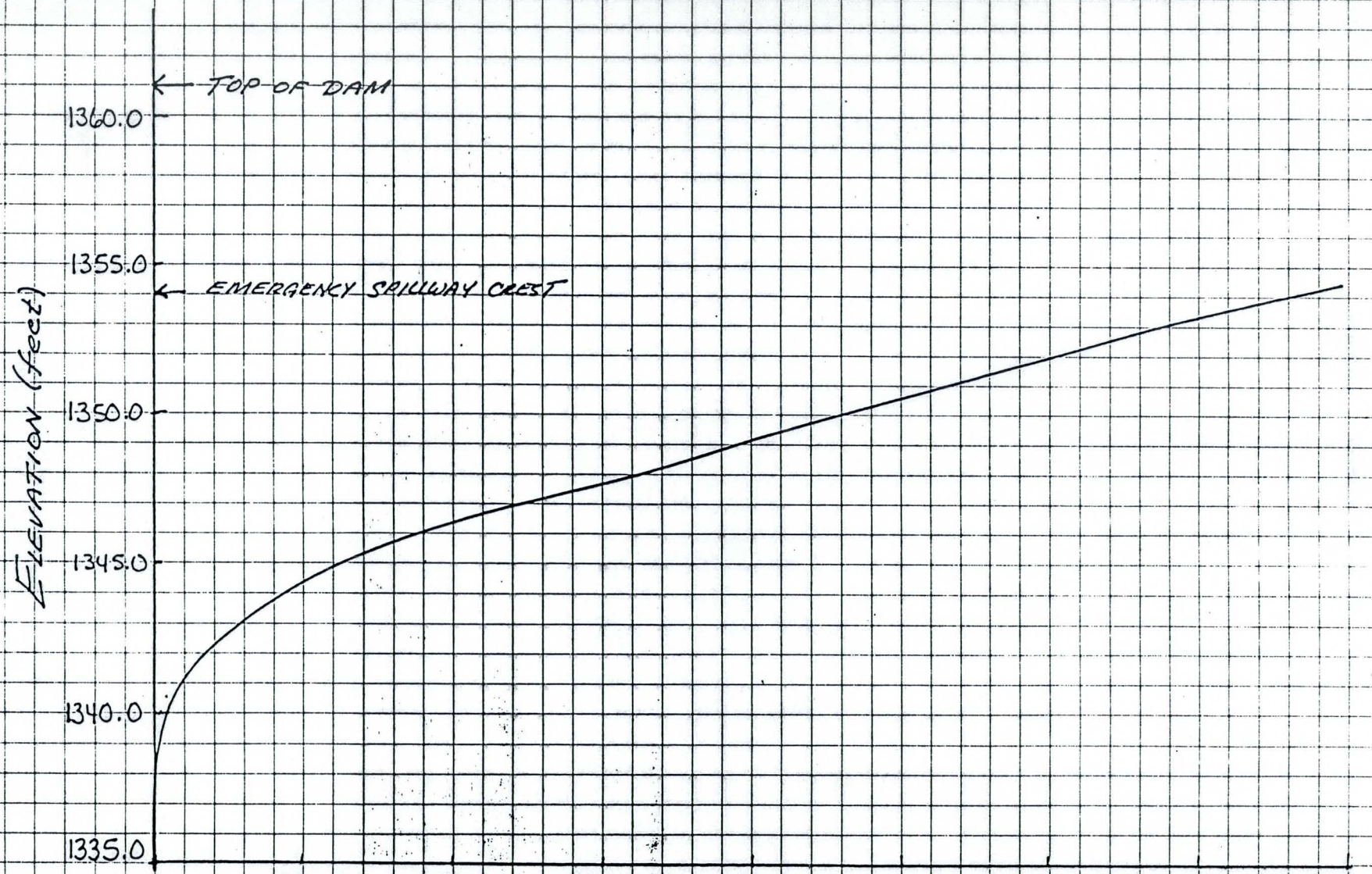


FIGURE 2: COMPOSITE OUTFLOW CURVE [BREACHES AND OUTLET] MCMICKEN DAM

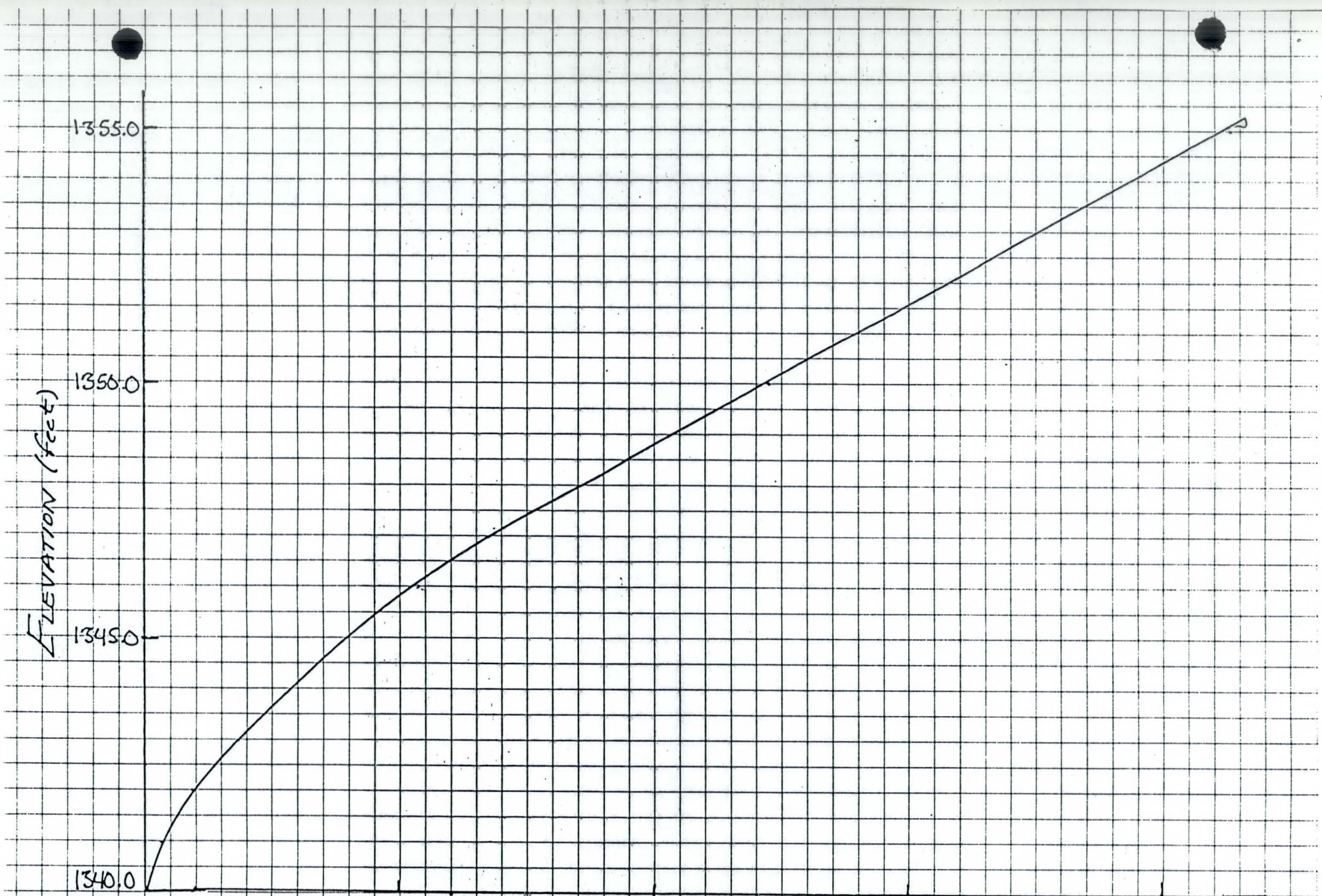


FIGURE 3: SMALL BREACH OUTFLOW CURVE for McMICKEN DAM

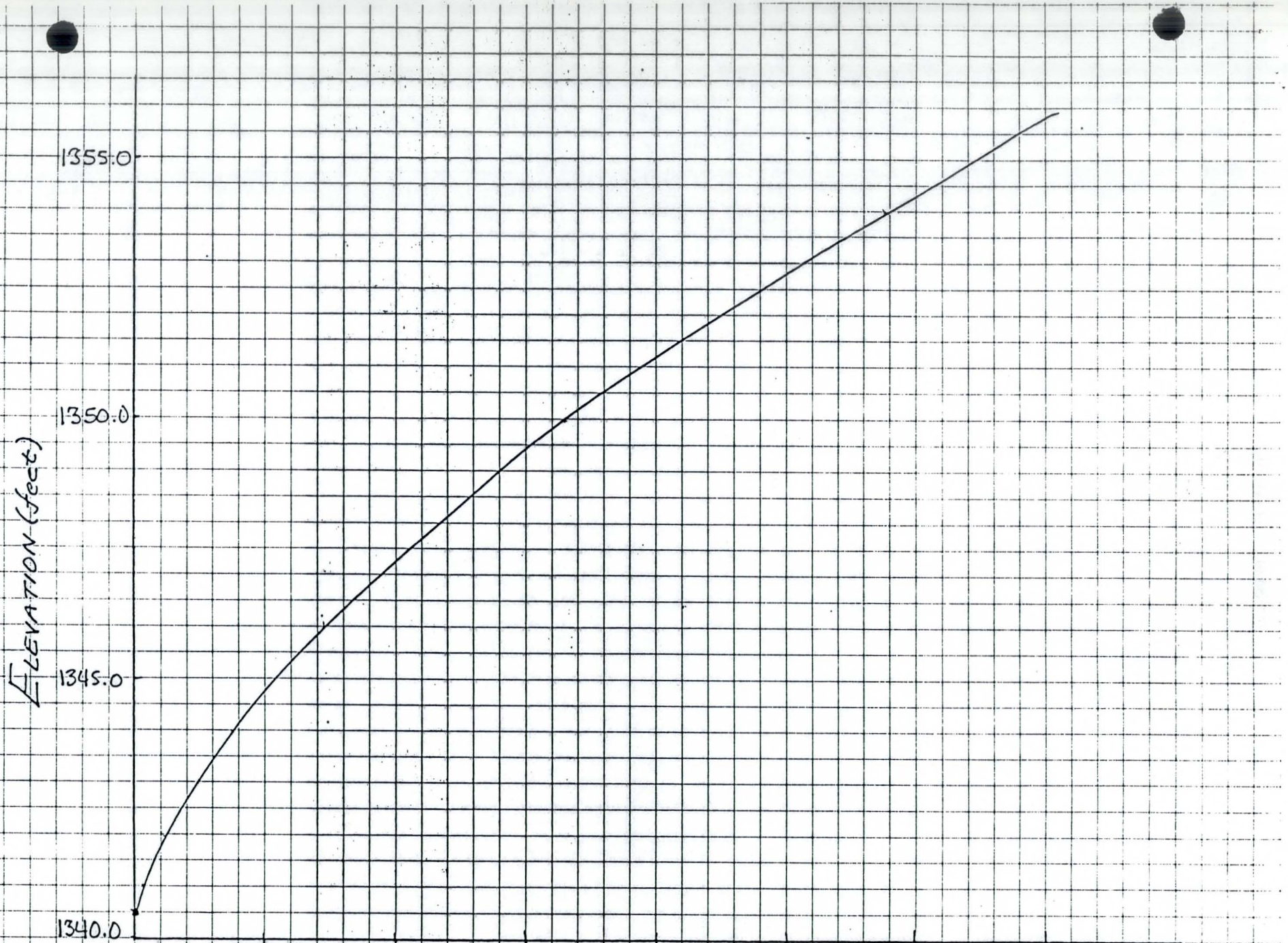
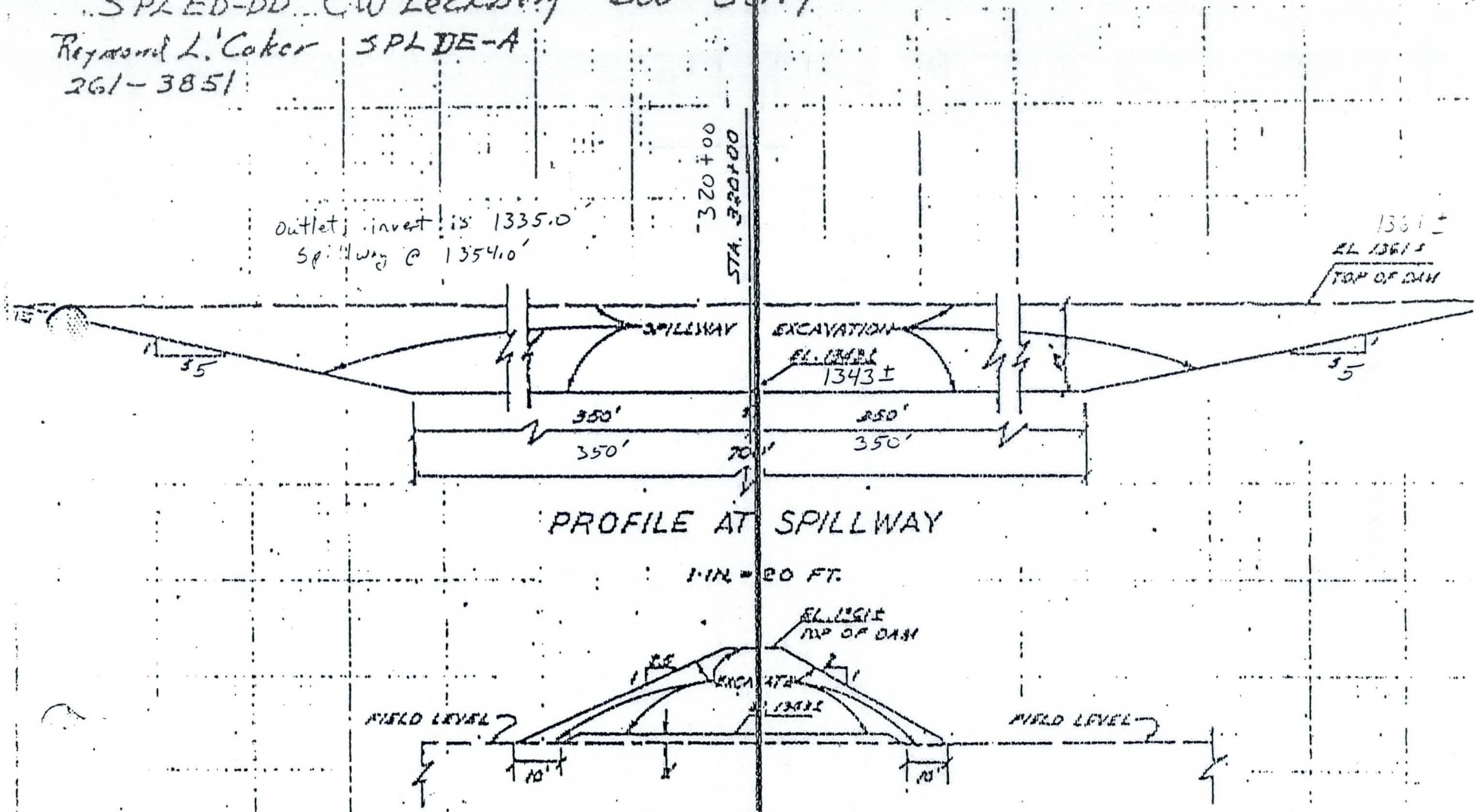


FIGURE 4: LARGE BREACH OUTFLOW CURVE for McMICKEN DAM

SPLED-DD C.W Leckbee 688-5519

Raymond L. Coker SPLDE-A
261-3851



TRILBY WA

FIGURE 5: BREACH GEOMETRY for LARGE BREACH

6/

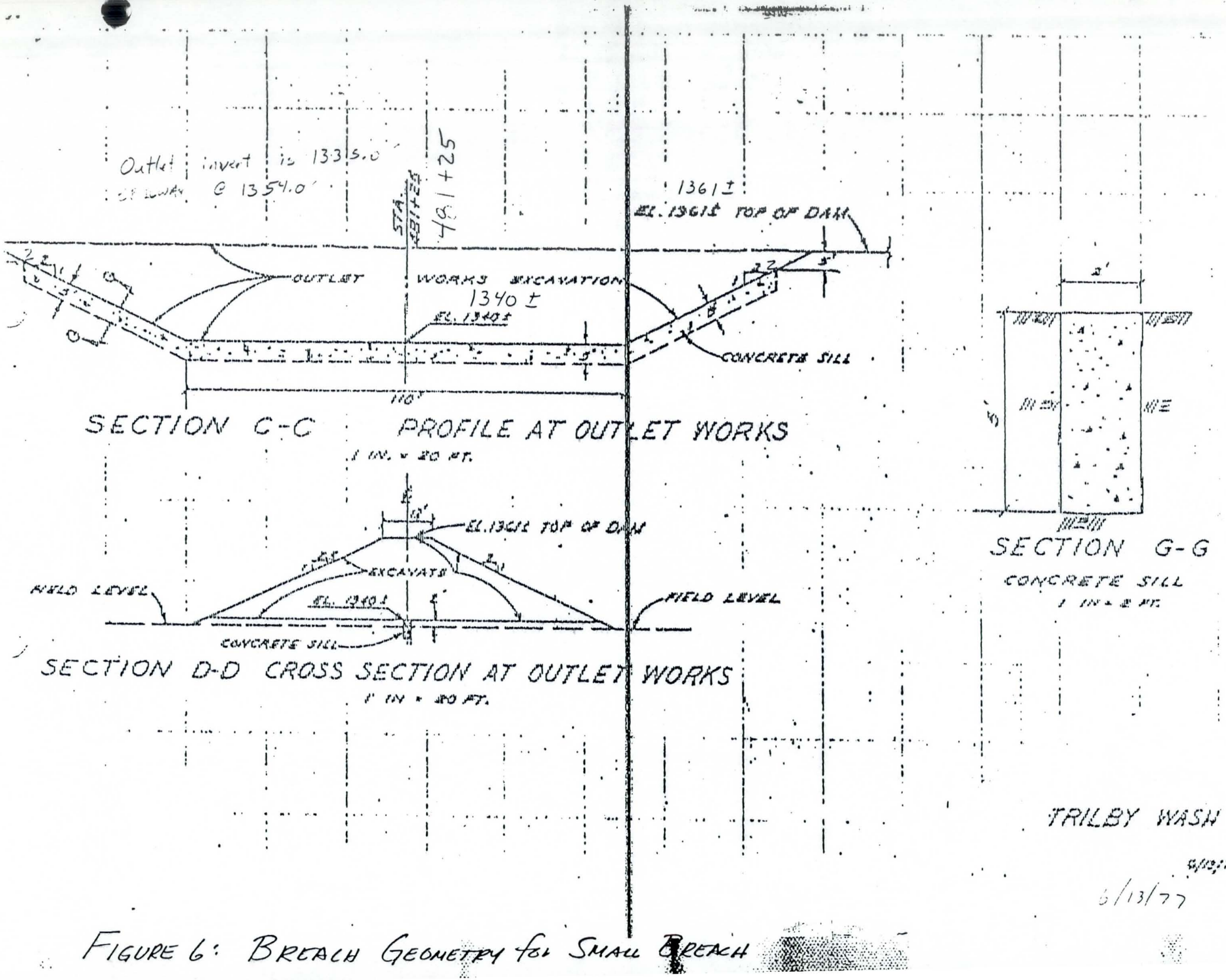


FIGURE 6: BREACH GEOMETRY for SMALL BREACH