SWEEP-PILOT WATERSHED PROGRAM

Master Implementation Plan
Soils and Agronomy

Prepared by:
Conservation Management Systems

For:
Agriculture Canada

November, 1988

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1.0 INTRODUCTION

The Master Implementation Plan (MIP) is a document that lays the foundation for implementation of the Pilot Watershed Project (PWP) of SWEEP. In this report the MIP is presented for agronomic aspects of the Pilot Watershed Project - namely the soil, crop, social and economic dimensions of the project.

The goal of the PWP is:

> To develop approaches to and evaluate the effectiveness of implementing comprehensive soil and water conservation practices on all farms in selected watersheds.

This goal calls for the comprehensive implementation of conservation farming practices on all farms in a small watershed and the subsequent monitoring of this "test" watershed and a paired "control" watershed over a period of several crop seasons in order to detect field, farm and watershed scale effects of implemented measures. To be of value to the farming community, public agencies and others, findings of the study must be effectively communicated.

Preparation of the MIP culminates a planning phase for the PWP involving watershed selection and the development of procedures for monitoring and analysis, for working with farm cooperators and for project administration. Its completion marks the initiation of the on-farm phase of the PWP commencing with farm planning and basin instrumentation.

The purpose of the MIP is to provide a blueprint for implementation of the on-farm phase of the PWP. The objectives pursued in preparation of the MIP correspond to the themes of report chapters that follow; these are:

- To characterize study watersheds, the associated soil and water conservation issues and the conservation farming practices that speak to these issues;

- To outline research needs, data requirements and monitoring protocols that will enable an analysis of the agronomic effects of implemented measures;

- To describe on-farm implementation plans including farm planning methods and arrangements for record keeping and cooperator compensation.

- To outline administrative arrangements for technical coordination and communications.

2.0 SOIL AND WATER CONSERVATION IN THE STUDY WATERSHEDS

2.1 Overview of Study Watersheds

The broad study area of the PWP is the Lake Erie Watershed. Estimated erosion rates for this area are presented in Figure 1.1. Project activities will be conducted within small sub-watersheds, approximately 400 ha in size, that are representative of broader regions with similar physiographic characteristics (Figure 1.2). Agriculture within these sub-watersheds must be of a commercial scale and should typify the predominant crop and livestock systems found in southwestern Ontario.

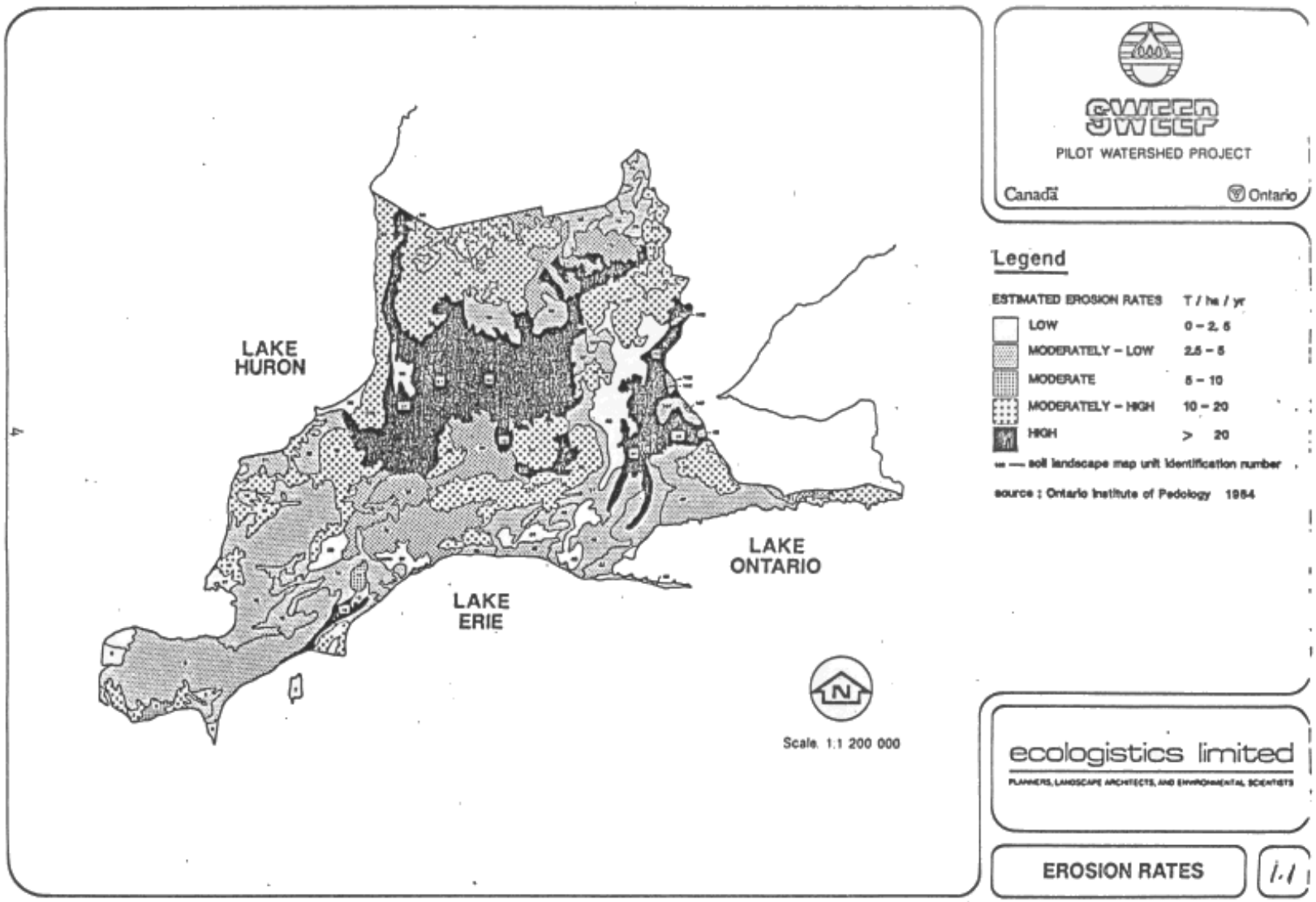
It is also important that the study watersheds be representative of the cross section of landscape types that are contributing phosphorus to Lake Erie. A classification of the study area in terms of phosphorus loading potential was developed by Miller and Spires (1978) (Figure 1.3). Major landscape groupings of interest in this classification are the highest class - P load > 1.4 kg ha^{-1} yr^{-1} - centred in the Essex region, and then the two most predominant classes - 0.51 to 0.80 kg P ha^{-1} yr^{-1} and 0.81 to 1.1 kg P ha^{-1} yr^{-1}.

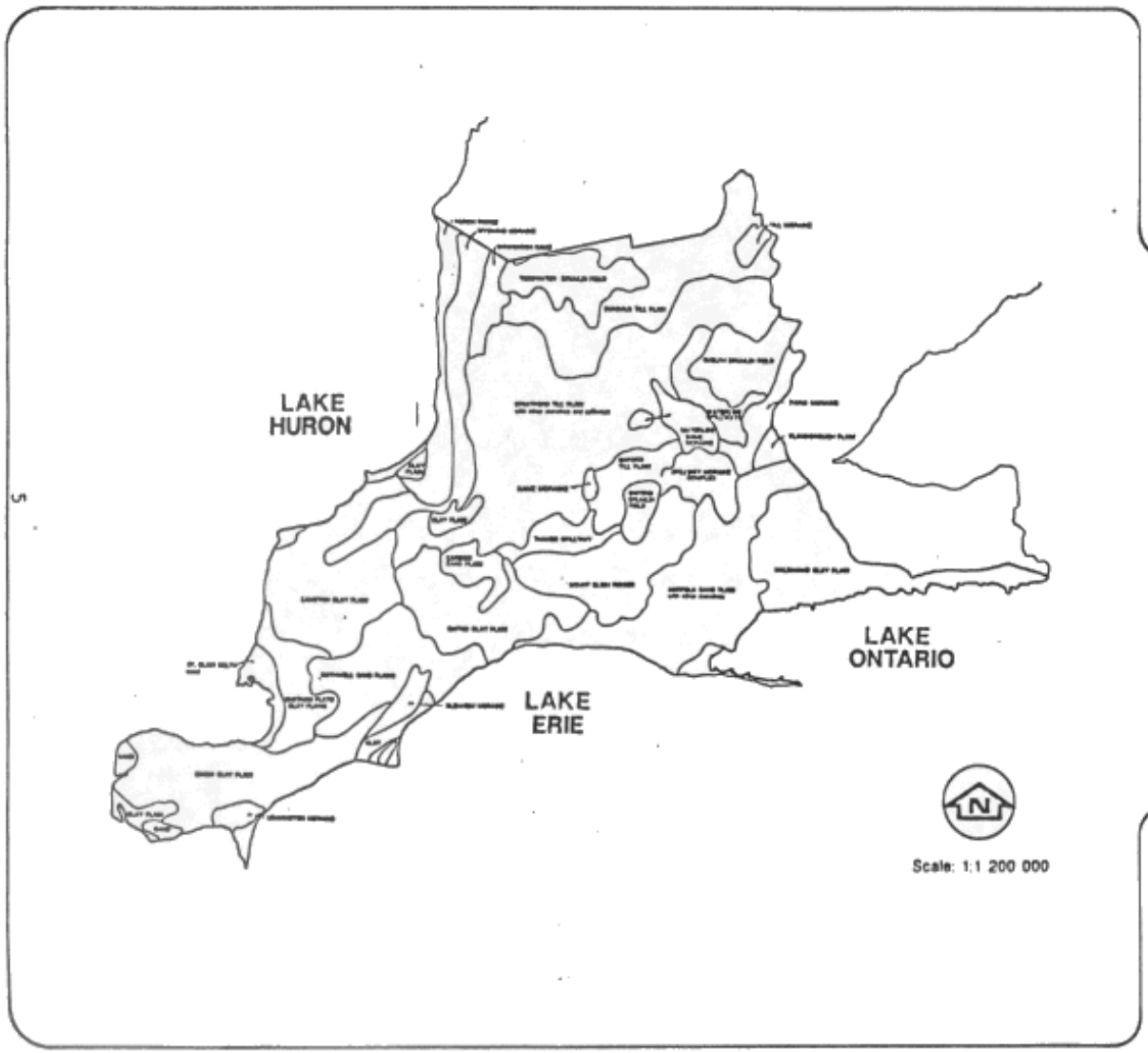
An intensive search for small paired watersheds typifying major landscape groupings and exhibiting suitable land use practices was conducted throughout the Lake Erie Watershed (Ecologistics Limited, 1988). This search resulted in the final selection of the following three pairs of watersheds (Figure 1.4):

- Second and Fifth Concession Drains in the Belle River watershed in Maidstone Township, Essex County;

- The Madter and East Drains flowing to Kettle Creek in Westminster Township, Middlesex County;

- The Goring and Webber Drains in the Thames River watershed in East Zorra-Tavistock Township, Oxford County.


LAKE HURON
LAKE ONTARIO
LAKE ERIE
N
Scale 1:1 200 000
GWEEP
PILOT WATERSHED PROJECT
Canada
Ontario
Legend
ESTIMATED EROSION RATES
T / ha / yr
LOW
0 – 2.5
MODERATELY – LOW
2.5 – 5
MODERATE
5 – 10
MODERATELY – HIGH
10 – 20
HIGH
> 20
soil landscape map unit identification number
source : Ontario Institute of Pedology 1984
ecologistics limited
PLANNERS, LANDSCAPE ARCHITECTS, AND ENVIRONMENTAL SCIENTISTS
EROSION RATES
1.1



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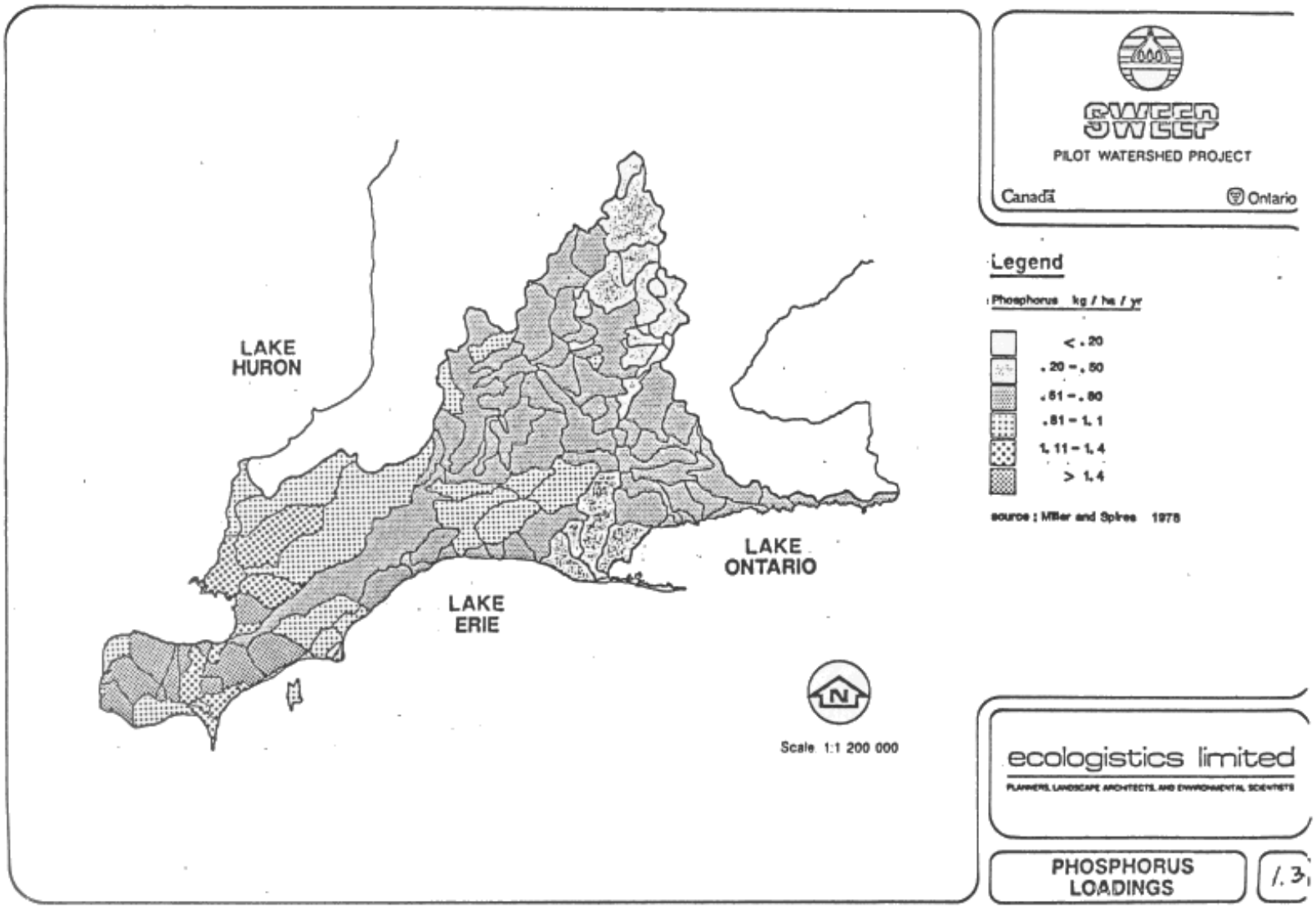
PHYSIOGRAPHIC FEATURES

1.2


LAKE HURON
LAKE ONTARIO
LAKE ERIE
N
Scale 1:1 200 000
GWEEP SWEEP
PILOT WATERSHED PROJECT
Canada
Ontario
Legend
Phosphorus kg / ha / yr
< .20
.20 - .50
.51 - .80
.81 - 1.1
1.11 - 1.4
> 1.4
source : Miller and Spires 1978
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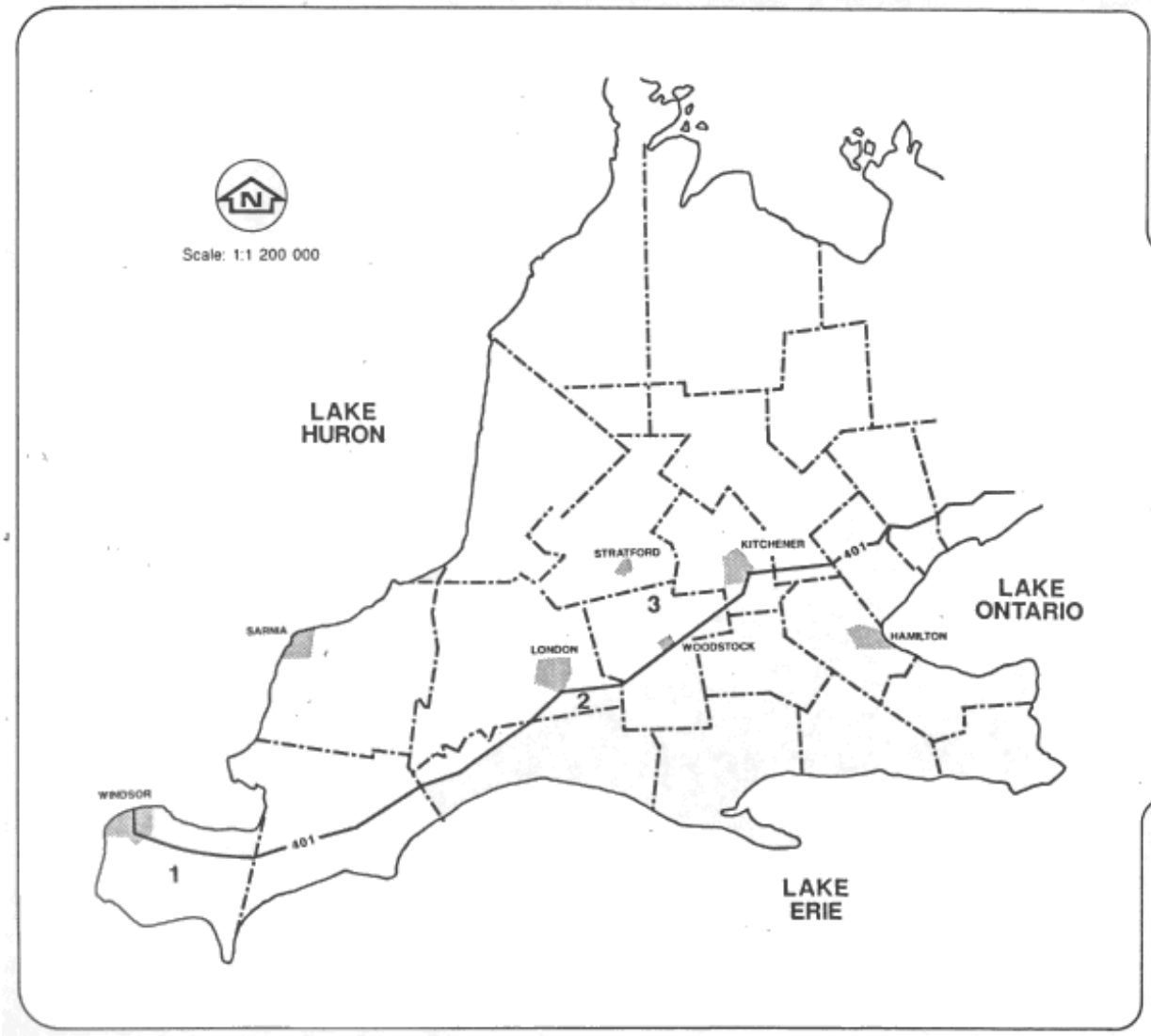
PLANNERS, LANDSCAPE ARCHITECTS, AND ENVIRONMENTAL SCIENTISTS
PHOSPHORUS LOADINGS
1.3



GREAT LAKES GREEN CLEAN

PILOT WATERSHED PROJECT

Canada Ontario

Legend

1 ESSEX REGION (Belle River Watershed), MAIDSTONE TOWNSHIP, ESSEX COUNTY.

2 KETTLE CREEK, WESTMINSTER TOWNSHIP, MIDDLESEX COUNTY.

3 PITTOCK (Thames River Watershed), EAST ZORRA-TAVISTOCK TOWNSHIP, OXFORD COUNTY.

CMS conservation management systems

CONSULTANTS IN SOIL CONSERVATION AND WATER MANAGEMENT

WATERSHED LOCATIONS 1.4

Essex Region

The Essex region is part of the extensive clay plains covering most of Essex County and parts of Kent County. The surface is a till plain draining largely north into Lake St. Clair. The area has a level topography with somewhat more relief to the south of low lying areas adjacent to Lake St. Clair. The predominant soil found in this basin is Brookston clay. Brookston clay is defined as a poorly drained clay and clay loam till composed of limestone material. It is stone free and very gently undulating. It has developed under a swamp forest of trees such as elm, black ash and white ash. Dredged ditches and subsurface tile drains are used throughout the area to overcome the poor drainage of this soil.

The basin is part of the North American corn belt. Grain corn is the most widely grown crop. Also of importance here are soybeans, hay and winter wheat.

The two watersheds in Maidstone Township (Figure 1.5) are typical of the Essex Region in terms of both soils and crops. Only 2 out of 27 operations have livestock with forage based rotations; others have cash crop rotations based for the most part on corn, soybeans and small grains.

Pittock Basin

The Pittock basin runs from north of Tavistock to Innerkip in the south. This basin is found in the Oxford Till Plain, with its gently rolling slopes, good drainage and medium textures. The major soil found in this basin is Tavistock silt loam. Tavistock soil is an imperfectly drained silt loam of lacustrine origin moderately deep over clay loam till. It is stone free and easily tilled. Embro and Honeywood silt loans are also found in this basin. Embro is an imperfectly drained and Honeywood a well drained silt loam of lacustrine origin. They have moderate depth over a loamy till and are also stone free and easily tilled. In addition, Guelph loam soil is also found within this basin and is a well drained loamy till of mainly dolomitic origin.

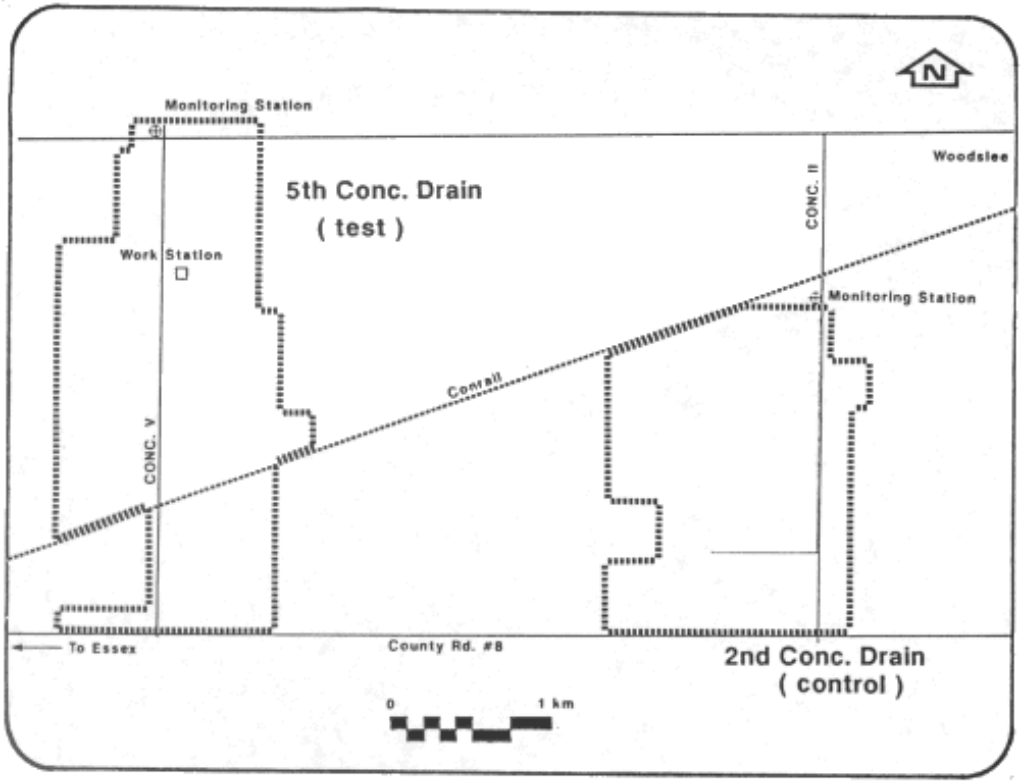
The Webber and Goring Drain watershed areas (Figure 1.6) exhibit long gentle slopes. Most watercourses within the basins have been connected to buried main drains and tile drainage is common. Livestock and cash crop operations are found in roughly equal proportions as are row and hay or mixed cropping systems.

Kettle Creek Basin

This basin is located in the complex of moraines known as the Mount Elgin Ridges. This includes southeastern Middlesex County, southern Oxford and parts of adjoining Elgin. The topography tends to be rolling, being made up of morainal ridges and hollows. The two major landform components of this region have contrasting soils. The ridges are well drained soils made up of silty clay and silty clay loam till. These are muriel soils described as being calcareous soils slightly stony with limestone as its primary material. The other major landform component is the imperfectly or poorly drained soil, made up of varying depths of eroded silt loam covering the glacial material below. These soils are Bennington silt loams.

Bennington silt loam is described as a cap of loam or silt loam lacustrine material overlying the silty clay till material beneath and is stone free.

The Madter and East Drain watershed areas (Figure 1.7) exhibit long rolling slopes to the north and gently undulating relief across the south. Row crop and grain cropping systems are common; some forage crops are associated with beef and dairy operations. There are few fences in the watersheds.



CANADA-ONTARIO AGREEMENT RESPECTING GREAT LAKES WATER QUALITY

PILOT WATERSHED PROJECT

Canada Ontario

MALDSTONE TOWNSHIP
ESSEX COUNTY

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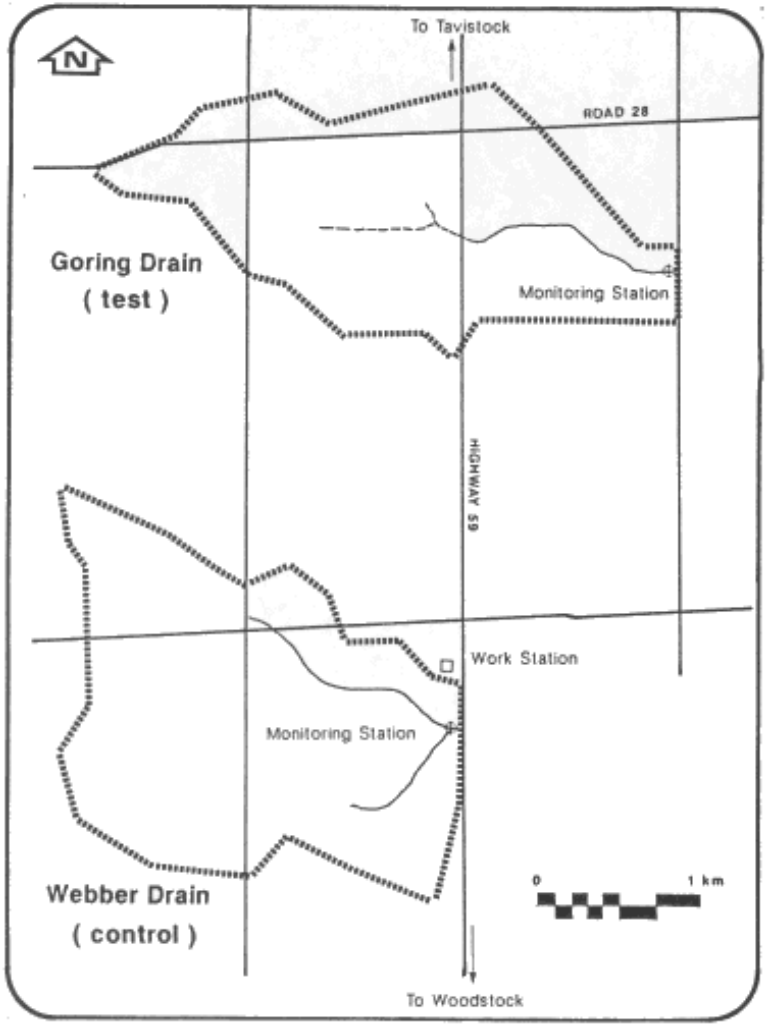
FINAL SUB-WATERSHEDS
ESSEX AREA

1.5



SWEEP
PILOT WATERSHED PROJECT
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Ontario

EAST ZORRA-TAVISTOCK
TOWNSHIP
OXFORD COUNTY

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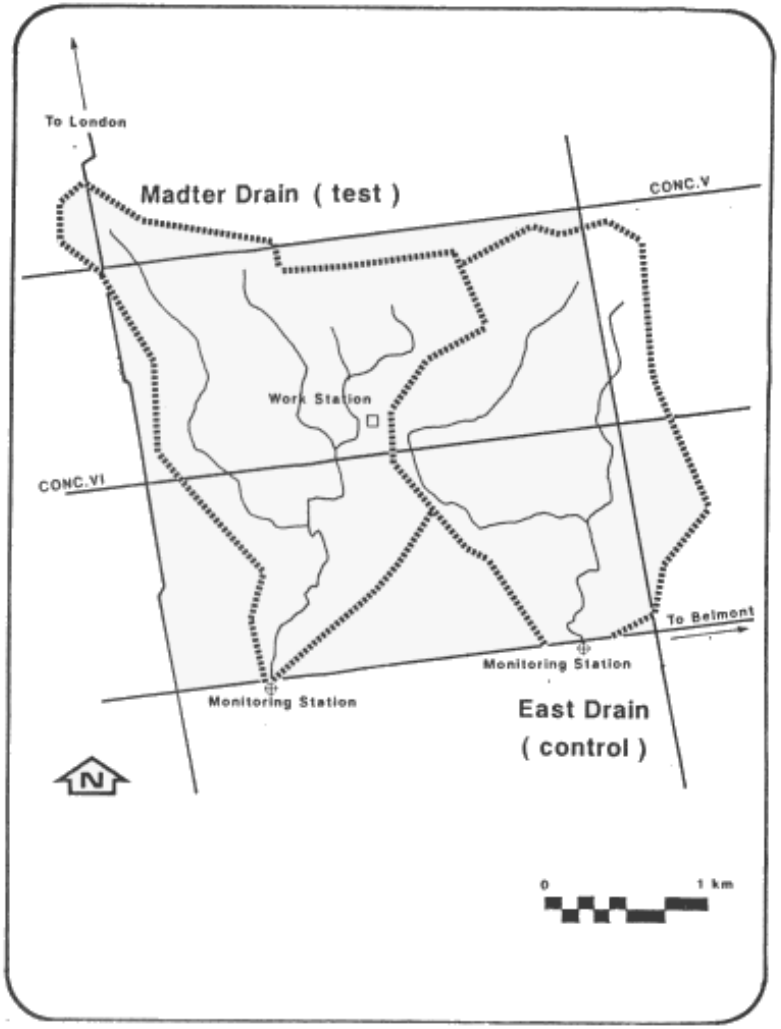
FINAL SUB-WATERSHEDS
PITTOCK

1.6



GREAT LAKES SWEEP
PILOT WATERSHED PROJECT
Canada
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WESTMINSTER TOWNSHIP
MIDDLESEX COUNTY

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FINAL SUB-WATERSHEDS
KETTLE CREEK

1.7

2.2 Summary of Soil and Water Conservation Issues

The pilot watershed program is expected to address a number of soil and water conservation issues. At the forefront are the issues of phosphorus loadings to Lake Erie from cropland run-off and the decline of agricultural productivity of soil due to erosion and related causes.

These issues are inter-related. For example measures to conserve cropland soil affect the soil's productivity, and also effect the amount of phosphorus entering the watercourse from that same cropland. The paired watersheds are representative of several landscape types found in Ontario; therefore the major concerns vary among paired watershed sites.

Essex Paired Watersheds

For the Essex watershed, its very gently undulating topography results in a relatively low rate of soil erosion on the basin's cropland area. The poorly drained, fine textured Brookston clay which forms the watershed's landbase, however, produces elevated phosphorus loading levels which are in direct contrast to the gross erosion rates. The combination of poor drainage and finely textured soils result in soil particles being suspended in run-off water for long periods of time. Consequently the soil that is detached from the soil mass has a high probability of remaining in suspension long enough to enter the stream waters. Phosphorus has a greater affinity to fine clay particles than other textural classes and this gives rise to a higher phosphorus to sediment ratio in Essex soils than with other soil types.

Another issue which is present in all of the test watersheds, but is perhaps most dominant in the Essex watershed, is soil degradation resulting from compaction. Use of heavy farm equipment has contributed to this problem under continuous row cropping conditions. Any improvement in soil structure in the study areas is expected to have a positive effect on crop yields and can reduce soil and phosphorus loss by increasing soil permeability and reducing runoff.

Pittock Paired Watersheds

The Pittock catchments are mid-way among the three pairs of basins in terms of topography and represent the largest landscape type contributing phosphorus to Lake Erie. The gently rolling topography combined with medium textured soils and a trend towards livestock-based farm operations gives rise to relatively low rates of gross erosion. However, sediment loading from this watershed is suspected to be higher from these watersheds than for the Essex basin. Due to the coarser soil texture and higher natural infiltrability of the watersheds' soils, the phosphorus to sediment ratio in runoff is expected to be lower than in Essex.

The presence of livestock operations in this watershed could result in point and non-point sources of phosphorus loading from manure.

Kettle Paired Watersheds

The Kettle watersheds possess the most rolling landscape of the three. When this is combined with row cropping and silt loam textured soils, the potential exists for high erosion rates. Slowing the rate of field erosion will have a direct positive effect on the amount of phosphorus and thus the quality of water entering the stream.

This watershed pair is mid-way in terms of the number of livestock operations found within its boundaries. Manure sources of phosphorus may be an issue on some farms.

2.3 Soil and Water Conservation Measures

Conservation measures can be categorized as follows:

a) Conservation Cropping (e.g. rotations, winter cover crops)
b) Conservation Tillage (e.g. minimum tillage, reduced depth)
c) Conservation Structures (e.g. berms, drop inlets)

Conservation measures to be implemented within each of the three test watersheds are generally proven technologies that have been implemented previously in southern Ontario to address the issues of reducing soil erosion rates and phosphorus loads to receiving waters.

Essex Watershed

Farm operators and project staff are considering measures which improve soil structure, prevent fine-textured soils from eroding and have the capability to filter out suspended fine sediment. These include such practices as growing cereals and legumes in rotation with row crops to begin improving soil structure, maintaining residue cover on the soil surface and placing hay-based crop filter strips along the banks of the major open waterways.

Note that the choice among tillage systems available to the landowner for maintaining adequate residue cover is limited for the Essex area. The no-till option may only be acceptable for planting winter cereals. Spring use of this system for corn, soybeans and spring cereals may have limited acceptability due to the predominance of Brookston clay soils and inherent problems with high soil moisture content during seedbed preparation and planting.

Minimum tillage using a coulter-chisel plough with either twisted shanks or sweeps may also have limited acceptability. The chisel plough works best when soil is relatively dry. These conditions are mainly found during the summer months of July, August and September after cereal harvest and in some cases after sweet corn or soybean harvest. Chisel ploughing will not be recommended during October and November after soybeans and corn due to the high potential for wet soils.

Minimum tillage using modified (cut-off) moldboards or the moldboard plough adjusted to leave as much residue on the soil surface as possible should have wide cooperator acceptance but varied effectiveness from a residue management standpoint.

Site specific ditchbank erosion problems will also need to be addressed through the installation of structures such as rock rip-rap, drop inlets and protected tile outlets.

Pittock Watershed

Strategic placement of crops currently being grown in the watershed is one of a variety of erosion control measures which farm operators and project staff will consider. The means to integrate conservation tillage practices with livestock farming and its related manure production will also need to be fully explored.

The Pittock landowners have a greater number of conservation alternatives than their counterparts in Essex. Their present rotation system is expected to be used and built on to assist in erosion control. The medium textured soils make all forms of conservation tillage appear to be reasonable alternatives at this point, the final choice being a function of the desired level of protection and landowner preference.

Most of the major concentrations of surface water flow are already tied in with subsurface tile systems. Protecting some of these runs with a system of berms and/or an overlying grassed waterway may be necessary as will rock protection at the outlet of major surface and tile flows into the open ditch.

Kettle Watershed

In the Kettle test basin, a number of erosion control solutions could be implemented given the extent of the erosion problem and the variety in farm operations. Residue management by means of conservation tillage will likely be the first consideration for cash crop landowners in the watershed. For the areas showing signs of gullying resulting from concentrated surface water flow, conservation structures such as grassed waterways, and water and sediment control basins may be installed. For the livestock operations, improved use and placement of hay crops will also be an option. Strip cropping may be considered by some of the cooperators.

2.4 Socioeconomic Considerations In Soil and Water Conservation

Demonstrating the effectiveness of the PWP will be a function of the degree to which participating producers agree to implement soil conservation measures complementary to the physical and management characteristics of their farms. Producers will have had varying degrees of exposure to and experience with conservation practices prior to PWP inception, which will influence the way they respond to the conservation measures offered within the PWP.

A number of socioeconomic factors are known to influence farmer decision-making with regard to the adoption or adaptation of conservation practices (Nowak, 1983).

These include:

- the physical (ecological) characteristics of the farm
- the characteristics of the conservation technology or practice
- personal characteristics, perceptions and preferences
- community values and norms
- characteristics of the farm economy

These factors in turn are influenced by the availability and quality of the education, research, marketing and economic incentive programs in place at any point in time. It is evident that there are no quick, technological solutions that are widely applicable and acceptable in all erosion control situations.

In each of the three paired watersheds, adoption rates, changes in landowner perceptions and attitudes, and the social and economic impacts of the conservation measures on both a watershed and an individual farm enterprise scale will be monitored and evaluated to determine the most appropriate measures relative to the conditions in the three study areas. Economic impacts will focus on the selection of tillage and cropping combinations which are most effective and economical in each watershed.

The procedures for the agronomic and socioeconomic monitoring work are outlined in Section 3.0 of this report.

3.0 MONITORING AND ANALYSIS

3.1 Research Format

The research format of the PWP has the following key features:

– comparative evaluation based on control and test watershed areas
– field and farm-scale application of conservation farming measures throughout the test watershed
– a three year test period after instrumentation and implementation of farm plans

From an agronomic point of view, effects of interest include:

– changes in tillage and planting practices
– changes in soil loss and in soil properties
– impacts on crop performance
– impacts on crop and general farm management
– shifts in the attitudes and perceptions of cooperators

Given the research format of the study, it will be possible to investigate such effects using both cross-sectional and time series information. Moreover, the watershed approach allows for a greater degree of integration and synthesis of information in order to evaluate effects from a systems perspective.

The watershed scale however also introduces considerable variability, that might more readily be controlled at a smaller scale. Such variability includes:

– variations in soils, topography and other physical characteristics
– climate variation through time and across watersheds
– variations in land use and crop management practices
– different levels of interest and ability among farm cooperators

Project effects will be the outcome of a complex interplay of these factors and the "designed" crop management systems that are implemented. Procedures for monitoring and analysis must therefore account for such extraneous sources of variation, enabling the study team to understand observed soil, crop and other project effects and to identify those effects related to conservation farming practices.

3.2 Soils and Soil Loss

The soil monitoring program is designed to document changes in soil characteristics over the study period, as well as to monitor soil conditions at key times in the production cycle. Monitoring changes in soil characteristics will assist in the estimation of soil loss from fields under various tillage and cropping practices. Specifically, the objectives of the soils monitoring program include:

– to assess the effect of conservation farming practices on soil characteristics
– to provide soils information needed in evaluating crop performance
– to contribute to the database required for estimating soil loss under conservation and conventional farming systems.

3.2.1 Approach to Soils Monitoring

With the information about the mapped soil series in hand (as provided by the soil survey contractor), benchmark sites will be established for soil monitoring over the study period. These will be situated on soil landscape positions where the most physical and chemical attribute change would be expected to occur within the project time horizon (i.e. shoulder slopes [erosion], toe slopes [deposition]).

Precise locations of benchmarks should be identified by scanning prospective soil landscapes with an electromagnetic induction meter (Geonics EM31 or EM38). By scanning along the slope contour, the influences of soil moisture content on the instrument reading should be minimized (Kachanoski et al., 1988) and an impression of lithological

TABLE 3.1 SOIL MONITORING APPROACHES

PARAMETER	LOCATION AND FREQUENCY	METHOD	COMMENTS
Particle Size Distribution	• all horizons in Year 1 • surface horizon thereafter	• pipette/s and fractionation	• critical to the determination of the K (soil erodibility)factor • coupled with the Cs-137 erosion rate method (Kachanoski and De Jong, 1984), changes in surface texture can indicate the extent of soil movement on a soil landscape through incorporation of subsoil horizon material with tillage on upper slope positions or deposition of finer fractions in depressional catchments
Organic Carbon	• all horizons in Year 1 • surface horizon thereafter	• modified Walkley-Black wet oxidation	• critical to determination of K factor
Water Permeability	• surface horizon thereafter	• Guelph "surface" permeameter	• critical to determination of K factor
Primary and Secondary Structure	• surface horizon thereafter	• visual morphological inspection	• critical to determination of K factor
Wet Aggregate Stability	• surface horizon thereafter	• A.S.T.M. • wet sieving	• wet aggregate stability has been shown to be one of the most sensitive physical parameters to past cropping history and a good index of soil structural integrity (B.D. Kay, per. comm.)
Dry Bulk Density	• 0-60 cm in 5 cm increments seasonally	• Campbell Pacific Nuclear Stratagauge	• important in assessing the influence that anthropogenic soil compaction or inherently tow total soil porosities have on soil erodibility
Soil Moisture (A)	• 0-60 cm in 5 cm increments seasonally	• Campbell Pacific Nuclear Stratagauge	• will help in assessing plant water deficit or surplus conditions as well as soil compactibility and erodibility

TABLE 3.1 – (Cont'd) SOIL MONITORING APPROACHES

PARAMETER	LOCATION AND FREQUENCY	METHOD	COMMENTS
Atterberg Consistency Limits	• all horizons in Year 1 • surface horizons thereafter	• standard A.S.T.M. (Casagrande) procedures	• can use field moisture content date to provide an indication of soil consistency (e.g. friable, plastic, fluid) at particular stages of the growing season, suitability for tillage operations (lower plastic limit moisture content is optimum) and likelihood of soil movement from sloping areas (probability high when moisture content exceeds upper plastic limit) (McBride, under review) • Atterberg limits can also be used to estimate the virgin compression line of soils for comparative compactibility assessment (McBride and Bober, under review)
Available Macronutrients, $CaCO_3$ equivalent, pH	• all horizons in Year 1 • surface horizon thereafter	• standard methods (Ont. Soil Test Laboratory)	• $CaCO_3$ equivalent end pH will provide an indication of the degree of existing erosion by the presence of free carbonates in the plow layer • crop yield is strongly correlated with the depth to the Ck horizon once the latter has been diminished to 50% or less of Its original depth in a non-eroded profile (Battison et al., 1987)
Cation Exchange Capacity	• all horizons in Year 1 • surface horizon thereafter	• NH_4 OAC method	• provides indication of capacity of the soil to retain and supply cationic nutrient ions.

TABLE 3.1 – Cont'd SOIL MONITORING APPROACHES

PARAMETER	LOCATION AND FREQUENCY	METHOD	COMMENTS
Soil Moisture (B)	• root zone during critical points in the crop production season	• I.R.A.M.S. Soil Moisture Analyser	• see above
Moisture Release Characteristics	• all horizons in Year 1 • surface horizons thereafter	• pressure plate apparatus at -10 Mpa and -1.5 kPa pressure potential	• this will provide a measure of the plant-available moisture holding capacity of the soil • estimated moisture retention curves using measured dry bulk density, particle size distribution and organic carbon content (McBride and Mackintosh 1984) can be compared to laboratory determined values for added interpretive information on the soil water regime
Particle Density	• all horizons in Year 1 • surface horizons thereafter	• pycnometer	• enables determination of air-filled porosity from any field (CPN) or lab (moisture release curve) simultaneous measure of dry bulk density end moisture content • air-filled porosities of less than about 0.10 $m^3 \bullet m^{-3}$ will cause root dysfunction and diminished crop growth and yield
Penetration Resistance	• 0-65 cm	• Rimik cone penetrometer	• along with measures of moisture content allows interpretation of mechanical impedance to root ramification • penetration resistance in excess of about 2.0 MPa will seriously restrict root elongation, density and distribution

consistency of soil parent materials can be obtained. Once that distribution of the sought after series parent material has been delineated, scanning perpendicular to the slope contour will give an impression of the catenary distribution with slope position (i.e. groundwater table position and internal drainage class). The final suitability of preferred benchmark locations so identified should be confirmed by soil profile inspection.

The absolute magnitude of the instrument readings also provides an indication of the nutrient status (i.e. solute concentration) of the soil to ensure that past cropping history has sustained a level of soil productivity consistent with the particular series or catena (McBride et al., under review).

Specific parameters to be monitored and associated soil profile locations and test methods are outlined in Table 3.1. All of these tests should be performed at all benchmarks. During collection of baseline data in year one, monitoring will be undertaken at additional monitoring sites selected at random within each soil series and in both test and control watersheds.

Additional locations for annual or more frequent determination of nutrient and soil moisture conditions will be determined in consultation with crop production specialists.

3.3. Crop Monitoring

The main goal of the PWP crops monitoring program is to assess the effect of conservation cropping and tillage practices on the growth, yield and residue management potential of a variety of crops.

The objectives of the crops monitoring program are as follows:

- To monitor whole plant or grain yields of various crops.
- To determine the proportion of the soil surface covered with crop residue at critical times in the cropping season.
- To monitor pests, soil fertility, weather and other factors that influence crop performance during the crop production season.

3.3.1 Approach

Crop monitoring activity will take place at two levels - watershed and field. Watershed-level monitoring implies comprehensive coverage of cropland in both test and control watersheds with measurements made at the whole field level. Field-level monitoring will rely on side-by-side test strips in the fields of selected cooperators. Parameters to be monitored and associated monitoring locations and methods are provided in Table 3.2.

P

In order to monitor those field conditions which may affect crop growth in both the test or control watersheds a crop scouting program will be carried out each year. Each field will be visited at critical times during crop development and when pest problems are likely to occur. In addition, daily weather patterns will be documented and soil fertility levels checked annually.

When identified, each pest or other problem will be rated for incidence and severity on a 0-5 scale on a per field basis. The growth stage of the crop will be identified when infestation occurs. Physical counts of pest organisms will only be done if absolutely necessary. Field monitoring will be conducted by walking a zigzag pattern across the fields, consistent with integrated pest management practices.

Prior to initiation of the program a complete field history for the last three years will be obtained and taken into consideration.

Appendix A contains further background information on the various components of the crop scouting program.

3.4 Socioeconomic Factors

Numerous factors are recognized as influencing cooperator's adoption behaviours including: the producer's personal characteristics; the community's norms and values; characteristics of the conservation practice or technology itself; characteristics of the physical land base, and the economic context.

TABLE 3.2 CROP MONITORING APPROACHES

PARAMETER	LOCATION AND FREQUENCY	METHOD	COMMENTS
Crop Yield (A)	• whole field every year	Options: • elevator weigh-in • count combine dumps • wagon or truck loads • weigh wagon (if necessary)	
(B)	• test strips (<.25 ha)	• weigh wagon	• 2-4 test strips per major crop per year per watershed on a representative soil type • subject to cooperator agreement
Grain or Plant Moisture Content	• for yields monitored on a whole field or test strip basis	• moisture meter	• measured at same time as yield sample
Residue Cover	• fields and test strips after harvest and in spring before planting and after planting (if time)	• knotted rope	• critical for estimation of soil erosion control potential
Crop Pests	• whole field periodically throughout the growing season	• crop scouting program	• method will vary by crop and includes: weed, insect, disease, monitoring; fertility problems; moisture stress; mechanical problems (e.g. planter) ; visual soil conditions

The main goal of monitoring socioeconomic factors is to examine the process of change in attitude and behaviour and the reasons for those changes as they relate to landowner decision-making about adoption of soil conservation practices. For example a conservation practice or technology shown to be effective on a given soil type and land form may remain unacceptable to a particular individual with a similar land base. Reason for the rejection must be understood so that the potential for change can be identified. The results of the socioeconomic analysis will enable the project and other agencies to make more informed judgements regarding potential changes in incentive programs to encourage implementation of conservation practices.

The objectives of the socioeconomic monitoring program are as follows:

- To document changes in farm management systems and agricultural land use related to soil conservation and other activities in the control and test watersheds.

- To determine operator perceptions of the extent to which soil degradation is occurring on project land and the effectiveness of applied conservation measures.

- To determine the extent to which soil and water degradation problems and their resolution have been 'owned' by the operator.

- To understand operator attitudes regarding a community-oriented approach to problem resolution, and to clarify the community's role in influencing conservation farming decisions.

- To identify reasons why farmers in the test basins have adopted or rejected certain practices, or alternatively, how they have adapted the practice to their management system to accommodate the practice.

- To assess cooperator attitudes and perceptions regarding project management and implementation such that procedural and other concerns can be dealt with as they arise.

- To collect requisite economic data for the SWEEP economic contractor.

All data collection efforts will occur in the test and/or control basins at specified times throughout the life cycle of the project, depending on the data required to meet the objective. In order to obtain baseline attitudinal, farm management, and personal information a socioeconomic self-administered survey was distributed as part of the first farm planning meeting in each of the 3 watersheds. Similar data collection instruments will be developed and administered for purposes of monitoring attitude and practice changes annually and at project completion.

There will be several other means by which data contributing to the socioeconomic analysis will be collected. The farm-based record keeping booklets (see Section 4.3) will monitor changes to specific cropping practices, and the "Plan of Action" in the Letter of Agreement (see Section 4.5) will provide information on changes to farm management and conservation practices over time. In addition, the field technicians will be in regular contact with the cooperators and can informally collect information regarding project-related concerns and their perceptions of the effectiveness of specific conservation practices. A description of the types of information required, the information sources, and the data collection methodology, timing and frequency is presented in Table 3.3.

TABLE 3.3

INFORMATION REQUIREMENTS	DATA SOURCE AND COLLECTION METHODOLOGY	TIMING AND FREQUENCY OF DATA COLLECTION.
The extent of the implementation of conservation measures (including the type of practice or structure and extent of use) over the lifespan of the program.	• interview of test and control basin cooperators • review of farm records and the conservation farm plans	• baseline, with annual update
Cooperators' perception of: • the effectiveness of the conservation measure in addressing the particular soil erosion problem. • the extent to which the form management system was modified to incorporate the conservation measure.	• interview of test basin cooperators	• annually, following implementation
Main reasons why a particular practice was tried or adopted.	• interview of test basin cooperators	• at project completion
The perception of soil erosion/degradation problems on-farm and in the drainage basin.	• interview of test and control basin cooperators	• baseline, and at project conclusion
Cooperator attitudes regarding the project schedule and activities.	• interview of test and control basin cooperators along with feedback from technician-cooperator contact	• baseline, with annual update to allow for response to problems
Impact of soil and water quality issues on farm management decisions.	• interview of test and control basin cooperators	• baseline, and at project conclusion
Cooperator perception of community-wide support for soil and water conservation efforts.	• interview of test and control basin cooperators	• baseline, and at project conclusion
Advantages and disadvantages of the group/community-oriented planning approach to addressing soil erosion problems: • identifying and overcoming negative community views (norms) regarding soil conservation. • obtaining operator interest.Why has the operator chosen to become involved? • processing problem identification and resolution. • maintaining cooperator participation.	• interview of test and control basin cooperators	• baseline,and at project conclusion

TABLE 3.3 - Cont'd

INFORMATION REQUIREMENTS	DATA SOURCE AND COLLECTION METHODOLOGY	TIMING AND FREQUENCY OF DATA COLLECTION
The extent that the Program has become a focal point in the basin with respect to: • soil conservation information and assistance • contact between operators in the basin	• interview of test basin cooperators	• baseline, and at project completion
Changes In knowledge the cooperators have about their on-farm physical resource base • drainage characteristics • slope characteristics • soil textures	• interview of test and control basin cooperators	• baseline and at projectcompletion
New farm management issues raised by the introduction of conservation practices • barriers to implementation/adoption • unanticipated impacts of the Program	• interview of test basin cooperators and technician contact	• following practice implementation on an annual basis (interview) • day-to-day cooperator interaction with technician
Cooperator's intention to carry on with, or implement new, conservation measures following project termination	• interview of test and control basin cooperators	• at project completion
Key personal information describing the cooperators in the program	• interview of test and control basin cooperators	• baseline only
Costs and benefits associated with conservation practices	• field operation record-keeping data sheets • interviews	• ongoing • annual

4.0 FARM OPERATOR COOPERATION

4.1 Overview

Obtaining and maintaining farm operator participation in soil and water conservation activities is essential to realizing PWP objectives and ultimately to improving water quality and agricultural productivity in the Lake Erie basin. In public meetings and in interviews held with farm operators to date, PWP staff have been cognizant of the complex of factors affecting conservation behaviour at the farm level. As noted in Section 2.4, physical (ecological), technological, economic, personal and community (norms and values) factors all contribute to moving an individual from the knowledge of a certain practice to its eventual adaptation or adoption. The level of cooperation that can be expected from the producer is therefore also influenced by such factors.

Having finalized the selection of the watersheds for the PWP, more intensive interaction with participating farm operators is scheduled to take place. This interaction will focus on developing conservation farm plans and ensuring that the cooperators fully understand the farm record keeping requirements, the benefits package, and the cooperator agreement. A clear understanding of these items on the part of project staff and farm cooperators is essential to maintaining a good rapport and building confidence in the PWP and its potential benefits.

4.2 Farm Planning Process

4.2.1 Introduction

In the United States, conservation farm plans have been termed the "building blocks of all Soil Conservation Service (SCS) programs and assistance" (Lewis, 1988). Conservation plans have been developed by SCS in consultation with farmers for more than 50 years. By 1961, 1.3 million farmers in the United States had a written conservation farm plan (U.S.D.A. 1961). It is clear that in the U.S., the development of farm plans are central to the establishment of practice and management systems to alleviate soil and water conservation problems.

By definition, a conservation plan is a "plan of action that land users follow in managing soil, water, and related plant and animal resources. It helps land users put these resources to the best use" (University of Illinois, 1987). Within the farm context, a conservation plan is essentially a document which specifies soil and water conserving activities or practices to be implemented on all parts of any given individual's farm. By formulating such a plan, the farm operator decides on the most effective and acceptable way to conserve soil and water, as well as maintain or enhance farm profitability.

Ultimately, it is the farm operator who makes the decisions about which conservation measure will be applied to the land in question. However, input from professional conservationists is required to identify interrelated soil and water conservation problems, formulate alternative solutions, and specify related costs and benefits. With this information in hand, the producer can then select the conservation options that mesh with his management system as well as provide the desired conservation effects.

4.2.2 Steps in the Farm Planning Process

Within the PWP, the farm planning process began with two group meetings in each of the three selected watersheds. The first meeting brought together farmers in both test and control basins. At this time, a project update was provided, and the field operations record form, the benefits package and cooperator agreement were discussed. Information about the cropping history of basin fields was requested, and the baseline socioeconomic survey was introduced.

The second meeting brought together farmers in the test basins only. The Universal Soil Loss Equation (USLE) was introduced, and an overview of tillage, cropping and structural means to minimize soil loss was provided.

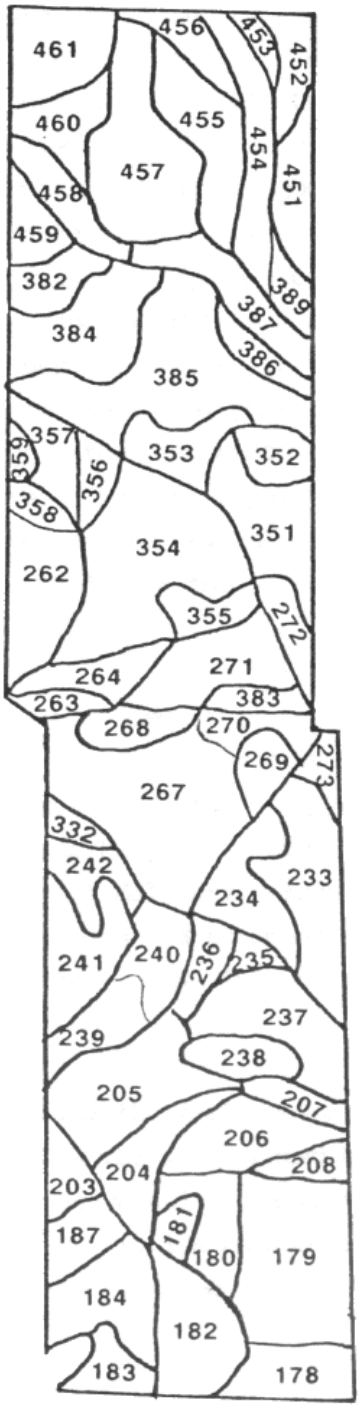
Through these group meetings, some elements of the group planning process found effective by SCS personal working in "hydrologic units" within Soil Conservation Districts, have been incorporated (Holtsclaw, 1988). Beginning the farm planning process in groups

provides some peer group support as individuals begin to consider the conservation options available to them.

Between the group meetings and the next step--the individual contact with each farm operator--background work was completed to provide the farm planners with information concerning the erodibility and soil delivery potential of the various farms, field and even areas within the fields found in the watershed. As with farm plan development in the United States, the major tool used in predicting the erosion potential of a farm was the Universal Soil Loss Equation. Unlike most American farm plans, however, the estimates were taken one step further by adapting GAMES (The Guelph model for evaluating effects of Agricultural Management systems on Erosion and Sedimentation--version 3.0) to the farm planning process. This model estimates, not only the gross erosion rates associated with areas within the watershed, but also to estimate what fraction of that eroded soil actually reaches the open watercourse. GAMES incorporates the USLE in its logic to estimate soil loss occurring from a "polygon" and then applies the sediment delivery ratio concept to each "polygon" to deliver a portion of that estimated gross erosion to the downstream cell until the soil eventually reaches the stream.

A polygon in GAMES can be defined as an area of any shape possessing the same soil type, field slope lengths and gradients, and the same crop or canopy cover. This polygon uniformity is required for the purpose of estimating gross erosion on the polygon by means of the USLE. Polygon maps were prepared for each test watershed and consequently each farm by overlaying soils, microdrainage and field boundary maps prepared for the study areas. The resulting polygon map for a single farm is shown in Figure 4.1. The number of distinct polygons associated with the entire watershed ranged from 80 to 543 depending on the inherent complexity of the soils and landform within the study basin being modelled.

Figure 4:1 POLYGON MAP FOR SAMPLE FARM 217



Modifications were made to GAMES to adapt it to the conservation planning process. First, additional identifiers were added to the GAMES data set in order to locate polygons within the various farms and fields. With these identifiers in place, the GAMES data set could be sorted by means of a computer program developed specifically to perform such a task on GAMES data sets. This added software allows the user to analyze soil loss on a specific farm or field for planning purposes. Table 4.1 lists the polygons associated with the sample farm presented in Figure 4.1. Because farm planning is normally completed at the field or farm level, the added software allows the user to summarize the polygon data to the point shown in Table 4.2. Note that in Table 4.2, both the field's average erosion rate as well as the field's critical polygon erosion rate is presented. This was done to assist the planner in determining whether the erosion problem is localized or is a general problem in the field. A large difference in magnitude between the actual polygon rate versus the average field erosion rate would trigger the planner to consider the possibility of managing the highly erosive polygon(s) separately by suggesting trees or permanent grass cover as opposed to severely limiting the cropping and tillage options on the entire field for the sake of one or two critical areas.

For planning purposes, the planner needs to set a target for soil loss for each field. For sustained agricultural productivity the target or upper soil loss limit is normally set at 6.7 tonnes/ha/yr. For water quality the target is normally 2.2 tonnes/ha/yr. By comparing existing soil loss and relative magnitude of sediment delivery, target soil loss levels were selected by the planners. If fields did not meet this target level, the target level was entered into the program in order to perform additional calculations.

Upon entering the target value for the field being analyzed, the critical "C" or cropping and management factor is computed by the software. The software can then prepare tillage-rotation charts such as the one shown in Table 4.3 for field 1 in order to provide management options for discussion at the individual farm planning level. The chart presented in Table 4.3 was developed for a target erosion rate of 6.7 tonnes/ha/yr,

TABLE 4.1 SUMMARY OF POLYGON EROSION AND DELIVERY RATES (SAMPLE FARM 217)

FARM ID	FIELD ID	CELL NO.	AREA -HA-	CELL D/R TO STM	CELL D/R TO ADJ CELL	SED RATE TO STM -TON/HA-	SED DEL TO STM TONNES-	SOIL LOSS --TON/HA-	POT.SO. LOSS --TONNES--
217	5	178	.7	.0299	.0094	.006	.004	.212	.15
217	5	179	2.0	.0092	.0036	.003	.005	.279	.55
217	5	180	.8	.0071	.0083	.002	.001	.220	.17
217	5	181	.2	.0061	.0127	.001	.000	.214	.04
217	5	182	1.1	.0122	.0048	.003	.004	.282	.30
217	2	183	.4	.0408	.0137	.061	.024	1.492	.60
217	2	184	1.1	.0331	.0103	.294	.328	8.903	9.91
217	2	185	.3	.0526	.1394	.784	.235	14.906	4.47
217	2	203	.4	.0444	.0214	.302	.125	6.793	2.81
217	2	204	.6	.0196	.1028	.358	.220	18.256	11.19
217	2	205	1.3	.0068	.0047	.069	.089	10.147	13.07
217	2	206	.8	.0067	.0046	.026	.021	3.833	3.07
217	2	207	.3	.0109	.0046	.043	.014	3.961	1.29
217	2	208	.3	.0169	.0128	.128	.034	7.605	2.00
217	2	233	1.2	.0093	.0085	.030	.037	3.204	3.92
217	2	234	1.0	.0068	.0066	.025	.024	3.674	3.54
217	2	235	.2	.0067	.0334	.015	.003	2.314	.46
217	2	236	.3	.0063	.0161	.017	.006	2.760	.93
217	2	237	1.0	.0071	.0072	.024	.023	3.369	3.20
217	2	238	.7	.0096	.0214	.063	.042	6.574	4.36
217	2	239	.4	.0028	.0443	.012	.005	4.450	1.67
217	2	240	.9	.0027	.0153	.020	.017	7.474	6.35
217	2	241	.9	.0028	.0054	.010	.008	3.408	2.90
217	2	242	.6	.0043	.0330	.013	.008	2.988	1.76
217	1	262	.5	.0019	.1272	.008	.004	4.363	2.18
217	1	263	.4	.0025	.0146	.014	.005	5.693	2.14
217	1	264	.5	.0025	.0529	.010	.005	3.944	1.87
217	2	267	2.4	.0022	.0057	.022	.051	9.892	23.25
217	2	268	.4	.0024	.0289	.020	.007	8.040	2.81
217	2	269	.3	.0021	.0189	.016	.005	7.491	2.43
217	2	270	.4	.0022	.0066	.008	.003	3.559	1.33
217	1	271	1.0	.0024	.0544	.033	.031	13.471	12.80
217	1	272	.3	.0024	.2486	.021	.005	8.727	2.18
217	2	273	.3	.0078	.0128	.065	.020	8.365	2.51
217	2	332	.1	.0043	.0917	.019	.002	4.482	.56
217	1	351	.8	.0074	.0372	.040	.033	5.348	4.41
217	1	352	.5	.0056	.0051	.030	.015	5.482	2.74
217	1	354	2.2	.0019	.0167	.013	.028	6.722	14.79
217	1	355	.3	.0024	.1061	.027	.009	11.131	3.62
21"	1	356	.3	.0019	.0784	.018	.004	9.404	2.35
217	1	357	.5	.0019	.0669	.008	.004	4.522	2.15
217	1	358	.3	.0019	.0323	.009	.002	4.688	1.29
217	1	359	.0	.0086	1.0000	.060	.004	6.943	.52
217	1	382	.5	.0023	.0285	.010	.004	4.249	1.91
217	1	383	.3	.0022	.1385	.007	.002	2.996	.82
217	1	384	1.2	.0022	.0346	.013	.015	5.747	6.61
217	1	385	2.3	.0023	.0263	.039	.091	16.584	38.56
217	1	386	.4	.0234	.5021	.216	.081	9.226	3.46
217	3	387	.7	.0024	.0009	.000	.000	.084	.06
217	3	389	.3	.0023	.0154	.000	.000	.123	.03
217	3	451	.6	.0016	.0127	.000	.000	.130	.07
217	3	452	.3	.0016	.0127	.000	.000	.123	.04
217	3	453	.2	.0016	.0194	.000	.000	.109	.02
217	3	454	.8	.0016	.0014	.000	.000	.196	.15
217	3	455	1.2	.0015	.0067	.000	.000	.136	.16
217	3	456	.3	.0078	.1743	.002	.000	.264	.07
217	4	457	1.7	.0014	.0036	.000	.000	.326	.55
217	1	458	.6	.0023	.0156	.016	.009	6.853	3.94
217	1	459	.4	.0022	.0132	.009	.004	3.927	1.67
217	1	460	.6	.0022	.0095	.009	.005	4.320	2.38
217	1	461	1.0	.0013	.0064	.006	.006	4.834	4.59

TABLE 4.2

Farm ID	Field ID	Polygon ID	Field Area (Ha)	Cell D/R to Stm	Poly Eros Rate (Ton/Ha)	Ave Field Eros Rate (Ton/Ha)	C Factor	Target Ave Field Eros rate (Ton/Ha)	Target C Factor	Ave Field DelRatetoStm (Ton/Ha)	% Soil Peach Stm
217	1	385	14.90	0.0023	16.58	7.85	0.380	0.00	0.323	0.0246	0.313
217	2	204	16.60	0.0196	18.26	6.65	0.310	0.00	0.311	0.0814	1.224
217	3	456	4.40	0.0077	0.26	0.14	0.005	0.00	0.000	0.0000	0.000
217	4	457	1.70	0.0014	0.33	0.32	0.010	0.00	0.000	0.0000	0.000
217	5	182	4.80	0.0122	0.28	0.25	0.010	0.00	0.000	0.0029	1.157

TABLE 4.3

Crop Rotations Based on Field C Factor

Tillage Practice	Residue Left on surface %	Continuous		SUITABLE ROTATIONS		
		WCCR	NCCR	2YR.	3YR.	4YR.
Fall Plow	Residue Left	Bn	Gf	GfGs	GfGs2	CsBnHs2
Spring Plow	Residue Left	Bn	Gs	CgGsI	Cg2Gsi	Cg3Gs
Reduced Tillage	10	----	Gs	CgGs	CgGs2	BnCgGsHs
	30	----	ANY	ANY	ANY	ANY
	50	----	ANY	ANY	ANY	ANY
No Till	30	----	ANY	ANY	ANY	ANY
	50	----	ANY	ANY	ANY	ANY
	70	----	ANY	ANY	ANY	ANY

NOTE:

(1) Crop Symbols :
- Cg - Corn Grain
- Cs - Corn Silage
- Bn - Beans
- Gf - Grain Fall Seeded
- Gs - Grain Spring Seeded
- H or Hs - Hay

(2) ANY stands for any rotation

(3) HAY stands for hay rotation

down from the present rate of 7.9 tonnes/ha/yr under a 1 year peas, 2 years sweet corn rotation. The "C" factors used to generate this chart are based on the most recent "C" factor information available for Ontario. The charts such as shown in Table 4.3 present solutions with respect to soil loss reduction only and do not attempt to address the economic or practical aspects of the management practices presented. These aspects are addressed in one-to-one meetings with the farmers.

With the group meetings and soil loss modelling complete, farm planning continues on a one-to-one basis with the farm operator. At this stage, a number of key steps must be included in the design of a farm plan if it is to be considered effective and acceptable to both the farm operator and the project. The steps which follow apply to the planning process as it is scheduled to take place with operators in the test basins;

1. Develop Conservation Objectives -

Development of the objectives includes the following considerations:

- a review of farm-specific soil and water conservation problems. This includes a review of the problem areas pinpointed by the soil loss modelling techniques, as well as what the landowners perceive as being areas of concern.
- a review of production goals and how conservation measures can contribute to them.

2. Evaluate Field Management Options -

Available options to meet the conservation objectives will be reviewed. Information to help guide this evaluation includes:

- farm operator's crop production requirements.
- farm resource inventory including soils, topography, drainage or other known resource constraints or opportunities.
- availability of equipment - on farm and through SWEEP.

<u>Evaluate Field Management Options</u> (cont'd -)

- farm operator's level of interest in altering practices and existing crop management systems.
- costs and benefits of practice changes.

3. Develop detailed field management plan -

Based on the evaluation of the management options in the previous step, decisions regarding conservation practices are made by the farmer. These decisions are noted on a field-by-field basis in the "Plan of Action" section of the Letter of Agreement. Any changes to these field plans should be made only after consultation with project staff.

4. Draw Up and Sign Agreements -

By signing the "Letter of Agreement", the farm operator and project staff indicate their readiness to implement the mutually agreed upon Plan of Action. (Further details of the Cooperator Agreement are found in Section 4.5).

For those in the control basins, the planning process on a one-to-one basis is restricted to essentially two steps. Field management plans for the existing operation must be documented. These plans will describe the crop management status quo and strive to discourage any significant shift towards conservation. The Letter of Agreement will then be drawn up and signed by the operator and project staff.

All farm plans in both the test and control basins will be reviewed annually with farm operators. This will provide regular opportunity for evaluating the effectiveness and acceptability of various conservation measures, and for making mutually agreed upon changes to the farm plans.

4.3 Farm-Based Record Keeping

4.3.1 The Need for and Importance of Farm Level Records

The Beak and Conservation Management Systems October, 1986 proposal for the Pilot (Demonstration) Watershed Sub-program stated that "data collected through the Pilot Watershed Demonstration Sub-program will be used directly by ...other... groups and associated agencies; compatibility of information format and quality is therefore a serious consideration". (Page 2.32).

The Deloitte, Haskins and Sells (DHS) Report, and economic evaluation of soil and water quality conservation technologies sets out the various details and responsibilities for PWP data collection that will allow DHS to "complete an economic evaluation of the alternative technologies" and, "evaluate the economic effectiveness of the sub-program (of SWEEP and the impacts at the field, farm (and) watershed...levels") (DHS, 1987 Page 2).

DHS recognized that it is best for only one person or group to maintain contact with the cooperators, and that hence the PWP contractor must endeavour to ensure that the necessary economic data is recorded and collected. To this end, DHS, Beak and CMS have agreed on the primary information to be collected by cooperating farmers. A modified version of the record keeping format suggested by DHS in their report has been adopted.

The records that farmers keep will be the basis upon which the economic success of the project will be measured, and so every effort is being made to make record keeping easy, interesting and effective. If farmers find the booklets easy to use and keep, there should be little problem getting data. Crucial to the long-term success of the project is the continuing participation of the cooperators and it is to this end that the field record booklets (pocket diaries) have been designed.

This record keeping format will also be useful for tracking implementation of the conservation practices specified in the farm plan, and will contribute to the database required for modelling phosphorus and sediment run off.

4.3.2 The Record Keeping Form

A preliminary design for a field diary was presented in the DHS Report previously cited. This structure was modified to accommodate and cater to the specific situation of PWP cooperators. A sample record keeping format is shown in Figure 4.1. Data to be collected includes the field operation performed, the equipment used, and the type and rate of inputs applied (seed, fertilizer, pesticide, etc.).

4.3.3 Data Collection Methodology

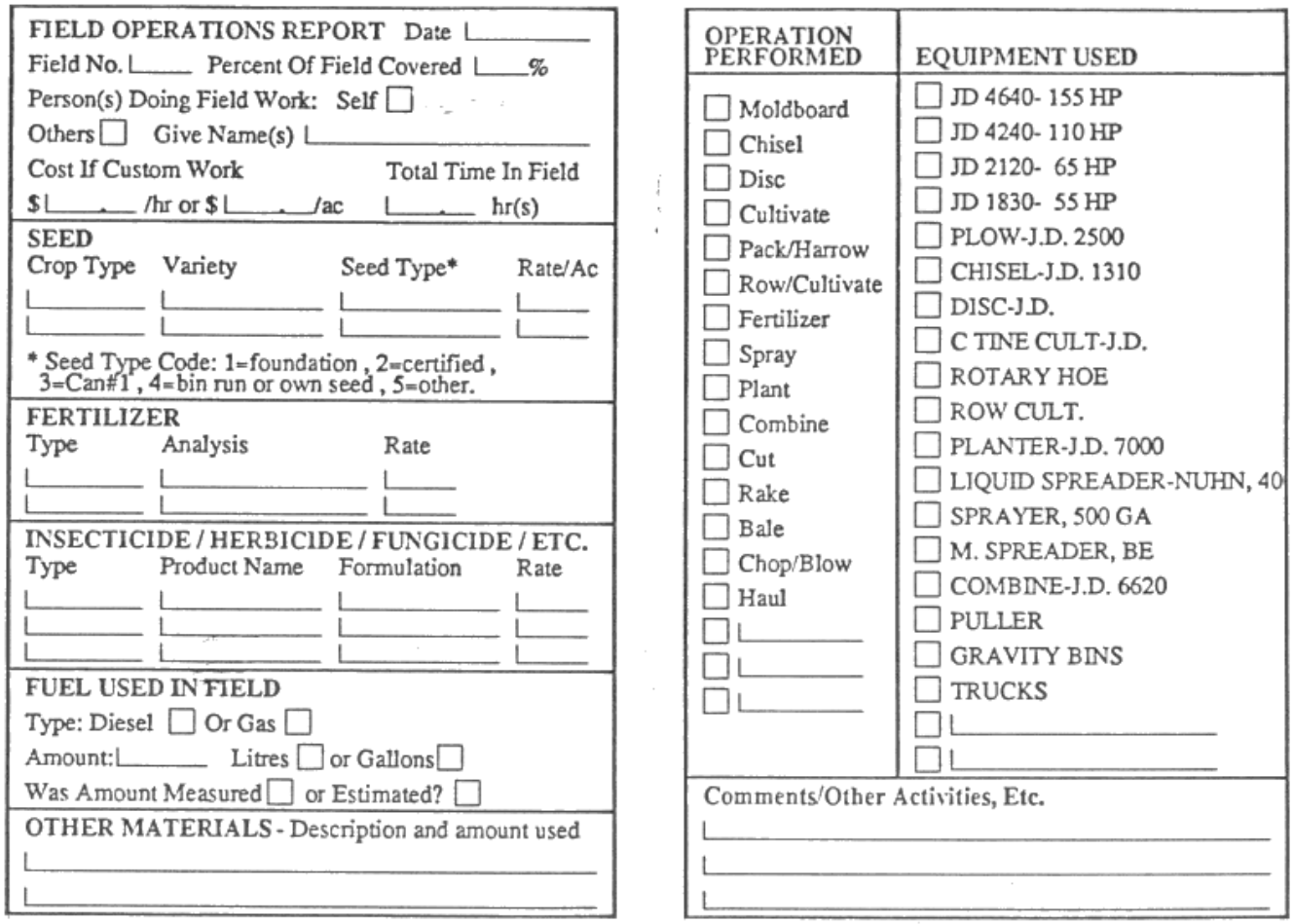
Farmers will be given customized pocket-sized field diaries in which to keep track of all their field operations in the study area. The booklets are designed to make logging of field operations a check-off procedure wherever possible. This will make it easy and quick for farmers to record their field specific information, and should contribute to a high proportion of accurately completed diaries. This in turn should contribute to more complete information on the practices and impacts of both the conservation and conventional farm systems.

The field diaries will be pre-tested by farmers in the PWP to ensure that they are "user friendly." The watershed technicians will collect the field diaries at least monthly, and will be assisting farmers to complete the records in a timely and accurate manner. This will be an important task especially during the initial months of record keeping by cooperators.

The information from the field diaries will be provided to the economic evaluation contractor for subsequent analysis.

FIGURE 4.2

Record Keeping Format



FIELD OPERATIONS REPORT Date ____

Field No. ____ Percent Of Field Covered ____%

Person(s) Doing Field Work: Self ☐

Others ☐ Give Name(s) ____

Cost If Custom Work: $____/hr or $____/ac

Total Time In Field: ____ hr(s)

SEED

Crop Type	Variety	Seed Type*	Rate/Ac

* Seed Type Code: 1=foundation , 2=certified , 3=Can#1 , 4=bin run or own seed , 5=other.

FERTILIZER

Type	Analysis	Rate

INSECTICIDE / HERBICIDE / FUNGICIDE / ETC.

Type	Product Name	Formulation	Rate

FUEL USED IN FIELD

Type: Diesel ☐ Or Gas ☐

Amount: ____ Litres ☐ or Gallons ☐

Was Amount Measured ☐ or Estimated? ☐

OTHER MATERIALS - Description and amount used

____

____

OPERATION PERFORMED	EQUIPMENT USED
☐ Moldboard	☐ JD 4640- 155 HP
☐ Chisel	☐ JD 4240- 110 HP
☐ Disc	☐ JD 2120- 65 HP
☐ Cultivate	☐ JD 1830- 55 HP
☐ Pack/Harrow	☐ PLOW-J.D. 2500
☐ Row/Cultivate	☐ CHISEL-J.D. 1310
☐ Fertilizer	☐ DISC-J.D.
☐ Spray	☐ C TINE CULT-J.D.
☐ Plant	☐ ROTARY HOE
☐ Combine	☐ ROW CULT.
☐ Cut	☐ PLANTER-J.D. 7000
☐ Rake	☐ LIQUID SPREADER-NUHN, 40
☐ Bale	☐ SPRAYER, 500 GA
☐ Chop/Blow	☐ M. SPREADER, BE
☐ Haul	☐ COMBINE-J.D. 6620
☐ ____	☐ PULLER
☐ ____	☐ GRAVITY BINS
☐ ____	☐ TRUCKS
	☐ ____
	☐ ____

Comments/Other Activities, Etc.

____

____

____

4.4 Benefits Package

It is recognized that working with many of the recommended conservation practices will be a new experience for some of the cooperators. The benefits package has been developed to provide monetary and other benefits to PWP cooperators in order to:

- lessen the risk or perceived risk associated with conservation practices.
- compensate for project-related learning or management time, as well as possible nuisance effects, out-of-pocket costs, and yield impacts.
- encourage cooperators to consider a variety of practices which are consistent with their conservation objectives and farm management systems.

The intent of the benefits package is to ensure that the available project resources are distributed as equitably as possible among participants without distorting the basic economic motivations that govern farm operations.

The benefit package consists of four components:

- financial assistance
- access to conservation equipment
- access to information, and
- access to experience

Each of these components is described and any conditions related to the delivery of the associated benefits are outlined in Appendix B. For example, for the field management record keeping grant of $400.00/field/year, total grants will not exceed $2,000.00/operator/year and minimum acreage per field has been set at 5 acres. These conditions will discourage attempts to take advantage of project resources, as well as enhance the equitable distribution of a limited pool of funds.

4.5 Cooperator Agreement

The Cooperator Agreement is a contractual agreement signed by both the cooperator and the project team which states that both parties agree to their responsibilities as outlined in the Agreement. It is really the culminating step in the farm planning process, indicating that a mutually acceptable conservation farm plan has been developed and is ready for implementation.

There are several components to the cooperator agreement, a copy of which appears in Figure 4.2. First of all, the appropriate spaces are provided for the signatures of the cooperators, the cooperator's spouse, the CMS project manager and a witness. Consent to fulfil the terms of the agreement by both parties is thereby provided.

Secondly, the general terms of the agreement are outlined in Section I. This section ensures understanding as to:

- the location of the affected farm properties
- the beginning date of the Agreement
- the conditions tied to Agreement review, amending and altering terms of liability

Any legal implications are thus addressed by this section.

Sharing locally-generated results of soil conservation practices among the PWP cooperators, and disseminating this information to the project-area communities will become important activities under the PWP. This will contribute toward the goal of increasing knowledge about conservation farming and its agronomic, environmental and socioeconomic benefits in southwestern Ontario.

FIGURE 4.3

Contract No. _____

LETTER OF AGREEMENT

BETWEEN:

Hereinafter referred to as CMS,

AND:

Hereinafter referred to as the Cooperator.

IN CONSIDERATIONof the Agreement hereinafter contained and the rights reserved n behalf of the parties concerned, the Cooperator and CMS agree to fulfill their various and several activities and responsibilities as indicated.

Executed in duplicate in the presence of a witness on the _____ day of _____, 198__ .

)
)_____
) Cooperator
)
)_____
) Spouse of Cooperator Witness)
)
) _____
) CMS, Manager

_____
Witness

Figure 4.3 (cont'd)

SECTION I. General Terms

1. Location of property: the specifics of this Agreement shall pertain to the parcel or tract of land and premises situate, lying and being in the Township of _____, in the County, District or Region of _____, consisting of _____ acres, more or less of crop land.
2. Term: the provisions of this Agreement shall be in effect for approximately three years commencing an the _____ day of 19___, and shall continue in effect from year to year thereafter (as an annual Agreement) unless written notice of termination is given by either party to the other at least 90 days prior to the termination date. Both parties shall be liable for the fulfillment and discharge of their various and several responsibilities and expenses incurred up to the date of termination of the Agreement.
3. Review of Agreenent: *a* verbal or written request is required for *a* general review of the Agreement or for consideration of proposed changes by either party, at least 30 days prior to the final date for giving notice to terminate the Agreement as specified in Section 1(2).
4. Amendments and Alterations: amendments and alterations to this Agri shall be in writing and shall be signed by both the Cooperator and CMS.
5. No Partnership Intended: it is particularly understood and agreed that this Agreerent shall not be deemed to be nor intended to give rise to a partnership relation.
6. Transfer of Property: on the day the Cooperator ceases to be the Landlord or Tenant of the property designated in this Agreement, the said Agreement shall also be considered null and void by both parties. Both parties shall be liable for the fulfillment and discharge of their various and several responsibilities and expenses incurred up to the date of termination of the Agreement.
7. Liability: Both parties shall hold each other, their heirs, executors, adminis[t]rators, successors, parent company, and staff free from any liability which might arise as a result of the activities proposed.

SECTION II: PLAN OF ACTION

(includes actual Plan agrees to by both parties and outlines activities, schedule, equipment, etc.)

SECTION III: RESPONSIBILITIES OF THE PARTIES

(includes the actual motion package agreed to plus services and all other Obligations for both parties)

To achieve Section II is called the "Plan of Action". This section describes on a field by field basis, the expected cropping practices, conservation structures to be emplaced, implementation schedule, equipment to be used and any other information contributing to the effective implementation of the conservation plan. This will need to be completed by farmers in both the test and control basins. The Plan of Action completed by the operators in the control basins will simply document the continuation of farming practices used at the time of the project start up.

Section III is the final section of the Agreement and is called "Responsibilities of the Parties." It details the financial assistance and other benefits associated with the conservation practices described in Section II, and outlines available services and all other obligations for both parties.

4.6 Information Program

Sharing locally-generated results of soil conservation practices among the PWP cooperators, and disseminating this information to the project-area communities will become important activities under the PWP. This will contribute toward the goal of increasing knowledge about conservation farming and its agronomic, environmental and socioeconomic benefits in southwestern Ontario.

To achieve this goal, the following objectives for the information program within the participating watersheds have been developed:

- to stimulate enthusiasm and motivation among cooperators for long-term commitment to soil and water conservation;
- to inform cooperators of project updates, and to solicit feedback from them regarding project problems and prospects;

- to inform local agricultural and community groups about the purpose and status of the PWP in order to stimulate a wider dissemination of conservation information and benefits;

- to provide a framework for the basin contractor to liaise with the communications contractor.

A key component of the information program will be the establishment of good rapport between the operators and the watershed technicians. This rapport will be developed primarily through frequent one-on-one contact the technicians will have with the cooperators throughout the course of the PWP. The appropriateness of possible involvement in the information program on the part of any of the cooperators will need to be determined through discussions with both the watershed technicians and the individual in question. This will ensure that the cooperator is comfortable with whatever information program involvement he agrees to.

Details of how the information program is to be managed in relation to the objectives, are contained in Table 4.1

TABLE 4.4 INFORMATION PROGRAM

	OBJECTIVE	METHODS TO ACHIEVE OBJECTIVES	FREQUENCY/TIMING	COMMENTS/TASKS
1.	Stimulate enthusiasm and motivation among cooperators; inform cooperators of program updates	A) newsletter	- 4 times annually	- contact watershed technicians for general interest stories - describe conservation practice implementation by watershed - describe status of PWP components. - announce upcoming conservation related activities.
		B) social gathering in each watershed	- annually	- provide opportunity for community spirit building and information exchange between test and control cooperators; between cooperators and project staff.
		C) social gathering for all three watersheds	- mid-project and at project conclusion	- provide opportunity for informal information exchange between cooperators in all 3 watersheds.
		D) research station/farm tours of conservation practices	- as opportunity arises (max. once/yr/watershed)	- if possible, hold tours where physiographic conditions and farming systems, are similar to participating watersheds.

TABLE 4.1 - cont'd INFORMATION PROGRAM COMPONENTS

	OBJECTIVE	METHODS TO ACHIEVE OBJECTIVES	FREQUENCY/TIMING	COMMENTS/TASKS
2.	Inform local groups about PWP purpose and status	A) circulate introductory letter to local groups	- PWP inception	- obtain listing of local groups with possible interest (watershed technicians)
		B) speak to local groups	- as requested	
		C) arrange for tours of watershed farms	- as requested, but preferably after the first full cropping season	- tours conducted only after full consent of cooperators - combine groups for tours wherever possible.
3.	Liaise with the communications contractor	A) provide copies of cooperator newsletter (objective 1) to communications	- as available	- ensure cooperator newsletter and SWEEP newsletter are complementary
		B) update communications contractor on key events happening in watersheds.	- as events are planned	

5.0 ADMINISTRATION

The purpose of this section of the report is to document those administrative features that pertain to the coordination of tasks in the agronomic and soils component of the PWP.

Key features of the administrative structure are:

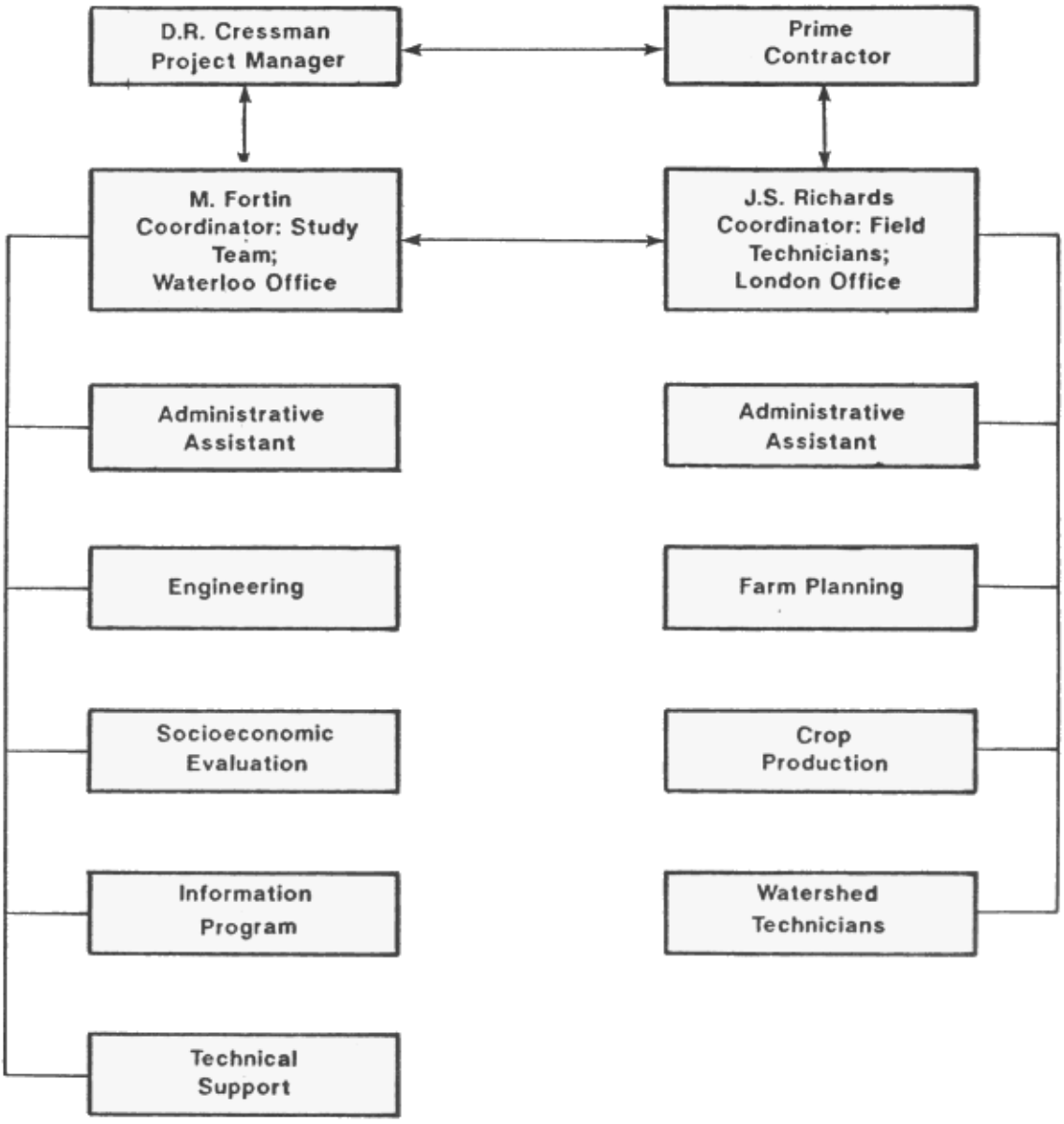
- clearly defined roles and reporting structure in the project team.
- regularly scheduled coordination meetings.
- filing and communication systems adapted to accommodate the involvement of five offices in the project (Waterloo, London, 3 field offices).

The CMS project team structure is illustrated in Figure 5.1. Linkages represent reporting and administrative responsibilities while technical tasks and communications involve additional linkages across the team that vary according to the nature of the tasks.

Project planning and task coordination are initiated within biweekly coordination meetings involving D.R. Cressman, M. Fortin, J.S. Richards and the Waterloo Administrative Assistant. Coordination of watershed activities out of the 3 field offices is achieved primarily by weekly meetings between J.S. Richards, the London Administrative Assistant and the 3 watershed technicians.

Figure 5.1

CMS PROJECT STUDY TEAM FOR THE PILOT WATERSHED PROJECT



A master filing system for technical materials with file headings and subheadings corresponding to project activities, is maintained in Waterloo. Parallel filing systems have been created for the London and field offices. Supplementary files are used to hold cooperator documents, to organize project maps, to manage computerized information, to preserve originals of technical documents, and to hold financial documents.

External communications from Waterloo are copied to London and vice versa. Other file materials are kept in Waterloo and copied to other offices only as needed.

Communication within the study team is maintained by virtue of the regular coordination meetings as well as through circulation of meeting minutes, phone notes and newsletters. All important telephone conversations are recorded and circulated to key study team members. An internal study team newsletter and a newsletter for cooperators are used to keep persons involved with various aspects of the study abreast of developments.

Information flow between the 5 offices is to be effected by mail and transmission using a computer mail and conference service provided out of the University of Guelph.

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APPENDIX A

CROP SCOUTING PROGRAM

A. ECONOMICALLY IMPORTANT INSECT AND DISEASE PESTS

CROP	PESTS
Corn	
i) Diseases	• seedling diseases (e.g. Pythium spp, Fusarium spp) • Anthracnose • Eyespot • Northern leaf blight and leaf spot • Bacterial leaf blight (Stewart's Wilt) • Head smut • Giberella stalk rot • Giberella ear rot
ii) Insects	• White grub • Seed corn maggot • Wireworm • Cutworm • Slugs • Corn rootworm • European corn borer • Armyworm • Corn leaf aphid
Soybean	• Phytophthora root rot • Rhizoctonia root rot • Powdery mildew • Downy mildew • Pod and Stem blight
i) Diseases	
ii) Insects	• Mites • Green cloverworm
Alfalfa	• Verticillium wilt • Leaf spot, common • Anthracnose • Phytophthora root rot • Fusarium root rot and crown rot
i) Diseases	
ii) Insects	• Alfalfa weevil

- Alfalfa blotch leaf miner
- Potato leaf hopper
- Armyworm

Cereals

Winter Wheat

i) Diseases

- Wheat spindle streak mosaic
- Snow mold
- Septoria leaf spot
- Septoria glume blotch
- Fusarium head blight
- Fusarium seedling blight
- Powdery mildew
- Eyespot
- Tan spot
- Sharp eyespot
- Take-all
- Leaf rust
- Stem rust
- Pythium root rot

ii) Insects

- Wireworms
- Armyworms
- Cereal leaf beetle

Barley

i) Diseases

- Seedling blight
- Loose smut
- Scald
- Net blotch
- Spot blotch
- Take-all

ii) Insects

- Wireworms
- Armyworm
- Cereal leaf beetle

Oats

i) Diseases

- Septoria leaf blotch
- Oat leaf rust
- Oat cyst nematode

ii) Insects

- Wireworms
- Armyworm
- Cereal leaf beetle

CROP SCOUTING - DISEASE PESTS

To date, the effects of many diseases are controlled by choosing resistant varieties and practising an appropriate crop rotation. As a result, general control of diseases is achieved by identifying infestations in the current crop and making appropriate management decisions to avoid infestation in future crops.

REFERENCE MATERIAL FOR CROP SCOUTING - INSECT PESTS

Corn

1. Western corn rootworm

References: OMAF Factsheet "Corn Rootworms" Agdex 111/622 .
OMAF Publication #296
Insecticide label

Comments: -these recommendations should be adhered to for cooperator agreements
-insecticide application at planting (banded)

2. European corn borer

References:. OMAF Factsheet "European corn borer" Agdex 111/622 .
OMAF Publication #296
insecticide label

Comments: -follow recommendations
-application for: 1 generation @ pre tasselling (x1,2); 2 generations @ August (x 2)

3. Cutworm

References: OMAF Publication #296
insecticide label

Comments: -follow recommendations
-application at 2 - 5 leaf stage of corn

4. Armyworm

Comments: -Spray weeds, grasses at borders when adjacent grain maturing.

5. Potato Stem Borer

Comments: -reduce quackgrass to prevent migration late May, early June

6. Corn Leaf Aphid

Reference:. OMAF Factsheet "Corn Leaf Aphid" Agdex 111/622 .

Comment: - > 400/plant are probably economically important

7. White Grub

Comment: -problem in corn following run-down field, pasture

8. Slugs

Reference: OMAF Factsheet "Slugs" Adgex 610

Comments: -molluscicide too expensive for application in May and June -problem on wet fields, soil surface crop residue e.g. minimum tillage

<u>Soybeans</u>

1. Mites

Reference: OMAF Publication #296 Table 68

Comment: -- > 4/leaf or one severely damaged leaf/plant warrant chemical control if rain not expected

2. Cloverworm

Reference: OMAF Publication #296 Table 67

Comments: - > 5 caterpillars/30cm of row

Alfalfa

1. Alfalfa Weevil

Reference: OMAF Factsheet "Alfalfa Weevil" Agdex 121/622
OMAF Factsheet "Early Warning System for Alfalfa Weevil Management" Agdex 121/622
OMAF Publication #296

Comments: -application when 25% stems have tip feeding and cannot take first cut
-if feeding serious on first cut, regrowth retarded, then apply.

2. Alfalfa Notch Leafminer

Continent: -fly emerges in later May with "pinhole" punctures

3. Potato Leafhopper

Comment -more prevalent late June to mid August with discoloured V-shape on leaflet tips

E. CROP SCOUTING - WEED PESTS

Weed mapping will assist in determining the proper control measures for the current and future crops. A change in practice may bring a change in weed spectrum and perhaps in methods of control.

Starting 10 to 14 days after crop/weed emergence, weeds are mapped on graph paper representing each field. Field boundaries are outlined with points of reference such as trees, fences and buildings. Compass direction (north) is included. Problem areas are identified on the map using weed names and intensity ratings. Intensity of each weed species in the field is classified under the categories: none, few, common, abundant, extreme (reference IPM manual Michigan State University 1988). The most common weeds in each field are ranked in order of severity. This will help the producer and field staff to develop a control program for the weeds of greatest relative importance.

The weed spectrum is also available to cooperators when considering the need for, and type of supplemental control measure (e.g. rotary - hoeing, row cultivation and/or postemergence herbicides).

(It is anticipated that alternatives to mechanical control would be encouraged in the test subwatershed therefore increasing the need for cooperator knowledge of chemical control.)

Weed Sampling Technique:

- accurate and efficient sampling will determine pest levels representing the whole field.
  - do not sample atypical areas such as field borders, fence rows, ditch banks.
  - enter field at convenient location at least 30 rows or 30 metres before taking first sample.
  - unusual topography, low or high areas, should be included.
  - most accurate information can be provided on field sizes up to 40 acres therefore larger fields should be broken into smaller units.
  - randomly select the first plant of a sampling area, perhaps by tossing an object or look upward and taking five steps to closest plant. -monitor twenty feet of a row, twelve inches to each side of the row in twenty locations in field.
  - this represents one sample for every two acres.

- a second weed mapping in late July early August should be done when weeds are easily identifiable.

B. CROP SCOUTING CALENDAR

CROP	CRITICAL PEST IDENTIFICATION PERIOD						
	April	**May**	**June**	**July**	**August**	**September**	**October**
CORN		PLANT	TASSEL/SILK/POLLINATE				HARVEST
i) **Diseases**							
		. fungi seedling diseases		. Anthracnose		. stalk rot	
				. Eyespot			. Ear rot
					.Northern leaf .Bacterial leaf blight		
				. Head smut			
ii) **Insects**							
		. White grub	.Rootworm larvae		.Rootworm adult		
		. Seed corn maggot					
		. Wireworm	.European corn borer larvae				
			(1st generation, »> 2nd generation)				
		. Cutworm					
		. Slugs					
			. Armyworm				
			.Corn leaf aphid				
iii) **Weeds**		. Weed mapping					

B. CROP SCOUTING CALENDAR - Cont'd

CROP	**CRITICAL PEST IDENTIFICATION PERIOD**						
	April	**May**	**June**	**July**	**August**	**September**	**October**
SOYBEAN		**PLANT**			**FLOWER/POD FILL**		**HARVEST**
i) **Diseases**		.Phytophthora root rot .Rhizoctonia root rot			.Phytophthora root rot .Powdery Mildew .Downy Mildew		.Pod and stem blight
ii) **Insects**			**.** Mites		.Green cloverworm		
iii) Weeds		.Weed mapping				.Weed Mapping	

B. CROP SCOUTING CALENDAR - Cont'd

CROP	CRITICAL PEST IDENTIFICATION PERIOD						
	April	**May**	**June**	**July**	**August**	**September**	**October**
ALFALFA			**1st cut**	**2nd cut**			**3rd or 4th cut**
i) Diseases			.Verticillium Wilt				
				. Fusarium root rot			
		.Leaf spot .Anthracnose »»»»»»»»»»»»					
			.Phytophthora root rot				
			.Crown rot				
ii) Insects			.Alfalfa Weevil	.Potato leafhopper			
			. Alfalfa Blotch Leafminer				
				.Armyworm			
iii) Weeds	.Weed Mapping						.Weed Mapping

B. CROP SCOUTING CALENDAR - Cont'd

CROP **CRITICAL PEST IDENTIFICATION PERIOD**

	April	May	June	July	August	September	October
WINTER WHEAT			**HEADING**		**HARVEST**		**PLANT**
i) Diseases							
		.Wheat spindle . Streak Mosaic	.Tan spot	. Stem rust			. Powdery Mildew
	. Snow mold	. Powdery Mildew	. Septoria Leaf spot/ glume/blotch				. Leaf rust
	Septoria Leaf spot	. Leaf rust	. Sharp eyespot				. Fusarium seedling blight
			. Take-all				. Pythium root rot
			. Fusarium head blight				
ii) Insects		. Wireworms	. Cereal leaf beetle	. Armyworms			
iii) Weeds							. Weed mapping

B. CROP SCOUTING CALENDAR - Cont'd

CROP **CRITICAL PEST IDENTIFICATION PERIOD**

	April	May	June	July	August	September	October
BARLEY	**PLANT**		**HEADING**	**HARVEST**			
i) Diseases							
		. Take-all	. loose smut				
		. Scald					
		. Net blotch	. Spot blotch				
	. Seedling blight						
ii) Insects.		Wireworms	. Armyworm				
			. Cereal Leaf beetle				
iii) Weeds	. Weed Mapping						

APPENDIX B

BENEFITS PACKAGE

THE BENEFITS PACKAGE

The purpose of the benefits package is to provide monetary and other benefits to those farm operators participating in the Pilot Watershed Project.

The benefits package consists of four components:

1. FINANCIAL ASSISTANCE

Monetary grants will be provided to participating operators to carry out mutually agreed-upon activities and practic es on lands within the project watersheds.

These grants will be available for:

a) field management records maintained for those lands within the test and/or control watersheds

b) conservation tillage and cropping practices carried out on lands within the test watersheds

c) conservation structures and special practices implemented on lands within the test watersheds

d) complete farm financial records provided by operators for enterprises with a majority of their land within the test or control watersheds.

2. ACCESS TO CONSERVATION EQUIPMENT

Operators in each pair of watersheds will have access to:

a) one conservation row crop planter

b) one conservation seed drill

c) two disc/coulter - chisel ploughs

d) funds for modifying moldboard ploughs as needed

3. ACCESS TO INFORMATION

Operators in both the test and control watersheds will have direct access to the following sources of information:

a) daily weather records including rainfall, wind speed, accumulated corn heat units, etc.
b) crop scouting service
c) a detailed soil survey of land within the watersheds including soil texture, organic matter, topography, drainage, erosion phases, etc.
d) a conservation plan for their land within the watersheds
e) provision for educational group activities
f) reports and newsletters
g) a one year subscription to "Successful Farming"

4. ACCESS TO EXPERIENCE

Operators in each pair of watersheds will have one sweep field staff member living and working in their area. In addition a strong team of individuals knowledgeable in a wide range of arec related to conservation farming systems is on call throu[g]h the field person at all times.

FINANCIAL ASSISTANCE

A) FIELD MANAGEMENT RECORDS

For all operators in the test or control watersheds:

- A grant of $400/field/yr. for the maintenance and completion of field management records.
- Initial payment of $100/field by April 15 of each year, starting in 1989. Final payment of $300/field when all records for that year are completed and received.
- Total field record keeping grants are not to exceed $2,000.00 per operator per year.
- Minimum acreage per field is 5 acres.

In the year of establishment improved pasture may receive the full $400/field grant for the maintenance and completion of field management records. In subsequent years a grant of $ 100/field will apply.

Conditions:

A field consists of a clearly delineated block of land planted to one crop (with or without an underseeded forage clop) and subject to separate and distinct management practice.

Unimproved pasture, trees, and rough land shall be excluded.

In the control watershed the field grant may be forfeited on those fields where a conservation tillage or cropping practice is used and was not practiced by the operator on any of his/her land before the 1987 crop year.

In the test or control watershed the above conditions may be waived where mutually agreed-upon check strips (less than 5 acres) are established within a field.

B) CONSERVATION TILLAGE AND CROPPING PRACTICES

- Total per acre grant combination not to exceed $15.00/acre in any field.
- No per acre grant will be paid for land with practices being funded by the Land Stewardship Program.

The following per acre grants will apply to each practice undertaken as part of the conservation farm plan:

Conservation tillage	Grant per Acre
1. adjusted moldboard plough – plough adjusted to 6" depth – no trash boards – furrows laid on side – furrow width 16" or less – fall plough, spring cultivate 2x	$ 5.00
2. Minimum tillage including	
a) modified moldboard plough – plough fitted with "cut-off" moldboards – adjusted as in (1) except furrow width is optional	10.00
b) disc/coulter - chisel plough – plough fitted with twisted shovels or sweeps – plough adjusted to 6" depth – fall plough, spring 2x disc/cultivate	10.00
c) no fall tillage – spring tillage with adjusted moldboard plough; chisel plough with sweeps; tandem disc or cultivator	10.00
d) disc or cultivate – 1 pass only in fall prior to seeding of winter cereal	5.00
3. No till – planting of crop with no previous tillage – includes use of a conservation row crop planter, conservation seed drill or ground or aerial broadcast	15.00

Conservation cropping

1. live crop cover over winter	
a) winter cereal/red clover/hay – grown for crop the following year	5.00
b) red clover/hay/winter cereal – tilled in spring	10.00
2. a cereal underseeded to red clover – stubble tilled in fall with moldboard plough or chisel with twisted shovels	5.00