Technical Reclamation Memorandum

TRM # 8

Kentucky Department for Surface Mining Reclamation and Enforcement

Date: January 31, 1983

From: William C. Eddins, Director
Division of Reclamation Services

Subject: Existing Structures-Supplement to TRM #1

The purpose of this TRM is to supplement TRM #1 by:

1) Providing additional guidance for preparing permit applications for existing structures in general, and

2) Providing additional guidance for preparing demonstrations of compliance with the settleable solids effluent limitation and cumulative impact assessment flood control criteria for existing sedimentation ponds.

Existing Structures - General

The department recently modified the definition of the term "existing structures" during the regular rulemaking process. The definition now reads:

> "Existing structure" means a structure or facility used in connection with or to facilitate surface coal mining and reclamation operations, for which construction begins prior to January 18, 1983 (405 KAR 7:020, Section 1(34)).

Construction will not be considered as having begun unless substantial portions of the structure itself have been constructed. Clearing, grubbing, and foundation preparation alone does not constitute construction of a portion of the structure.

The comprehensive permit application must include only those existing structures which will be used in connection with or to facilitate operations conducted under the permanent program permit. Therefore, any existing structure which will be used in connection with active mining areas (as opposed to areas that are in some stage of reclamation) on or after the time of the permit walk (when the application is judged to be ready for technical review) must be included in the comprehensive permit application and the applicant must include all required information for such structures.

The following information must be submitted for each existing structure:

1. As-built plans indicating the structure's current condition or stage of construction. Such plans must be certified using the certification language required for maps, plans and drawings (RAM #37).

2. Approximate dates of construction, including dates construction began and ended.

3. Structure location on the mining and reclamation plan map. Mining status lines must be drawn on the map indicating the status of the mining operation as of (1) January 18, 1983 and (2) the ready for technical review date.

4. Compliance demonstration according to TRM #1 and this TRM.

5. Compliance plan. If the structure does not comply with the permanent program performance standards, the application must include a compliance plan in accordance with the provisions of 405 KAR 8:030, Section 25(2) or 405 KAR 8:040, Section 25(2).

Existing Sedimentation Ponds - Effluent Limitations and Flood Control

There are two categories of performance standards that apply to sedimentation ponds: 1) those related to compliance with effluent limitations and 2) those related to safety (hydraulic capacity and structural stability). This TRM supplements information provided in TRM #1 for compliance demonstrations related to effluent limitations. Refer to TRM #1, pages 4 and 5 for guidance on compliance demonstrations related to safety.

TRM #1 recommends alternatives for demonstrating that existing ponds can meet the settleable solids effluent limitation of 0.5 ml/l for the 10-year, 24-hour storm. One of the suggested alternatives is to use the SEDIMOT II or DEPOSITS computer program to predict the performance of a pond for the 10-year storm event. If an existing pond will not meet the settleable soilds limitation, the SEDIMOT II model provides the design professional with flexiblity to consider other sediment control measures (diversions, revegetation, small detention basins, rock check dams, ponds in series, etc.) which can be used in addition to or in place of modifying an existing structure. In many cases, the use of alternative sediment control measures may be preferable to modifying an existing structure.

Because the SEDIMOT II computer model provides engineers with a design tool which can be used to efficiently evaluate various alternative sediment control plans and thereby produce a cost-effective design tailored to an individual operation, SEDIMOT II continues to be the department's recommended technique for evaluating existing ponds and designing new sediment ponds. However, because many engineers have not yet had an opportunity to learn how to use SEDIMOT II, do not have access to SEDIMOT II, or are not normally involved in design situations which require the capabilities of SEDIMOT II, the department is currently developing simplified design procedures which can be used in lieu of DEPOSITS or SEDIMOT II for both existing and new sediment pond design. The simplified design procedures will likely produce conservative pond designs but should be capable of considering some of the major input variables associated with pond design and be applicable to relatively simple watershed and pond configurations.

A second alternative mentioned in TRM #1 for demonstrating that an existing pond will meet the settleable solids effluent limitation involves the use of suspended and settleable solids monitoring data in combination with suitable extrapolation techniques to provide a prediction of pond performance at the 10-year storm level. The department has received numerous requests to provide explanation in addition to that contained in TRM #1 for analyzing monitoring data. The following material is furnished in fulfillment of those requests. The department intends that the methodology for using monitoring data be applied to existing ponds only and not be extended in any way to include the design of new sediment ponds. The following basic techniques can be used when analyzing monitoring data:

(1) Assemble existing suspended or settleable solids monitoring data and associated discharge measurements and convert existing suspended solids concentrations to settleable solids concentrations.

(2) If sufficient existing data is not available, perform additional data collection to develop an adequate settleable solids and discharge data base for making a prediction of pond performance at the 10-year storm level.

(3) Extrapolate the settleable solids concentrations to the 10-year, 24-hour storm discharge and compare the concentration with the 0.5 ml/l effluent limitation.

(4) If the extrapolated concentration exceeds 0.5 ml/l, provide additional sediment control in the watershed or upgrade the pond to meet the settleable solids limitation.

Applicants should realize that the above technique using monitoring data provides no guarantee that the concentration determined through the extrapolation procedure will be equal to or less than 0.5 ml/l. If the concentration is greater than 0.5 ml/l, the applicant will be faced with a design situation in which additional sediment control must be provided. In this case, the monitoring data base will provide little direct information which can be used in designing sediment control measures to meet the effluent limitation. As previously discussed, the department is currently developing a simplified design procedure which can be used in lieu of DEPOSITS or SEDIMOT II to design sediment ponds for relatively simple watershed and pond configurations. This simplified design procedure should be of assistance in determining certain watershed sediment control measures or sediment pond modifications which can be used with existing ponds to meet the settleable solids effluent limitation.

The following material provides a more detailed description of the department's recommended procedure for using monitoring data.

Use of existing data

Operations which have existing suspended solids data or settleable solids data and accompanying discharge measurements collected under the NPDES self-monitoring program may use the data to analyze pond performance. The self-monitoring data should be relatively recent and be representative of the watershed condition as it is expected to exist under the permanent program permit. Use of existing suspended solids data in units of mg/l requires that the data first be converted to settleable solids in ml/l. This conversion requires that the particle size distribution of the sample be known to determine the fraction of suspended solids which are actually in the settleable solids range. If the size distribution of the sample is not known, a conservative estimate (high settleable solids) of the settleable solids concentration can be made by assuming that all particle sizes are in the settleable size range. Using this assumption, the suspended solids concentration in mg/l can be divided by 1250 mg/ml to determine the settleable solids concentration.

A more accurate suspended solids to settleable solids conversion can be obtained for existing data by performing additional sampling and determining a representative particle size distribution for the sediment pond. The representative particle size distribution can be applied to existing suspended solids data to determine settleable solids. To be representative of the entire range of suspended solids data, the particle size distribution should be determined from a sample which was collected at a discharge above the average discharge for all samples. Additional information on the suspended solids to settleable solids conversion technique is provided in the next section.

Applicants should have a minimum of 4 to 6 samples and associated discharge measurements which cover a reasonable flow range to make an extrapolation to the 10-year storm level. The flow range covered by the samples is more important than the number of samples in making an extrapolation. For example, a large number of samples collected at base flow may provide no basis for making an extrapolation, whereas only 4 samples covering a wide range in flow may be quite adequate. The adequacy of the data and extrapolation will be determined on a case-by-case basis during permit review. Enforcement data collected by the department's inspectors will be used to review the adequacy of the data and analysis submitted by the applicant.

Collection of new data

In those cases where insufficient suspended solids, settleable solids, or flow data are available, the applicant may collect additional settleable solids and discharge information to predict pond performance. Applicants having a Priority 1 code may continue to collect new data for compliance demonstrations (Item 27.2 in the comprehensive application) beyond the date for submitting the technical information (March 1, 1983). In such cases, the application will be technically withdrawn until the data and analysis are submitted. However, applicants with a Priority 1 code should submit the new data and analysis by May 1, 1983. Applicants with other priority codes must submit all data and analysis by the required date for submitting the technical information.

Since the Imhoff Cone settleable solids test is not accurate in the 0 to 0.4 ml/l range (the detection limit is 0.4 ml/l) it will not generally be possible for applicants to directly measure settleable solids for use in extrapolating settleable solids concentrations to the 10-year storm level. This problem can be circumvented by determining total suspended solids and the particle size distribution for each sample. With the particle size distribution known, the settleable solids concentration can be calculated from the equation:

$$SS = \frac{C}{W} \left[(1 - X_o) + \sum_{i=1}^{X_o} k \, {V_{si}}^3 \, \Delta X_i \right]$$

where SS is the settleable solids concentration in ml/l, C is the total suspended solids concentration in mg/l, W is the dry bulk density of the solids (1250 mg/ml), X_o is the fraction of particles with a diameter less than 0.011 mm (assuming a water temperature of 68°F), k is a constant equal to 2.135×10^{10} sec^3/ft^3, V_{si} is the particle settling velocity in ft/sec for a particle diameter d_i, and ΔX_i is the fraction of particles represented by a particle diameter d_i.

The particle settling velocity can be calculated from Stoke's Law:

$$V_{si} = 2.81 \, d_i^2$$

where V_{si} is the particle settling velocity in ft/sec at a water temperature of 68°F, and d_i is the representative particle diameter in mm.

A discussion of the derivation of the above equation and an example calculation can be found in Applied Hydrology and Sedimentology for Disturbed Areas by Barfield, Warner, and Haan. An example conversion calculation is also provided in the Appendix of this TRM.

Applicants can measure pond effluent discharge using conventional discharge measuring techniques or use stage-discharge ratings for the principal and emergency spillway. By measuring the water surface elevation above the principal or emergency spillway at the time a sample is taken, a discharge estimate can easily be obtained from spillway stage-discharge relationships. Applicants may develop stage-discharge ratings for their specific structures or use general stage-discharge relationships developed by the department. The department's rating curves covering common types and sizes of spillways will be released in a future TRM.

To measure stage in the pond, the department suggests that simple staff gages (stake of wood or other suitable material marked in feet and tenths of feet) be installed for the principal and emergency spillway. The "zero point" of the staff gage should be located at the crest or invert of the spillway. Locating the "zero point" of a staff gage at the crest or invert of a principal spillway could be accomplished simply by installing the gage at the pond water surface elevation when the water surface is near the crest of the riser or invert of the "trickle tube." This technique uses the pond water surface as a means of leveling the staff gage with the principal spillway crest or invert. Although one staff gage can be used to provide water surface elevations for both the principal and emergency spillway (the elevation difference between the principal and emergency must be known), it may be desirable in some cases to install a separate staff gage in the emergency spillway with the "zero point" located at the crest of the spillway.

Applicants should have a minimum of 4 to 6 samples and associated discharge measurements collected from separate storm events and covering a reasonable flow range. Data collection should occur at the peak discharge or as near the peak discharge as practical. Settleable solids samples collected on the low end of the rising or recession hydrograph (several hours before or after the maximum discharge has occurred) may not be representative of pond performance.

Analysis of data

Concurrent settleable solids concentrations and discharge values should be plotted on log-log graph paper to determine if a reasonable correlation exists for the data. If the discharge values do not cover a reasonable flow range, the sample values were not obtained within a reasonable time surrounding the peak discharge, or other problems occurred, the data may not be suitable for making a prediction of settleable solids concentrations at the 10-year storm level.

If the correlation between discharge and settleable solids concentration appears adequate, a best fit line should be drawn through the plotted data and extended to the 10-year, 24-hour routed peak discharge. Applicants may calculate an inflow hydrograph and perform the pond routing themselves to determine the 10-year peak discharge or use graphical procedures furnished by the department. The department is currently developing approximate graphical procedures for common spillway types and sizes which will allow applicants to determine a routed 10-year, 24-hour peak discharge for existing sediment ponds. The graphical routing procedures will be furnished in a future TRM.

Examples

Two example mine operations have been included to illustrate use of the above discussed analysis technique. Operation A has a total drainage area of 79 acres with a disturbed area of 30 acres. Operation B has a total drainage area of 30 acres with a disturbed area of 30 acres. The same pond stage-storage relationship was used with each of the example operations.

Both sediment ponds were designed with the permanent pool elevation (crest of the principal spillway) set at 0.125 acre-feet per acre of the disturbed area and a permanent sediment storage volume of 60 percent of the permanent pool. The riser and conduit diameter were 30 inches and 18 inches, respectively, for Operation A, and 18 inches and 12 inches, respectively, for Operation B. Both ponds were designed with the emergency spillway set 2.0 feet above the principal spillway. This pond design was selected because information obtained by the department indicates that many sediment ponds constructed under the interim program were sized in a similar manner. The data sets for each operation including discharge estimates, suspended solids, particle size distributions, and settleable solids are contained in Table 1 and Table 2, respectively.

TABLE 1

Operation A Example Data Set

			Size Distribution % Finer					
			Particle Size (mm)					
Date	Discharge (cfs)	Suspended Solids (mg/l)	.02	.01	.005	.003	.001	Settleable Solids ml/l
2/2/83	10.4	25800	100	100	84.6	54.7	18.0	0.28
2/11/83	2.73	9700	100	100	100.	76.4	25.3	0.004
2/21/83	9.26	17400	100	100	89.3	57.7	19.0	0.105
3/8/83	2.86	17100	100	100	92.6	59.8	19.8	0.046
3/17/83	8.97	17400	100	100	97.1	62.7	20.7	0.014
3/28/83	6.98	14900	100	100	100.	66.4	22.0	0.009

TABLE 2

Operation B Example Data Set

			Size Distribution % Finer					
			Particle Size (mm)					
Date	Discharge (cfs)	Suspended Solids (mg/l)	.02	.01	.005	.003	.001	Settleable Solids ml/l
2/2/83	0.64	11500	100	100	100	93.2	31.1	0.0009
2/11/83	2.15	11900	100	100	100	91.0	30.3	0.002
2/21/83	3.82	16100	100	100	100	82.7	27.6	0.005
3/8/83	1.91	28400	100	100	100	73.3	24.4	0.014
3/17/83	5.06	34200	100	100	100	69.7	23.2	0.019
3/28/83	5.17	47200	100	100	100	65.7	21.9	0.030

The six samples from each of the data sets are plotted in Figures 1 and 2. Both data sets cover a reasonable flow range and demonstrate reasonable correlation between settleable solids and discharge. Extrapolation of the data to the 10-year, 24-hour discharge shows that Operation A would exceed the 0.5 ml/l effluent limitations at the 10-year, 24-hour storm (Figure 1) while Operation B would meet the effluent limitation with a predicted concentration of 0.38 ml/l (Figure 2). Thus, Operation B has demonstrated that the existing sediment control facilities are adequate to meet the settleable solids effluent limitation while Operation A would need to provide additional sediment control.

Cumulative impact assessment flood control

Since many watersheds in which existing sediment ponds are located already contain a significant percentage of disturbed area, it will not be necessary for applicants to demonstrate that the active mining 25-year, 24-hour peak discharge will be equal to or less than the pre-mining (pre-permanent program) 25-year, 24-hour peak discharge for existing ponds (See Article 3.2.1.2 of the Hydrology and Geology Guidelines for the Permanent Regulatory Program).

Due to ongoing reclamation which will take place in most watersheds disturbed by existing operations, the hydrologic condition of the watershed should improve under a permanent program permit and thus produce less runoff than the pre-permanent program condition. Consequently, on a cumulative basis, existing disturbed watersheds should not produce increases in peak discharge and it will not be necessary for applicants to demonstrate that an existing pond will meet the cumulative impact assessment flood control criteria.

Any questions concerning the submission requirements for existing structures should be directed to the Division of Permits. A Division of Permits task force has been assigned to provide consistency in response to these questions. Contact persons within the Division of Permits are Keith Crim, Jim Wade and Bob Salyers. Questions should be directed to one of these three persons or to the Director or Assistant Director of the Division of Permits.

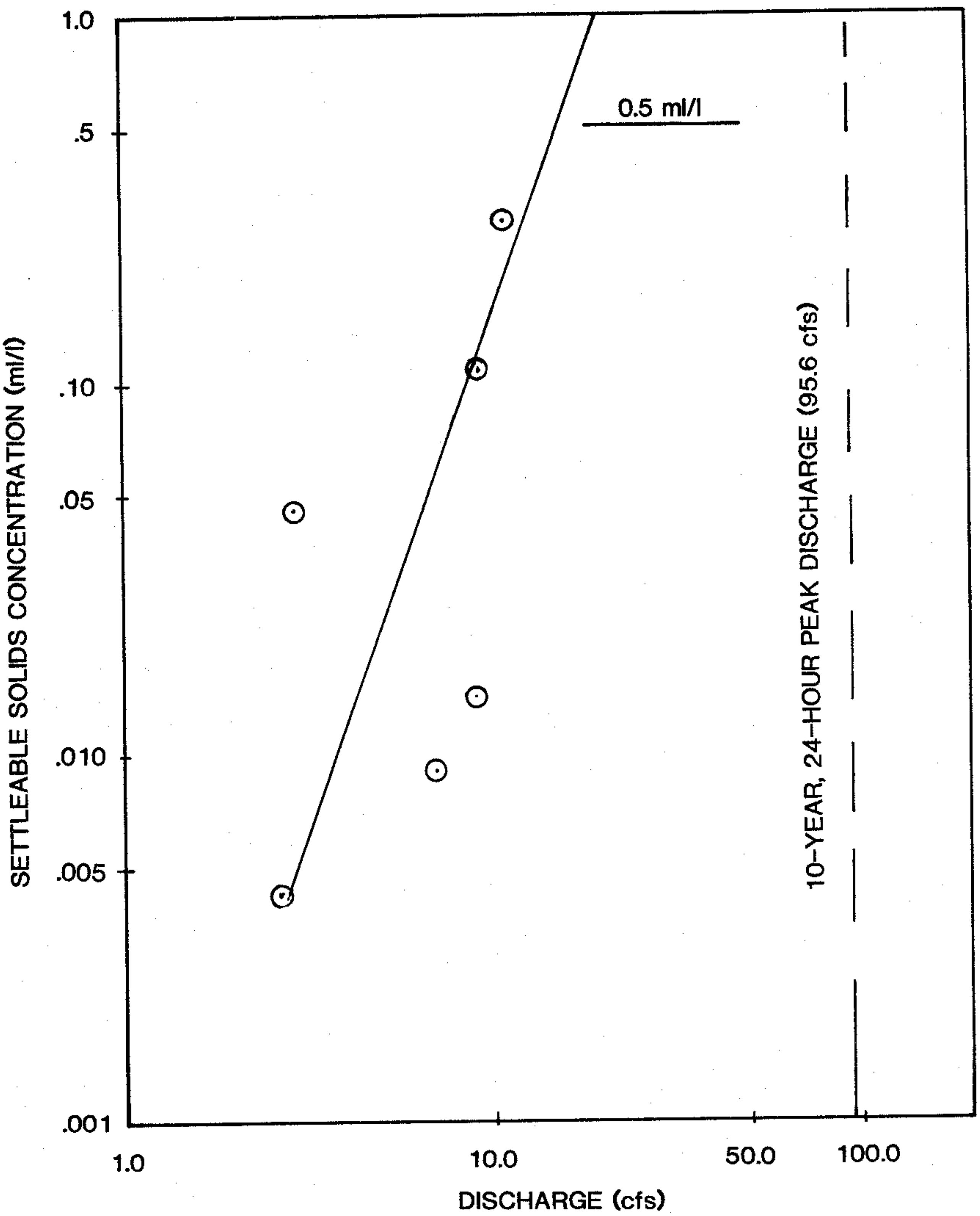

Figure 1 Discharge - Settleable Solids Extrapolation for Operation A.

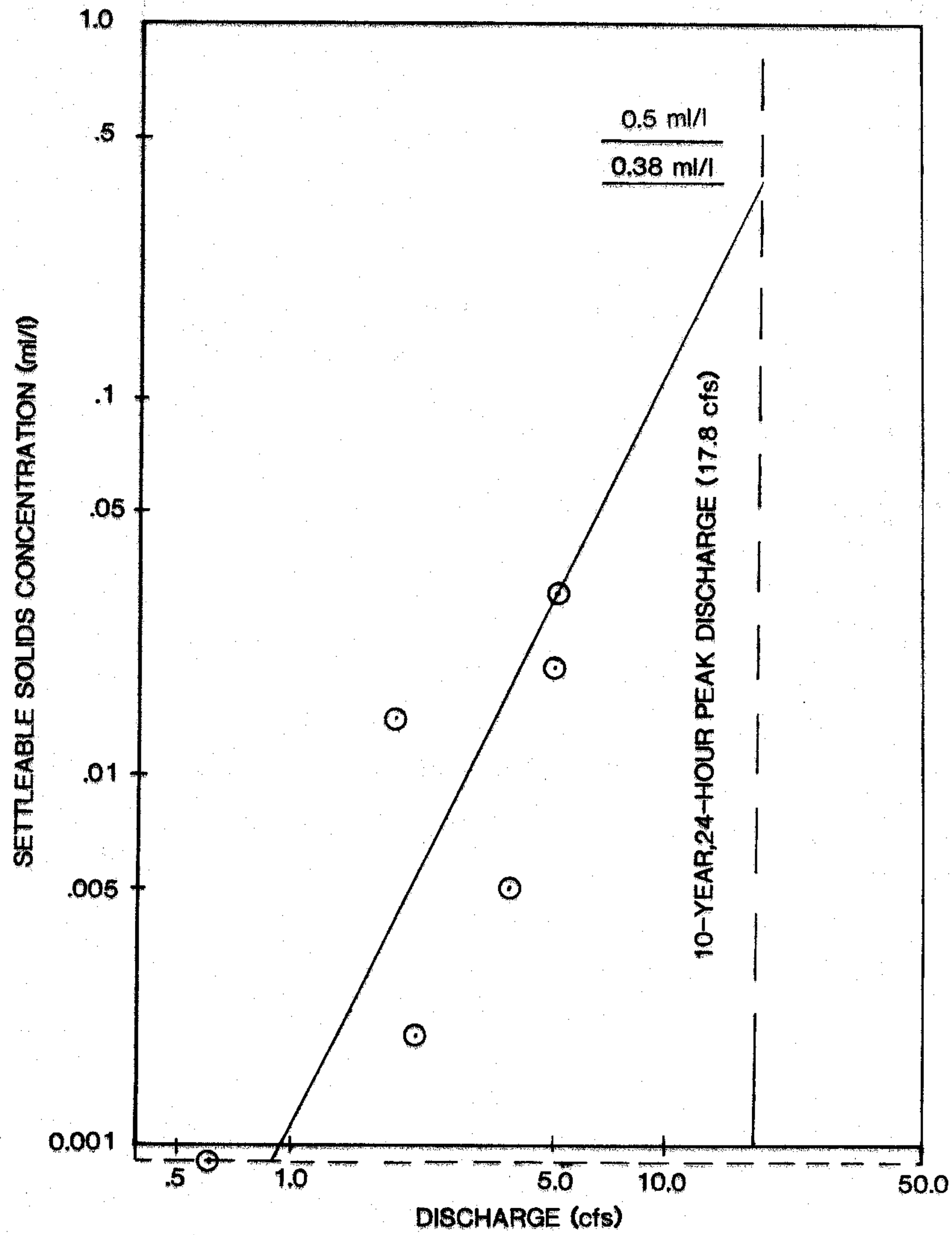

Figure 2 Discharge - Settleable Solids Extrapolation for Operation B.

APPENDIX

Example Settleable Solids Calculation

The example calculation is for the Operation A sample dated 3/17/83 with a suspended solids concentration of 17400 mg/l. The size distribution was separated into equal fractional intervals of 10 percent (ΔX_i = .10) as shown in Figure A-1.

Range (mm)	Avg. (mm)	ΔX_i	V_{si}(ft/sec)	$k\ V_{si}^3 \Delta X_i$
< 0.00053	0.0004	0.10	≃0	≃0
0.00053 - 0.00096	0.0007	0.10	1.38×10^{-6}	5.57×10^{-9}
0.00096 - 0.0013	0.0011	0.10	3.40×10^{-6}	8.39×10^{-8}
0.0013 - 0.0018	0.0016	0.10	7.19×10^{-6}	7.95×10^{-7}
0.0018 - 0.0023	0.0021	0.10	1.24×10^{-5}	4.06×10^{-6}
0.0023 - 0.0028	0.0026	0.10	1.90×10^{-5}	1.46×10^{-5}
0.0028 - 0.0033	0.0030	0.10	2.53×10^{-5}	3.45×10^{-5}
0.0033 - 0.0038	0.0035	0.10	3.44×10^{-5}	8.71×10^{-5}
0.0038 - 0.0044	0.0041	0.10	4.72×10^{-5}	2.25×10^{-4}
0.0044 - 0.0052	0.0049	0.10	6.75×10^{-5}	6.56×10^{-4}
		$\Sigma \Delta X_i = 1.00$		$\Sigma k V_{si}^3 \Delta X_i = 1.04 \times 10^{-3}$

$$SS = \frac{C}{W}\left[(1 - X_o) + \sum_{i=1}^{X_o} k\ V_{si}^3 \Delta X_i\right]$$

$$SS = \frac{17400 \text{ mg/l}}{1250 \text{ mg/ml}}\left[(1 - 1.00) + 1.04 \times 10^{-3}\right]$$

$$SS = 0.014 \text{ ml/l}$$

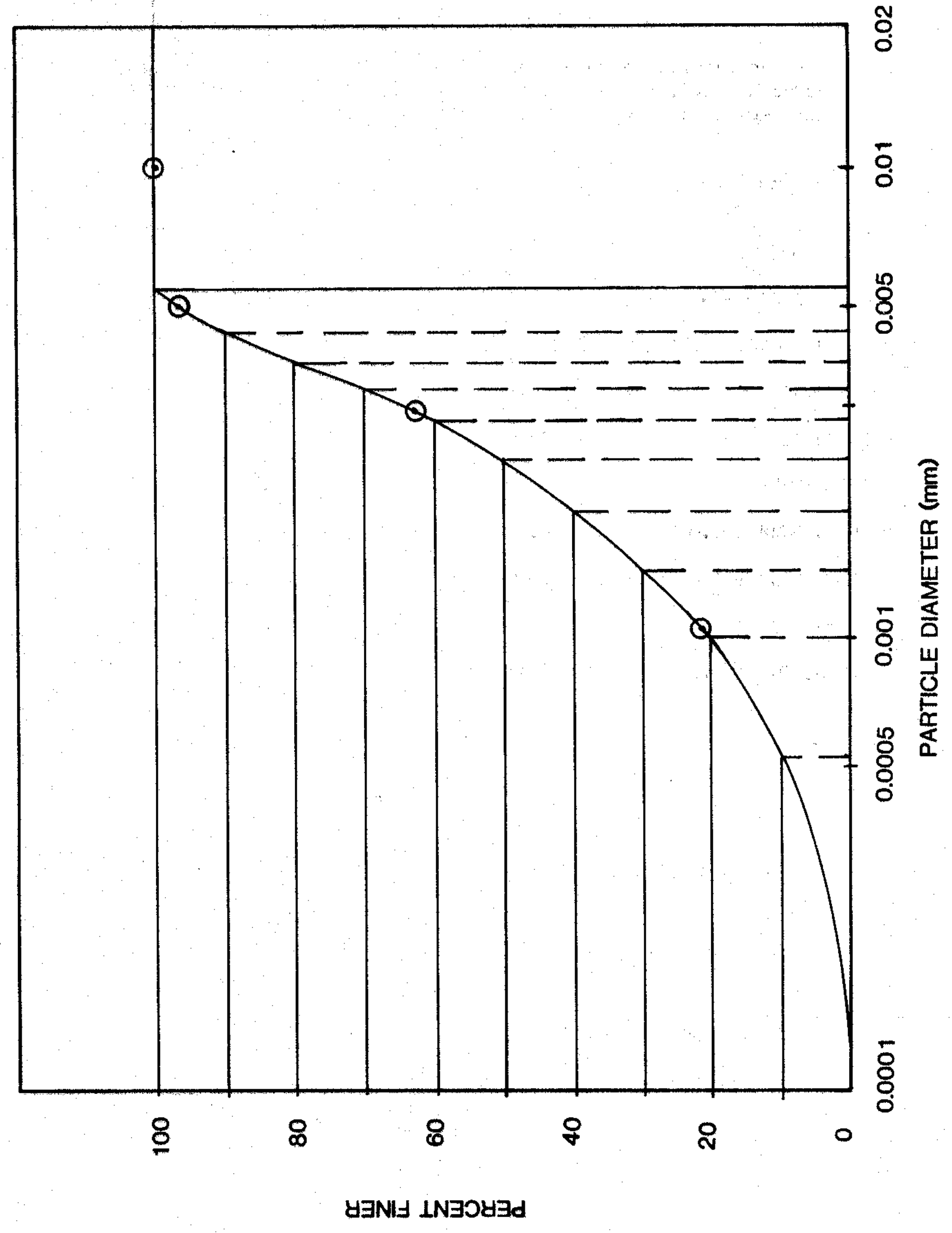

Figure A-1 Particle . Distribution.