THAMES RIVER IMPLEMENTATION COMMITTEE
AND
STRATFORD/AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT

SEDIMENT BASIN DEMONSTRATION PROJECT

Technical Report R-13

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PREFACE

This report is one of a series of technical reports resulting from work undertaken as part of the Stratford/Avon River Environmental Management Project (SAREMP) and the Thames River Implementation Committee (TRIC).

SAREMP was initiated in April 1980, at the request of the City of Stratford. It was funded by the Ontario Ministry of the Environment. The purpose of the project is to provide a comprehensive water quality management strategy for the Avon River basin. In order to accomplish this considerable investigation, monitoring and analysis has taken place. The outcome of these investigations and field demonstrations will be a documented strategy outlining the program and implementation mechanisms most effective in resolving the water quality problems now facing the residents of the basin. The project is assessing urban, rural and in-stream management mechanisms for improving water quality.

TRIC was formed in 1976 in response to a recommendation of the Thames River Basin Water Management Study carried out by the Ontario Ministries of Environment and Natural Resources. In 1980, these ministries committed funding for a three-year work program to address the specific recommendations of the Water Management Study regarding both flood control and water quality issues. Ninety-five percent of the $788,000 three-year budget was directed at improving agricultural land management in an effort to reduce the adverse water quality impacts of rural diffuse sources.

This report results directly from the aforementioned investigations. It is meant to be technical in nature and not a statement of policy or program direction. Observations and conclusions are those of the authors and do not necessarily reflect the attitudes or philosophies of agencies or individuals affiliated with SAREMP and TRIC. In certain cases, results are interim in nature and should not be taken as definitive until such time as additional support data is collected.

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ABSTRACT

An in-channel sediment basin was constructed on the Avon Municipal Drain, Lot 16, Con. II of North Easthope Township. This uppermost section of the Avon falls into the SAREMP's Demonstration Sub-Watershed where a variety of remedial measures have been put into place over the three-year study period. The purpose of the sediment basin was to determine the costs and benefits of sediment basin construction in municipal drainage works with regard to reduced drain cleanouts and improved water quality.

The basin constructed in November, 1980 at an approximate cost of $4000. Over the first two years of its operation, the basin has trapped 1031 yd^3 of sediment. The demonstration project has been well received both locally and by visiting professional personnel. Continued monitoring of the basin's effectiveness will give a better indication of cleanout frequency and of the long-term effect on water quality.

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1.0 INTRODUCTION

In many areas, soil erosion is directly responsible for the reduced productivity of agricultural land. When soil erosion takes place, the lost soil is usually the most fertile surface soil[1]. This sediment is the major transport vehicle for phosphorus and organic nitrogen. It is carried in suspension by overland runoff, until the velocity of the runoff is reduced sufficiently to allow the particles to settle out[2].

Depending on local topographic, soil, and land use conditions and relative runoff flow volumes and velocities, sediment and nutrients may be eroded and transported to the bottom of slopes or may be carried directly into a receiving watercourse. Serious water quality impairment and sedimentation of the channel may then result. Sediment that settles in channels reduces their carrying capacity, lowers the drainage capability of tributary tile drains by raising water levels, and creates sediment bars which divert flow and contribute to bank erosion. Nutrients carried with the sediment may cause eutrophication of these channels and of downstream bodies of water, thus the economic and environmental impacts of erosion and of sediment delivery to streams can be severe.

Efforts can be made to control erosion at the source before sediment becomes a problem in drains and watercourses. Many such practices have been cooperatively demonstrated by the Stratford/Avon River Environmental Management Project (SAREMP), the Thames River Implementation Committee (TRIC), and participating landowners operating in a two-square mile 'Demonstration Sub-Watershed' to the immediate northeast of Shakespeare and Highway No.7. This watershed had been designated for intensive studies of land and water management (see SAREMP Technical Report R-1).

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1 Soil Erosion By Water, Agriculture Canada Publication No. 1083, Ottawa, 1975.

2 Jeschke, J.L. et al, Soil Erosion and Sedimentation, Proceedings of National Symposium on Soil Erosion and Sedimentation by Water, Chicago, Illinois: ASAE Publication 4-77, p.102.

The demonstration projects carried out within this area included drainbank stabilization, grassed waterways, controlled livestock access to drains, minimum tillage practices, and strip cropping. Soil erosion is a naturally occurring process, however, and even the most sophisticated conservation program cannot prevent all erosion[3]. Consequently, additional measures such as sediment basins can be used to further control sediment leaving a watershed.

Sediment basins are in-channel storage reservoirs that trap sediment by slowing the velocity of runoff flows sufficiently to allow a portion of the suspended soil particles to settle out. Thus they serve to control the location of sedimentation along a drain. Sediment basins have commonly been used as temporary remedial measures on construction sites involving housing developments or highway projects. On occasion, they have also been successfully included as permanent structures in municipal drainage works[4]. To remain effective in these circumstances, however, sediment basins must be cleaned out periodically.

In the Stratford/Avon study, the sediment basin served to trap sediment disturbed by the construction of upstream demonstrations. In this role it was meant primarily to protect water quality; it was also hoped that by monitoring sedimentation rates in the basin over time, some indication of the construction and post-construction impacts of the upstream remedial measures could be provided.

2.0 METHODS

2.1 Site Description

The Avon Municipal Drain has its origins on Lots 15 and 16, Concession II, North Easthope Township, where it flows westerly across the properties of Messrs. Lichti and Hyde before leaving the Demonstration Sub-Watershed at County Road 14 just north of Shakespeare.

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3 Ibid., p.107

Two tributary drains join the Avon Drain on Lot 16; the first will be referred to here simply as a private drain, the second is called the 'North Branch' drain. The total drainage area above the confluence of the North Branch and the Avon Drain, is 601 acres. This represents approximately one-half of the 2-square mile Demonstration Sub-Watershed.

Prior to the remedial efforts commenced in November, 1980, this drainage system was characterized by poor bank stability and severe channel sedimentation. This was compounded by uncontrolled livestock access to a pasture area surrounding the confluence of the Avon and 'North Branch' drains. These conditions contributed to severe drainage inefficiency and to a deterioration of water quality in the Avon headwaters.

With technical and financial assistance with the Stratford/Avon Project and the Thames River Implementation Committee, the landowners operating within the 601-acre sub-watershed supported proposals for the reconstruction of the Avon Drain and thus provided the projects with a prime study area in which to demonstrate recommended drain design, construction and maintenance practices. Before upstream drain improvements were initiated in November, 1980, the construction of a sediment basin was proposed immediately downstream of the confluence of the Avon and 'North Branch' drains to control sediment generated by these activities. The landowner, Mr. Ronald Hyde, was cooperative in allowing the Project to construct the basin on his property, and to continue to monitor its effectiveness both in the short term and the long-term. The locations of various remedial measures demonstrated during the study are given in Figure 1.

The drain demonstrations carried out over the three-year study period may be effectively divided into three phases:

1) Sediment basin construction (funded 100% by the TRIC), open drain improvements to 3500 feet of the Avon Municipal Drain through Lots 15 and 16 (SAREMP Technical Report R-6), and a livestock crossing on the 'North Branch' (Technical Report R-8), November, 1980.

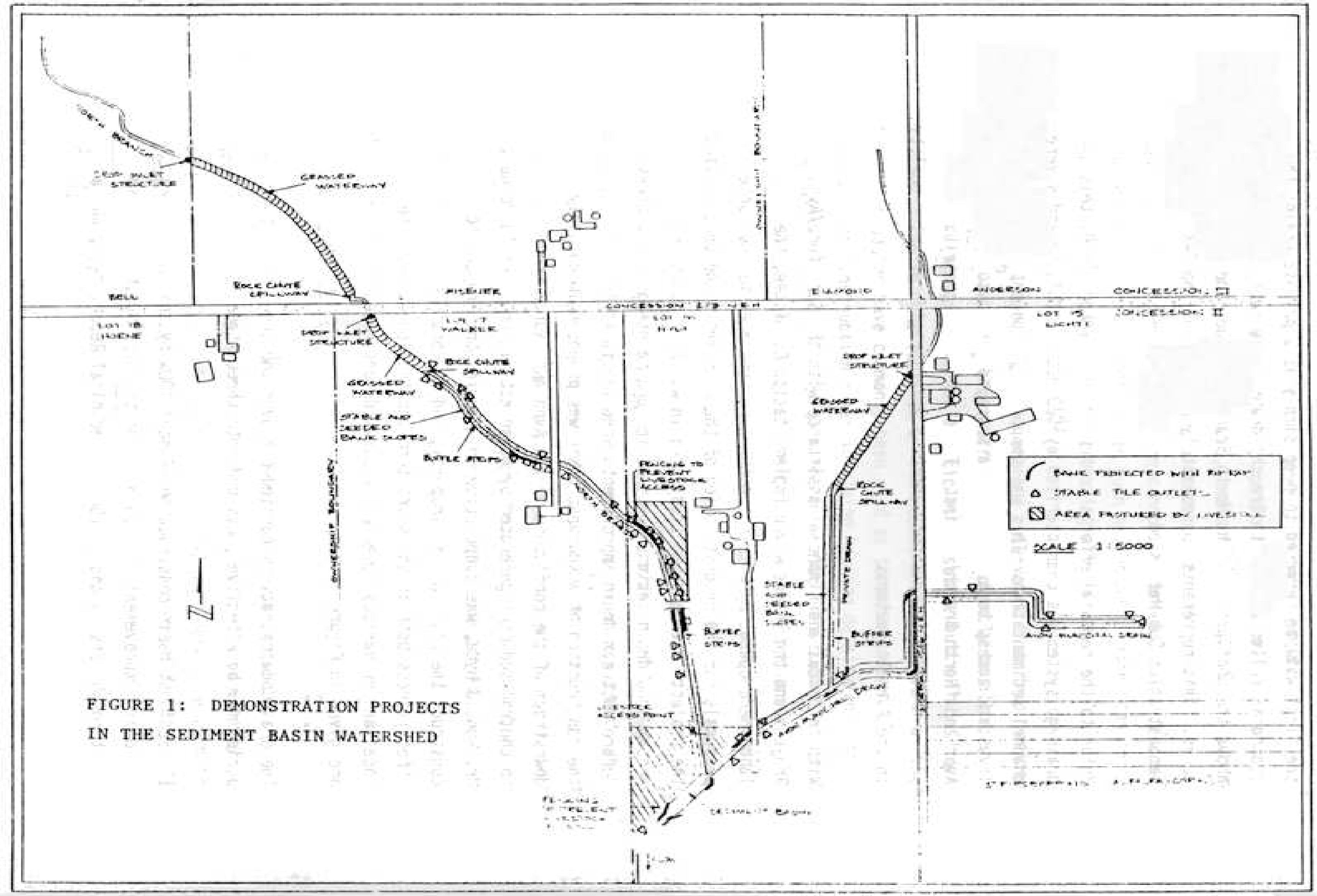

FIGURE 1: DEMONSTRATION PROJECTS IN THE SEDIMENT BASIN WATERSHED

Grassed waterway construction and drainbank reshaping along 1900 feet of the private drain crossing Lot 16 (Technical Report R-7), and completion of the controlled livestock access with suspension fencing, May, 1981.

Open drain improvements to the 'North Branch' including 1470 feet of grassed waterway construction and 2700 feet of drainbank stabilization (TRIC File Report), August, 1982.

2.2 Design Principles

The sediment basin was designed in accordance with engineering principles with features adopted to local conditions. The dimensions of the basin are as follows: 244-foot length, 70-foot top width, 30-foot bottom width, and a 2-foot depth below the grade of the Avon Drain. Design considerations must be taken into account if a sediment basin is to be a cost-effective structure. In this case, the maximum design flow rate calculated for the 601-acre watershed, the minimum particle size to be collected at that design flow, and the desired efficiency of sediment removal were used to help calculate basin dimensions. In turn, these parameters are dependent on a series of other factors such as soil types in the upstream watershed, rainfall patterns, land uses, and channel hydraulics[5]. Other considerations in designing this particular sediment basin included erosion control measures (rip-rap), gabion work) and an outflow weir. In addition, basin dimensions had to facilitate construction and clean-out operations. Basin dimensions and profiles appear in Figure 2. A perspective drawing is given in Figure 3.

The sediment basin was designed to remove up to 80% of suspended sediment particles

5 Rouse, H., Engineering Hydraulics, Institute of Hydraulic Research, Wiley and Sons, New York, 1949.

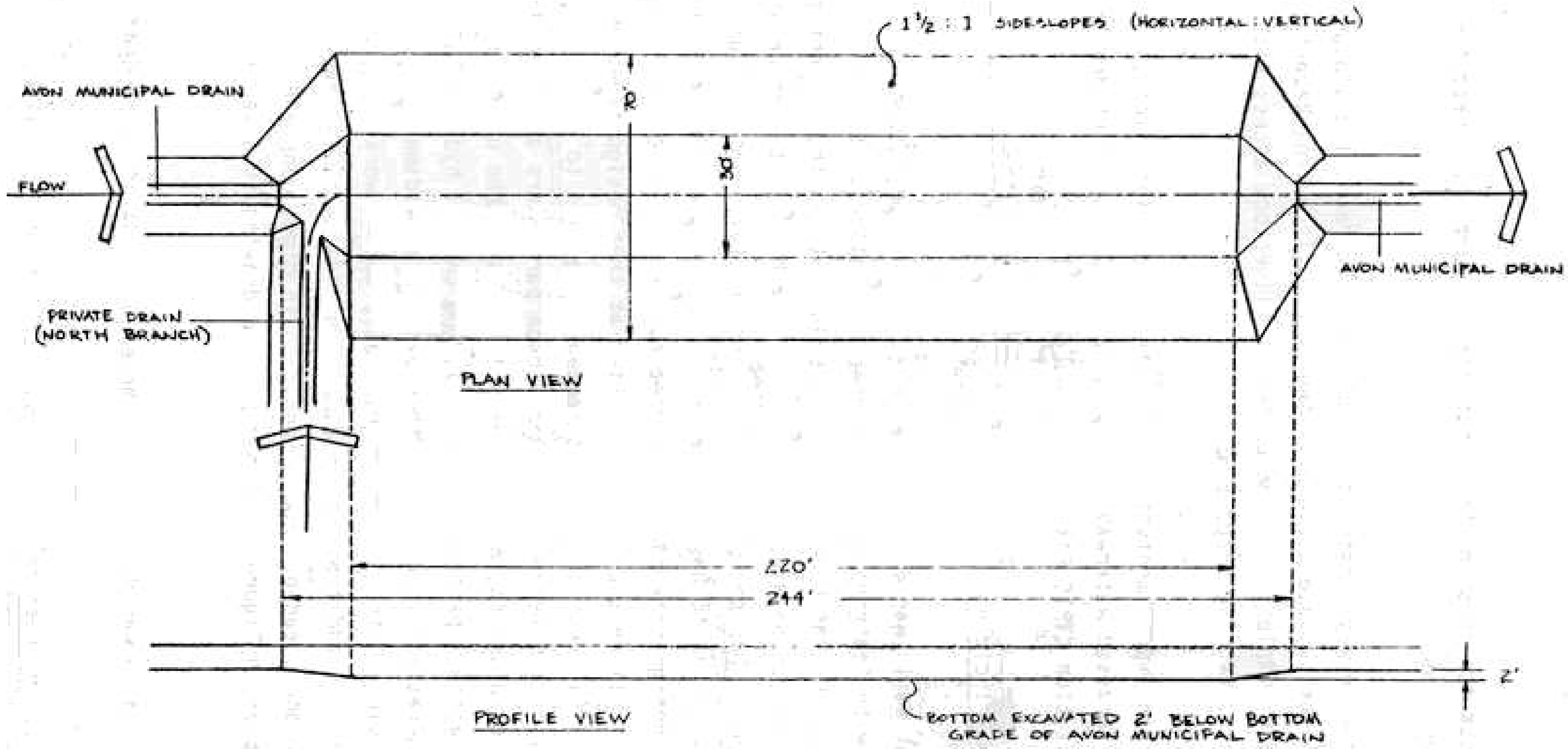

FIGURE 2: Sediment Basin Plan And Profile Views

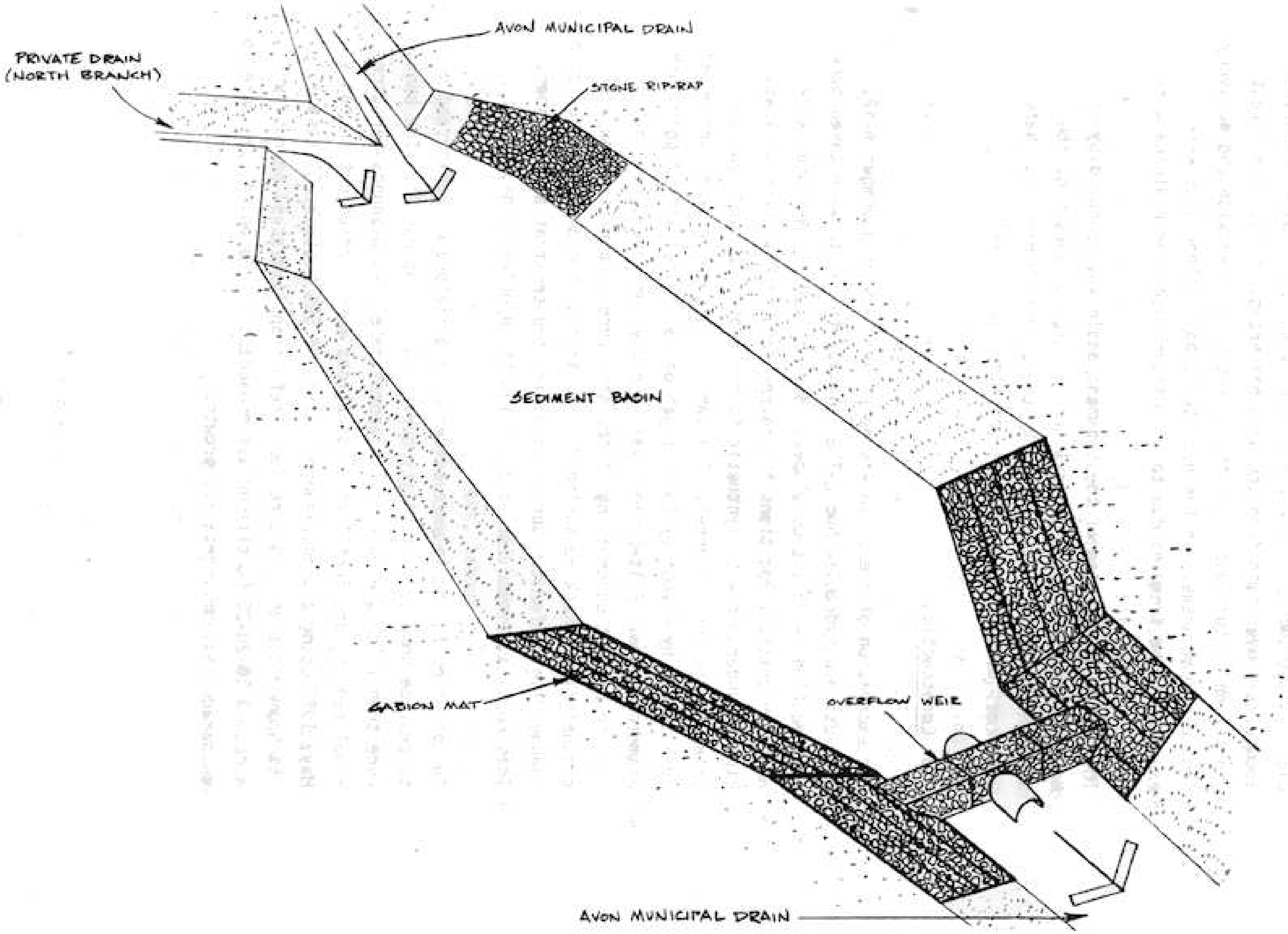

FIGURE 3: Sediment Basin (Lot 16, Concession II, North Easthope Twp.)

larger than 0.003 inches in diameter at design flow rates. This particle size represents very fine sands. The clean-out frequency of the basin depends on the volumes of sediment accumulated over time from the upstream areas. Rates of sediment deposition in turn depend on the degree of soil erosion and delivery from upstream areas. In the near term, basin clean-outs were expected to be frequent due to the disturbance from drainage work.

The design and purpose of the sediment basin was approved by the North Easthope Township Council. Permission to construct the sediment basin was also granted by the Ontario Ministry of Natural Resources under the Lakes and Rivers Improvement Act.

2.3 Construction

The excavation of the basin was performed between November 6-12, 1980 using a hydraulic hoe. The banks of the basin were taken back to specified 1-½:1 side-slopes. Bank protection measures were added in critical locations to prevent scouring by channel flows. Rip-rap underlain with synthetic filter cloth was used near the inlet of the north channel. The banks of the outlet were protected by a 9-inch by 6-foot by 50-foot gabion mat filled with 4 to 9 inch diameter stone. Filter cloth was also used underneath the gabion work to prevent undermining of the structure by bank seepage and channel flow. Rock measuring 7 to 12 inches in diameter served as a channel lining for the apron outletting the sediment basin proper. This rock was firmed into place using the hydraulic hoe.

The banks of the basin were seeded with a mixture of barley and oats to provide some soil stability during the spring runoff. The banks were then mulched with straw at approximately 4500 pounds per acre. Final seeding and fertilizing operations were carried out in early May, 1981 using a grass/legume mixture of 50% Kentucky-31 fescue, 25% bromegrass and 25% birdsfood trefoil applied at 53 pounds per acre. A 10-20-20 fertilizer was broadcast at 275 pounds per acre to encourage maximum vegetative growth.

Spoil from the initial construction of the sediment basin was levelled by a bulldozer and subsequently seeded with a forage mixture by the landowner. Spoil resulting from two subsequent cleanouts was disced and reseeded to provide a pasture area for controlled livestock grazing.

In early June, 1981, a 2 x 3 x 9 foot gabion basket was positioned in the channel at the outlet of the sediment basin to act as an overflow weir. The gabion basket was buried to a one-foot depth below the channel bottom to increase weir stability. A five-foot length of 12-inch diameter corrugated steel culvert was projected through the basket to outlet low flows from the basin (Figure 3). This weir increased the wet-weather impoundment depth behind the basin by one foot. A channel survey was completed prior to installation to assure that the higher water levels in the basin during these increased flow conditions, would not interfere with the drainage of the inletting Avon or 'North Branch' drains. The added capacity of the basin would increase sediment trap efficiency by increasing flow retention times, and would act as a physical barrier to downstream movement of the sediment.

On August 17, 1982, the date of the second clean-out, the capacity of the basin was increased by 110 cubic yards in order to reduce the frequency of cleanouts and maintenance operations.

Material and equipment costs associated with the sediment basin construction are itemized in Table 1. These costs do not represent total costs as the professional services, labour, and materials supplied by Project staff and the landowner are not included.

2.4 Monitoring Programs

The sediment basin was initially surveyed on November 21, 1980 to determine its dimensions and to provide a reference for future surveys. A benchmark and eleven stations along the banks were established at this time. Subsequent surveys and basin cleanouts were carried out periodically through 1981 and 1982.

TABLE 1: Sediment Basin Construction Cost

Amount	Materials And Equipment	Unit	Unit Price	Unit Total
2000	Filter Cloth	Ft^3	$ 0.146	$ 292.61
34.5	Excavation with Hydraulic Hoe	Hr.	55.00	1897.50
126	Stone 4-12 inch Diameter	Yd^3	4.56	574.56
2	Gabion Mat 9" x 6' x 100'	100'	454.18	908.36
17	Straw Bales	Bale	1.00	17.00
1	Gabion Basket 2' x 3' x 9'	Unit	34.00	34.00
5	Corrugated Steel Pipe 12 inch Diameter	Ft.	4.14	20.70
2	Leo Birdsfoot Trefoil	Lb.	4.70	9.40
6	⅔ K-31 Fescue, ⅓ Bromegrass Mixture	Lb.	2.30	13.80
42	10-20-20 Granulated Fertilizer	Lb.	0.12	5.04
7	Bulldozer for Leveling Excavated Spoil	Hr.	40.00	280.00
	TOTAL COST:			$4052.63

To determine the volume of sediment deposition in the basin, a rod and level were used with readings taken along eleven cross-sections; three feet in from the toe of the bank and along the centerline of the basin. These measurements were then compared to the initial survey data from November 21, 1980 to determine total accumulated sediment volume. A rough check was also made at the time of basin cleanouts by estimating the volume of excavated material.

Sediment samples were randomly collected from the basin and analyzed for four major parameters: loss on ignition, total Kjeldahl nitrogen, total phosphorus and total solids. Samples were also analyzed for particle size to help determine sediment basin efficiency in removing material from the flow. This data was supplemented by visual and textural observations of the deposited material.

Water samples were obtained from three locations at the sediment basin site to determine impacts on suspended solids and nutrient concentrations in downstream flows. The three stations were a) the Avon Municipal Drain inlet to the sediment basin, b) the inlet of the 'North Branch' drain, and c) the outlet of the basin. During the 1981 study period, grab samples were collected on a random basis and analyzed for eight parameters: suspended solids, free ammonia, total Kjeldahl nitrogen, nitrite, nitrate, total and dissolved phosphorus, and conductivity. Over the 1982 season, bimonthly water samples were taken at these same stations and analyzed for suspended solids and total phosphorus. In addition, intensive wet weather water sampling surveys were conducted.

Project staff also monitored a tipping bucket rain gauge at the sediment basin site. Data from these gauges provides information on rainfall.

3.0 RESULTS

3.1 Basin Sedimentation

Over the first year of its operation, from November 1980 to November 1981, approximately 671 cubic yards of sediment accumulated in the basin. This volume was removed by hydraulic hoe on May 13, 1981, at a cost of $164.00 (Table 2). Drain improvements made during this time to the upstream sections of the Avon Municipal Drain included 3500 feet of bottom cleanout work and bank stabilization measures.

From the period December 1981 to August, 1982, the sediment basin collected 406 cubic yards of sediment which were removed during the second clean-out operation (Table 2). An additional 110 cubic yards was excavated by the hydraulic hoe to deepen the basin in an attempt to increase basin efficiency while extending the period between cleanouts. A final survey conducted on November 15, 1982 indicated that an additional 286 cubic yards had settled in the basin since the August clean-out. Activities which may be responsible for these sediment loadings included 1470 feet of waterway construction and 2700 feet of bank stabilization on the North Branch drain.

3.2 Sediment Analysis

The predominant soil type of the 601-acre sub-watershed is a Harriston silt loam which is medium-textured. It exhibits good drainage with a well-developed 6-inch dark brown surface horizon. A band of Waterloo sandy loam also appears to the southeast of the sediment basin. Particle size analysis of a representative field sample taken upslope of the sediment basin, revealed a composition of 30% sand, 48% silt and 22% clay. Collections of eroding soil taken from the same field were made using soil traps (SAREMP Technical Report R-14), and determined to be 39% sand, 47% silt and 14% clay. The average composition of sediment collected from the central portion of the sediment basin was 2% gravel, 59% sand, 33% silt, and 6% clay. Chemical analysis of these same samples revealed and average 5.4% loss on ignition, 1.8 mg/g total Kjeldahl nitrogen content, and 0.83 mg/g total phosphorus content.

TABLE 2: Schedule Of Operations And Sedimentation Data

Date	Survey Or Operation	Spoil Volume	Accumulated Sediment*
		yd^3	
Nov.12,1980	Construction of sediment basin	-	-
Nov.21,1980	Initial survey to determine basin dimensions	-	0
May 11,1981	Survey prior to first cleanout	-	339
May 13, 1981	First cleanout ($137.50)	339	0
June 10,1981	Weir installed to increase basin capacity	-	-
Dec. 8,1981	Survey for new volume	-	332
May 11, 1982	Survey for new volume	-	90
July 28,1982	Survey prior to second cleanout	-	-16
Aug.17,1982	Second basin cleanout ($240)	406	0
Aug.17,1982	Sediment basin deepened by110 yd^3 to increase capacity	110	-
Nov.15,1982	Survey for new volume	-	286
TOTAL		855	1031

* Accumulated sediment values measure net additions, i.e. sediment that has been trapped between surveys.

By visual and textural observations of the sedimentation process, Project staff identified deposits of coarse sand near the upper end of the basin, with finer silt and clay particles being trapped at the lower end. A gravel bar formed at the mouth of the basin, originating largely from the channel bedload of the North Branch drain.

3.3 Water Quality Data

Water quality data are summarized in Table 3. Only suspended solids and total phosphorus results are given since these are the parameters of greatest interest here.

4.0 DISCUSSION

4.1 Sediment Control

Over a two year period of surveillance, the sediment basin trapped 1031 yd^3 of material eroded from upland areas. As expected, this material was primarily coarse in texture (60% gravel and sand). The rate of sediment entrapment is depicted by the slope of line segments in Figure 4. Just after clean-outs, sediment is seen to accumulate rapidly. The storage volume of the basin below the grade of the drain bottom is about 560 yd^3. As this volume is filled with sediment, the rate of accumulation appears to slow down. This is happening between November 1981 and August 1982; a period spanning the spring freshet when sediment loads and the potential for sediment entrapment are typically high. Sediment accumulation after August 1982 is more rapid than previously observed due perhaps to the larger basin volume and to the disturbance from reconstruction of the North Branch drain in August.

Delivery of sediment to the basin over the three-year study period may be attributed to a number of factors related to conditions in the sub-watershed prior to 1980, and to subsequent activities of SAREMP and TRIC aimed at controlling long-term soil erosion and sediment delivery to the Avon. Reconstruction activities on approximately 9570 feet of

TABLE 3: Water Quality Data

Water Sampling Survey Description	MEAN WATER QUALITY DATA - mg/L (sample size):					
	Total Phosphorus			Suspended Solids		
	Avon Drain Inlet	North Drain Inlet	Basin Outlet	Avon Drain Inlet	North Drain Inlet	Basin Outlet
Routing Monitoring - 1981, 1982						
1. dry weather	0.119 (4)	0.052 (4)	0.039 (4)	1.7 (2)	3.1 (2)	5.9 (2)
2. wet weather	0.111 (8)	0.334 (8)	0.259 (8)	11.5 (6)	28.8 (6)	35.8 (6)
Intensive Surveys - 1982						
1. spring freshet, March 16-April 20	0.299 (40)	1.830 (41)	0.112 (43)	107.8 (40)	252.7 (41)	102.4 (43)
2. wet weather, Aug. 19-20, after North Drain and basin cleanout and 17.9 mm of rain	0.470 (3)	0.157 (3)	0.648 (3)	263.9 (3)	84.2 (3)	125.5 (3)
3. wet weather, Aug.26, after 48.5 mm of rain	0.133 (6)	1.30 (6)	0.283 (6)	35.2 (6)	133.6 (6)	43.2 (3)
4. wet weather, Sept. 14-15 after 18.3 mm of rain	0.300 (3)	0.458 (3)	0.523 (3)	38.0 (3)	139.9 (3)	121.6 (3)

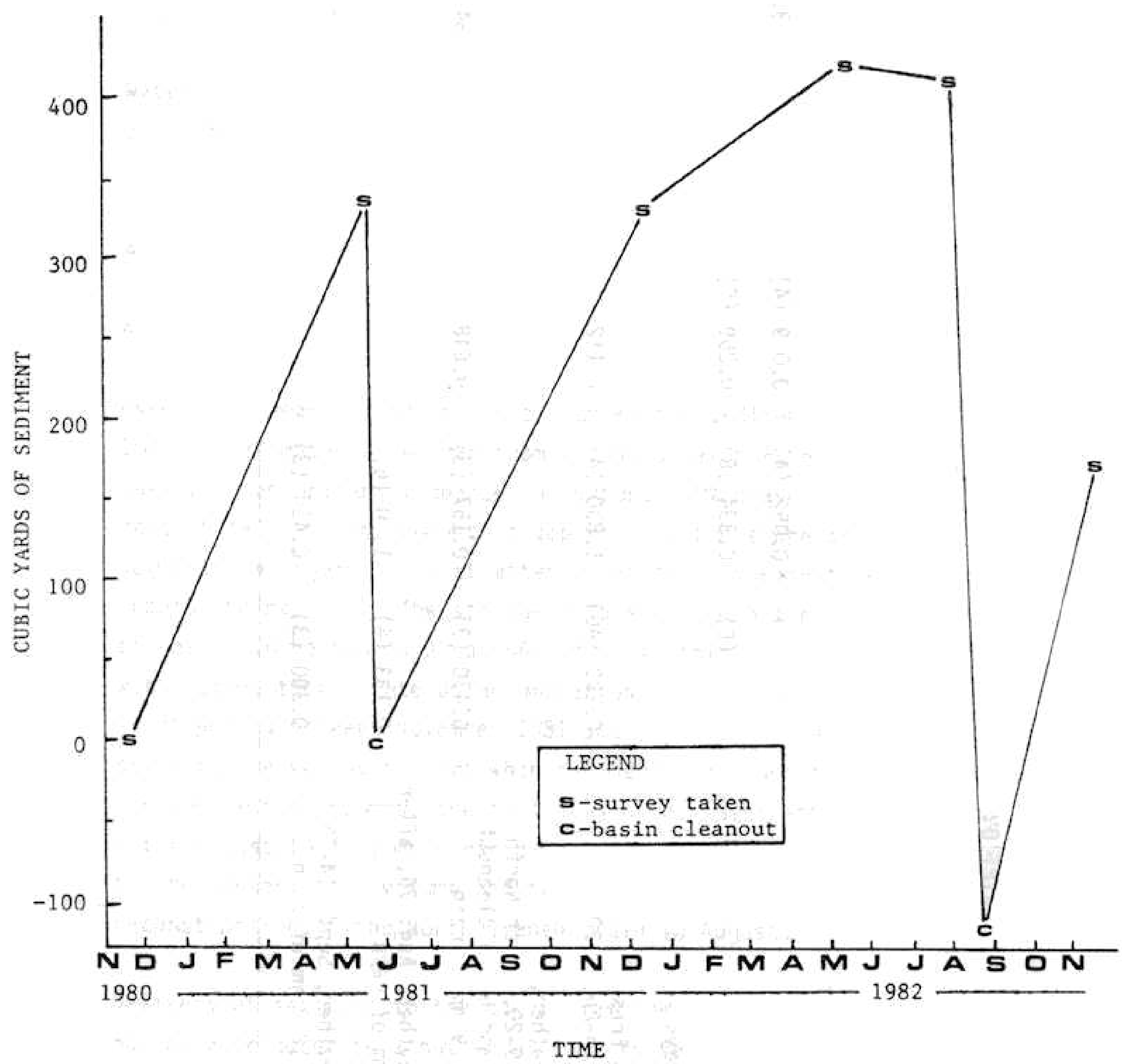

FIGURE 4: Accumulation Of Sediment In The Sediment Basin

drain and grassed waterways upstream of the sediment basin over the study period must be considered a primary source of this sediment. The land base above the basin, however, is one of the more highly erosive areas in the Avon River Basin. The impact of rainfall and runoff under conditions of 12% slopes in continuous corn, for example, would contribute high sediment loadings under intensive storm conditions. In-field demonstrations of strip cropping, conservation tillage, and buffer strips were promoted by SAREMP as means of reducing this impact. Stabilization of the surface drainage-ways by vegetative growth and other erosion control measures will reduce bank erosion contributions. The net result will be a reduction of sediment loadings to the sediment basin and to the Avon Drain.

Based on the total amount of sediment removed from the basin during cleanout operations, the sediment basin clearly acted as an effective sediment trap during the period of upstream reconstruction. Only a long-term monitoring program of the demonstration sub-watershed including continued sediment basin surveys will determine the full impact of the sediment basin and upstream conservation measures.

4.2 Water Quality Impacts

Generally there was not enough information available to fully describe input and output hydrographs and polutographs for wet weather events that were monitored. The analysis of water quality impacts therefore is based on mean concentrations of water quality parameters.

Flows from the North Branch drain showed generally higher levels of these two parameters compared to the Avon Drain during both wet-weather and dry-weather sampling (Table 3). These higher levels are related to a number of factors: 1) dense bank and channel vegetation in the Avon Drain which stabilized the banks and trapped sediment, 2) the erosive condition of the North Branch prior to reconstruction in August, 1982, and 3) the presence of a cattle access point on the North Branch just upstream of the sediment basin.

Suspended solids levels in samples from the basin outlet exceeded inlet values during dry weather periods in the summer. This was likely caused by the growth and subsequent decay of algae in the basin which was quite eutrophic through the growing season. This explanation is not conclusive since the organic fraction of the suspended sediment was not isolated in routine laboratory analysis of the water samples. However, similar impacts have been noted for other impoundments in the basin (SAREMP Technical Report S-1).

For intensively monitored runoff events, outlet concentrations of suspended sediments usually were intermediate between inlet flows from the North Branch and Avon drains. A conclusive analysis of this data therefore requires flow data for these two inlets. These were not available, however, it was observed throughout the field season that the North Branch drain tended to have a faster hydraulic response time and to exhibit somewhat larger flows. If the basin has no impact, then outlet concentrations will be the result of simple mixing and should be mid-way between the inlet concentrations or perhaps closer to the North Branch concentrations due to the larger flows there.

Using this as a guideline, some entrapment of sediment seems to have occurred during the spring freshet and the August 26 survey. The other two intensive surveys do not show evidence of sediment entrapment. The same conclusions can be reached regarding total phosphorus, only here the evidence is even clearer for the August 19-20 and September 14-15 surveys. For these, outlet total phosphorus concentrations exceed inlet values. Thus there is some ambiguity as far as wet weather water quality impacts are concerned. While sediment control is clearly taking place, it is not obvious that suspended sediments and total phosphorus in the water column are reduced. Since these are associated with fine silt and clay particles, and since the sediment basin is designed to capture particles ranging in size down to fine sands, it is perhaps reasonable not to expect a notable impact on these parameters.

4.3 Other Watershed Experiences

The use of sediment basins in municipal drainage works has not reached popular status, however, various townships have recently constructed or otherwise experimented with the concept (e.g. Zorra, E. Zorra-Tavistock, Norwich, Camden Twps.). Two local basin projects are briefly described below as cases I and II. A study of sediment basin implementation in the Black Creek watershed in Indiana is discussed as Case III.

Case I. Patterson-Robbins Drain - Zorra Township:

Two sediment basins were constructed 1000 feet apart along this drain at the time of its construction in 1978. Basin dimensions were 100-foot length, 50-foot width and 3-foot depth below grade. These were constructed at a cost of $200 per basin. Both basins were filled to capacity after four years, and were cleaned out in the fall of 1982. Area farmers and township officials are enthusiastic about the success of the basins in removing sediment from the watercourse[6].

Case II. Treffry Drain - Norwich Township:

The major function of this 'desilting' basin was to trap sediment resulting from upstream reconstruction of the drain in 1982. Dimensions of the basin are 33-foot width, 50-foot length, and 1-foot depth below grade. The basin had filled to near capacity within 1-½ months after construction as a result of the highly unstable soil conditions of the drainbanks and channel bed. Continuous 'creeping' of the sand bottom was observed where the drain enters the basin. Efforts to re-vegetate the banks have proven successful, particularly where the clay content of the soil increases. The basin will be cleaned out for the second time in the spring of 1983, and township officials continue to monitor its

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6 H. Rout, Zorra Township, Personal Communication

performance under these erosive conditions. Construction costs were approximately $250, with cleanouts costing slightly less [7].

Case III. Basin Study - Black Creek Project (Indiana)

Reports on a channel desilting basin approximately 300 feet in length, constructed in the main channel of the Black Creek, give sediment accumulation after nine months at 980 cubic yards. The following year an additional 530 cubic yards had been deposited. Cleanout frequency is estimated at 4 to 5 years during the initial period. Channel construction activities, and one storm with a greater than 50-year recurrence interval are largely responsible for these sediment volumes. The approximate cost of construction was $5500.00. Much of the trapped material was bed-load, with the basin collecting 95% sand near the inlet and 35% sand at the lower end of the basin.

As in the Avon study, turbidity, total solids, and total phosphorus increased at the outlet during low flows. The use of desilting basins was not recommended based on these negative impacts on water quality[8]. In categorizing sediment basins according to direct benefit, however, the study revealed water quality benefits to be the primary impact of their construction. This conclusion is likely based on wet weather control of suspended sediment loads.

4.4 Design, Construction and Maintenance Considerations

Sediment basins may be included as part of an Engineer's Report to reduce the impact of drain construction activities on downstream water quality, or to reduce the frequency of future drain cleanouts as a result of channel sedimentation processes. A temporary

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7 D. Wilson, Norwich Township, Personal Communication.

8 Lake, J., J. Morrison, Environmental Impact of Land Use on Water Quality: Final Report on the Black Creek Project, U.S. Environmental Protection Agency, EPA-905/9-77-077-B, Chicago 1977, p.13.

deepening of the channel to form a stilling basin may be considered, or a permanent structure such as implemented in the present study may become part of a longer term solution to downstream impacts of sedimentation.

Construction costs will vary according to design specifications and the intended impact of the basin, and the time period over which it is meant to remain effective. The cost-effectiveness of different designs must therefore be studied in relation to the local and sub-watershed characteristics. Section 2.2 of this report discusses these factors in more detail.

The sediment basin constructed on the Avon Drain was designed for a 100-year storm. Excavation costs were high due to existing 8-foot bank heights along this section of the drain. Rip-rap work at the mouth of the basin opposite the North Branch inlet, and extensive gabion mat installation at the outlet were necessary to protect the drainbanks under predicted high flow conditions. As a result of these additional measures to stabilize the structure, material and equipment costs appearing in Table 1 may not represent typical values for sediment basin construction elsewhere. In addition to these costs, considerable support for design work, labour, and monitoring over the 3-year study period was provided by TRIC and SAREMP.

The main economic benefit of sediment basin construction may be realized through the reduction in frequency, and extent of drain cleanouts. Since the basin traps sediment at a fixed location on a drain, maintenance operations are also localized to this site. Basin cleanouts may take less time and effort than the drain cleanouts that would otherwise be needed. Total costs of drain maintenance are thus reduced, and lower assessments to landowners are made.

5.0 CONCLUSION

Construction of the sediment basin in the uppermost reaches of the Avon Municipal Drain has had a positive impact on reducing downstream sedimentation. A total of 1031 cubic yards of sediment accumulated in the basin over the 2-year period November 1980 to November 1982. Much of this material came from extensive drain reconstruction carried out within the 601-acre drainage area above the basin.

Soil erosion and sediment delivery processes from the land base occur at above-recommended rates due mainly to physiographic conditions. Increased application of conservation measures to this land will reduce the volume of sediment delivered to the sediment basin, and thus reduce the basin cleanout frequency. Monitoring of the Avon headwaters arising within the Demonstration Sub-Watershed should continue on a long-term basis in order to confirm the impact of these land-use and drainage demonstrations.

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STRATFORD-AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT
LIST OF TECHNICAL REPORTS

S-1 Impact of Stratford City Impoundments on Water Quality in the Avon River
S-2 Physical Characteristics of the Avon River
S-3 Water Quality Monitoring of the Avon River - 1980, 1981
S-4 Experimental Efforts to Inject Pure Oxygen into the Avon River
S-5 Experimental Efforts to Aerate the Avon River with Small In-stream Dams
S-6 Growth of Aquatic Plants in the Avon River
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