Technical Reclamation Memorandum

TRM # 2

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Division of Reclamation Services

Kentucky Department for Surface Mining Reclamation and Enforcement

Subject: Design of New Sediment Ponds Under Permanent Program Regulations

The Department for Surface Mining Reclamation and Enforcement has received numerous questions from professionals involved in the design of existing and new sediment ponds to meet permanent program requirements. Professionals contacting the department have requested general information on recommended procedures for the hydrologic design of existing and new structures and, more specifically, on recommended procedures for demonstrating that a sediment pond will meet EPA suspended and settleable solids effluent limitations.

The purpose of this technical memorandum is to provide recommendations for addressing those hydrologic provisions of the permanent program regulations which determine the size (height and storage volume) of new sediment ponds. Subsequent technical memorandums which the department plans to release in the near future will (1) address this subject for existing sediment ponds and (2) provide recommendations for the design of single spillway ponds.

Permanent program regulatory hydrologic requirements which control the size of sediment ponds include (1) sediment storage volume; (2) detention time needed to meet effluent limitations; (3) principal and emergency spillway requirements; (4) final height or top of embankment criteria; and (5) cumulative impact assessment flood control considerations. A summary of these sediment pond sizing requirements as they pertain to Class A, low hazard structures is provided below:

(1) Sediment storage volume - A minimum sediment storage volume of 0.125 acre-feet per acre disturbed within the upstream drainage shall be provided.

(2) Detention time - Sufficient detention time shall be provided such that all discharges from the pond meet applicable EPA effluent limitations.

(3) Principal and Emergency Spillways - (a) There shall be no outflow through an emergency spillway during the passage of the runoff resulting from the 10-year, 24-hour precipitation event; (b) an appropriate combination of principal and emergency spillways shall be provided to safely discharge the runoff from a 25-year, 24-hour precipitation event or if the embankment is more than 20 feet in height (measured from the upstream toe to the crest of the emergency spillway) or has a storage volume of 20 acre-feet or more (measured at the crest of the emergency spillway), an appropriate combination of principal and emergency spillways shall be provided to safely

discharge the runoff resulting from the 100-year, 24-hour precipitation event; and (c) the elevation of the crest of the emergency spillway shall be a minimum of 1.5 feet above the crest of the principal spillway.

(4) Top of embankment - (a) The minimum elevation at the top of the settled embankment shall be 1.0 foot above the water surface in the pond with the emergency spillway flowing at design depth; and (b) the constructed height of the dam shall be increased a minimum of 5 percent over the design height to allow for settlement.

(5) Cumulative impact assessment flood control - At the location of the most downstream sediment pond, provide sufficient flood control (diversion ditches, terraces, and upstream sediment ponds should be considered in conjunction with the most downstream sediment pond) such that the peak discharge resulting from the 25-year, 24-hour storm for a "worst case" active mining watershed condition is less than or equal to the 25-year, 24-hour peak discharge for the pre-mining watershed condition.

On October 13, 1982, the U.S. Environmental Protection Agency published new final effluent limitations for the coal mining point source category which will become effective on November 26, 1982. These effluent limitations are summarized in Table 1. The major difference between the existing effluent limitations and new effluent limitations with respect to pond sizing is the imposition of a settleable solids limitation of 0.5 ml/l which is applicable to discharges resulting from a precipitation event less than or equal to the 10-year, 24-hour storm. Consequently, the design of sediment ponds under the new effluent limitations will require for surface disturbed areas during the period of active mining that sufficient volume be provided above the sediment storage pool to meet (1) the 70 mg/l maximum and 35 mg/l average suspended solids limitation for base flow conditions and (2) the 0.5 ml/l settleable solids effluent limitation for the 10-year, 24-hour precipitation event.

At the present time, the department is recommending that the DEPOSITS or SEDIMOT II computer programs developed by the University of Kentucky, Department of Agricultural Engineering, be used for the design of sediment ponds to meet the settleable solids effluent limitation. DEPOSITS simulates the removal of suspended and settleable solids by sediment ponds, and SEDIMOT II determines sediment loads generated by disturbed watersheds in addition to simulating the performance of sediment ponds and other sediment trapping facilities. SEDIMOT II contains a slightly modified version of DEPOSITS as one of the program modules. DEPOSITS and SEDIMOT II have the capability to model the performance of disturbed watersheds and sediment ponds in a more complete manner than other design techniques which are generally available to professionals preparing permit applications.

TABLE 1

SUMMARY OF EPA EFFLUENT LIMITATIONS FOR THE COAL MINING POINT SOURCE CATEGORY
40 CFR 434 FINAL RULES, EFFECTIVE NOVEMBER 26, 1982

APPLICABLE TIME PERIOD AND/OR TYPE OF OPERATION	EFFLUENT LIMITATIONS(1) Fe	Mn	TSS	SS	pH	Category(2)
Coal Preparation Plants	No Discharge except occasionally to reduce solids					NSPS
Coal Preparation Plant Associated Areas	6.0/3.0	4.0/2.0	70/35	-	6-9	NSPS
Coal Preparation Plants and Associated Areas	7.0/3.5(3)	4.0/2.0(4)	70/35	-	6-9	BPT
Active Mining						
Surface Disturbance and Underground Workings	6.0/3.0	4.0/2.0(5)	70/35	-	6-9	NSPS
Surface Disturbance and Underground Workings	7.0/3.5	4.0/2.0(5)	70/35	-	6-9	BPT
Post-mining (Reclamation)						
Surface Disturbance	-	-	-	0.5	6-9	NSPS, BPT
Underground Workings	6.0/3.0	4.0/2.0(5)	70/35	-	6-9	NSPS
Underground Workings	7.0/3.5	4.0/2.0(5)	70/35	-	6-9	BPT
Discharge Resulting from Precipitation 10-Year, 24-Hour Storm						
All operations except underground workings	-	-	-	0.5	6-9	NSPS, BPT
Discharge Resulting from Precipitation 10-Year, 24-Hour Storm						
All operations except underground workings	-	-	-	-	6-9	NSPS, BPT
Commingled Discharge						
All operations	Meet the most stringent effluent limitations applicable to any component of the commingled discharge except for storm event discharge for commingled underground working and surface disturbance drainage					

(1) Fe - Total iron (mg/l).
Mn - Total manganese (mg/l).
TSS - Total suspended solids (mg/l).
SS - Settleable solids (ml/l).
pH - Standard pH units.

(2) NSPS - New source performance standards.
BPT - Best practicable control technology currently available.
BAT (Best available technology economically achievable) and
BCT (Best conventional pollutant control technology) effluent limitations are not contained in this table.

(3) 7.0 - maximum concentration for one day; 3.5 - average concentration for 30 consecutive days.

(4) Manganese applicable only if the pH is normally less than 6.0 in the untreated discharge.

(5) Manganese applicable only if the pH is normally less than 6.0 or iron is normally equal to or greater than 10 mg/l.

Even though DEPOSITS and SEDIMOT II are currently recommended for sediment pond design, the department recognizes that some professional personnel preparing permit applications (1) will not yet have sufficient training and background to use the DEPOSITS or SEDIMOT II models, (2) will not find it possible to load these programs on their own computer or to access the programs at other computer facilities, or (3) will have other design methods which they prefer to use. In consideration of these factors, the department will accept other appropriate techniques for designing sediment ponds to meet the settleable solids limitation. However, the department does consider that the DEPOSITS and SEDIMOT II models employ the best available analytic techniques for simulating surface mine hydrologic and hydraulic relationships and other methodologies will generally be evaluated in comparison to DEPOSITS and SEDIMOT II. In the future, the department plans to investigate and provide recommendations for other sediment pond design techniques which are less complex than the DEPOSITS or SEDIMOT II models and will provide comparable sediment pond designs.

In designing new, Class A, low hazard sediment ponds to meet the settleable solids effluent limitation and the other sizing requirements contained in the permanent program regulations, the department recommends that the applicant consider the following design procedure:

(1) Determine the surface area to be disturbed by the proposed operation and the sediment pond volume required to store 0.125 acre-feet of sediment per acre disturbed.

(2) Assume that the sediment storage volume determined in (1) above does not provide detention time for the removal of settleable solids (i.e. assume the sediment pool is full of sediment) and determine an appropriate principal spillway height and size which will meet the 0.5 ml/l settleable solids effluent limitation at the 10-year, 24-hour storm for a "worst-case" disturbed watershed condition.

(3) Set the elevation of the emergency spillway at the maximum water surface elevation for the 10-year, 24-hour storm as established in (2) above, or if the maximum water surface elevation is less that 1.5 feet above the elevation of the crest of the principal spillway, set the emergency spillway elevation 1.5 feet above the principal spillway crest elevation.

(4) If the elevation of the crest of the emergency spillway is less than or equal to 20 feet above the upstream toe of the embankment and the storage volume is less than or equal to 20 acre-feet, design the emergency spillway (considering discharge through the principal spillway and available storage capacity) to pass the 25-year, 24-hour storm. If the embankment elevation is greater than 20 feet in height or the storage volume is greater than 20 acre-feet, design the emergency spillway to pass the 100-year, 24-hour storm.

(5) If the sediment pond under consideration is the most downstream pond in the watershed, determine the 25-year, 24-hour peak discharge for the pre-mining watershed condition and compare the 25-year, 24-hour peak discharge from the sediment pond with the pre-mining peak discharge. If the 25-year, 24-hour peak discharge from the sediment pond is greater than the pre-mining peak discharge, modify the pond design so that the 25-year, 24-hour peak discharge from the pond for the active mining watershed condition is less than or equal to the pre-mining 25-year, 24-hour peak discharge.

(6) Add 1 foot to the appropriate emergency spillway water surface elevation (25-year, 24-hour or 100-year, 24-hour storm) to determine the final design height of the embankment. Increase the final design height by 5% to account for settlement.

The following material presents two design examples using the above recommended procedures. The two examples assume the same upstream watershed conditions (drainage area, disturbed area, curve number, etc.) but assume two different locations for the sediment ponds. The first sediment pond location produces a proportionately greater storage volume for comparable pool depths than the second pond location. Consequently, all other factors being equal, the first location would be considered more desirable for the construction of a sediment pond than the second location. Physical characteristics of the common watershed for the two sediment structures are provided in Table 2. Stage-area-storage curves and the influent sediment size distribution are contained in Figures 1 and 2, respectively.

Design of the sediment ponds to meet the 0.5 ml/l settleable solids effluent limitation was accomplished with the DEPOSITS model. Conversion of the DEPOSITS maximum effluent concentration in milligrams per liter to milliliters per liter was accomplished with the conversion routine used in SEDIMOT II. A summary of pertinent design information for each structure is provided in Table 3. The elevations of the sediment pool, principal spillway crest, emergency spillway crest, and top of the unsettled embankment are marked on Figure 1 for each structure.

The heights of structure #1 and structure #2 at the emergency spillway crest were 19.8 feet and 34.0 feet, respectively. Since structure #2 exceeded 20 feet, it was necessary to design the principal and emergency spillway for the 100-year, 24-hour storm.

For structure #1, a depth of 11.0 feet was required for sediment storage, the riser was set 6.0 feet above the sediment pool, and the maximum head on the riser was 2.1 feet for the 10-year, 24-hour routed storm. The maximum settleable solids effluent concentration was 0.36 ml/l.

For structure #2, a depth of 15.5 feet was required for sediment storage, the riser was set 14.5 feet above the sediment pool, and the maximum head on the riser was 2.2 feet for the 10-year, 24-hour routed storm. The maximum settleable solids effluent concentration was 0.48 ml/l.

For both structures, large riser diameters (48 and 42 inches) were used to minimize the increase in stage above the riser for the 10-year, 24-hour storm. This allowed use of the "top withdrawal" option in the DEPOSITS program.

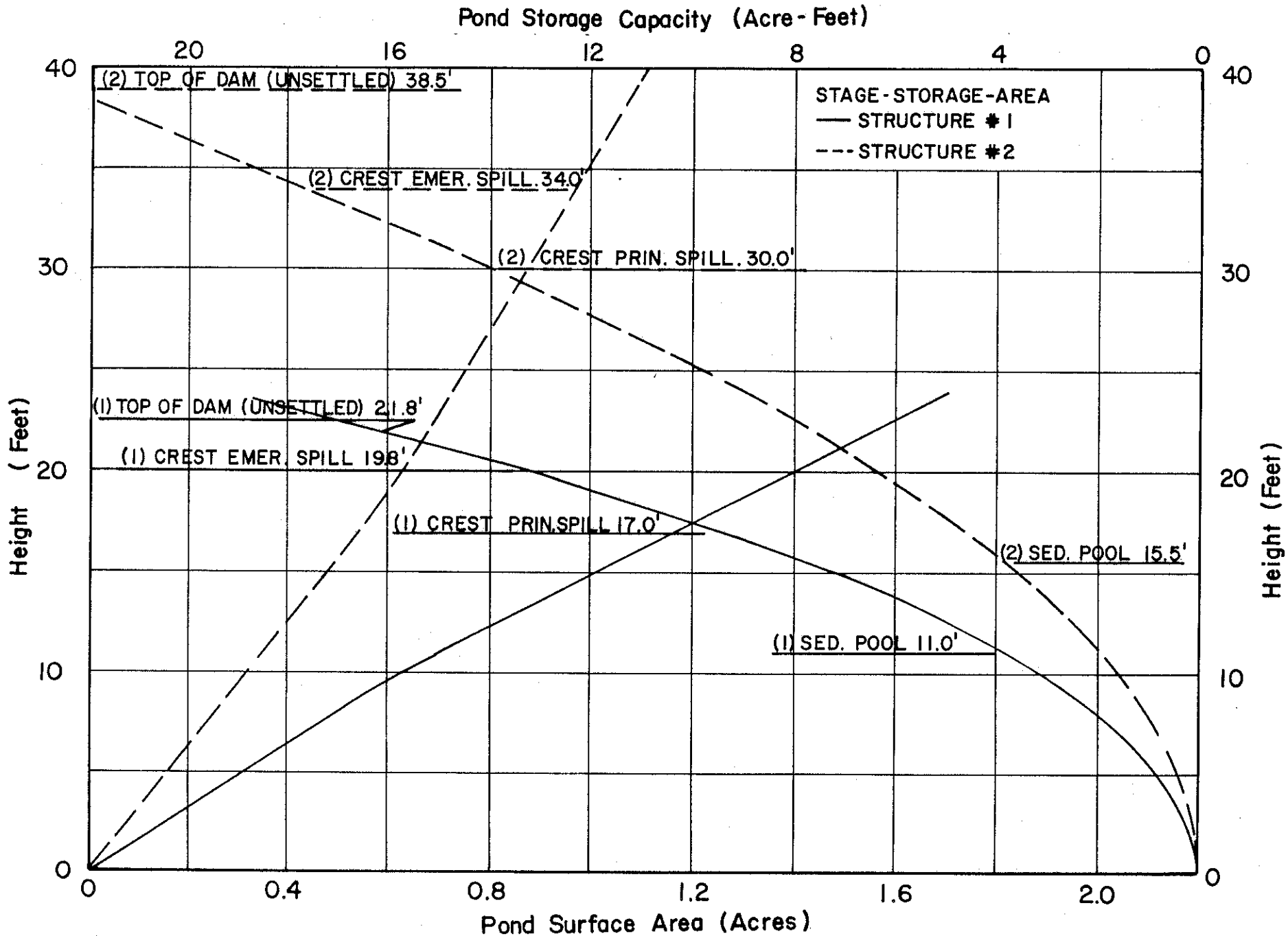
It was necessary to provide a small amount of additional storage for both structures to limit the active mining 25-year, 24-hour peak flow to a discharge which was less than or equal to the pre-mining 25-year, 24-hour peak flow (179 cfs). For structure #1, the emergency spillway was raised from 19.1 to 19.8 feet which produced a maximum 25-year discharge of 163 cfs. For structure #2, the emergency spillway was raised from 32.2 to 34.0 feet and the riser diameter was decreased from 48 to 42 inches which produced a maximum 25-year discharge of 157 cfs.

TABLE 2
SUMMARY OF WATERSHED PHYSICAL CHARACTERISTICS

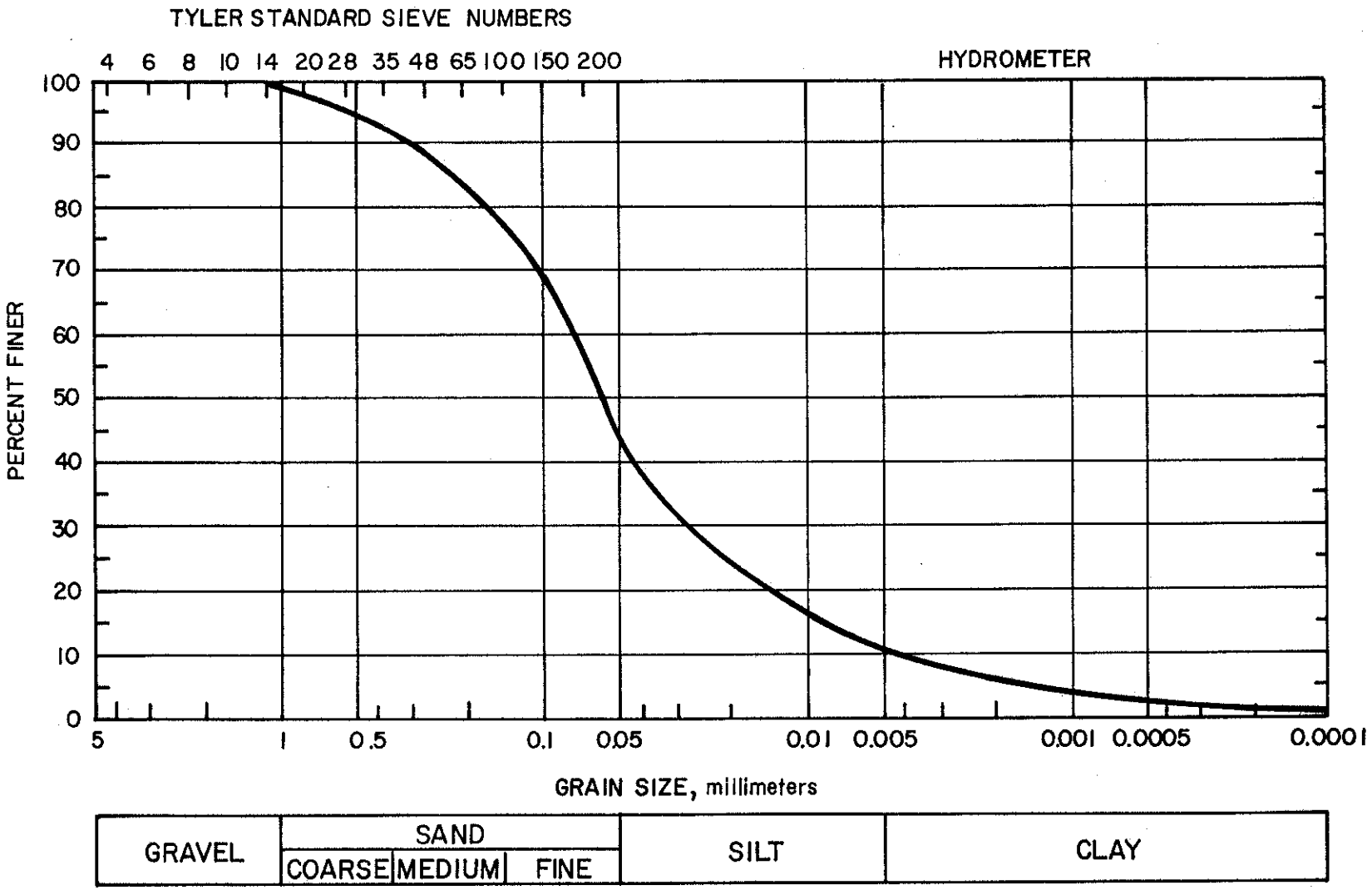
Drainage Area (ac)	155
Disturbed Area (ac)	31
SCS Curve Number, Undisturbed	63
25-Year, 24-Hour Peak Inflow, Undisturbed (cfs)	179
SCS Curve Number, Disturbed	68
10-Year, 24-Hour Peak Inflow, Disturbed (cfs)	189
25-Year, 24-Hour Peak Inflow, Disturbed (cfs)	256
100-Year, 24-Hour Peak Inflow, Disturbed (cfs)	369
10-Year Influent Sediment Load (tons)	270
10-Year Peak Influent Suspended Solids Concentration (mg/l)	25,100
10-Year Peak Influent Settleable Solids Concentration (ml/l)	23.8

TABLE 3
SUMMARY OF DESIGN INFORMATION

	Structure #1	Structure #2
Volume of Sediment Pool (af)	3.88	3.88
Depth of Sediment Pool (ft)	11.0	15.5
Volume at Principal Spillway (af)	9.38	13.90
Depth at Principal Spillway (ft)	17.0	30.0
Dead Storage (%)	25	25
Volume at 10-Year Peak Stage (af)	11.99	16.12
Depth at 10-Year Peak Stage (ft)	19.1	32.5
Settleable Solids Concentration (ml/l)	0.36	0.48
Surface Area at 10-Year Peak Stage (ac)	1.33	0.92
Riser Diameter (in)	48	42
Volume at Emergency Spillway (af)	12.94	17.55
Depth at Emergency Spillway (ft)	19.8	34.0
Peak Discharge 10-Year Storm (cfs)	140	131
Peak Discharge 25-Year Storm (cfs)	163	157
Peak Discharge 100-Year Storm (cfs)	-	257
Top of Unsettled Embankment (ft)	21.8	38.5


Pond Storage Capacity (Acre-Feet)
20
16
12
8
4
0
40
30
20
10
0
(2) TOP OF DAM (UNSETTLED) 38.5'
(2) CREST EMER. SPILL. 34.0'
(2) CREST PRIN. SPILL. 30.0'
(1) TOP OF DAM (UNSETTLED) 21.8'
(1) CREST EMER. SPILL 19.8'
(1) CREST PRIN.SPILL 17.0'
(2) SED. POOL 15.5'
(1) SED. POOL 11.0'
STAGE-STORAGE-AREA
STRUCTURE #1
STRUCTURE #2
Height (Feet)
Height (Feet)
0
0.4
0.8
1.2
1.6
2.0
Pond Surface Area (Acres)

RE 1



PARTICLE SIZE DISTRIBUTION OF INFLUENT

FIGURE 2