1) Seltzer ... 2) Phipps ... 3) Bk case

ENGINEERING TECHNICAL INFORMATION SYSTEM

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Field Notes

Volume 7 Number 1 January 1975

Sedimentation Basin Design

Treatment of Septic Tank Effluent Using Underground Peat Filters

Washington Office Engineering News

FOREST SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange engineering information and ideas of a technical or administrative nature among Forest Service personnel. The text in the publication represents the personal opinions of the respective author and must not be construed as recommended or approved procedures, mandatory instructions, or policy, except by FSM references. Because of the type of material in the publication, all engineers and engineering technicians should read each issue; however, this publication is not intended exclusively for engineers.

This publication is distributed from the Washington Office directly to all Regional, Station, and Area Headquarters. If you are not now receiving a copy and would like one, ask your Office Manager or the Regional Information Coordinator to increase the number of copies sent to your office. Use Form 7100-60 for this purpose. Copies of back issues are also available from the Washington Office and can be ordered on Form 7100-60.

Invitation to Readers: Every reader is a potential author of an article for FIELD NOTES. If you have a news item or short article you would like to share with other Engineers, we invite you to submit it to FIELD NOTES for publication.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to engineers Service-wide (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages. However, short articles or news items are preferred. The Washington Office will edit for grammar only. All material submitted to the Washington Office should be typed double-spaced, and all illustrations should be original drawings or glossy black and white photos.

Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

R-1	Bill McCabe	R-6	Kjell Bakke
R-2	Allen Groven	R-8	Ernest Quinn
R-3	Bill Strohschein	R-9	Ron Pokrandt
R-4	Fleet Stanton	R-10	Bill Vischer
R-5	Jim McCoy	WO	Al Colley

Coordinators should direct questions concerning format, editing, publishing dates, etc., to Rita Wright, Editorial Assistant, Engineering Staff Unit, Forest Service, USDA, Washington, D.C. 20250.

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SEDIMENTATION BASIN DESIGN

By Edward A. Hansen
Hydrologist, North Central Forest Experiment Station, Region 9

Even with the best designed engineering projects, sediment occasionally finds its way into stream channels. This may be due to construction deficiencies or to some infrequent event such as an extremely severe storm. In either case, once sediment is deposited in the stream channel, it may be desirable to remove it. Sedimentation basins or traps located in the streambed are one means of doing so.[1]

Basin construction at the start of projects that have a high risk of soil spillage or erosion provides added insurance against stream damage. This paper tells how to design in-channel sedimentation basins for trapping sand-size and larger material.

BASIN TYPE

Sedimentation basins can be constructed by excavating a depression in the streambed or by creating an impoundment with a low-head dam. A low-head dam is the less desirable alternative for most situations because of construction expense and the risk of structural failure.

BASIN LOCATION

To maximize trap efficiency (percent of sediment load deposited), the basin should be located in a section of stream which has a relatively flat gradient and minimum stream turbulence. Since these two variables are closely related, the problem can be simplified by concentrating on stream gradient. The stream can be surveyed to determine the sections with the lowest gradients. Or, in a stream with a wide range in bed material (i.e., gravel, sand, and silt), the low gradient sections can be identified as those zones with no gravel, particularly sandbed area containing wide bands of silt deposits. In locating a basin for a stream with a fairly uniform gradient, other factors, such as access or storage requirements for spoil, may take priority.

TRAP EFFICIENCY

A sediment basin is designed to remove certain percentages of selected particle sizes from a stream. The larger the basin, the larger the percentage trapped, and hence, the greater the

[1] *Hansen, Edward A., "In-channel sedimentation basins – a possible tool for trout habitat management," **Progressive Fish Culture,** 35(3), 1973, pp. 138-142.*

efficiency. Trap efficiency can also be improved in all cases by providing a gradual transition in cross section between the stream and the basin, and by having a uniform distribution of flow across the basin.

Sediment basins are usually designed to trap only sand and larger material. Although fine sediment can be removed with a basin, it is not usually done since it would require a much larger basin than for the removal of coarse sediments only.[2,3] In addition to its much higher cost, a large basin would tend to warm the water, a consideration if downstream fisheries are important.

DESIGN CRITERIA

The engineer first decides what sediment sizes need removal from the stream. Next, the basin size required to trap the smallest of these sediment sizes can be determined as follows:

- Determine the basin width and length necessary for trapping the selected particle sizes.
- Determine the depth required to halt bedload movement through the basin.
- Select a storage volume and calculate the depth necessary for storage. (This is in addition to the depth determined above.)

Deposition of sediment in a basin is a function of the fall velocity of the sediment, the basin length, and the stream discharge per foot of basin width. Vetter has expressed this in equation form:[4,5]

$$\frac{W}{W_o} = - \frac{V_s L}{e^q} \qquad (1)$$

where W_o = weight of sediment entering basin
W = weight of sediment leaving basin
L = length of basin
q = stream discharge per foot width of basin
e = base of natural logs
V_s = fall velocity of sediment particle

[2] *Brune, G.M., "Trap efficiency of reservoirs,"* ***American Geophysics Union Transactions,*** *34(3), 1953, pp. 407-418.*

[3] *Moore, Charles M., Walter J. Wood, and Graham W. Renfro, "Trap efficiency of reservoirs, debris basins, and debris dams,"* ***American Society of Civil Engineers, Hydraulics Division Journal,*** *86 (HY2), 1960, pp. 69-87.*

[4] *Pemberton, Ernest L., and Joe M. Lara, "A procedure to determine sediment deposition in a settling basin,"* ***United States Department of the Interior, Bureau of Reclamation, Sedimentation Investigation Technical Guide Series,*** *Section E, Part 2, p. 8, August 1971.*

[5] *Vetter, C.P., "Technical aspects of the silt problem on the Colorado River,"* ***Civil Engineering,*** *10(11), November 1940, pp. 698-704.*

The fall velocity is mainly dependent upon particle size and water temperature.

Vetter's formula was solved for a range of particle sizes and water temperatures and the results are presented graphically in Figure 1. The percent of the sediment load removed is shown on the *X* axis, in terms of the basin dimensions represented in the parameter LW/Q (Q = stream discharge) on the *Y* axis. It is apparent that, as either basin length (L) or width (W) increases, both LW/Q and the percent of material trapped increase.

Figure 1 can be used to determine the combination of basin length and width required to trap a selected particle size. One of the basin dimensions is fixed by the designer and the remaining dimension is then calculated as follows:

Find the basin length given a selected basin width (W = 25 feet), stream discharge (Q = 20 cubic feet per second), and stream temperature (50°F). Assume that we want to remove 99 percent of the sediment measuring 0.125 mm and larger. (Normally, the preponderance of sandbed material is greater than 0.125 mm so this will result in the removal of nearly all of the bedload.)

$$\frac{LW}{Q} = 140$$

Then

$$\frac{25L}{20} = 140 \qquad (2)$$

and

$$L = 112 \text{ feet}$$

A basin of 25 by 112 feet would trap essentially all sediment larger than 0.125 mm in size for a stream discharge of 20 CFS. From Figure 1 it is apparent that this basin (LW/Q = 140) would also trap 71 percent of the 0.062 mm size class and 26 percent of the 0.031 mm size class.

Once the basin width and stream discharge are known, it is possible to calculate the depth. The total water depth in a sediment basin designed to trap bedload is the sum of the depth necessary to stop bedload movement (d_1) and the depth required for sediment storage (d_2). This is illustrated in Figure 2. The d_1 value also gives an approximation of the level to which the basin can fill before it needs reexcavation. The velocity is calculated by dividing the measured stream discharge by the basin cross sectional area (width times depth). Various investigators working with canals have recommended maximum velocities of 0.5 to 1.0 foot per second. Thus, a mean velocity of 0.5 foot per second in the basin cross section would provide a conservative value for design purposes.

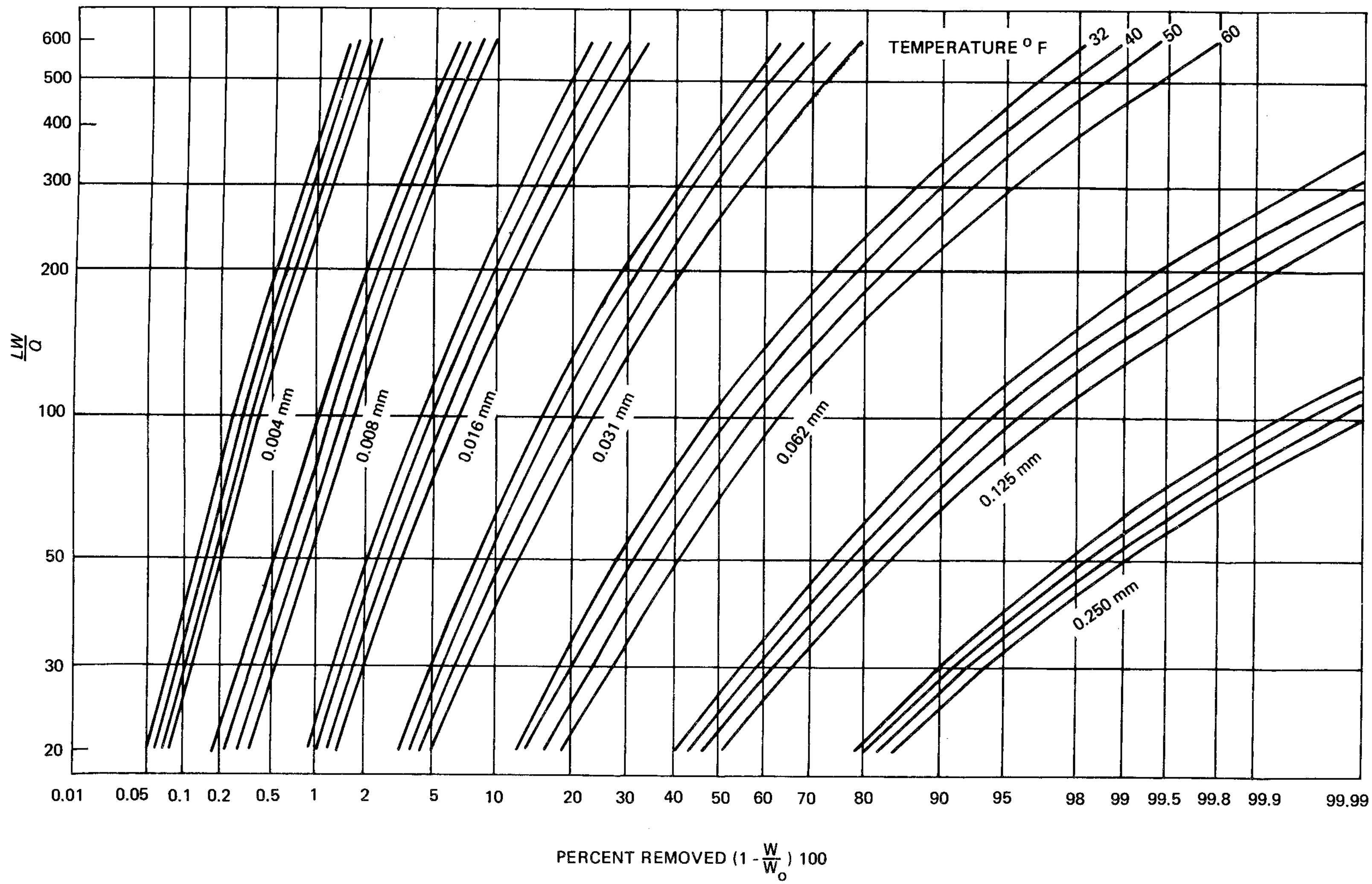

Figure 1. – *Percent of Sediment Removed for Different Basin Sizes, Stream Discharges, Water Temperatures, and Sediment Sizes*

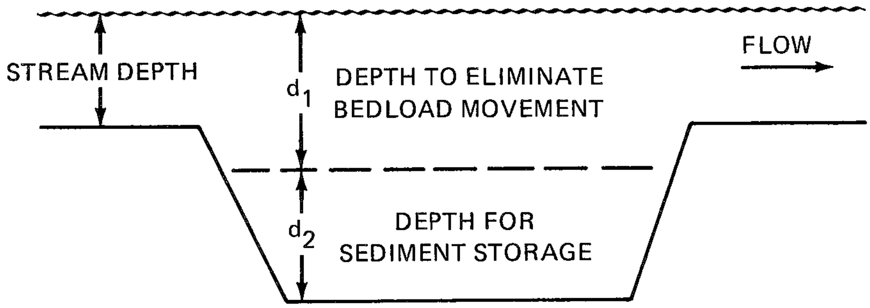

Figure 2. – Total Depth Required in a Sedimentation Basin

The basin depth (d_2) depends upon the required sediment storage volume. The volume of sediment to be trapped will usually be roughly estimated. When estimated sediment volumes require depths greatly in excess of the practical limit for basin depth, periodic cleanouts will be required.

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TREATMENT OF SEPTIC TANK EFFLUENT USING UNDERGROUND PEAT FILTERS

By Harold T. Stanlick

The operation of pilot treatment plants was undertaken to determine the ability of underground peat beds to treat the effluent discharge from septic tanks receiving domestic waste. If the project was successful, it could also provide the necessary data to formulate design criteria for individual underground peat bed systems for soils where a standard septic system is not advisable and a discharge would be expected. What follows is an abstract of the complete report on this project.

The septic tank waste, the final effluent, and intermediate points were tested for dissolved oxygen, BOD_5, Kjeldahl nitrogen, ammonia nitrogen, phosphorous, suspended solids, volatile suspended solids, total coliforms, and fecal coliforms.

The project was run under five different treatment processes to compare the removal efficiencies of each process:

- Septic tank effluent was applied directly to a peat bed.
- The waste was aerated before being applied to a peat bed.
- The waste was treated by a standard subsurface sand filter before application to a peat bed.
- The waste was treated by a sand-lime filter before application to a peat bed.
- Septic tank effluent was applied directly to a peat bed and then treated with a sand-lime filter.

Application of the effluent directly to a peat bed showed that distribution lines will have to be closed, as lateral movement of the waste on its way through the bed was only 50 to 70 centimeters. The system removed 100 percent of the coliforms, 85 percent of the Kjeldahl nitrogen, 95 percent of the ammonia nitrogen, 90 percent of the suspended solids, 90 percent of the volatile suspended solids, and left an average BOD_5 of 23 milligrams per liter (mg/1) at normal sewage strength. The system only removed 20 to 25 percent of the phosphates. The effluent dissolved oxygen was increased from 0 mg/1 to an average of 3.9 mg/1 after peat bed treatment. The system would not handle high-strength waste.

The aeration of the septic tank effluent before application on the peat bed showed little advantage over applying the effluent directly to the peat bed.

The pretreatment with a standard subsurface sand filter followed by peat bed treatment gave excellent coliform removal, with 100-percent and 99- to 100-percent removals of fecal and total coliforms respectively. The removal of 87 percent of the BOD_5, 99 percent of the ammonia nitrogen, 90 percent of the Kjeldahl nitrogen, 85 percent of the suspended solids, and 85 percent of the volatile suspended solids was considered good. The dissolved oxygen was increased from 0 mg/1 at the septic tank to between 5 and 7 mg/1 after the peat bed, which is higher than most treatment plant effluents. The phosphate removal was approximately 40 percent, which is only half the 80 percent that we had expected to obtain.

The use of lime, either before or after the peat bed, removed 99 percent of the phosphates. However, when the capacity of the lime to tie up the phosphates was exhausted, a rapid drop occurred and a method of adding or replacing the lime would be needed. Other parameters were substantially the same as for the sand filter.

The advantage of using unprocessed peat over commercially packaged peat for the removal of phosphates was demonstrated by the immediate jump from 39-percent removal to 80-percent phosphate removal when raw peat directly from the bog was installed as a replacement for the commercial peat being used.

This should be an economical alternative in some areas for the development of land not suitable for percolation fields. A limited supply of the complete report is available from Region 9.

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WASHINGTON OFFICE ENGINEERING NEWS

OPERATIONS

Harold L. Strickland
Assistant Director

ORTHOPHOTO INNOVATION

Rather recently there has been a minor but significant advance made within the Geometronics Units of the Forest Service in the use of the UNIVAC 1108 computer located at Fort Collins, Colorado.

Each Region and the Washington Office has a link to the Fort Collins Computer Center (FCCC) through high-speed terminals and telephone lines that provide the opportunity and flexibility to use the full power of the UNIVAC 1108.

Region 4 wished to explore the possibility of obtaining orthophotos through the use of a digital terrain model and asked for some assistance from the Washington Office Geometronics group. Region 4 personnel were provided with procedural guidance on how to digitize the terrain in their digitizing stereoplotters and this work was accomplished at their office. The data was transmitted to FCCC via Region 4's terminal and was then transformed into ground coordinates using existing programs. The transformed data was cataloged and stored at FCCC.

The film diapositives of the aerial photographs covering the area, along with instructions as to area and scale, were sent by mail to the Washington Office as input for the Zeiss orthoprojector.

The Washington Office Geometronics group interrogated the data stored at FCCC to develop the profile plates, and set up parameters and other information used to prepare the orthophotos. Orthophotos of the area were successfully produced using this method.

The important feature of this operation is that Region 4 established, cataloged, and stored a terrain data base at FCCC in a systematic manner using documented computer programs which are available to any Forest Service facility. The data was then used at another location to develop displays.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

PERSONNEL CHANGES

We made numerous personnel changes in Technological Improvements this year, including the transfer of the Engineering Design Support Group (EDSG) to the Fort Collins Computer Center at Fort Collins, Colorado. Significant changes are as follows:

- Olin Bockes, Engineer for Developmental Remote Sensing and Display Systems, transferred to the Soil Conservation Service at Washington, D.C.

- Jim Hogan, Engineer for Systems Development, transferred to the Region 1 Regional Office. His replacement is Romaine Thompson from EDSG. Thompson's replacement is Harvey Krantz from Engineering Staff, Region 9.

- Charlie Howard, Director of the San Dimas Equipment Development Center, San Dimas, California, retired. His replacement is Boone Richardson from the Washington Office ED&T staff. Richardson's replacement is Farnum Burbank, Director of the Missoula Equipment Development Center.

- Herb Shields, Program Planning and Field Services at SEDC, is now Staff Assistant to the Director, responsible for Aircraft and Aerospace-Related Product Development. Shields' replacement is Larry Matson, ED&T Staff, Washington Office.

- Dave Jones, Material Engineer, Washington Office, transferred to Material Engineer, Consultation and Standards, Washington Office.

- The entire Engineering Design Support Group moved to Fort Collins.

On the next page is an updated directory for Washington Office Technological Improvements, the Equipment Development Centers, and the Engineering Design Support Group.

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CONSULTATION AND STANDARDS

Charles R. Weller
Assistant Director

FPC LICENSE COORDINATION CONFERENCE

A Service-Wide Federal Power Commission license coordination conference, similar to the one held in Washington, D.C. in October 1972, is being planned for late March in San Francisco. The objective is to update Regional and Area FPC Coordinators on various aspects of interfacing Forest Service land and resource management objectives with power company requirements and FPC regulations and statutes. Particular emphasis is being given to procedures for revocation and restoration of withdrawn lands, improved effectiveness in Forest Service participation in FPC Regional Office annual inspections, and methods for Forest Service field units to correct or mitigate project impacts on resources, lands, and management objectives.

Federal Power Commission representatives from Washington and San Francisco are being invited to attend. Washington Office attendees will include appropriate resource staff members. It is anticipated that Regional and Area attendees will be the designated FPC Coordinator for the Region and one other staff member.

The conference will immediately follow the Dam Safety Workshop at the same location. Jointly, the Conference and Workshop will last 5 days. This has been scheduled in this manner because there is a certain commonality of interests in these topics. In some Regions, the same staff member has responsibility for FPC license coordination and dam management. Where responsibilities are split, we anticipate Regional attendees will be different during the two sessions.

Letters giving firm dates, location, and tentative agenda will be issued later in the 2770 and 7500 correspondence series.

WATER AND SANITATION

The July 1973 FIELD NOTES contained a brief information paragraph on proposed drinking water legislation. This will update that information. Both the Senate and the House of Representatives passed drinking water bills in November 1974. The House bill (H.R. 13002) was passed by the Senate with one amendment pertaining to State grants. We can assume this minor difference will be readily resolved. Unless stopped by Presidential veto, there will be a Safe Drinking Water Act in effect by the time you read this news note.

Both bills specifically cover all Federal facilities that are available to the public. Thus, all of our recreation sites and most of our administrative sites will be subject to criteria and standards included in, or required to be developed by, the bills. Primary drinking water standards would include not only constituent limits, but also treatment techniques when available instrumentation is not capable of accurately measuring certain parameters. States and/or EPA can enforce the bills' mandatory requirements at Federal facilities.

Whether or not a Safe Drinking Water Act is passed, EPA will be revising the 1962 Drinking Water Standards. Information on those standards, if you have not already picked it up through various literature reviews, will be available to those persons attending the National Forest Service Water and Sanitation Workshop in February 1975.

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GPO 882-919