STRATFORD/AVON RIVER ENVIRONMENTAL MANAGEMENT PROJECT

STRIP CROPPING DEMONSTRATION PROJECT

Technical Report R-10

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Rural Sub-Committee

September, 1982

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 (S.A.R.E.M.P.).

This two year Project was initiated in April 1980, at the request of the City of Stratford. The S.A.R.E.M.P. is funded entirely 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 residents of the basin. The Project is assessing urban, rural and in-stream management mechanisms for improving water quality.

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 philosophy of all agencies and individuals affiliated with the Project. In certain cases the results presented are interim in nature and should not be taken as definitive until such time as additional support data is collected.

Reference to equipment, brand names or supplies in this publication is not to be interpreted as an endorsement of that particular product or supplier.

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ABSTRACT

- Stratford/Avon River Environmental Management Project
- Rural Sub-Committee
- Strip cropping Demonstration Project

The Stratford/Avon Project was involved in a major strip cropping project undertaken by a landowner located in the upper part of the Avon River basin in the Demonstration Sub Watershed during 1981-1982. The purpose of the project is to demonstrate the effectiveness of strip cropping in relation to the overall goals of the Rural Sub-Committee of reducing non-point source pollution through runoff and erosion control. Alternate strips of an alfalfa forage mixture were introduced into a field which had grown continuous corn for several years previous. The farmer is convinced that the strip cropping, in combination with other conservation measures, will assist greatly in controlling sheet and rill erosion while maintaining the long-term productivity of the soil.

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1.1 General Introduction

Strip cropping is a practice used to reduce runoff velocity and therefore soil loss from agricultural land. Strip cropping on the contour consists of alternate strips of row crops (for instance, corn or beans) and forage crops with all strips at right angles to the slope. The sod strips effectively divide up the field, increasing roughness and therefore decreasing overland flow velocity and soil erosion. Soil washed from the exposed land is filtered out by the protective crop. In addition, the soil under the sod does not become sealed and compacted by the impact of rain, and so moisture can enter the soil more easily [(1)]. There are fewer erosion scars to be worked over and the soil is able to build up its tilth, its moisture and its fertility[(2)]. When combined with other good soil management practices (i.e. contour tillage), strip cropping can reduce soil losses by up to 85% [(3)]. Lower power requirements and ease of operation are also realized when fields are worked on the contour, or at least across the main slope. Depending on the size of the individual field and the complexity of the slopes, contour tillage and cropping programs may not be practical. In cases such as this, cross-slope farming might prove advantageous.

Strip cropping should be used in conjunction with other good soil management practices such as crop rotations, cover crops, conservation tillage, grassed waterways, etc., to be most effective in reducing soil erosion and maintaining long-term soil productivity.

1.2 Statement of Problem

John Lichti of Avon Head Farms, in co-operation with the Stratford/Avon River Environmental Management Project, began a strip cropping program in the spring of 1981. The farm is located in the uppermost extent of the Avon Basin on Lots 13-15, Concession II of North Easthope Township. This area falls within the Stratford/Avon Project's Demonstration Sub-Watershed (see SAREMP Technical Report R-13).

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(1) Upper Thames River Conservation Authority, Avon Valley Plan. 1952. Page 9.

(2) Ibid. Page 8.

(3) P.L.U.A.R.G. Evaluation of Remedial Measures to Control Non-Point Sources of Water Pollution in the Great Lakes Basin. International Joint Commission. 1977.

The topography in the area is rolling with predominantly silt loam soils, although complexes fran a number of soil textures are common. The agricultural land immediately surrounding the upper reaches of the Avon Municipal Drain had been cropped in continuous corn for about eleven years previously. The long, simple slopes making up the approximately 150 acre field drained directly into the Avon (see Figure 1). Critical slopes average about 10 percent. The gently sloped acreages adjacent to the drain are, for the most part, systematically tile drained; only random runs serve the upper areas of the field.

Cross-slope farming has been practiced on the land for some time. Tillage was kept to an acceptable minimum involving one pass with a moldboard plough in the fall and one pass with a disc in spring prior to planting.

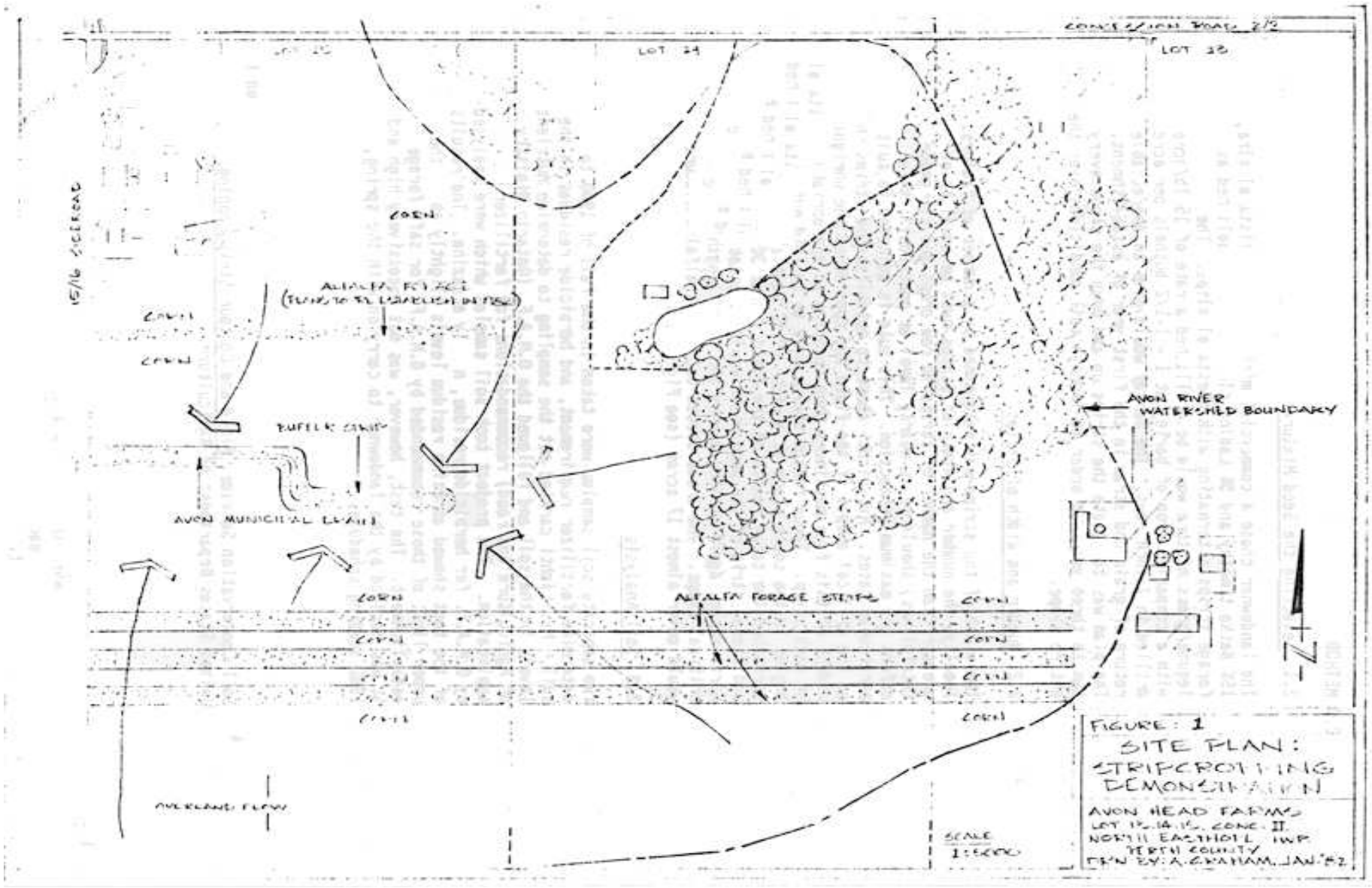
However, regardless of this moderate till age program, the soil problems associated with the continuous corn crop led to very noticeable erosion and may have caused reduced soil productivity.

Severe sheet and rill erosion was taking place on the slopes. This was evidenced by the loss of topsoil on the hills and the subsequent sediment build-up in the Avon Municipal Drain. In addition, gully erosion was progressing in a couple of locations where overland flow had been concentrated.

Mr. Lichti had already considered practicing strip cropping at the site prior to his involvement with SAREMP. He was attracted by the prospect of reduced soil erosion and improved soil productivity. Moreover, he required a forage crop for a newly established dairy goat herd. He had given further consideration to the use of grassed waterways along some erosion-prone draws, but chose to decide on their implementation only after the impact of strip cropping could be fully assessed.

The project had co-operated with the landowner in 1980 in conducting a drain cleanout demonstration on the Avon Municipal Drain. This work involved stabilizing the drain banks, properly protecting the tile outlets and establishing permanent buffer strips. The drain clean-out was completed in the fall of 1980 and is detailed in SAREMP Technical Report R-5.

The landowner invited the project to assist him with initiating the strip cropping program. The project offered both technical advice and financial assistance in the form of a 60% subsidy on capital costs. Terms of the assistance are laid out according to the Engineering Practice Agreement (see Figure 2).


CONCESSION ROAD 2/3
LOT 13
LOT 12
15/16 SIDEROAD
CORN
ALFALFA FORAGE STRIPS
(PLANTED TO BE HARVESTED IN 1992)
BUFFER STRIP
AVON MUNICIPAL DRAIN
AVON RIVER
WATERSHED BOUNDARY
OVERLAND FLOW
SCALE
1:4000
FIGURE: 1
SITE PLAN:
STRIPCROPPING
DEMONSTRATION
AVON HEAD FARMS
LOT 13, 14, 15, CONC. II.
NORTH EASTHOPE TWP.
PERTH COUNTY
DRN BY: A. GRAHAM, JAN '92

2.0 METHOD

2.1 Selecting the Seed Mixture

The landowner chose a commercial mixture of 80% Vista alfalfa, 15% Basko timothy and 5% Ladino clover to be established as forage strips alternating with the corn strips. The legume/grass mixture would be drilled at a rate of 15 lb/acre with a companion crop of barley at 1 - 1½ bushels per acre drilled in 7 inch rows. The barley would give an appreciable return of grain and straw in the first year of establishment. The plan was to rotate the strips up and down the slope every two to three years in order to improve soil conditions over the entire slope.

2.2 Number and Width of Strips

The width of the strips was determined by a number of factors. Ideally, the number and width of strips must be equal to or greater than the number of strips in row crops and all grade (striplines) should be as nearly level as practical[4]; this offers the maximum protection. This rule is adjusted to suit particular cases. Mr. Lichti chose to establish the strips only on the critical slopes of the field and considered the working widths of this farm machinery when choosing an appropriate width of each strip. Three forage strips were to be laid out at right angles to the south slope at a width of 72 feet apiece; each stretched the total length of the field, about 3000 feet. An additional strip of the same width would be established on the north slope, again running across the total length of the critical slope. The areas seeded out to the alfalfa mixture would cover almost 17 acres (see Figure 1).

2.3 Soil Analysis

Two separate soil samples were taken in the fall of 1980 to determine fertilizer requirement, and herbicide residues in the soil. Mr. Lichti carried out the sampling to determine nutrient levels in the soil and followed the O.M.A.F. (Ontario Ministry of Agriculture and Food) recommendations for fertilizer application. The project took soil samples which were analysed by O.M.A.F. for herbicide residue, namely atrazine. The results of the test showed atrazine residue levels slightly above the upper limit of those recommended by O.M.A.F. for safe forage establishment. The test, however, was not excessively high and it was decided by

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[4] Soil Conservation Service, Field and Contour Strip cropping, United States Department of Agriculture.

the landowner to carry on with the spring, 1981 seeding schedule.

2.4 Seeding Operations

The strips were staked out by the landowner in preparation for seeding in the spring. The strips were aligned the across the slope to run straight east-west the length of the field. The seeding was done in April by the landowner using his own equipment.

In addition to the alfalfa strips, a red clover strip was added parallel to the other forage strips. The red clover would serve to build up the fertility and the physical characteristics of the soil before it was ploughed down in the fall of 1981.

2.5 Costs

Pursuant to the Engineering Practice Agreement, the Stratford/Avon Project offered a subsidy to the co-operator of 60% of the total capital costs.

Only the forage mixture was subsidized by the Stratford/Avon Project. This was the decision made by the landowner. The costs associated with fertilizer, barley and the red clover seed were paid for entirely by Avon Head Farms.

The costs associated with the forage mixture were as follows:

210 kg of Forage Mixture @ $6.255/kg	= $ 1,313.55
60% Stratford/Avon Project	= $ 788.13
40% Co-operator	= $ 525.42

No attempt has been made to assess the impact on net farm income resulting from the shift to a strip-cropping rotation on this farm. Analysis of this sort is given in SAREMP Technical Report E-6 entitled "Crop Production Impacts of Management Measures to Control Soil Erosion".

3.0 RESULTS

The alfalfa forage strips and the barley companion crop both established well on the south slope. Atrazine residual levels proved not to be a major problem, as only very small areas of the forage and barley were killed out. However, the sod strip on the north slope suffered severe stress, resulting in a very poor, weed infested stand. This was attributed to critical levels of residual atrazine. This strip was ploughed under in the fall of 1981.

Vigorous growth of the alfalfa mixture was noticed after the barley had been harvested. By fall, a very acceptable sod cover had established on all 3 of the strips on the south slope. There were no forage cuts taken off in the seeding year. The red clover stand also displayed good growth before it was turned under in the fall.

Corn grain yields were taken from various locations in the field including the strips which alternated with the forage crop. This exercise will be repeated annually in an attempt to record any yield differences which may be attributed to the improved soil management practices.

The landowner did not encounter any major problems or inconveniences when laying out the strips or during the tillage, planting and harvesting operations.

4.0 DISCUSSION

The landowner plans to re-establish the forage strip on the north slope in spring of 1982. He is also seriously considering the inclusion of grassed waterways in this land management scheme. He is satisfied with his present tillage practices on this property and has no immediate plans to change them in any way.

Significant overland flow was not observed by project staff in the 1981 growing season which could give some kind of indication of how effective the strip cropping efforts are in controlling surface runoff.

The perceived reductions in sheet and rill erosion will be monitored visually over the course of the seasons. Future crop yields will also give an indication of improved soil conditions.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

A number of good soil conservation practices have been implemented by the landowner of this particular property; some have been done in co-operation with the Stratford/Avon Project.

These measures will have a beneficial effect on his own soil productivity as well as on downstream water quality. The strip cropping and minimum tillage practices are intended to keep the productive topsoil on the field and cut erosion losses by reducing runoff velocity and promoting infiltration of the surface water. In this particular case, the change in land management has allowed the farmer to introduce a forage rotation into what was previously a continuous corn cropping system. Implementation of additional conservation practices in the future (i.e. grassed waterways) could further improve soil conservation on this farm.

The conservation practices carried out on the land were complimented by erosion control measures undertaken on the Avon Municipal Drain. This work included improved cleanout techniques, tile outlet protection, bank stabilization, as well as buffer strips alongside the watercourse.

The topography of this particular farm is common to the upper watershed area of the Avon River basin. It is characterized by long, rolling hills and numerous soil types and is very susceptible to soil erosion. There are many proven conservation practices which can be implemented relatively easily by landowners. These practices reduce erosion, contribute to the maintenance of soil productivity and improve downstream water quality by reducing sediment loadings.

The same strip cropping technique used for water erosion control can also be used for wind erosion control. Strips are placed at right angles to the direction of the prevailing wind.

5.2 Recommendations

The following are recommendations (some resulting from the demonstration) which may apply to other landowners initiating strip cropping as a land management option:

a) Strip cropping is most effective when combined with other soil management practices such as crop rotations, cover crops, conservation tillage, grassed

waterways, etc.

b) The width of strips is determined by any number of factors:

- the type and severity of the erosion problem, ideally the number and width of forage strips must be equal to or greater than the number of strips in row crops.

- keep working widths of farm equipment in mind; this will help to choose a convenient width for the strips.

- aim for an even number of passes on the strips so farm machinery working the strip can finish up at the starting end of the field.

c) Survey the position of the first strip. The contour of the first strip may then have to be changed slightly to a practical alignment within the field.

d) The protective crop chosen to alternate with the erosion-susceptible row crop must be compatible with the particular farm operation. That is, the farmer must have means of planting and harvesting as well as a use or ready market for the crop. Forage is the best alternative, but other close-growing crops such as cereal grains may be effective in the alternate strips; providing the widths and number of the individual strips are sufficient to slow the surface runoff and promote infiltration.

e) Be sure before planting that there are no critical levels of residual herbicide (i.e. atrazine) in the soil where the strips of forage or cereal grains are to be established.

APPENDICES

APPENDIX 1

METRIC EQUIVALENTS

LENGTH

inch	= 2.54 cm	millimetre	= 0.039 in.
foot	= 0.3048 m	centimetre	= 0.394 in.
yard	= 0.914 m	decimetre	= 3.937 in.
mile	= 1.609 km	metre	= 3.28 ft

AREA

square inch	= 6.452 cm^2	cm^2	= 0.155 sq in.
square foot	= 0.093 m^2	m^2	= 1.196 sq yd
square yard	= 0.836 m^2	km^2	= 0.386 sq mile
square mile	= 2.59 km^2	ha	= 2.471ac

VOLUME (DRY)

cubic inch	= 16.387 cm^3	cm^3	= 0.061 cu in.
cubic foot	= 0.028 m^3	m^3	= 31.338 cu ft
cubic yard	= 0.765 m^3	hectolitre	= 2.8 bu
bushel	= 36.368 litres	m^3	= 1.308 cu yd
board foot	= 0.0024 m^3		

VOLUME(LIQUID)

fluid ounce(imp)	= 28.412 ml	litre	= 35.2 fluid oz
pint	= 0.568 litre	hectolitre	= 22 gal
gallon	= 4.546 litres		

WEIGHT

ounce	= 28.349 g	gram	= 0.035 oz avdp
pound	= 453.592g	kilogram	= 2.205 lb avdp
hundredweight(imp)	= 45.359 kg	tonne	= 1.102 short ton
ton	= 0.907 tonne		

PROPORTION

1 gal/acre	= 11.232 litres/ha	1 litre/ha	= 14.24 fluid oz/acre
1 lb/acre	= 1.120 kg/ha	1kg/ha	= 14.5 oz avdp/acre
1 lb/sq in.	= 0.0702 kg/cm^2	1 kg/cm^2	= 14.227lb/sq in.
1 bu/acre	= 0.898 hl/ha	1 hl/ha	= 1.112 bu/acre

APPENDIX 2: ENGINEERING PRACTICE AGREEMENT

This agreement between:
Stratford-Avon Environmental Management Project (SAREMP)

and

_____

Co-operator

1. The Co-operator agrees to assist the with implementation of the following soil conservation practices on his property as noted below:

   _____

   _____

2. The Co-operator agrees that for the purposes of demonstration, practices shall be accessible for viewing by others, that photographs may be taken for documenting the success of the practice, and that a sign may be installed identifying the practice as part of a Project.
3. The **SAREMP** and the Co-operator. jointly agree to undertake the above-noted demonstration in accordance with this Agreement and the plans and specifications attached hereto.
4. Modifications to the demonstration specifications and/or Agreement may be made in the future, subject to the approval of both Co-operator and **SAREMP**
5. The **SAREMP** agrees to have a staff member or representative at the site to oversee the implementation of the demonstration, according to the demonstration specifications. If none are available, the Co-operator agrees to keep detailed records on all activities at the site during that period.

6. The Co-operator agrees to have at the demonstration site, in working order, those machines to be provided by him, as stated in the demonstration specifications. The Co-operator should be available to operate such tractors and/or machinery.
7. The **SAREMP** agrees to document changes in each project (eg. grass establishment on grassed waterways), throughout the life of the demonstration.
8. The Co-operator agrees to maintain the demonstration according to the specifications, for at least 3 years from the time of installation.
9. Should the **SAREMP** staff or the Co-operator note any problems that could jeopardize the success of the demonstration, both parties will be notified, and mutually acceptable, appropriate, corrective measures undertaken.
10. The Co-operator agrees not to undertake any cultural practices in the demonstration area without the consent of the **SAREMP** staff.
11. The **SAREMP** agrees to inform the Co-operator when a tour stop is to be made at the site, and will invite, on occasion, the Co-operator to attend the site while the tour is being conducted.
12. The **SAREMP** agrees to pay 60% of the total cost (exclusive of project staff and Co-operator labour), of the engineering practices noted above, subject to the satisfactory completion of the project and the provision of acceptable invoices.
13. Financial assistance will be made available by **SAREMP** in the following manner:

    _____

    _____

    _____

14. The Co-operator agrees to release the project, its staff and associated agencies from all liability which might arise as a result of the activity proposed.

_____ _____

Co-operator Program Co-ordinator

Date: _____

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
S-7 Alternative Methods of Reducing Aquatic Plant Growth in the Avon River
S-8 Dispersion of the Stratford Sewage Treatment Plant Effluent into the Avon River
S-9 Avon River In-stream Water Quality Modelling
S-10 Fisheries of the Avon River
S-11 Comparison of Avon River Water Quality During Wet and Dry Weather Conditions
S-12 Phosphorus Bioavailability of the Avon River
S-13 A Feasibility Study for Augmenting Avon River Flow by Ground Water
S-14 Experiments to Control Aquatic Plant Growth by Shading
S-15 Design of an Arboreal Shade Project to Control Aquatic Plant Growth

U-1 Urban Pollution Control Strategy for Stratford, Ontario - An Overview
U-2 Inflow/Infiltration Isolation Analysis
U-3 Characterization of Urban Dry Weather Loadings
U-4 Advanced Phosphorus Control at the Stratford WPCP
U-5 Municipal Experience in Inflow Control Through Removal of Household Roof Leaders
U-6 Analysis and Control of Wet Weather Sanitary Flows
U-7 Characterization and Control of Urban Runoff
U-8 Analysis of Disinfection Alternatives

R-1 Agricultural Impacts on the Avon River - An Overview
R-2 Earth Berms and Drop Inlet Structures
R-3 Demonstration of Improved Livestock and Manure Management Techniques in a Swine operation
R-4 Identification of Priority Management Areas in the Avon River
R-5 Occurrence and Control of Soil Erosion and Fluvial Sedimentation in Selected Basins of the Thames River Watershed
R-6 Open Drain Improvement
R-7 Grassed Waterway Demonstration Projects
R-8 The Controlled Access of Livestock to Open Water Courses
R-9 Physical Characteristics and Land Uses of the Avon River Drainage Basin
R-10 Strip cropping Demonstration Project
R-11 Water Quality Monitoring of Agricultural Diffuse Sources
R-12 Comparative Tillage Trials
R-13 Sediment Basin Demonstration Project
R-14 Evaluation of Tillage Demonstration Using Sediment Traps
R-15 Statistical Modelling of In-stream Phosphorus
R-16 Gully Erosion Control Demonstration Project
R-17 Institutional Framework for the Control of Diffuse Agricultural Sources of Water Pollution
R-18 Cropping-Income Impacts of Management Measures to Control Soil Loss
R-19 An Intensive Water Quality Survey of Stream Cattle Access Sites